

Engineering Standard

SAES-P-113

29 June 2005

Motors and Generators

Motors and Generators Standards Committee Members

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1 Scope

- 1.1 This standard prescribes mandatory requirements for the procurement and installation of induction and synchronous motors and generators for fixed installation in Saudi Aramco industrial and non-industrial facilities. This document may not be attached to nor made a part of purchase orders.

Commentary Note:

Refer to [SAES-P-116](#) for the definition of "industrial" and "non-industrial" facilities.

- 1.2 This standard does not cover:
- Submersible pump motors for oil or production water well service.
 - Motors used on drilling or workover rigs.
 - Motors used on mobile equipment or marine vessels.
 - Canned pump motors for oil or production water well service.
 - Motors used for crane applications.
 - Motor Operated Valve (MOV) actuators.

2 Conflicts and Deviations

- 2.1 If there are any conflicts between this Standard and associated purchasing, project or engineering documents, this standard shall take precedence. The exception is if an approved Waiver has been included with the purchasing documents.
- 2.2 Any conflicts between this Standard and other Mandatory Saudi Aramco Engineering Requirements (MSAERs*) or referenced industry standards shall be identified to the Company or Buyer Representative who will request the Manager, Consulting Services Department of Saudi Aramco, Dhahran to resolve the conflict.
- * *Examples of MSAERs are Saudi Aramco Materials System Specifications (SAMSSs), Engineering Standards (SAESs) and Standard Drawings (SASDs).*
- 2.3 Direct all requests to deviate from this Standard in writing to the Company or Buyer Representative, who shall follow internal company procedure [SAEP-302](#) and forward to the Manager, Consulting Services Department of Saudi Aramco, Dhahran requesting his approval.
- 2.4 The designation "Commentary" is used to label a sub-paragraph that contains comments that are explanatory or advisory. These comments are not mandatory,
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except to the extent that they explain mandatory requirements contained in this SAES.

3 References

The selection of material and equipment, and the design, construction, maintenance, and repair of equipment and facilities covered by this standard shall comply with the latest edition of the references listed below, unless otherwise noted.

3.1 Saudi Aramco References

Saudi Aramco Engineering Procedure

<u>SAEP-302</u>	<i>Instructions for Obtaining a Waiver of a Mandatory Saudi Aramco Engineering Requirement</i>
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Saudi Aramco Engineering Standards

<u>SAES-A-105</u>	<i>Noise Control</i>
<u>SAES-A-112</u>	<i>Meteorological and Seismic Design Data</i>
<u>SAES-B-068</u>	<i>Electrical Area Classification</i>
<u>SAES-J-604</u>	<i>Protective Instrumentation for Rotating Machinery</i>
<u>SAES-P-100</u>	<i>Basic Power System Design Criteria</i>
<u>SAES-P-101</u>	<i>Regulated Vendor List for Electrical Equipment</i>
<u>SAES-P-111</u>	<i>Grounding</i>
<u>SAES-P-114</u>	<i>Power System and Equipment Protection</i>
<u>SAES-P-116</u>	<i>Switchgear and Control Equipment</i>

Saudi Aramco Materials System Specifications

<u>16-SAMSS-502</u>	<i>Metal-Enclosed Low-Voltage Switchgear Assemblies</i>
<u>16-SAMSS-503</u>	<i>Indoor Controlgear - Low Voltage</i>
<u>16-SAMSS-504</u>	<i>Indoor Metal-Clad Switchgear: 1 to 38 kV</i>
<u>16-SAMSS-506</u>	<i>Indoor Controlgear - High Voltage</i>
<u>16-SAMSS-507</u>	<i>High Voltage Motor Controller – Outdoor</i>
<u>16-SAMSS-512</u>	<i>Outdoor Switchrack - Low Voltage</i>

<u>16-SAMSS-517</u>	<i>Adjustable-Frequency Drive System: 1 kV and Above</i>
<u>17-SAMSS-502</u>	<i>Form-Wound Induction Motors</i>
<u>17-SAMSS-503</u>	<i>Severe Duty Totally Enclosed Squirrel Cage Induction Motors to 250 HP</i>
<u>17-SAMSS-510</u>	<i>Synchronous Generators</i>
<u>17-SAMSS-518</u>	<i>Diesel Generator Sets</i>
<u>17-SAMSS-520</u>	<i>Form Wound Brushless Synchronous Motors</i>
<u>31-SAMSS-010</u>	<i>Submersible Pumps and Motors for Water Well and Offshore Service</i>
<u>34-SAMSS-625</u>	<i>Vibration, Axial Position, and Bearing Temperature Monitoring Systems</i>

Saudi Aramco Library Drawing

<i>DD-950114</i>	<i>Generator Protection - Large Direct-Connected Generator</i>
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3.2 Industry Codes and Standards

American National Standards Institute

<i>ANSI C37.101</i>	<i>Guide for Generator Ground Protection</i>
<i>ANSI C37.102</i>	<i>Guide for AC Generator Protection</i>
<i>ANSI C50.13</i>	<i>Rotating Electrical Machinery</i>

American Petroleum Institute

<i>API STD 541</i>	<i>Form Wound Squirrel Cage Induction Motor</i>
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National Electrical Manufacturers Association

<i>NEMA MG 1</i>	<i>Motors and Generators</i>
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National Fire Protection Association

<i>ANSI/NFPA 70</i>	<i>National Electrical Code (NEC)</i>
<i>NFPA 110</i>	<i>Emergency and Standby Power Systems</i>

Institute of Electrical and Electronics Engineers

<i>IEEE 446</i>	<i>Emergency and Standby Power Systems</i>
<i>IEEE 841</i>	<i>Standard for Petroleum and Chemical Industry- Severe Duty Totally Enclosed Fan-Cooled</i>

(TEFC) Squirrel Cage Induction Motors - Up to and Including 500 HP

International Electrotechnical Commission

<i>IEC 60034</i>	<i>Rotating Electric Machines</i>
<i>IEC 60072</i>	<i>Dimensions and Output Series for Rotating Electrical Machines</i>
<i>IEC 60079</i>	<i>Electrical Apparatus for Explosive Gas</i>

Underwriters Laboratories, Inc.

<i>UL 674</i>	<i>Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations</i>
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4 Definitions

Approval or **approved:** written approval of the Coordinator, Electrical Systems Division, Consulting Services Department, Saudi Aramco, Dhahran.

Industrial Facilities: Includes the following:

- a) Facilities directly associated with production, processing, or bulk distribution of hydrocarbons.

This includes, but is not limited to, facilities such as the following:

- i) Pumping or compression facilities in GOSPs
 - ii) Water injection plants
 - iii) Refineries
 - iv) Bulk distribution plants
 - v) Pumping stations
 - vi) Gas plants
- b) Hospitals
 - c) Office buildings exceeding three occupied floors
 - d) Control buildings

NEC: ANSI/NFPA 70, National Electric Code.

Non-Industrial Facilities: Includes commercial type building applications. This includes, but is not limited to, the following;

- a) Shops
 - b) Small office buildings
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- c) Schools
- d) Community buildings
- e) Warehouses

Commentary Note:

Non-industrial Facilities" such as shops, small office buildings, and warehouses can exist in non-hazardous areas in facilities that in general are defined as "Industrial Facilities", such as gas plants and refineries.

Severe Corrosive Environment: shall be as defined within [SAES-P-100](#), "Environmental Conditions".

5 General Requirements

- 5.1 Terms in **bold** font are defined within Section 4.
- 5.2 Refer to Section 2 for direction on conflict resolution between documents. For example, if there are any conflicts between this Standard and associated project or engineering documents, this specification shall take precedence.
- 5.3 Motors and generators shall be installed in accordance with **NEC**.
- 5.4 Motors and generators used in hazardous locations, as defined in [SAES-B-068](#), shall be totally enclosed and meet the requirements of the ANSI/NFPA 70 for such use.
 - 5.4.1 Motors for use in Zone 1 hazardous (classified) locations shall meet the requirements of UL 674 or equivalent international specification, and be certified by one of the agencies listed in Paragraph 5.4.2 of [SAES-P-100](#).
 - 5.4.2 Motors listed for use in Zone 1 hazardous locations shall be repaired as follows:
 - 5.4.2.1 Motors used in Zone 1 hazardous locations (explosionproof or flameproof motors) shall be repaired by a repair agency approved to recertify the motors for use in hazardous locations. After repair, the motor shall be recertified.

Commentary Note 5.4.2.1:

Currently there are no in-Kingdom repair agencies that are approved to recertify explosionproof/flameproof motors.
 - 5.4.2.2 Explosionproof/flameproof motors (normally used in Zone 1 areas) used in Zone 2 hazardous locations or nonhazardous locations may be repaired by any Saudi Aramco approved

repair agency. During the repair, the explosionproof/Zone 1 certification label shall be removed from the motor. After repair, motors used in Zone 2 hazardous locations shall continue to meet ANSI/NFPA 70 requirements for application in Zone 2 hazardous locations.

Commentary Note:

Where possible, motors should be located outside of Zone 1 hazardous locations.

5.4.2.3 Increased safety type motors shall not be used in Zone 1 classified areas.

- 5.5 Cable, conduit and/or other connections shall not electrically bridge insulated bearings.
- 5.6 Motors and generators exposed to ambient temperatures shall be rated in accordance with NEMA MG 1 as modified by this standard, [17-SAMSS-502](#), [17-SAMSS-503](#), [17-SAMSS-510](#), [17-SAMSS-518](#), or [17-SAMSS-520](#), as applicable, for a 50°C ambient. Motors shall be applied and sized based on their 1.0 service factor rating.

Commentary Notes 5.6:

Motors covered by [17-SAMSS-502](#), [17-SAMSS-503](#) and [17-SAMSS-520](#) and/or this standard are required to meet the criteria for Class F insulation, with an allowable temperature rise, above the ambient of 50°C, to not exceed that listed for Class B insulation in NEMA MG 1, Part 12, Part 20 or Part 21, ANSI C50.13 or IEC 60034-1 limits as applicable.

- 5.7 Diesel-engine driven generator sets rated 45 kVA (35 kW) through 2500 kVA (2000 kW) shall comply with [17-SAMSS-518](#). Other type generators rated 125 kVA (100 kW) through 1250 kVA (1000 kW) shall comply with [17-SAMSS-510](#).
- 5.8 Specialty (definite-purpose) motors shall meet the requirements of NEMA MG 1 or IEC 60034.
- 5.9 Protective instruments (Temperature, vibration, speed, etc.) for motors shall comply with [SAES-J-604](#).
- 5.10 Motors for submersible pumps for community water well and offshore (other than those in production water well service) service shall comply with the requirements of [31-SAMSS-010](#).
- 5.11 Motor and generator packages shall meet the noise requirements of [SAES-A-105](#).
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- 5.12 New form wound induction and synchronous motor installations shall meet the vibration requirements of [17-SAMSS-502](#) and [17-SAMSS-520](#) when coupled to the driven equipment and run loaded.
- 5.13 New or replacement 1000 HP and larger motor driven pump and compressor applications in pipeline service, GOSP crude oil shipping pump service, GOSP HP gas compressor service, and pump or compressor applications with significant variations in operating conditions shall be evaluated for variable speed operation utilizing Adjustable Frequency Drive(s) (AFD).

These applications shall be identified to the Coordinator, Electrical Systems Division (ESD) of Consulting Services Department (CSD) responsible for electrical engineering aspects of potential AFD applications.

Commentary Notes 5.13:

The proposed motor(s) should be identified to CSD/ESD as early as possible in the project cycle, ideally prior to development of the Design Basis Scoping Paper (DBSP).

The exact decision process, and who will be involved will be dependant on many factors (i.e., replacement vs. new and if new, whether it is identified during DBSP, project proposal or detailed design). CSD Rotating Equipment Division (RED) will generate pump and compressor performance data and CSD/ESD will provide electrical system/AFD characteristics for use in the cost/benefit analysis. For new installations, this cost/benefit analysis would be done by the Facilities Planning Department (FPD). For replacements, the analysis could be performed by either CSD/RED or FPD."

6 Motors for Industrial Facilities

- 6.1 Motors rated 0.746 kW (1 HP) and above shall comply with [17-SAMSS-502](#), [17-SAMSS-503](#) or [17-SAMSS-520](#).

Exceptions:

Unless specified, [17-SAMSS-503](#) does not apply to motors supplied as an integral part of manufacturer's standard packaged parent equipment such as exhaust fan ventilation assemblies and air conditioning units which meet standards recognized by Saudi Aramco. However, such motors shall have minimum of Class F insulation.

The specifications listed in Paragraph 6.1 may not apply to motors for special purpose applications, such as starter motors for gas turbine driven generators. Refer to the Electrical Standards Committee Chairman for determination.

- 6.2 Motors shall be selected in accordance with Table 1*.
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Table 1

Nominal System Voltage	Motor Nameplate Voltage	Number of Phases	kW (HP)	Type	Notes
120	115	1	up to 0.25 (0.34)	-	-
208	200	1	up to 0.25 (0.34)	-	1
240	230	1	up to 0.25 (0.34)	-	1
208	200	3	0.18 (0.25) to 3.7 (5)	Induction	1
240	230	3	0.18 (0.25) to 7.5 (10)	Induction	1,2
480	460	3	0.18 (0.25) to 185 (250)	Induction	2
4160	4,000	3	185 (250) to 3000 (4000)	Induction	-
4160	4,000	3	370 (500) to 3000 (4000)	Synchronous	3
6900	6,600	3	750 (1000) to 6000 (8000)	Induction or Synchronous	3,4
13,800	13,200	3	750 (1000) to 10500 (14000)	Induction or Synchronous	3
13,800	13,200	3	above 10500 (14000)	Synchronous	

Notes:

- (1) 200 V rating only for operation on 208 V system, and 230 V only for operation on 240 V system. 220 V and 380 V motors applied on 220 V and 380 V systems permitted by [SAES-P-100](#), Table 2, Note 1, shall follow the guidelines for 230 V and 480 V rated motors respectively.
- (2) Dual voltage 230/460V are only acceptable for motors up to 30 HP.
- (3) Below 3750 kW (5000 HP) synchronous motors shall only be applied at operating speeds of 1200 rpm and below.
- (4) Above 1000 kW (1340 HP) the additional level of 6.6 kV is permitted. The use of a 6.6 kV motor plus unit transformer must be compared with a 13.2 kV motor on the basis of cost.

** Exception 6.2:*

The rated voltage of motors which are part of an Adjustable-Frequency Drive system, shall be at the discretion of the drive system supplier. Table 1 does not apply to motors controlled with an Adjustable Frequency Drive.

6.3 Direct replacement of existing 2300 V Squirrel Cage Induction Motors is permitted. New installations of 2300 V Squirrel Cage Induction Motors with ratings from 185 kW (250 HP) to 1500 kW (2000 HP) are permitted if they are part of a 2400 V system expansion or addition which meets the requirements of [SAES-P-100](#), Paragraph 5.2.2, Note 1. New and replacement motors for 2400 V systems shall be dual rated 2300/4000 V.

6.4 Fractional Kilowatt (Horsepower) Motors

The requirements of this section do not apply to fractional horsepower motors which are an integral part of packaged parent equipment such as air conditioning units.

Motors rated less than 0.746 kW (1 HP) shall comply with NEMA MG 1, or IEC 60034, and the following additional requirements:

- a) Motors for exposed outdoor installation shall be of the totally enclosed type and rated in accordance with NEMA MG 1 or IEC 60034-1 for a 50°C ambient and a Class B winding temperature rise.
- b) Motors for indoor installation shall be totally enclosed or of the drip proof guarded type.
- c) The insulation system shall be Class F minimum.
- d) Enclosures and terminal housings shall be metallic.
- e) Single Phase Motors shall be provided with a built-in thermal protective device.
- f) Fans shall be metallic or reinforced fiberglass, and shall be designed for dual rotation.

7 Motors for Non-Industrial Facilities

Motors shall comply with NEMA MG 1 and the following additional requirements:

- 7.1 Motor ratings shall be selected from Table 1, except that where required, when the designated power supply is not available, larger single phase 115 V, 200 V, and 230 V rated motors may be used as long as the full load current does not exceed 50 A and larger three phase 200 V and 230 V rated motors may be used as long as the full load current does not exceed 100 A.
- 7.2 Motors for outdoor installation shall be a totally enclosed type.
- 7.3 Motors for indoor application shall be totally enclosed or of the dripproof guarded type.
- 7.4 The insulation system shall be Class F minimum.

8 Life Cycle Cost Evaluation

Quotations for motors purchased in accordance with [17-SAMSS-502](#) and [17-SAMSS-520](#) shall be evaluated on the basis of a life cycle cost, which is composed of the quoted cost of the motor plus the present worth of the losses over an assumed motor life of 15 years, using a loss factor (\$/kW) which will be shown on the data sheet that goes with the quotation request. The loss factor is determined from the following formula:

$$EF = 5.85 \times EC \times AH \quad (1)$$

where,

AH = Annual operating hours

EC = Energy cost in \$/kWhr

The present worth of the losses is the evaluation factor (EF) multiplied by the motor losses in kilowatts. The motor losses shall be derived from the motor vendor's guaranteed efficiency at the operating load of the driven equipment. For the calculation, losses at the operating load of the driven equipment shall be used.

Commentary Notes 8:

The normal operating load of the driven equipment, upon which the efficiency is based, must be specified (either by the purchaser or by the driven equipment manufacturer) on the motor data sheet, which will accompany the quotation request. The motors are evaluated at the normal operating load of the driven equipment.

The constant 5.85 is a present value factor based on the formula below, where i is the discount rate (15%) expressed as a decimal number and n is the life of the motor (15 years).

$$PV = \left[\frac{(1+i)^n - 1}{i(1+i)^n} \right] \quad (2)$$

9 Protection

9.1 General

9.1.1 Motor protection requirements are covered within the applicable Saudi Aramco Materials System Specifications (SAMSSs) to which the equipment is connected. Specifically:

- a) Low Voltage Switchgear – [16-SAMSS-502](#)
- b) Low Voltage Controlgear – [16-SAMSS-503](#)
- c) High Voltage Switchgear – [16-SAMSS-504](#)
- d) High Voltage Controlgear, Indoor – [16-SAMSS-506](#)
- e) High Voltage Controlgear, Outdoor – [16-SAMSS-507](#)
- f) Low Voltage Switchrack – [16-SAMSS-512](#)
- g) Adjustable Frequency Drive System: 1 kV and above – [16-SAMSS-517](#)

Commentary Note:

Equipment protection requirements are specified within the applicable SAMSSs. For example, for a large synchronous motor controlled from switchgear and an exciter panel, the protection and control requirements

*are specified within the switchgear **SAMSS** and the motor **SAMSS**. Integration and interconnection of protection systems is covered within [SAES-P-114](#).*

9.1.2 Within **Non-Industrial Facilities**: protection requirements shall be per the **NEC** unless specified otherwise within the **SAMSS**.

9.2 Stator Temperature Monitoring for Form-Wound Motors and Generators

9.2.1 Resistance temperature detectors (RTDs) provided for monitoring stator temperature shall be 100-ohm, platinum, three lead type with a temperature coefficient of resistance equal to 0.00385 ohm/ohm/°C.

9.2.2 RTDs shall be monitored by the multipurpose motor protection package which shall be set to trip or alarm on high temperature in accordance with the direction of the facility proponent. Where more than one RTD per phase is installed, the RTD that shows the highest reading during normal operating conditions shall be used to provide temperature information for trip and alarm functions.

Commentary Note 9.2.2:

Automatic trip on high stator temperature is recommended only for motors and generators in unmanned facilities. Alarm and trip settings should be based on the reading of the highest RTD and should be in accordance with the motor manufacturer's recommendations, if available. If manufacturer's recommendations are not available the following guidelines may be used: For alarm only installations High Temperature Alarm, 125°C and High High Temperature Alarm, 140°C. For alarm and trip installations High Temperature Alarm, 125°C, and High Temperature Trip, 140°C.

9.2.3 RTDs shall be installed in accordance with Table 2.

Table 2 – Stator Temperature Sensing Requirements

Type of Machine	Rating kW (Motor)	Rating HP (Motor)	Rating KVA (Generator)	Number of RTD Phase
Motor	185-7500	250-10,000		2
Motor	>7500	>10,000		3
Synchronous Generator			500-10,000	2
Synchronous Generator			>10,000	3

9.3 Bearing Temperature Monitoring for Form-Wound Motors and Generators

9.3.1 Horizontal motors rated 370 kW (500 HP) and above and generators rated 500 kVA and above shall have bearing temperature monitoring.

- 9.3.2 RTDs for bearing temperature monitoring shall meet requirements of 9.2.1.
- 9.3.3 Bearing temperature sensor installations shall meet the requirements of [34-SAMSS-625](#). Bearing temperature sensors may be offset from the bearing centerline where required.
- 9.3.4 Bearing temperature sensors shall be monitored either by the multifunction motor protection package or by a separate integrated system protecting the motor and the driven equipment.

Exception to 9.2 and 9.3:

Diesel generator sets built to [17-SAMSS-518](#).

Commentary Note 9.3:

Automatic trip on high bearing temperature is recommended. Settings should be in accordance with motor manufacturer's recommendations, if available, or 90°C for alarm and 95°C for trip.

9.4 Generator Protection

9.4.1 General

- a) The following ANSI Standards shall be consulted for additional guidance, explanation, and definition of the protection schemes required in this section:

Reference A: ANSI C37.101 Guide for Generator Ground Protection

Reference B: ANSI C37.102 Guide for AC Generator Protection

- b) For other than Standby/Emergency generators, where protection functions are provided by an integrated package, some redundancy must be provided. As a minimum, phase and ground overcurrent shall be provided by other relays or other packages.

9.4.2 Large Direct-Connected Synchronous Generators

- a) Refer to DD-950114/1 for the typical required protection for large direct-connected synchronous generators with a voltage rating of 13.8 kV or above and a kVA rating greater than 12,500 kVA.
 - b) The neutral grounding for the generator shall be low resistance type as described in ANSI C37.101, Table 1, Grounding Method III (Low Resistance).
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- c) The minimum required generator protection schemes for ground faults are described in ANSI C37.101, Table 1, Generator Connection E. Also refer to DD-950114/1 for a typical scheme.
 - i) Scheme 10 (Primary-connected CT with time-delay ground overcurrent relay) plus
 - ii) Scheme 16 (Percentage differential and polarized neutral overcurrent).
- d) Dual multifunction protection relays from two different manufacturers shall be used as listed in 16-SAMSS-513.

9.4.3 Large Unit-Transformer Connected Synchronous Generators

- a) Refer to DD-950114/2 for the typical protection for large unit-transformer connected synchronous generators with a voltage rating of 13.8 kV or above and a kVA rating greater than 12,500 kVA.
- b) The type of neutral grounding for the generator shall be high resistance type as described in ANSI C37.101, Table 1, Method I (Distribution Transformer grounded - High Resistance).
- c) The minimum required generator protection schemes for ground faults are described in ANSI C37.101, Table 1, Generator Connection E. Also refer to DD-950114/2 for a typical scheme.
 - i) Scheme 1 (Ground overvoltage) plus
 - ii) Scheme 5S (Starting ground overvoltage) plus
 - iii) Scheme 10 (Primary-connected CT with time-delay ground overcurrent).
- d) Dual multifunction protection relays from two different manufacturers shall be used as listed in 16-SAMSS-513.

9.4.4 Medium Size Direct-Connected Synchronous Generators

- a) Refer to DD-950114/3 for the typical protection for medium size direct-connected synchronous generators with a voltage rating of 1000 to 13,800 volts and kVA ratings greater than 1000 but not exceeding 12,500 kVA.
- b) The type of neutral grounding for the generator shall be low resistance type as described in ANSI C37.101, Table 1, Grounding Method III (Low-Resistance).

- c) The minimum required generator protection schemes for ground faults are described in ANSI C37.101, Table 1, Generator Connection E. Also refer to DD-950114/3 for a typical scheme.
 - i) Scheme 10 (Primary-connected CT with time-delay ground overcurrent) plus
 - ii) Scheme 16 (Percentage differential and polarized neutral overcurrent).
- d) Dual multifunction protection relays from two different manufacturers shall be used as listed in 16-SAMSS-513.

9.4.5 Small Standby/Emergency Generators

This section provides general protection requirements for small low voltage standby/emergency, diesel-engine driven generators.

- a) Where built-in protection is provided by the generator manufacturer, the protection for generators above 250 kW shall be subject to review in accordance with the system and equipment protection requirements of NFPA 70.
 - b) The generator's purpose and classification as emergency, standby, or both, shall be determined by the project proponent in accordance with NFPA 70, NFPA 110 and IEEE 446, Emergency and Standby Power Systems.
 - c) The minimum protection shall consist of phase overcurrent and ground overcurrent, protection devices.
 - d) The type of ground fault protection required for emergency generators shall be subject to review in accordance with the system and equipment protection requirements of NFPA 70.
 - e) The generator protection scheme shall be compatible with the following generator, exciter, and system parameters:
 - i) Type of Excitation System
 - ii) Magnitude and duration of generator fault currents
 - iii) Generator short-circuit withstand capability
 - iv) Coordination with downstream protective devices
 - f) Where a generator system is supplied with a molded-case main circuit breaker, the breaker shall have a continuous current rating not exceeding 125% of the generator's rated capacity.
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- g) Where a low-voltage main power circuit breaker is used, the breaker shall have a continuous current rating not less than the generator maximum rating. When a circuit breaker integral protection device is provided, it shall have long-time and short-time phase units only. A separate ground fault relay shall alarm only.
- h) The Vendor shall supply the following generator data for review and for use in calculating the relay settings:
 - i) Nameplate ratings.
 - ii) Short-circuit test data showing the magnitude and duration of fault currents for various types of faults on the generator terminals.
 - iii) Type and characteristics of excitation system.
 - iv) Short-circuit withstand capability (I^2T).
 - v) Built-in protection devices that are supplied as part of the generator assembly.

9.4.6 Relay Selection and Functions

Relays for generator protection shall be selected from those listed in 16-SAMSS-513. Refer to DD-950114/1,2,3 for typical schemes.

10 Duplication of Existing Motors

Motors 250 HP and Larger: For spare or direct replacement purposes only, duplicates of existing Saudi Aramco Form-type motors 250 HP and larger may be procured with **approval**. The duplicate motor does not have to meet present day Saudi Aramco standards but all the following guidelines must be adhered to:

- a) The duplicate is to be manufactured by the Original Equipment Manufacturer (OEM) of the existing motor or a listed manufacturer that owns the license and/or right to manufacture a duplicate, based on the outline drawings and performance curves for the existing motor.

Commentary Note 10 (a):

An approved (RVL) vendor may manufacture the duplicate motor, if the outline drawings and performance curves are available with Saudi Aramco or can be obtained from the OEM.

- b) The duplicated motor(s) shall match the original motor in the following:
 - 1. Electrically similar (motor rating and performance).
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2. Mechanically interchangeable (Footprint, shaft height, shaft extension dimension and other mechanical interfaces).
 3. Location of electrical equipment, termination box and other interfaces.
- c) Duplicate replacement is allowed if there are two or more existing motors of the exact type and size. A single duplicate spare is allowed if there are one or more existing motors of the exact type and size. The addition of a single duplicate motor to an existing train is allowed if the facility had planned for the addition when first built.
 - d) The existing motor design must have been free from major problems during its lifetime. CSD shall review the maintenance records and shall make a recommendation as to the suitability for duplication.
 - e) The new duplicate motor shall not be loaded beyond the usual loading of the existing motor and shall not exceed 100% of the nameplate rating.
 - f) If the plant has made minor modifications to the existing motor, such as the replacement of obsolete vibration transducers, these shall be noted in the purchase order so that the new duplicate motor may be outfitted with the minor modifications by the vendor in their factory.
 - g) The vendor shall put a hold on the manufacture of the new duplicate motor until the outline drawings and performance curves of the existing motor and the new duplicate motor have been reviewed by Saudi Aramco and the new duplicate motor drawings approved. To be acceptable the duplicate motor must fit into the exact footprint of the existing motor and must exhibit equal or better performance. CSD shall make a recommendation as to the suitability of the new duplicate for release to manufacture.

29 June 2005

Revision Summary
Major revision.