

SCOPE

- I 1.1 This practice covers the design and inspection of synchronous generators of the cylindrical rotor (non salient pole) type rated over 1000 kW and driven by steam turbines or combustion gas turbines.
- I 1.2 **An asterisk (*)** indicates that a decision by the Purchaser is required or that additional information is furnished by the Purchaser.

VENDOR QUALIFICATION

- I 2.1 **Vendor qualification.** Generators shall be supplied by vendors qualified by experience in manufacturing the units proposed. To qualify, the vendor must have manufactured, at the proposed point of manufacture, at least two generators of similar design and comparable output, speed and voltage rating. These generators must have been in service at least one year and must be performing satisfactorily. The vendor shall submit a list of operating units.

SUMMARY OF ADDITIONAL REQUIREMENTS

- I ↕ 3.1 **Table 1** lists the practices which shall be used with this practice.

TABLE 1

PRACTICES	
IP 2-1-1	Plant Noise Design Criteria
IP 10-12-1	Vibration, Axial Position, and Bearing-Temperature Monitoring Systems for Compressors and Drivers
IP 10-14-1	Lube and Seal Oil Systems for Machinery
IP 20-1-1	Inspection of Equipment and Materials

- I * 3.2 **IEC-85, Recommendations for the Classification of Materials for the Insulation of Electrical Machinery and Apparatus in Relation to their Thermal Stability in Service**, shall be used with this practice **as specified** by the Purchaser.
- I ↕ 3.3 **Table 2** lists standards which shall be used for generators purchased **in the USA for use in the USA**:

TABLE 2

STANDARDS	
ANSI Standards	
C50.10	Rotating Electrical Machinery - Synchronous Machines
C50.13	Rotating Electrical Machinery - Cylindrical Rotor Synchronous Generators
C50.14	Requirements for Combustion Gas Turbine Driven Cylindrical Rotor Synchronous Generators
C50.15	Requirements for Hydrogen-Cooled Combustion Gas-Turbine-Driven Cylindrical-Rotor Synchronous Generators
IEEE Standards	
421.5	IEEE Recommended Practice for Excitation System Models for Power System Stability Studies
NEMA Standards	
SM 23	Steam Turbines for Mechanical Drive Service
SM 24	Land Based Steam Turbine Generator Sets 0 to 33,000 kW
MG-1	Motors and Generators

- I * 3.4 **For other conditions of purchase and use**, the applicable standards of manufacture and test will be specified by the Purchaser.

DOCUMENTATION

- I 4.1 The **data** listed in **Table 3 (Appendix)** shall be submitted with the generator vendor's proposal.
- I 4.2 **Factory test reports** shall be submitted to the Purchaser for each generator.

IP 16-9-3		Synchronous Generators	EXXON INTERNATIONAL PRACTICE
Page 2 of 9			
Rev. 1	March 1998		

(This practice is appropriate for attachment to Inquiry or Purchase Document)

(This practice is appropriate for attachment to Inquiry or Purchase Document)

GENERATOR DESIGN

ENCLOSURE REQUIREMENTS

- R *5.1 If the equipment inside the enclosures, i.e., control panels, motor controls, batteries, UPS systems, etc., requires to be air conditioned, **100% redundant air conditioning systems** shall be provided.

INSULATION AND CONDUCTORS

- R ♦ 5.2 **Stator and field insulation systems** shall be **Class F with Class B temperature rise**. All windings shall have copper conductors.

STATOR WINDING CONNECTION, LEADS AND RELATED EQUIPMENT

- O,M *5.3 **Generator stator windings** shall be arranged for WYE-connection. Phase leads shall be brought out. Unless otherwise specified, neutral leads shall also be brought out.
- R 5.4 **Parts carrying generator current continuously** shall be rated for at least maximum generator capability. All equipment and materials shall have mechanical and thermal capability to withstand effects of short circuit currents for times as stated for the abnormal current limits in the applicable specified standards.

EXCITATION SYSTEM

- O,R *5.5 When specified, the **generator and excitation system**, while **under automatic voltage regulator control**, shall have the **capability** to:
- Maintain 350 percent of generator rated current for a minimum time of 2 seconds to any type of short circuit at the generator's terminals.
 - Maintain 200 percent of generator rated current for a minimum time of 30 seconds to a load consisting of starting or reaccelerating motors having an average power factor of 20% lagging.

WINDING TEMPERATURE DETECTORS

- O,R ♦ 5.6 **Generators shall have resistance type temperature detectors in their stator windings** per the following:
- A minimum of six detectors shall be provided spaced equally around the circumference of the stator.
 - All detector leads shall be metallic armored.
- M 5.7 **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 a separate box** 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.

GENERATOR COOLING

- O,R *5.8 The **cooling system** shall employ closed-circuit air-water (preferred) or hydrogen-water cooling per the following:
- The **coolers** shall be side or bottom mounted within the generator enclosure. Top mounted coolers are not acceptable.
Vendor may propose **external coolers** for mounting beneath the generator enclosure as an **alternative**. Such proposals shall be submitted to the Purchaser for the Owner Engineer's approval.
 - The design of the **generator enclosure** shall prevent water from cooler leaks from directly striking the generator windings.
 - The system shall provide **two or more independent cooler sections**, sized to permit one section out of service without reducing heat removal capability below 67% of the maximum generator requirement.
 - Cooling water piping** shall enter from the bottom, unless otherwise specified.
 - For **fresh water, tube side water velocity** shall be between 4 and 10 ft/sec (1.2 to 3 m/s), preferably in the range of 6 to 8 ft/sec (1.8 to 2.4 m/s). For **salt or brackish water, tube side water velocity** shall be between 3 and 6 ft/sec (0.9 to 1.8 m/s) preferably 3 ft/sec (0.9 m/s).
 - Cooling water type, and water inlet temperature and pressure conditions will be specified.

O,R * 5.9 **Materials of construction for coolers** shall be as follows:

COMPONENT	FRESH WATER SERVICE	SALTWATER SERVICE
Tubes	Inhibited Admiralty, Aluminum Brass, or Copper-Nickel; .049 in. (1.25 mm) min. wall thickness	Materials will be specified
Tube Sheets	Vendor's standard Copper Alloy	
Water Boxes	Cast Iron, or Carbon Steel; 1/8 in. (3 mm) corrosion allowance on water side	

O 5.10 **Instrumentation to be furnished for air (or hydrogen)-water cooling systems** shall be as given below. Instruments shall be mounted on vendor furnished local instrument panel and shall have contacts for use with normally energized alarm circuits.

FUNCTION	ACTUATION REQUIREMENTS
Water , high and low flow indicator	1) High flow , contact to alarm. 2) Low flow , connect to alarm and actuate a delayed tripping relay. Low flow set point shall be per generator vendor's recommendation - at a value below which the generator will overheat and winding damage will result within 15 minutes of flow occurrence.
Air, (or hydrogen) , high moisture indicator (See Note)	High moisture content of exit cooling air (or hydrogen) , contact to alarm.

Note: Vendor's proposal for any alternative method to provide early warning alarm of cooler water leakage shall be submitted to the Purchaser for the Owner Engineer's approval.

O,R 5.11 **Collector ring enclosures** furnished for generators having **static excitation systems** shall not be included in the closed circuit cooling system supplied for air (or hydrogen)-water cooled generators. Collector ring enclosures requiring cooling air shall have a separate once-through air cooling system provided with inlet air filters with removable elements.

O,R * 5.12 **When specified, an open-ventilated air-cooling system design** shall be proposed as an **alternative to the air (or hydrogen)-water cooling system**. Such designs shall be submitted to the Purchaser for approval by the Owner's Engineer and shall have the following features:

- The design shall include inlet air filters with removable elements, however, alternative means for cleaning the inlet air, such as inertial separators, may be proposed for consideration.
- For generators having collector ring enclosures requiring cooling air, separate cooling circuits** shall be provided for the generator enclosure and the collector ring enclosure to avoid contamination of the generator windings with carbon dust.

SPACE HEATERS

O,R 5.13 **Space heaters** shall be provided inside the following enclosures:

- Generator enclosure of air-cooled generators.
- Collector ring enclosure of generators having static type exciters.
- Exciter enclosure of generators having shaft driven brushless type exciters.

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

Note: Purchaser will furnish portable heaters to protect hydrogen-cooled generators from condensation during pre-installation storage period.

M 5.14 **Heater leads** shall be brought out to a separate terminal box on the generator enclosure.

VIBRATION AND BEARING TEMPERATURE MONITORING SYSTEMS

O,R 5.15 **Vibration and bearing temperature monitoring systems** shall be provided in accordance with [IP 10-12-1](#).