MATERIALS AND EQUIPMENT STANDARD

FOR

SYNCHRONOUS

GENERATORS

FIRST EDITION

MARCH 2013

FOREWORD

The Iranian Petroleum Standards (IPS) reflect the views of the Iranian Ministry of Petroleum and are intended for use in the oil and gas production facilities, oil refineries, chemical and petrochemical plants, gas handling and processing installations and other such facilities.

IPS are based on internationally acceptable standards and include selections from the items stipulated in the referenced standards. They are also supplemented by additional requirements and/or modifications based on the experience acquired by the Iranian Petroleum Industry and the local market availability. The options which are not specified in the text of the standards are itemized in data sheet/s, so that, the user can select his appropriate preferences therein.

The IPS standards are therefore expected to be sufficiently flexible so that the users can adapt these standards to their requirements. However, they may not cover every requirement of each project. For such cases, an addendum to IPS Standard shall be prepared by the user which elaborates the particular requirements of the user. This addendum together with the relevant IPS shall form the job specification for the specific project or work.

The IPS is reviewed and up-dated approximately every five years. Each standards are subject to amendment or withdrawal, if required, thus the latest edition of IPS shall be applicable

The users of IPS are therefore requested to send their views and comments, including any addendum prepared for particular cases to the following address. These comments and recommendations will be reviewed by the relevant technical committee and in case of approval will be incorporated in the next revision of the standard.

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GENERAL DEFINITIONS

Throughout this Standard the following definitions shall apply.

COMPANY :

Refers to one of the related and/or affiliated companies of the Iranian Ministry of Petroleum such as National Iranian Oil Company, National Iranian Gas Company, National Petrochemical Company and National Iranian Oil Refinery And Distribution Company.

PURCHASER :

Means the “Company" where this standard is a part of direct purchaser order by the “Company”, and the “Contractor” where this Standard is a part of contract document.

VENDOR AND SUPPLIER:

Refers to firm or person who will supply and/or fabricate the equipment or material.

CONTRACTOR:

Refers to the persons, firm or company whose tender has been accepted by the company.

EXECUTOR :

Executor is the party which carries out all or part of construction and/or commissioning for the project.

INSPECTOR :

The Inspector referred to in this Standard is a person/persons or a body appointed in writing by the company for the inspection of fabrication and installation work.

SHALL:

Is used where a provision is mandatory.

SHOULD:

Is used where a provision is advisory only.

WILL:

Is normally used in connection with the action by the “Company” rather than by a contractor, supplier or vendor.

MAY:

Is used where a provision is completely discretionary.

CONTENTS: PAGE No.

0. INTRODUCTION

This Standard gives the minimum technical requirements for alternating current 3 phase 4 wire LV, and/or 3 phase MV air cooled generating unit(s) of rotating type up to 25 MVA. It deals with synchronous a.c. generators of rotary excited.

Design and construction shall be in accordance with the recommendations contained in IEC publication 60034 and 60085 as supplemented and adopted by this standard.

Generating unit(s) shall also comply with applicable national regulations but if these regulations are less stringent than this generator standard the latter shall prevail.

Information as required for each individual case shall be given in data sheet.

1. SCOPE

This standard covers the minimum requirements for design, manufacture, quality control, testing and finishing of industrial type, revolving field cylindrical pole, construction, self exciting brushless, self regulating LV and MV 3 phase (4 wire in case of LV) 50 Hz 4 pole 1500 r. p. m at 0.8 lagging power factor generators.

For speed lower than 1500 r. p. m salient pole may be considered with purchaser approval.

Note:

This is a revised version of this standard, which is issued as revision (1)-2013. Revision (0)-1994 of the said standard specification is withdrawn.

2. REFERENCES

Throughout this Standard the following dated and undated standards/codes are referred to. These referenced documents shall, to the extent specified herein, form a part of this standard. For dated references, the edition cited applies. The applicability of changes in dated references that occur after the cited date shall be mutually agreed upon by the Company and the Vendor. For undated references, the latest edition of the referenced documents (including any supplements and amendments) applies.

IEC (INTERNATIONAL ELECTROTECHNICAL COMMISSION)

60034.1	"Rotating Electrical Machines: Part 1: Rating and Performance"
60034.2-1	"Rotating Electrical Machines: Part 2-1: Standard Methods of Determining Losses and Efficiency from Tests" (Excluding Machines for Traction Vehicles)
60034.3	"Rotating Electrical Machines: Part 3: Specific Requirement for Synchronous Generators Driven by Steam Turbines or Combustion Gas Turbines"
60034.4	"Rotating Electrical Machines: Part 4: Methods for Determining Synchronous Machine Qualities from Tests"
60034.5	"Rotating Electrical Machines: Part 5: Degrees of Protection Provided by the Integral Design of Rotating Electrical Machines (IP Code) Classification"
60034.6	"Rotating Electrical Machines: Part 6: Method of Cooling (IC Code) Rotating Machinery"
60034.7	"Rotating Electrical Machines: Symbols for Type of Construction and Mounting Arrangements of Rotating Electrical Ma- Part 7 chinery"
60034.8	"Rotating Electrical Machines: Part 8: Terminal Markings and Direction of Rotation of Rotating Machines"
60034.9	"Rotating Electrical Machines: Part 9: Noise Limits"
60034.11	"Rotating Electrical Machines: Built in Thermal Protection Chapter 1: Rules for Protection of Rotating Electrical Ma- Part 11 chines"
60034.12	"Rotating Electrical Machines: Starting Performance of Single Speed Three Phase Induction Motors for Voltages Up to Part 12 and Including 660 Volt"
60034.14	"Rotating Electrical Machines: Part 14: Mechanical Vibration of Certain Machines with Shaft Height 56 mm and Higher"
60051	"Rotating Electrical Machines: Direct Acting Indicating Analogue Electrical Measuring Instrument and Their Accessories"

60072 "Rotating Electrical Machines: Dimensions and Output Ratings for Rotating Electrical Machines"

60085 "Rotating Electrical Machines: Thermal Evaluation and Designation"

BSI (BRITISH STANDARDS INSTITUTION)

BS EN 55014-1: 2006 + A2: 2011 "Electromagnetic Compatibility Requirements for Household Appliances, Electric Tools and Similar Apparatus, Emission"

BS 6121 "Mechanical Cable Glands"

API (AMERICAN PETROLEUM INSTITUTE)

API 616 "Gas Turbines for the Petroleum, Chemical, and Gas Industry Services"

IPS (IRANIAN PETROLEUM STANDARDS)

IPS-M-PM-240 "General Purpose Steam Turbine"

IPS-G-PM-250 "Special Purpose Steam Turbine"

IPS-G-PM-260 "Combustion Gas Turbine"

IPS-G-IN-290 "Engineering and Construction Standard for Programmable Logic Controllers (PLC)"

IPS-M-IN-290 "Material and Equipment Standard for Programmable Logic Controllers (PLC)"

IPS-M-PM-290 "Reciprocating Internal Combustion Engines"

IPS-M-EL-143 "Material and Equipment Standard for Low Voltage Switchgear and Controlgear"

IPS-M-EL-144 "Material and Equipment Standard for Medium and High Voltage Switchgear and Controlgear"

Notes:

1) Where standards other than IEC are specified it is understood that equivalent IEC standard is accepted.

2) The testing and certification by the following authorities are acceptable where relevant:

a) European organization for testing and certification under "CENELEC" administration (EOTC).

b) Electrical equipment certification services (EECS).

3. UNITS

This Standard is based on International System of Units (SI), as per IPS-E-GN-100 except where otherwise specified.

4. ENVIRONMENTAL CONDITIONS

See Attachment No. 1.

5. DESIGN AND CONSTRUCTION

5.1 Enclosure

Generators shall have ingress protection specified in data sheets.

In all cases terminal boxes for outdoor installations shall have enclosure type IP 55 at least.

In offshore and coastal installation, generator terminal boxes shall have an ingress protection of IP 56 at least.

The ingress protection shall comply with the requirements of IEC 60034.5 part 5.

5.2 Stator Winding and Cable Terminations

5.2.1 Stator winding shall be made from copper conductor.

5.2.2 Terminations shall comply with the requirements of IEC 60034 from following points of views:

- Minimum creepage and clearance distances.
- Rated voltage, rated current and rated frequency.
- Short circuit capacity of system.

5.2.3 Terminal marking shall be U-V-W and provided in a clear and permanent manner. The direction of rotation shall be in accordance with IEC 60034.

5.2.4 Terminal arrangements shall have adequate space to accommodate easily the size and type of cable specified.

Means shall be provided to prevent accidental reduction of the clearance at terminal due to loose strand or movement of uninsulated cable lugs.

5.2.5 Heaters or any other additional connections shall be clearly identified. Circuits shall be separated and terminals fully shrouded.

5.2.6 The earthing terminals shall be external to the terminal box unless specified otherwise.

5.2.7 For location of terminal box see data sheet for individual case.

5.2.8 Mechanical metallic gland to BS 6121 shall be provided for the type and size of cable described in data sheet.

5.3 Temperature Measurement of Winding

5.3.1 Generator(s) shall have resistance type temperature detectors in their stator windings as follows:

a) A minimum of six detectors shall be provided and spaced equally around the circumference of the stator, for winding and two for bearings.

b) Detectors shall be located between coil sides in the stator slots with their centers at the longitudinal midpoints of the stator.

c) All detector leads shall be metallic armored.

5.3.2 A separate terminal box shall be provided on the outside of the generator enclosure for termination of the temperature detector leads. A common box is acceptable in lieu of separate boxes, if it only contains signal and control leads, and the detector leads and other low level signal leads are separated by a barrier from control and high level signal leads.

5.3.3 When specified in data sheet vendor shall furnish an indicating temperature controller and all necessary auxiliary devices to indicate and monitor stator winding temperatures as measured by

the resistance temperature detectors.

5.4 Rotor

5.4.1 The rotor and fan(s) shall be dynamically balanced.

Balanced weight if fitted shall not be of lead or similar ductile material and the rotor design shall allow for the addition of balancing weight.

5.4.2 The direction of the air flow shall be such that the discharged air does not pass over the driver. (The ventilation system shall include air intake filter).

5.4.3 The direction of rotation shall be clearly and permanently indicated by means of an arrow on the external surface of the frame at the non drive end. Painted or adhesive tape method of indication is not acceptable.

5.4.4 The shaft shall be precision machined from high quality steel and shall carry the alternator rotating field system, the D.C. exciter rotor, the rotory three phase full wave rectifier assembly and the cooling fan.

5.4.5 The complete rotor assembly shall be securely braced and statically and dynamically balanced on completion.

5.4.6 The rotor shall include on integral brushless self regulating solid state excitation system independent of external power supplies.

5.4.7 Winding conductor of rotor shall be copper with Mica paper, glass cloth and epoxy resin insulation, impregnation and curing shall be either by the resin rich method or by the vacuum pressure impregnation method.

The insulation shall be baked and treated to provide a hard setting, oil and moisture resistant anti tracking finish suitable for a dusty saline and tropical environment.

5.5 Exciter

5.5.1 Power for field excitation of the brushless exciter shall be supplied from the shaft driven pilot exciter. The rotating rectifier system shall be:

a) Capable of providing full excitation power with only 80% of the diodes per phase in operation or with one arm of the three phase bridge inoperative.

b) Protected against diode failure by series connected fuses.

c) Provided with visual indication for operation of any diode fuse.

5.6 Automatic Voltage Regulation

The machines, including excitation systems, shall be designed for a rated power factor of 0.8 lagging (overexcited) at rated output, expressed in kilo-volt-amperes, and with the generator voltage between 90% and 110% of the rated value. Each excitation system shall be rated for at least 110% of the excitation current required during full load operation at rated voltage and rated power factor.

5.6.1 The automatic voltage regulator shall be provided and shall have provision for manual operation.

5.6.2 The steady-state voltage variations shall be limited, when machine operating individually, to ± 0.5% of the rated voltage.

5.6.3 The voltage regulator shall have adjustable droop characteristic.

5.6.4 The generator supplier shall provide for each generator the complete voltage regulation system including:

a) Motor operated exciter, field rheostat and all accessories such as resistor, contactors, meters including null balance volt meters and control switches.

b) C.T. and PT.

5.7 Insulation

5.7.1 Stator and field winding shall have class F insulation with a design temperature rise at normal power limited to class B temperature (Ref. IEC 60085).

5.8 Bearings and Lubrication

5.8.1 All bearings shall be sleeve type and shall be lubricated from common lubricating system provided for the drive (unless otherwise specified).

The supplier of the drive shall furnish the generator lube oil supply, drain headers and laterals, and instrumentation associated with this piping.

The lube oil piping furnished by the generator supplier shall be coordinated with that of the drive.

5.8.2 All bearings and bearing housings shall be in accordance with the following:

5.8.2.1 Renewable liners or shells shall be babbitt lined and steel backed.

5.8.2.2 Bearing housing shall have provision for mounting two shaft vibration probes at each radial bearing with the probes mounted 90 ±10° circumferentially apart.

5.8.2.3 All bearings shall provide shaft access for manual vibration measurement through or adjacent to the housings.

5.8.2.4 All bearing housings shall be furnished with standard breather.

5.8.2.5 Insulating fitting shall be provided in the lube oil supply connections to prevent the oil supply lines bypassing the bearing insulation.

5.8.3 A non restrictive flow indicator shall be furnished in the oil return from each bearing.

5.8.4 Generator and exciter bearings shall be insulated to prevent the flow of shaft current through any bearing. Associated piping tubing and conduits shall have insulated sections where necessary to avoid bypassing the bearing insulation.

5.8.5 Temperature indicators shall be furnished to measure oil outlet temperature at the bearings. The indicators to be dial type thermometers with detachable thermowells made of stainless steel. Accuracy shall be within 1% of range over scale.

5.9 Anti Condensation Heater(s)

5.9.1 Anti condensation space heaters shall be installed inside the generator.

5.9.2 Heater location and capacity shall be as required to prevent condensation in the enclosure when the generator is not operating. Heaters will be energized automatically when the generator is not in operation by purchaser's control device.

Power for heaters will be from purchaser's single phase low voltage 230 or three phase 400 volt A.C. 50 Hz supply as dictated by requirements.

Heater(s) leads shall be brought out to a separate terminal box on the generator enclosure.

All generators shall also be provided with the drain plug(s) too.

5.10 Cooling System

5.10.1 The cooling system shall employ a closed circuit for all the synchronous generators. The primary coolant shall be air and the secondary coolant where required shall be either air or water. The water coolers shall be side or bottom mounted. Top mounted water coolers are not acceptable.

Leak detectors and alarms shall be considered where applicable.

5.10.2 Cooler shall be designed so that if one section is intended to be taken out of service for cleaning the unit can carry at least two thirds of the rated load continuously without the permissible temperatures of the active parts of the machine being exceeded.

5.10.3 The coolers shall be tested in accordance with IEC publication 60034.6. The followings are given in data sheet where applicable:

Cooling water supply pressure

Cooling water temperature including maximum, minimum and normal temperature.

The test pressure shall be twice of the working pressure.

5.10.4 Fans for generators shall be brass, bronze or aluminum.

Plastic or non-metallic fans housing are not acceptable.

Fans shall be non-sparking.

5.11 Electromagnetic Compatibility (EMC)

5.11.1 EMC shall comply with BS EN 55014-1.

5.12 Surge Protection

5.12.1 Surge protection shall be provided for each generator where specified in data sheets.

The surge protection shall be either inside the generator enclosure or close to the generator phase terminals as practicable.

5.13 Lifting Points

5.13.1 Lifting points shall be an integral part of the frame. Where this is not the case and the lifting is by the use of eyebolts these shall be supplied; they shall be of collar pattern.

5.14 Grounding Bolts

5.14.1 Generators shall be provided with a grounding bolt on generator's frame and in each connection box.

5.15 Rating Plate(s)

5.15.1 A rating plate of corrosion resistance metal shall be fixed on the generator frame and shall give the following information in English:

- Customer order No. and date
- Manufacturer's name
- Serial number, type and frame reference
- Year of manufacture
- Rated output KVA at ISO condition and at specific environmental conditions
- Rated power factor
- Rated frequency
- Speed at rated output
- Rated voltage
- Rated stator current
- Subtransient and transient reactance
- Class of insulation
- Number and date of reference standard e.g. IEC 60034.1
- Phase rotation: clockwise or counter clockwise
- Exciter current and voltage at rated output
- Weight of rotor, and stator in kg

5.16 Generator Control Panel

5.16.1 The generator local control panel shall be totally enclosed with 2.5 mm thickness sheet steel construction, damp and dust protected IP 55, protected by canopy resiliently mounted on the generating set main frame, unless otherwise specified with hinged and lockable access doors.

The enclosure of control panel shall be constructed and assembled so that it will have the strength and rigidity necessary to resist the abuses to which it is likely to be subjected, without total or partial collaps resulting in a risk of fire electric shock or injury to persons due to reduction of spacing, loosening or displacement of parts or other serious defects.

5.16.2 All cabling terminations shall be provided prior to shipment on site.

Alternatively where the panel is considered too large for base frame mounting, it shall be free floor standing for location near the set or installation elsewhere.

5.16.3 The control panel for the generator shall include all controls, instruments, relays pertinent CTS and indications to provide complete control of the generator.

5.16.4 Electrical instruments shall be of the flush mounted industrial grade, enclosed in dust and damp proof casing, non projecting dial with non-glare, non-reflecting window and in compliance with the requirements of pertinent parts of IEC 60051.

5.17 Control System

5.17.1 The generating units shall be equipped with microprocessor based control system with redundancy facilities.

5.17.2 The redundancy shall be considered for the power supply and control unit at least. The redundancy for input/output boards may be considered as per owner requirements.

5.17.3 The suitable human-machine interface (HMI) shall be considered.

Note:
For details refer to IPS-G-IN-290 and IPS-M-IN-290.

5.18 Possible configuration unit

The unit may be one of the following configurations:

a) Manual paralleling “Low voltage” synchronous unit. See Fig. 1

b) Non paralleling “Low voltage” synchronous unit. See Fig. 2

c) Manual paralleling “Medium voltage” synchronous unit. See Fig. 3

d) Non-paralleling “Medium voltage” synchronous unit. See Fig. 4

Notes:

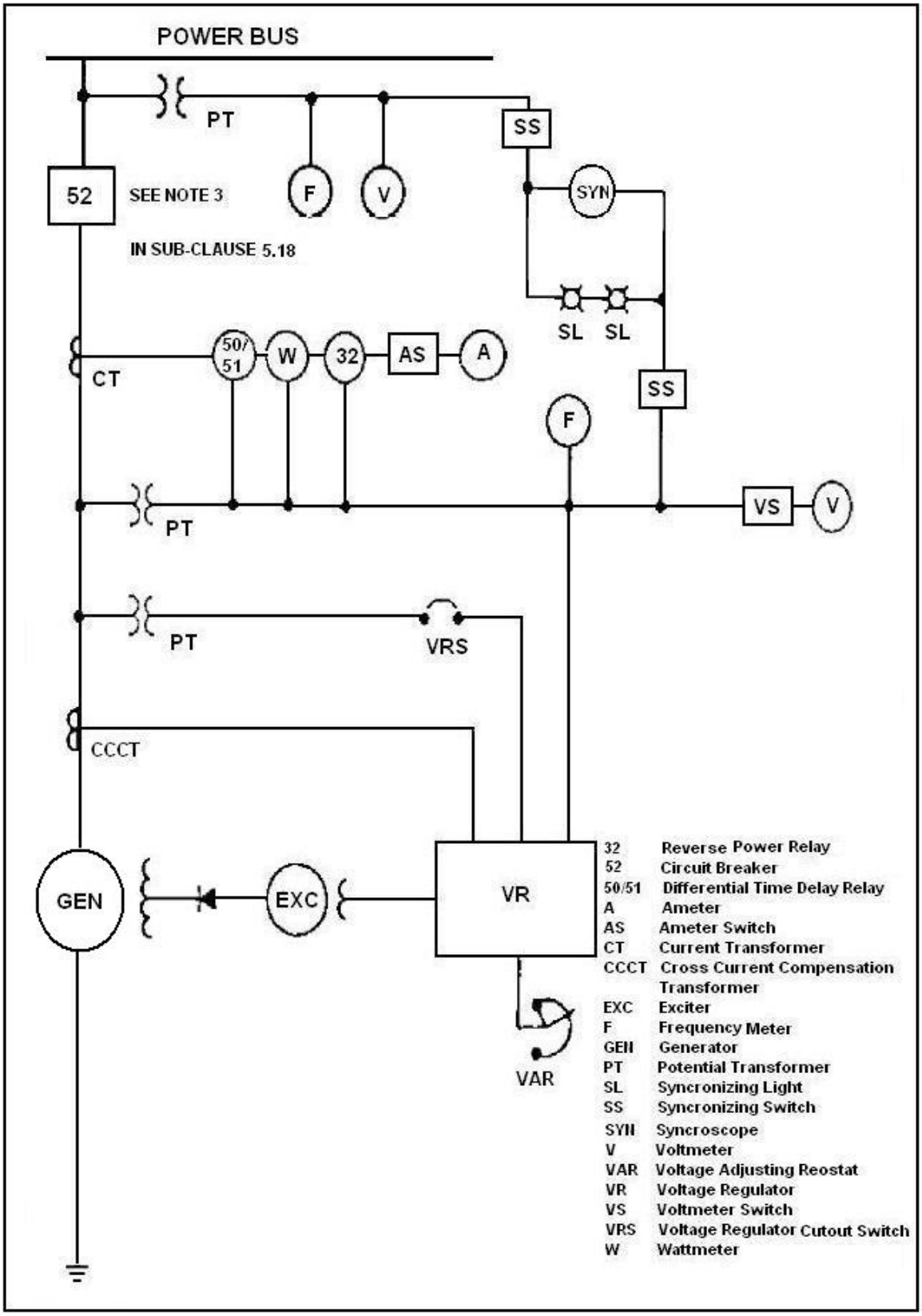
1) Minimum accessories are shown in Figs. 1 to 4 for different configurations.

2) Circuit breakers are beyond the scope of this Standard, and are dealt within standard IPS-M-EL-143 and IPS-M-EL-144.

3) The following are accessories which may be selected depending on ratings, voltage and application of specific cases. For protection details refer to IPS-E-EL-100.

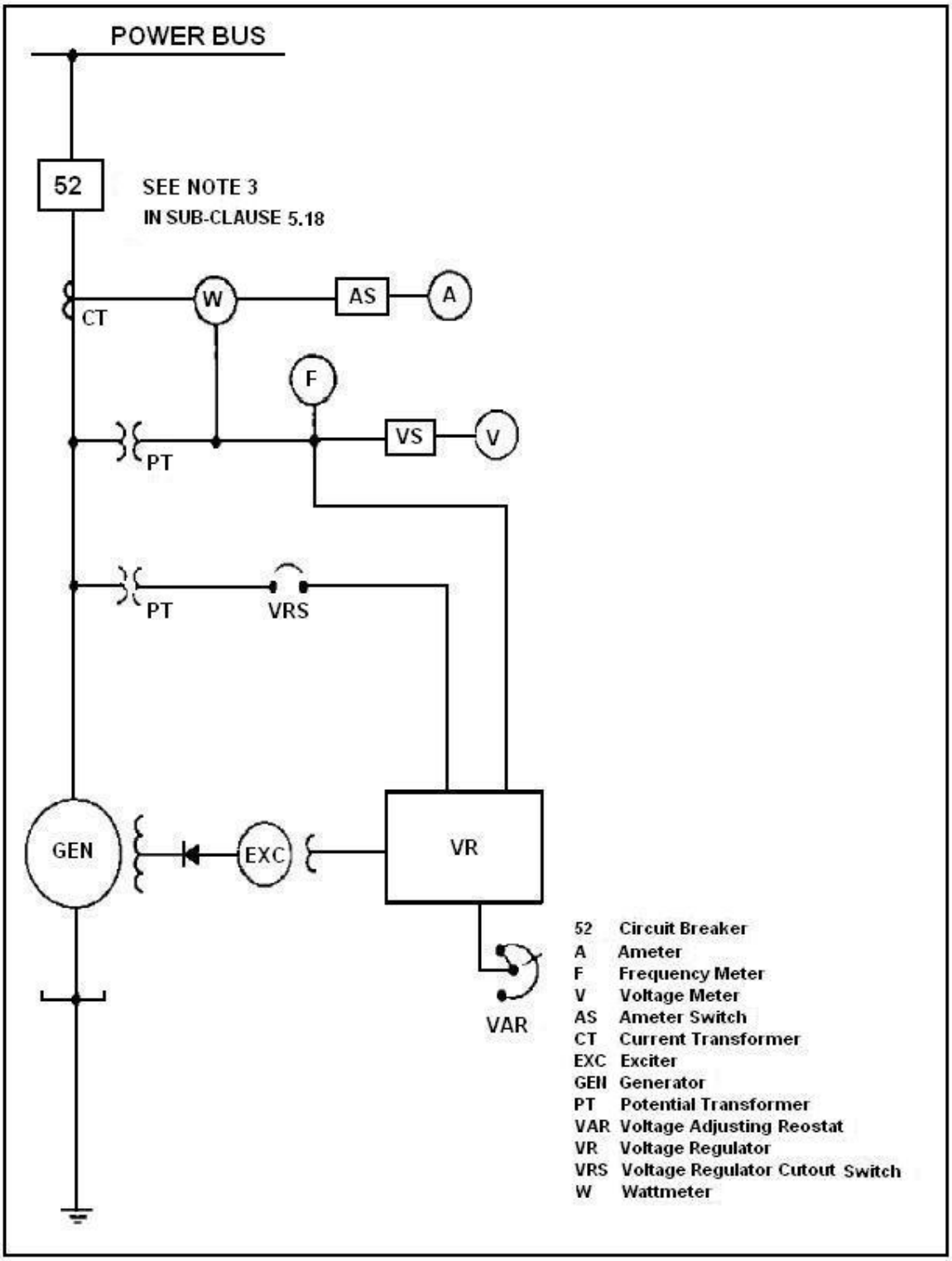
a) Power factor meter
b) VAR meter
c) Under/over frequency protection.
d) Short circuit sustaining protection.
e) Ground fault protection.
f) Differential protection.
g) Surge protection
h) Lightning arrester
l) Synchronizing check relay.

4) Ground fault resistors where applicable shall be specified by generator manufacturer.



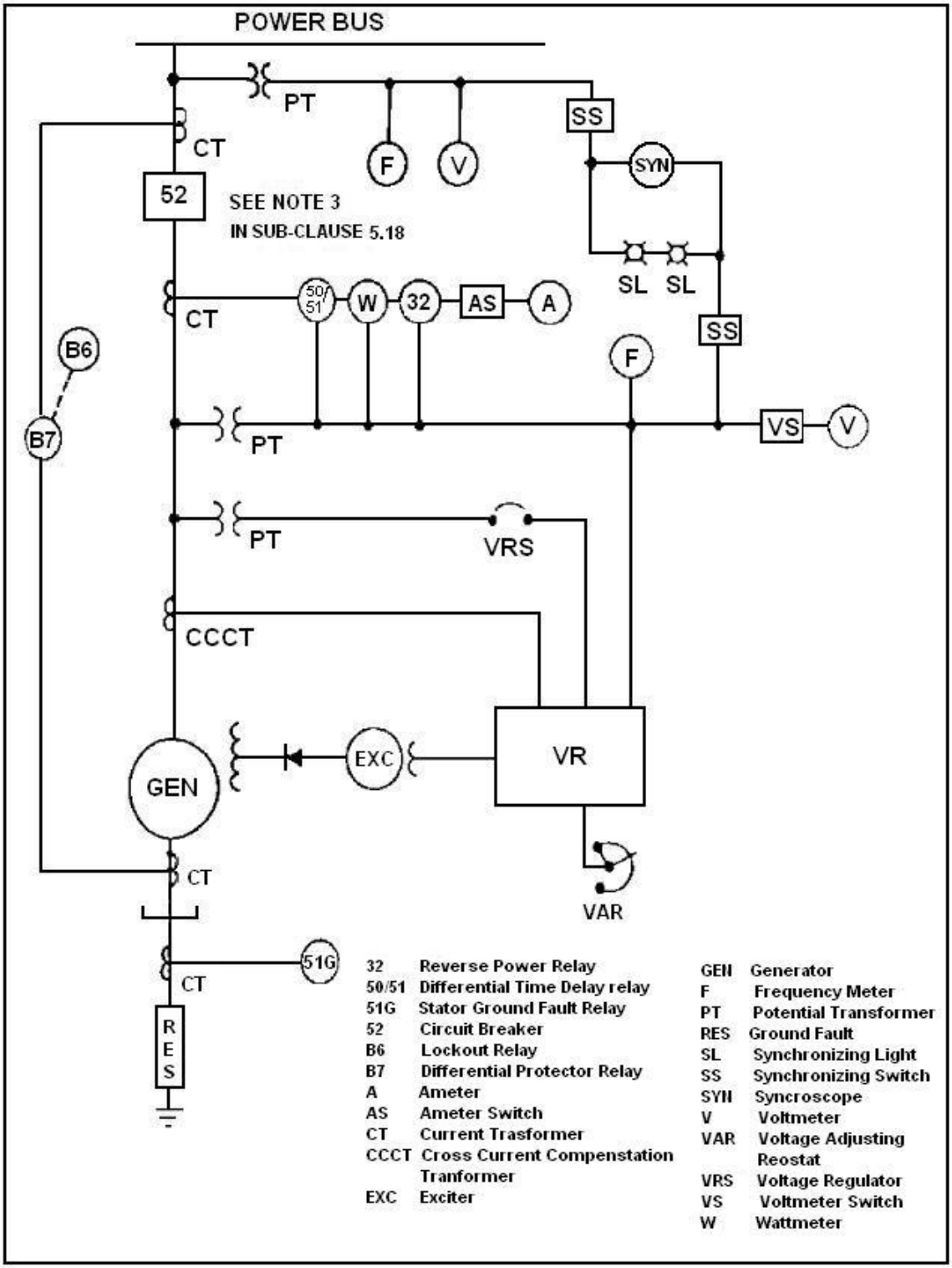
MANUAL PARALLELING LOW VOLTAGE SYNCHRONOUS UNITS

Fig. 1



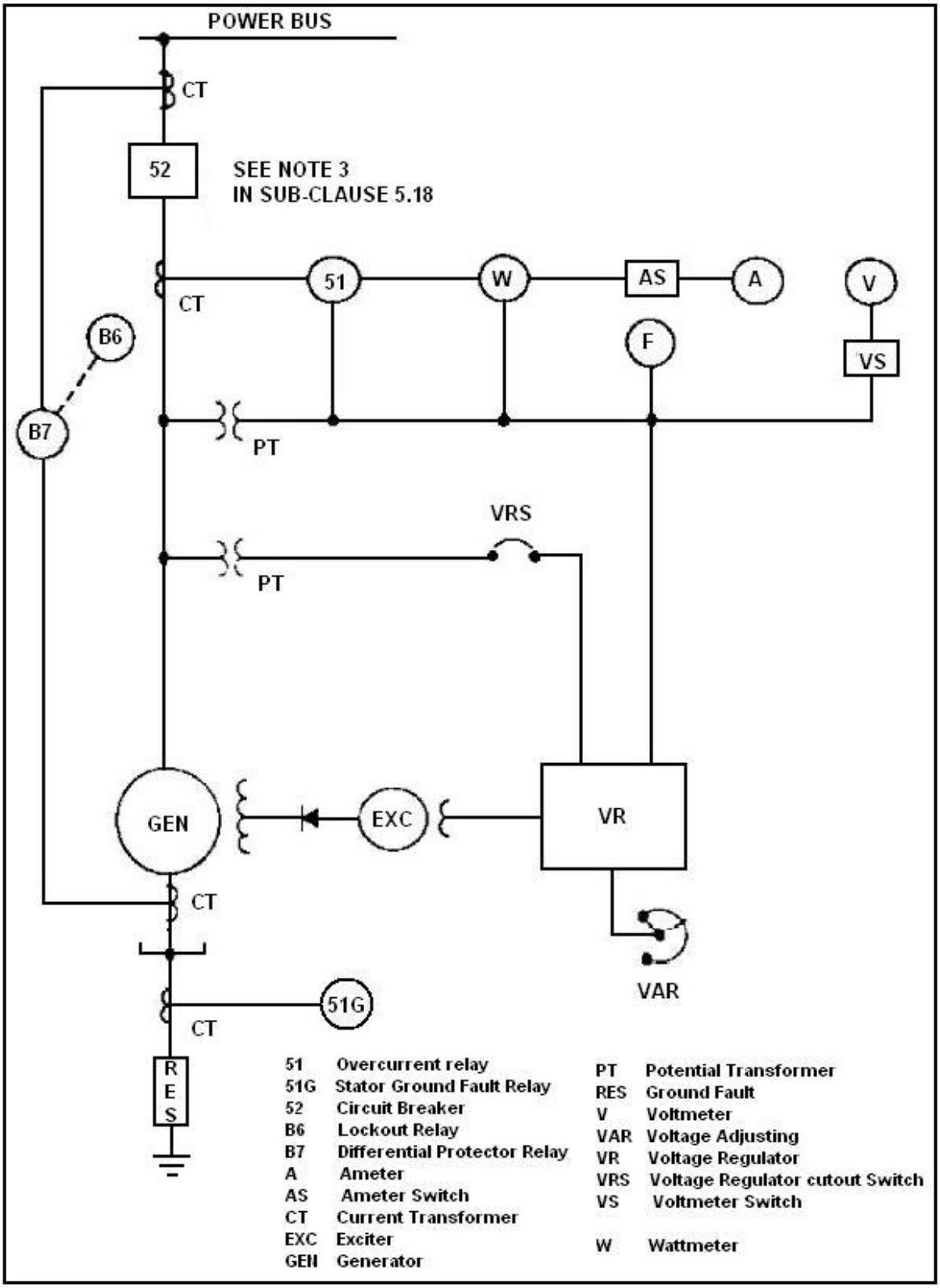
NON-PARALLELING LOW VOLTAGE SYNCHRONOUS UNITS

Fig. 2



MANUAL PARALLELING MEDIUM VOLTAGE SYNCHRONOUS UNITS

Fig. 3



NON-PARALLEL MEDIUM VOLTAGE SYNCHRONOUS UNITS

Fig. 4

6. PERFORMANCE REQUIREMENTS

6.1 Parallel Operation

6.1.1 Generating units shall be suitable for continuous operation with other generating sets and/or outside supply at operating voltages as specified in data sheet, and under load conditions up to rated value, whereby the power factor shall be maintained approximately at rated value by means of automatic reactive load sharing. Detail of existing unit and the outside supply will be specified in requisition where applicable.

6.2 Temperature Rise

6.2.1 Limits of temperature rise at rated voltages shall be in accordance with the requirements of IEC publication 60034.1 with due consideration to local ambient temperature.

Cooling air temperature shall be designed for a maximum cooling air temperature as specified in data sheet. This shall be measured at the inlet of the generating unit.

Note:

If the specified or resulting maximum coolant temperature exceeds 60°C or is less than 0°C the limits of temperature rise shall be agreed between manufacturer and purchaser.

6.3 Momentary Excess Current

Generating unit(s) shall be capable of withstanding for 15 seconds a current 50% in excess of its current rated output, with the voltage being maintained as near as possible to the rated value.

6.4 Sustained Overload

Generating unit(s) shall be capable of carrying an overload of 10% of rated current for a period of one hour at rated voltage, frequency and power factor without the temperature exceeding the limits set in IEC publication 60034.1.

6.5 Short Circuit Requirements

Generator(s) shall be capable of withstanding without damage a three phase , a line to line, a line to earth, or two line to earth short circuit for period of 3 seconds when operating at rated speed and with an excitation corresponding to 5% over voltage at no load.

6.6 Voltage Variations during Operation

6.6.1 Generating unit(s) shall be capable of supplying their rated output at rated speed and power factor at voltages ranging from -5% to +5% of rated value.

6.7 Unbalanced Load

6.7.1 Unless otherwise specified, three phase synchronous machines shall be capable of operating continuously on an unbalanced system, such that with none of the phase currents exceeding the

rated current, the rates of the negative sequence components of current (I2) to the rated current (IN) does not exceed the values in Table 2 of IEC 60034-1; and under fault conditions shall be capable of operation with the product of (I2/IN)2 and time in seconds t not exceeding the values given in above mentioned table.

6.8 Wave Form

6.8.1 The characteristic of the wave form shall be in accordance to requirements of IEC publication 60034-1 and the total harmonic contents shall be less than 3%.

6.9 Overspeed

6.9.1 Generating unit(s) shall withstand an overspeed of 20% above rated speed for two minutes, without mechanical damage or permanent distortion.

6.9.2 Gas turbine driven generating unit(s) shall however be constructed so that in an emergency state they will withstand the runaway speed of the set on 12% above rated speed which ever is the greater, for two minutes without mechanical damage or permanent distortion.

6.10 Subtransient Reactance

6.10.1 A guaranteed value of the subtransient reactance and applied tolerances shall be given. Unless otherwise specified on the requisition the subtransient reactance shall have a value of at least 10% for generators to 3125 KVA including and at least 13% for generators of higher rating.

6.11 Noise Level

6.11.1 Noise level shall be to the purchasers stated requirements, but in the event of no requirement being stated, then the vendor shall state the mean sound pressure level at 1 meter which should not normally exceed 81 dB(A) in the no load running condition.

6.11.2 The noise level measurement shall be carried out in accordance with the requirements of IEC 60034-9.

6.12 Balance and Vibration

6.12.1 Rotor(s) of generator(s) shall be dynamically balanced before generator(s) assembly in accordance with the following:

a) Rotor shall be heated at rated full load temperature during balancing.

b) Balancing shall be done preferably with all shaft or rotor mounted fans installed. Fans not installed shall be dynamically balanced separately.

c) Balancing shall be done at a speed not less than normal operating speed.

d) Rotor(s) with single key ways at coupling ends shall be balanced with half keys mounted.

e) Rotor(s) shall be final balanced after the overspeed test.

6.12.2 Rotating component for shaft driven excitation shall be dynamically balanced.

6.12.3 After final balancing, vibration shall be measured on the generator rotor with its shaft axis in

normal position at the following locations:

a) On each bearing housing in the horizontal vertical and axial directions;

b) On the shaft adjacent to each bearing housing.

6.13 Critical Speeds

6.13.1 The first actual critical speed of stiff rotor shall be at least above 125% of synchronous speed.

For flexible rotor this shall be between 60% and 80% of synchronous speed.

The second actual critical speed shall be above 125% of synchronous speed.

Note:

The complete assembly comprising generator and its driver (and where applicable its transmission) should be checked for proper match with respect to axial float limitations and critical speeds. Torsional critical speeds and vibrations shall be established and checked for compliance with API recommendations 616 in case of combustion gas turbine driven generators.

7. INSPECTION / QUALITY CONTROL AND QUALITY RECORD

7.1 Inspection/Quality Control

7.1.1 The purchaser's inspector, or his authorised representative shall have free access to the manufacturing plant engaged in the manufacture of the equipment, to carry out necessary inspection at any stage of work.

7.1.2 Inspection may include the visit to quality control laboratories, work shops, testing bay etc.

7.1.3 The supplier shall make available technical data, test pieces and samples that the purchaser's representative may require for verification in conjunction with pertinent equipment.

If required the supplier shall forward the same to any person or location that the purchaser's representative may direct.

7.1.4 Purchaser will require the presence of his nominated representative to witness the final inspection and performance tests. For such purpose a type test on an identical machine is acceptable. The supplier shall inform the date of such tests at least four weeks in advance.

7.2 Quality Records

7.2.1 The supplier shall maintain appropriate inspection and test records to substantiate conformance with specified requirements.

7.2.2 Quality record shall be legible and relevant to the product involved.

7.2.3 Quality records that substantiate conformance with the specified requirements, shall be retained by manufacturer and made available on request by purchaser.

7.2.4 The supplier shall establish and maintain procedure for identification collection, indexing, filing, storage, maintenance and disposition of quality records.

7.2.5 Supplier shall submit to purchaser: reports, test schedules, and test certificates (in ----------

copies) on completion of tests.

8. TESTS

The following routine tests are the minimum tests required.

- Over speed tests;
- Measurement of winding resistance;
- Generator characteristics in open circuit and short circuit excitation and losses;
- Vibration measurement;
- High voltage dielectric tests;
- Measurement of insulation resistance;
- Measurement of polarization test of generator stator winding;
- Phase sequence;
- No load characteristic;
- Temperature rise;
- Test for calculation of efficiency;
- Mechanical balancing and measurement of vibration of rotor;
- Measurement of insulation of pedestal/housing;

In addition, type test are required on the first machine of each type or selected machine in a contract.

Type test includes:

- Windage heat run;
- Open circuit heat run;
- Short circuit heat run;
- Measurement of voltage waveform;
- Measurement of reactances;
- Determination of noise rating;
- Determination of moment of inertia;
- Response of automatic voltage regulation and frequency with sudden shedding of 25%, 50%, 75%, and 100% of rated load respectively.

Note:

Complete records of checks, verification and tests shall be accompanied with the certifications to which reference is made in Appendix B.

9. PAINTING

Manufacturer standard finish is acceptable provided that it is compatible with specified environmental condition given in attachment No. 1.

The color of final layer shall be light gray unless otherwise specified in data sheet.

10. DOCUMENTATION / LITERATURE TO BE SUBMITTED BY MANUFACTURER / SUPPLIER

10.1 At Quotation Stage

10.1.1 Supplier shall submit the following:

a) Report of experience, background, major clients and annual sale for similar equipment.

b) Reference list showing the successful operation of equipment for at least two years and the locations of equipment offered in major oil industries.

c) Typical type test certificate of similar equipment.

d) Declaration of confirmation with set standards and or clear indication of deviation from the standards and the specifications.

10.1.2 Drawings and Documents relating to:

a) Dimensioned outlines and foundation details including weights and cable entries (size and clearance).

b) Details of cross sectional arrangements.

c) Mounting details.

10.1.3 Electrical schematic diagram

10.1.4 Electrical reference documents relating to:

a) General Description.

b) Equipment Specification.

c) Performance Data.

d) Characteristic Curves.

10.1.5 Spare parts and special tools requirements as follows:

a) List of recommended commissioning spares with price.

b) List of recommended spares for three years of operation.

c) List of special tools, testing devices and instruments.

10.1.6 Guarantee policies

10.1.7 Compliant and compensation policies.

Note:

The quotation will be considered as incomplete and rejected if the above mentioned information are not included.

10.2 At Ordering Stage

10.2.1 Final general arrangement drawings, showing floor plan, elevation and end view of equipment.

10.2.2 Mass and dimensions of the assembly and of individual shipping sections.

10.2.3 Electrical wiring documents concerning

a) Schematic diagrams of all circuits.

b) Wiring diagrams.

c) Alarms, indications and acknowledgment schemes.

10.2.4 Final electrical reference documents relating to:

a) General description

b) Equipment specification

c) Performance data. (See Appendix B)

d) Characteristic curves including generator characteristic curve, reactive capability curve unbalanced load-time curve, current over load capability curve

e) Drawings/parts and material lists.

f) Generator constants

10.2.5 Instruction manuals relating to:

a) Transport and storage.

b) Installation.

c) Commissioning.

d) Operation.

e) Inspection/Test.

f) Maintenance incorporating trouble shooting guide.

10.2.6 Illustrated spare parts lists including special tools.

a) List of components, showing complete reordering information for all replaceable parts.

10.2.7 Certificates concerning:

a) Applicable type tests.

b) Applicable routine tests.

c) Quality assurance.

Notes:

1) The above mentioned documents shall include identifications of all proprietary items including order number and purchaser name.

2) For list of drawings, documents, manuals and certificates to be submitted by manufacturer/supplier in number and the time: see Appendix B.

11. PACKING

11.1 Equipment must be carefully packed to provide necessary protection during transit to destination and shall be in accordance with any special provision contained in the order.

11.2 Special attention must be given to protection against corrosion during transit, and silica gel or similar dehydrating compound shall be enclosed.

11.3 The method of cleaning preserving and the details of packing including moisture elimination, cushioning, blocking and crating shall be such that to protect the product against all damages or defects which may occur during handling, sea shipment to the port and rough road haulage to site and extended tropical open air storage.

11.4 All bright and machined parts must be given the protection against corrosion.

11.5 Ancillary items forming an integral part of the equipment should be packed preferably in a

separate container if the equipment is normally cased or crated.

Alternatively the ancillary items should be fixed securely to the equipment and adequate precautions taken to ensure that the items do not come loose in transit or be otherwise damaged.

11.6 The supplier shall provide methods of handling to prevent damage and or deterioration during transit.

11.7 Where deemed necessary each shipping section shall be furnished with removable steel angles.

11.8 The requirements of above items shall not relieve the supplier of any of his responsibilities and his obligations for delivery of equipment in a sound undamaged and operable conditions at site.

11.9 Identification for Shipment

The marking and labels of products should be legible, durable and in accordance to specification.

Identification should remain intact from the time of initial dispatch at work to the final destination.

Marking shall be adequate for identifying a particular equipment in the event that a recall or inspection becomes necessary.

12. SHIPMENT

12.1 Each unit shall be suitably prepared for the type of shipment agreed.

The preparation shall be suitable for at least 6 months of outdoor storage from the time of shipment in a manner requiring no disassembly prior to operation (except for bearing and seal operations).

12.2 The supplier shall provide the purchaser with the instructions necessary to preserve the integrity of the storage preparation after the equipment arrives at job site.

12.3 Preparation for shipment shall be made after all testing and inspection of the equipment has been accomplished and the equipment has been released for shipment.

The preparation shall include those specified in 12.3.1 through 12.3.9 which follows:

12.3.1 Exterior surfaces except for machined surfaces should have been painted.

12.3.2 Exterior machined surfaces shall be coated with suitable rust preventive.

12.3.3 After having been thoroughly drained and cleaned, internal areas of bearing and all auxiliary equipment in oil lubrication system using carbon steel shall be coated with suitable oil soluble rust preventive.

12.3.4 Flanged opening shall be provided with metal closure at least 5 millimeters thick with synthetic rubber gaskets.

At least four full diameter bolts shall be used for flanged opening.

12.3.5 Threaded opening shall be provided with steel caps or solid shank still plugs. In no case shall nonmetallic plugs or caps be used.

12.3.6 The rotors shall be blocked to prevent axial and radial movements.

12.3.7 Space heater leads shall be accessible without disturbing the shipping page and shall be suitably tagged for easy identification.

12.3.8 Lifting points if not obvious or lugs shall be clearly marked. Each generator shall be properly identified with item and serial numbers.

All material shipped in separate crates shall be suitably identified with securely affixed corrosion resistant metal tags indicating the item and serial number of the equipment for which it is intended.

12.3.9 Vents shall be waterproof sealed.

12.4 The greatest care must be taken to ensure that shipping and associated documents with exact description for custom release are accompanied with the shipment.

13. GUARANTEE

13.1 Clearance of Defects

The supplier shall guarantee his equipment during commissioning and for one year operation starting from the completion of seven days continuous service test in site at full load against the following defects:

- All operational defects
- All material defects
- All constructional and design defects

13.2 Replacement of Defective Parts

All defective parts shall be replaced by the supplier in the shortest possible time free of charge including dismantling reassembling at site and all transportation cost. The above mentioned period shall not however be longer than 18 months from the date of dispatch from the manufacturer's works.

13.3 Supply of Spare Parts

Further more the supplier shall guarantee the provision of spare parts to the purchaser for a minimum period of 10 years from the date of dispatch.

13.4 After Sale Technical Services

13.4.1 Commissioning

13.4.1.1 The supplier shall quote if required for the services of competent engineer(s) and or technician(s) to assist in installation commissioning and testing of the equipment at site on a per diem basis.

13.4.1.2 The quoted rates shall be irrespective of duration and frequency and the supplier shall guarantee the services of the engineer(s) and technician(s) on the specified date within a minimum of 4 weeks advance notice by the purchaser.

13.4.2 Training

13.4.2.1 The purchaser may require the supplier to arrange for training of his personnel in the manufacturing plant and or in site for the operation and maintenance of the equipment offered.

13.4.2.2 The supplier shall quote (if required) for the cost of any of above mentioned services on a per person per diem basis. The program for the training shall be prepared by mutual agreement. An advance notice of 8 weeks minimum, is required by purchaser for the commencement of training program.

14. SPARE PARTS

14.1 Together with the supply of generators under this specification, a complete set of spare parts for commissioning shall be supplied for each generator.

14.2 The vendor shall also supply a list of recommended spare parts for two years of operation.

14.3 All spare parts shall comply with the same standards, specification and tests of the original

equipment and shall be fully interchangeable with the original parts without any modification at site.

14.4 They shall be correctly marked in accordance with client reference and manufacturer part numbers, giving also the purchaser's order number.

14.5 Spare parts shall be preserved to prevent deterioration during shipment and storage in humid tropical climate.

14.6 List of recommended spare parts and interchangeability with spare parts of similar equipment shall be submitted by supplier.

15. LANGUAGE

15.1 All correspondence drawings, documents, certificates, including testing operation and maintenance manuals and spare part lists etc. shall be in English.

15.2 Offers in other languages will not be considered.

16. COORDINATION, RESPONSIBILITY WITH OTHERS

16.1 In case the equipment ordered should be mounted on, aligned, connected, adjusted, or tested with the equipment of other manufacturer(s) the supplier shall contact directly the said manufacturer(s) and supply and obtain all dimensional and technical information and arrange for any interconnecting equipment and combined test that may be required.

16.2 The supplier shall be responsible for correct and timely communication with the said manufacturer(s) and for any delay and/or cost claims arising from such communications.

16.3 Copies of all correspondence should be sent to purchaser.

16.4 The name and address of the manufacturer(s) will be given as soon as their orders have been confirmed.

APPENDICES

APPENDIX A

DATA SHEET FOR A.C. GENERATOR

- PROJECT NAME .....
- SPECIFICATION NUMBER .....
- NOMINAL VOLTAGE ..... VOLT
- RATING ..... kW ..... kVA
- PHASE.....WIRE.....FREQUENCY.....Hz
- SYSTEM NEUTRAL .....
- PHASE ROTATION.....
- POWER FACTOR .....
- VOLTAGE REGULATION .....
- CLASS OF INSULATION .....
- SPEED .....rpm
- TYPE:
  Self excited ..... self regulated ..... brushless .....

- CONSTRUCTION:
  Cylindrical ..... salient pole rotor .....

- ENCLOSURE DEGREE OF PROTECTION: .....
- BEARING:
  Oil lubricated bracket .....
  Pedestal mounted sleeve type .....

- MOUNTING .....
- CANOPY ENCLOSURE: IP .....

- PRIME MOVER:
  □ Diesel Engines □ Steam Turbine □ Gas Turbine

- STANDARDS: .....
- VOLTAGE REGULATOR: .....
- ACCESSORIES:
  Space heaters: .....
  Winding temperature detectors: .....
  Bearing temperature detector .....
  Air temperature detector .....
  Surge protection .....

- MAXIMUM NOISE LEVEL: .....dB (A)
- NATURE OF LOAD: .....
- METHOD OF COOLING:.....air/air.....water/air .....
  Working pressure of cooling water .....
  Cooling water supply pressure .....
  Cooling water temperature: Maximum ..... Normal ..... Minimum ……

- HEATER POWER SUPPLY: .....
- MISCELLANEOUS: .....
  Drain plug: .....
  Lifting eyebolts: .....
  Earthing bolts: .....

- DESCRIPTION OF CABLES:
  Outgoing main cable: .....
  Anti-condensation heater cable: .....
  Temperature detector cables: .....

- THE POSITION OF TERMINAL BOX VIEWED FROM THE DRIVE END: ….....
- THE ORIENTATION OF TERMINAL BOX: ……..
- METERING:
  Ammeter .....
  Volt meter .....
  KW meter .....
  Power factor meter .....
  Synchronouscope (Where applicable): .....

- DETAILS OF LOCAL POWER SUPPLY (NETWORK):
  Voltage: .....
  Frequency: .....
  Power factor: ..... ……..

- DETAILS OF GENERATOR SET WITH WHICH PARALLELING IS REQUIRED:
  Generator:
    Manufacturer: .....
    Serial No.: .....
    Voltage: ..... Volts
    Frequency: ..... Hz
    Power: ..... KW
    Power factor: .....
  Driver:
    □ Diesel □ Gas turbine □ Steam turbine
    Manufacturer: .....

APPENDIX B

LIST OF DRAWING, DOCUMENTS, MANUALS AND CERTIFICATES TO BE SUBMITTED BY MANUFACTURER / SUPPLIER IN NUMBERS AND THE TIMES INDICATED BELOW

	DESCRIPTION	REQUIRED WITH QUOTATION	CERTIFIED INFORMATION REQ. WITH PURCHASE ORDER			NUMBER OF WEEKS BEFORE DELIVERY
			NO. OF COPIES		NUMBER OF WEEKS AFTER ORDER	
			ELECTRONIC FILES	HARD COPY		
A	DRAWING AND OTHER DOCUMENTS:					
	a) ELECTRICAL EQUIPMENT:					
	1. DIMENSIONED OUTLINES AND FOUNDATION DETAILS INCLUDING CABLE ENTRIES AND CLEARANCES					
	2. DETAILS AND CROSS-SECTIONAL ARRANGEMENT					
	3. MOUNTING DETAILS					
	4. PERFORMANCE DATA (TYPICAL)					
	5. PARTS / MATERIAL LIST					
	6. RELEVANT CATALOGUES					
	7. NAME PLATES					
	8. LIST OF FINAL LABELS					
	b) TERMINATION:					
	1. CONNECTION DIAGRAM					
	2. TERMINAL BOX ARRANGEMENT					
	3. CONNECTION AND TERMINAL DESIGNATION					
	c) ELECTRICAL REFERENCE DOCUMENTS:					
	1. GENERAL DESCRIPTION					
	2. EQUIPMENT SPECIFICATION					
	3. PERFORMANCE DATA (ACTUAL)					
	4. DRAWINGS / PARTS / MATERIALS LIST					
B	INSTRUCTION MANUALS : (FOR ALL REQUIRED ITEMS)					
	1. INSTALLATION, COMMISSIONING AND INSPECTION					
	2. OPERATION AND MAINTENANCE					
C	SPARE PARTS REQUIREMENTS:					
	1. ILLUSTRATED SPARE PARTS					
	2. RECOMMENDED COMMISSIONING SPARE LIST					
	3. RECOMMENDED SPARES FOR TWO YEARS OPERATION					
D	CERTIFICATION:					
	1. PERFORMANCE TEST, MATERIALS CERTIFICATES AND CURVES					

APPENDIX C

DATA OF SYNCHRONOUS GENERATOR TO BE FILLED BY MANUFACTURER

GENERATOR SET

TYPE .....
Manufacturer ....
Model No. ....
Base Load Unit Net kW (ISO Gaseous Fuel) .....
Peak Load Unit Net kW (ISO Gaseous Fuel) .....

GAS TURBINE/STEAM TURBINE/DIESEL

Type .....
Manufacturer .....

GENERATOR

Type .....
Form type .....
Manufacturer .....
Degrees of protection (IP):
Generator enclosure .....
Terminal boxes .....
Speed (rpm) .....
Frequency .....
Rated kVA at site ambient temperature and altitude.....
Rated Voltage .....
Rated Current .....
Rated Power Factor .....
Field Voltage - no load .....
Field Voltage - peak load, 0.8 pf .....
Field Current - peak load, 0.8 pf .....
De-excitation time (decrease from 100 to 25% of excitation current) .....
Maximum total temperature at base load:
Rotor (°C) .....
Stator (°C) .....
Generator short circuit ratio at base rated kVA .....

(to be continued)

APPENDIX C (continued)

Short circuit current .....

Excitation current corresponding to the rated armature (primary) short-circuit current Direct-axis synchronous reactance .....

Quadrature-axis synchronous reactance .....

Direct-axis transient reactance. ....

Quadrature-axis trasient reactance. ....

Quadrature-axis subtransient reactance ....

Negative-sequance reactance .....

Zero sequence reactance .....

Armature-leakage reactance .....

Initial starting impedance of synchronous motors .....

Direct-axis transient open-circuit time constant ....

Direct-axis transient short-circuit time constant .....

Quadrature-axis transient open-circuit time constant ....

Quadrature-axis transient short-circuit time constant ....

Direct-axis subtransient open-circuit time constant .....

Quadrature-axis subtransient open-circuit time constant ....

Quadrature-axis subtransient short-circuit time constant ....

Direct-axis open-circuit excitation winding time constant .....

Direct-axis open circuit equivalent damper circuit time constant .....

Direct-axis short-circuit excitation winding time constant ....

Direct-axis short-circuit equivalent damper winding time constant .....

Frequency response characteristics ....

Air Flow (cubic meters per minute)…….....

Efficiency at ¼, ½, ¾, 4/4, load and 0.8 p.f. .....

Curve of maximum overload durations (between 4/4 load and S.C. Current) .....

Type of bearings .....

(to be continued)

APPENDIX C (continued)

Type and number of RTDs:

Windings .....

Bearings .....

Type, number and power supply of anti condensation heaters .....

EXCITER AND VOLTAGE REGULATOR

Manufacturer .....

Type of Exciter .....

Capacity, kW .....

Rated Voltage .....

Type of Voltage Regulator .....

Response time .....

CONTROL SYSTEM

Manufacturer .....

Type and specification .....

GENERATOR INTAKE AIR FILTER

Manufacturer .....

Type and specification .....

STARTING SYSTEM

Type and specification .....

WEIGHT

Gas Turbine/Steam Turbine/Diesel Unit .....

Generator and Exciter .....

Exciter .....

Starting Equipment. .....

Heaviest piece to be handled after erection .....

Heaviest piece to be handled for hot-gas path inspection .....

Heaviest piece to be handled for combustion inspection. .....

Turbine and compressor rotor(s) weight (where applicable) .....

(to be continued)

APPENDIX C (continued)

Generator rotor: .....

MR^2 of turbine shaft (where applicable) ……..

MR^2 of gearbox (where applicable) ……..

MR^2 of generator shaft .....

AUXILIARY POWER REQUIREMENTS

(Check those that are shaft driven)

Air compressors (if required) .....

Lube oil and space heaters .....

Generator inlet air filter system .....

Lub oil pump(s) - a.c .....

Lub oil radiator fan(s) .....

Cooling water pump(s) .....

Rotor turning device .....

Lube oil pump(s) - d.c .....

Turbine inlet cooler pumps .....

Other .....

Total running .....

Total standby .....

ATTACHMENTS

GENERAL

ATTACHMENT 1

ENVIRONMENTAL CONDITIONS

1.1 Site elevation: ---------- meters above sea level.

1.2 Maximum ambient air temperature: ---------- degree centigrade.

(Bare metal directly exposed to the sun can at times reach a surface temperature of ---------- degree centigrade.)

1.3 Minimum air temperature: ---------- degree centigrade.

1.4 Relative humidity: ---------- percent.

1.5 Atmosphere: saliferrous, dusty corrosive and subject to dust storms with concentration of 70 - 1412 mg/cubic meter, H_2S may be present, unless otherwise specified.

1.6 Lightning storm isoceraunic level: ---------- storm days / year.

1.7 Maximum intensity of earthquake ---------- richters.

Note:

Blanks to be filled by client.

ATTACHMENT 2

TESTS AND CERTIFICATION

2.1 General Requirements

2.1.1 Test procedure as proposed by the supplier shall be agreed upon, and approved by the purchaser before any test is carried out.

2.1.2 Purchaser may require witnessed tests to be carried out in the presence of his nominated representative who should be informed at least ---------- weeks in advance of the date of the tests and confirmed ---------- weeks before the tests.

2.1.3 Test certificates and test reports shall refer to the serial No. of the equipment tested and must bear the purchaser's name, order No. and manufacturer's name and seal.

The certificates shall be approved by the purchaser before shipment instruction is given.

2.1.4 Approval by the purchaser's inspector or representative shall not relieve the vendor of his commitments under the terms of this specification or any associated order.

2.1.5 The equipment may be rejected if measurement and inspection reveal any discrepancies between quoted figures resulting in purchase order and those measured actually.

2.1.6 Any charges incurred by the tests quoted under heading of specific requirements for tests to be quoted as a separate item and are not to be included in the cost of the equipment.

Note:

Blanks to be filled by client.