Engineering Standard

SAES-P-116 2 June 2013

Switchgear and Control Equipment

Document Responsibility: Electrical Substations Equipment Standards Committee

Saudi Aramco DeskTop Standards

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1 Scope

This standard presents the mandatory requirements for the selection and application of Power and Control Equipment. This document may not be attached to nor made a part of purchase orders.

2 Conflicts and Deviations

2.1 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).*

2.2 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 waiver request to the Manager, Consulting Services Department of Saudi Aramco, Dhahran requesting his approval.

2.3 The designation "Commentary" is used to label a sub-paragraph that contains comments that are explanatory or advisory. These comments are not mandatory, 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 Procedures

SAEP-136	*Saudi Aramco Management of Electric Equipment Obsolescence Program*
SAEP-302	*Instructions for Obtaining a Waiver of a Mandatory Saudi Aramco Engineering Requirement*

Saudi Aramco Engineering Standards

SAES-B-009	*Firewater Protection and Safety Requirements for*

	Offshore Production Facilities
SAES-K-001	*Heating, Ventilating & Air Conditioning (HVAC)*
SAES-K-002	*Air Conditioning Systems for Essential Operating Facilities*
SAES-P-100	*Basic Power System Design Criteria*
SAES-P-101	*Regulated Vendors List for Electrical Equipment*
SAES-P-103	*Direct Current and UPS Systems*
SAES-P-104	*Wiring Methods and Materials*
SAES-P-113	*Motors and Generators*
SAES-P-114	*Power System and Equipment Protection*
SAES-P-119	*Onshore Substations*
SAES-P-121	*Transformers and Reactors*
SAES-P-126	*Power Monitoring System*

Saudi Aramco Materials System Specifications

14-SAMSS-531	*Power Transformers*
14-SAMSS-536	*Pad-Mounted, Three-Phase Distribution Transformers*
16-SAMSS-502	*Metal-Enclosed Low-Voltage Switchgear Assemblies*
16-SAMSS-503	*Indoor Controlgear - Low-Voltage*
16-SAMSS-504	*Indoor Metal-Clad Switchgear - 1 to 38 kV*
16-SAMSS-506	*Indoor Controlgear - High Voltage*
16-SAMSS-507	*High Voltage Motor Controller - Outdoor*
16-SAMSS-508	*SF_6 Gas Insulated Circuit Breakers, Outdoor - 34.5 kV through 230 kV*
16-SAMSS-510	*Manually Operated Pad Mounted SF6 Switchgear: 1 kV to 36 kV*
16-SAMSS-512	*Switchracks and Factory Built Assemblies - Low Voltage*
16-SAMSS-514	*Control and Protective Relay Panel - Indoor*
16-SAMSS-517	*Adjustable-Frequency Drive System: 1 kV and above*
16-SAMSS-518	*Low Voltage Panel Boards*

16-SAMSS-519	*Indoor Switchboard - Low Voltage*
16-SAMSS-520	*Cablebus*
16-SAMSS-521	*Indoor Transfer Switch – Low Voltage*
16-SAMSS-522	*Retrofit/Replacement Vacuum Circuit Breakers Applied in Indoor Metal-Clad Switchgear: 1 to 38 kV*
16-SAMSS-523	*Enclosed Isolated Phase Bus - Indoor and Outdoor*

3.2 Industry Codes and Standards

American National Standards Institute

ANSI C37.010	*Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis (IEEE STD 320)*
ANSI C37.13	*Low-Voltage AC Power Circuit Breakers Used in Enclosures*

Institute of Electrical and Electronics Engineers

IEEE C37.04	*Rating Structure for High-Voltage Circuit Breakers*
IEEE C37.09	*Standard Test Procedures for High Voltage Circuit Breakers*
IEEE C37.20.2	*Standard for Metal-Clad Switchgear*
IEEE C37.54	*Conformance Test Procedures*

International Electrotechnical Commission

IEC 60146 series	*Semiconductor Convertors*
IEC 61136 series	*Semiconductor Power Convertors – Adjustable Speed Electric Drive Systems*

National Electrical Manufacturers Association

NEMA ICS 7	*Industrial Control and Systems Adjustable Speed Drives*

National Fire Protection Association

NFPA 20	*Standard for the Installation of Centrifugal Fire Pumps*
NFPA 70	*National Electrical Code*

Underwriters Laboratories

UL 218	*Safety Fire Pump Controllers*
UL 489	*Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures*

4 Definitions

AFD: Adjustable Frequency Drive

Air-Conditioned: The design shall be as defined within standards SAES-K-001 / SAES-K-002 with the requirement that the temperature shall be controlled to a maximum of 35°C.

Approval: Written approval of the **ESD Coordinator**.

Approved Manufacturers: As listed within SAES-P-101.

Automatic Molded Case Switch: Switch meeting the requirements of UL 489 and complying with the requirements of UL 489 for molded case circuit breakers, except that the only release mechanism is a factory set and sealed instantaneous release mechanism.

Branch Circuit, Separately Derived System, etc.: Refer to NFPA 70 for general definitions.

Bus Tie Breaker: A breaker used to connect separately derived systems together, of the same voltage, frequency and phase sequence. Only acceptable within secondary-selective switchgear.

Cablebus: Equipment manufactured to 16-SAMSS-520.

Enclosed Isolated Phase Bus: Equipment manufactured to 16-SAMSS-523.

ESP System: Electrical Submersible Pump in crude oil service complying with SAES-I and 55-SAMSS series of standards.

Cascade Rated Protection System: Using an interrupting device with a short circuit interrupting rating less than the fault current at the point of application. The design depends upon an upstream interrupting device with an instantaneous element clearing the fault before the under-rated breaker operates.

Controlgear: Equipment manufactured to either 16-SAMSS-503 (Low Voltage Controlgear), 16-SAMSS-506 (High Voltage Controlgear) or 16-SAMSS-507 (High Voltage Motor Controller - Outdoor).

Critical Loads: Refer to SAES-P-100 for definition:

Demand: Electrical load averaged over a specified time period.

Distribution equipment: Equipment used to distribute power to utilization equipment or other distribution equipment. For example switchgear, controlgear, panelboards, switchracks, switchboards etc.

Emergency Application: Devices and equipment whose failure to operate satisfactorily would jeopardize the health and safety of personnel or result in property damage. Includes Life Support and Life Safety Applications.

ESD Coordinator: Coordinator, Consulting Services Department/Electrical Systems Division, Saudi Aramco, Dhahran

Factory Built Assemblies or FBAs: Individual, self-contained electrical devices (e.g., combination motor controllers, enclosed circuit breakers, enclosed contactors, pushbutton stations, receptacles, etc.) which meet the requirements within 16-SAMSS-512 for such devices contained.

Firewater Pump Controller: Equipment meeting the requirements of NFPA 20 and listed by UL 218.

Commentary Notes:

- *16-SAMSS-506 is not applicable to the manufacturer of this equipment.*
- *The **approved manufacturers** of these controllers are different than the approved **manufacturers** for non-firewater pump controllers.*

Gas Insulated Circuit Breakers: Equipment manufactured per 16-SAMSS-508.

GIS: Gas Insulated Switchgear

High Voltage: Voltages greater than 1 kV but less than 100 kV.

High Voltage AFD (rated 1 kV and above): is equipment manufactured to 16-SAMSS-517.

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.

Life Safety Application: An Emergency Application involving equipment necessary to protect life during emergencies (e.g., fire monitoring and alarm, safety lighting, communications, etc.).

Life Support Application: An Emergency Application involving equipment necessary to sustain life. This equipment is generally only found in hospitals. (e.g., operating room equipment).

Loop Distribution: Characterized by equipment having two incoming power connections and multiple outgoing power feeds, but only one source of power. The incoming connection that is not the power source is used to route the power to another **loop distribution** device.

Low Voltage: Less than 1000 V.

Low Voltage AFD (less than 1 kV): is equipment meeting the requirements of IEC 60146 and IEC 61136 series of standards or NEMA ICS 7.

Main Disconnector: A device to isolate equipment (e.g., controlgear) from the main incoming circuit.

Manually-Operated Pad Mounted Switchgear: Equipment manufactured per 16-SAMSS-510.

Motor Bus: Switchgear whose feeder breakers will (present and future) only be used to control motors.

Nominal Voltage: Refer to SAES-P-100 for definition.

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

a) Shops

b) Small office buildings

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.

Operating Load:

a) For new facilities: Anticipated one-hour **demand** based on plant or facility design conditions.

b) For existing facilities: When data from metering equipment is available; Maximum 60-minute **demand** measured over a minimum of one year.

Commentary Note:

Depending on the nature of the loads, the operating load may be substantially less than the total connected load.

Pad-Mounted Transformer: Equipment manufactured per 14-SAMSS-536.

Panelboard: Equipment manufactured per 16-SAMSS-518.

Power Transformer: Equipment manufactured per 14-SAMSS-531.

Radial Distribution: Characterized by equipment having one incoming power connection and multiple outgoing power feeds.

SAMSS: Saudi Aramco Materials System Specification

Secondary-Selective Substation: As defined within SAES-P-100.

Secondary-Selective: A **switchgear** assembly consisting of two buses connected with a single **bus tie breaker**. Each bus has one breaker to receive incoming power (i.e., power flow into and between the two busses is controlled with three breakers), also, referred to as "double-ended" switchgear.

Series Rated Protection Systems: A short-circuit interrupting rating assigned to a combination of two or more overcurrent devices connected in series and in which the rating of individual upstream and/or downstream device(s) in the combination is less than the series rating.

Site Rating: Actual operating rating of the equipment based upon environmental

conditions stated in SAES-P-100.

Spare and **Space:** Are as described within the applicable SAMSS for Switchgear, Controlgear and Switchboards.

Substation: Per the definition within SAES-P-119.

Switchboard: Equipment manufactured per 16-SAMSS-519.

Switchgear: Equipment manufactured to either 16-SAMSS-502 (Low Voltage Switchgear) or 16-SAMSS-504 (High Voltage Switchgear).

Switching assembly: Refer to 16-SAMSS-503 for definition.

Switching Device: Device intended to make or break the current in one or more electrical circuits.

Switchrack: Equipment manufactured per 16-SAMSS-512.

Transfer Switch(es)/(TS): Equipment manufactured per 16-SAMSS-521.

Utilization equipment: Equipment whose primary function is to convert electrical energy to another form, or store electrical energy. Examples of utilization equipment would be motors, heaters, lamps, batteries, etc.). Equipment directly feeding/controlling the utilization equipment is considered part of the utilization equipment (e.g., AFDs, reduced voltage starters, battery chargers etc.)

5 General

5.1 Terms in **bold** font are defined within Section 4.

5.2 The engineering documents (e.g., one-line drawings) that are part of the purchasing requisitions shall indicate the type of devices connected to allow the equipment manufacturer to properly select the equipment components.

5.3 Protection requirements for specific equipment are covered within the applicable **SAMSS** to which the equipment is connected. For general protection guidelines and protection of equipment not covered by the **SAMSS**, refer to SAES-P-114.

5.4 If **switchgear** or **controlgear** is being considered for expansion, SAEP-136 shall be applied to determine if the existing equipment is obsolete. If application of the process within SAEP-136 deems the equipment is obsolete, the equipment shall not be expanded. It is acceptable that the new equipment receive power from the obsolete equipment however the new equipment shall be physically independent of the obsolete equipment.

Commentary Notes 5.4:

"Expansion" would generally include, for example, physically extending the main bus structure by adding vertical sections to equipment,

"Physically Independent" would generally mean that the new equipment has its own ***main disconnector*** *or receives power on the line side of the obsolete equipment.*

6 Selection

6.1 Transformers serving industrial facilities shall be fed from either switchgear, GIS, switchracks, manually-operated pad mounted switchgear or gas insulated circuit breakers.

Exception:

For overhead lines operating at a maximum of 15 kV, pole mounted cut-outs, switches, and circuit switchers are acceptable to feed transformers.

6.2 Transformers with resistance grounded secondaries shall be fed by circuit breakers.

6.3 Only the following equipment shall be used for the distribution, switching, protection and control of electrical systems:

a) Switchgear.

b) Controlgear.

c) **Switchracks** rated 600A or less.

d) Manually-operated pad mounted switchgear.

Exception:

Shall not be used in ***Industrial Facilities with the exception of ESP Systems.***

e) Firewater pump controllers.

f) Adjustable frequency drives (AFDs).

g) Panelboards.

Exception:

In ***industrial facilities***, ***panelboards*** *shall be rated 400 A or less.*

h) Switchboards

Exception:

Switchboards shall not be used in ***industrial facilities****.*

i) Transfer Switches.

j) Factory Built Assemblies (FBAs).

k) Gas Insulated Circuit Breakers.

6.4 **Bus tie breakers** shall conform to the following:

a) Shall only be used within **switchgear**.

b) Shall be operated normally-open.

c) Shall consist of a single breaker. (e.g., two breakers in series are not permitted).

6.5 Neutral buses shall not be used within **controlgear** or **switchgear**.

Exception:

If the equipment is a direct replacement for existing equipment with neutral busses.

6.6 All electrical equipment operating at greater than 240 V shall have an individual **switching device** intended to be used for electrical isolation. This **switching device** shall be equipped with a padlockable lock-off device which will mechanically prevent the connection of the primary power to the equipment when the padlock is installed.

Commentary Note:

*This **switching device** does not have to be local to the equipment. The term "individual" means that there shall be a **switching device** for each piece of equipment (i.e., the **switching device** which isolates a particular piece of equipment shall not isolate any other equipment).*

6.7 Silicone liquids or flammable liquids (such as oils and esters) shall not be used as an insulating or current interrupting media.

Exception:

Transformers.

6.8 Main bus systems of different types of equipment shall not be directly connected together.

Commentary Note:

*For example, this prohibits the main bus of **controlgear** to be directly connected to the main bus of **switchgear**. This requirement does not prevent a **switchgear** assembly with a single circuit breaker to be used as a **main disconnector** for the **controlgear**.*

6.9 Environmental rating of enclosures and equipment installed outdoors shall be per SAES-P-104.

6.10 Motor controller selection shall be based upon the following criteria:

6.10.1 **Switchgear** shall not be used to control motors.

Exception to 6.10.1:

***High voltage** motors rated greater than 4 kV.*

6.10.2 Reduced voltage starters shall not be used.

Exception to 6.10.2:

*If **approval** is obtained.*

6.11 Substations operating at 69 kV or above offshore or within 5 km of the coast shall be of the **GIS** type.

6.12 Busduct shall not be used.

Exception:

Direct replacement for existing busduct system.

6.13 The interrupting rating shall not be dependent upon upstream interruption devices. (i.e., series rated and cascade rated protection systems are prohibited).

6.14 Only **secondary-selective switchgear** shall be used to feed critical loads.

Exception:

*With **approval, critical loads** or equipment fed from a single-ended substation bus which has a standby generator capable of automatically supplying the required power to the bus within 10 seconds after a power failure.*

7 Installation

7.1 **Switchgear**, **controlgear**, **switchboards, transfer switches** and **adjustable frequency drives** shall only be installed in an indoor, air-conditioned environment.

Exceptions:

Controller manufactured to 16-SAMSS-507 "High Voltage Motor Controller - Outdoor".

*Manual **transfer switches** are allowed outdoors.*

7.2 Unobstructed horizontal space shall be provided as follows:

7.2.1 **Switchgear**

a) 2 meters in front.

b) 1 meter in back and sides.

7.2.2 **Controlgear, switchboards, transfer switches, and floor mounted adjustable frequency drives**:

a) 1.5 meters in front.

b) 1 meter on the sides.

Commentary Note:

***Controlgear** mounted in a back-to-back configuration has two fronts.*

Exceptions to 7.2.1 and 7.2.2:

For extensions to existing equipment, spacing shall meet the requirements of NFPA 70.

7.2.3 **Panelboards and switchracks**: 1 meter in front.

7.2.4 The spacing requirement between equipment shall be based upon the largest dimension for either.

Commentary Note:

*The spacing requirement is not additive. For example, if **controlgear** is installed parallel, and in front of **switchgear**, the space between the front of the **switchgear** and the front of the **controlgear** shall be 2 meters.*

7.2.5 For on-shore, outdoor installations, pad-mounted electrical equipment shall be placed on a level concrete pad, the top of which is elevated a minimum of 100 mm above natural grade. Unless greater clearances are specified by the NEC, the following minimum clearances shall apply:

a) A minimum working clearance of 2 meters on all sides.

b) A minimum working clearance of 3 meters on the sides of the equipment having doors or access panels which can be opened to expose live parts.

c) The intent of the above requirements is met by gate(s) which can be opened to provide the required clearance.

Exception:

Clearance between pad-mounted electrical equipment and fences or walls installed for the purpose of protecting the equipment from unauthorized access is permitted to be reduced to a minimum of 1 meter with the concurrence of the proponent, provided that the 3-meter clearance is maintained for equipment doors and access panels required to be opened for normal maintenance and/or operations.

Commentary Note:

The above clearances are minimums, NFPA 70 or equipment manufacturer may require greater clearances for some installations.

7.3 Cable shall not be used to extend the main bus of **switchgear, controlgear, switchboards**, **switchracks** and **panelboards**.

7.4 Motor Installations:

7.4.1 A manual shutdown device shall be located within sight of each motor or motor location (if the motor is not visible). With the exception of skid mounted or packaged equipment, each motor shall have a separate, independent shutdown device. The shutdown device shall have the following characteristics:

a) Operation of the device shall de-energize the motor and a manual operation must be performed at the shutdown device location before motor operation is allowed to resume.

b) Shall be either:

i) A fully rated manual main circuit switch, or

ii) A switch/pull/push-button hard-wired within the motor control circuit of the main circuit contactor or circuit breaker. This device shall not be designed, or equipped with features, capable of accepting padlocks.

c) Loss of continuity within the hard-wired control circuit shall de-energize the motor:

Exceptions:

i) Fire pump motors.

*ii) Motors controlled via switchgear providing the conductors are continuous and unspliced between the **switchgear** and the manual shutdown device.*

d) The function of the device shall not be dependent upon solid-state devices and shall be independent of, and in addition to, any shutdown initiating devices implemented through an emergency shutdown (ESD) or regulatory control (e.g., DCS) system.

7.4.2 Field mounted motor operation indicating lights shall be provided if the operation of the motor can not be visually determined from the manual shutdown device (description above) location. Indicating light system shall have the following characteristics:

a) Be mounted with, or within, the manual shutdown device.

b) Separate red and green colored lights shall be used to indicate motor operation status. Lights shall be controlled via the contactor/circuit breaker auxiliary contacts.

c) Fixture design shall be able to withstand the continuous shorting out of the lamp terminals. Under these conditions, the associated controller shall function normally.

d) Lamp shall be high density LED (Light Emitting Diode) type providing a light intensity similar to an incandescent fixture.

7.4.3 Motor space heater control equipment shall be provided. This equipment shall have the following characteristics:

a) Each motor with space heater shall have a separate enclosed contactor to operate all the space heaters in the motor. This space heater system shall be as follows:

b) A separate branch circuit shall be provided for each motor space heater system.

c) Control voltage shall operate at a maximum of 24 V.

d) Energization of contactor shall energize the space heaters in the motor.

Commentary Note:

*The **SAMSS** for **controlgear** and **switchgear** requires the manufacturer to provide a contact for each switching assemblies controlling a motor be wired to a terminal block within the assembly that is closed when the space heater is required to be energized.*

7.5 Motor Operated Valves (MOVs) are not required to have a local, padlockable disconnect device.

7.6 Protection and control equipment for **high voltage**, outdoor SF_6 circuit breaker systems 69 kV and above shall be contained with a panel meeting the

requirements or 16-SAMSS-514. This panel shall be installed within the **air-conditioned** electrical building containing the other electrical equipment associated with the substation.

8 Common Area Facilities

8.1 Within a room containing **switchgear, switchboards, adjustable frequency drives, controlgear** or **panelboards**, lifting/handling devices shall be provided to mechanically assist in removing to floor level, any withdrawable component (e.g., circuit breaker, contactor, potential transformer, etc.) weighing over 20 kg. For switchgear, these devices shall be specified via Data Schedule 1 within the switchgear specification.

8.2 Within a room containing **high voltage switchgear,** a 125 VDC control power system shall be supplied complying to SAES-P-103. A **panelboard** shall be provided with the capability to supply two branch circuits to each **switchgear** bus plus an additional 20% spare pole capacity.

Commentary Note:

*A **secondary selective** switchgear lineup has two busses.*

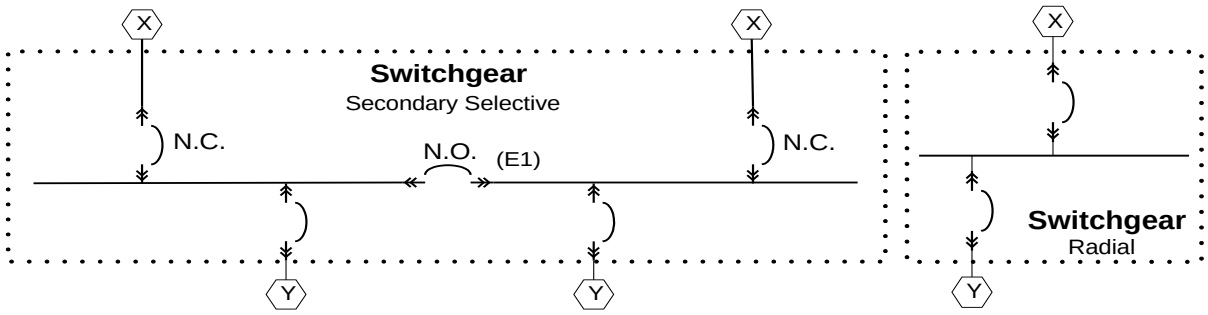
8.3 As specified within SAES-P-119, all new or expanded electrical buildings containing **high voltage** equipment shall be interconnected to the central control room with a data and voice communications system.

8.4 SAES-P-126 prescribes mandatory design and installation requirements of the protection, control, and metering system.

9 Switchgear

9.1 General

9.1.1 **Switchgear** assemblies shall be configured as follows:



Column A	B	C		D		E		F		G	H		I	
Nominal Voltage	Connection	Transformer Winding		Switchgear		Controlgear Firewater Pump Controller		Motor		TS	Switchrack		HV AFD	
13.8kV	X	Yes	(L1)	Yes	(E3)	No		N/A		No	No		No	
	Y	Yes	(L2)	Yes		No		Yes	(L3) (E4)	No	No		Yes	
4.16kV	X	Yes	(L1)	Yes	(E3)	No		N/A		No	No		No	
	Y	No	(E2)	Yes	(L4)	Yes		No		No	No		Yes	
480V	X	Yes	(L2)	Yes	(E3) (L4)	No		N/A		Yes	No		No	
	Y	No	(E2)	Yes		Yes		No		Yes	Yes	L5	Yes	

Limitations:

L1 Secondary winding of step-down transformer

L2 Primary winding of step-down transformer

L3 Individual motor rated (in HP) a maximum of 20% of MVA, OA rating of transformer winding in Column C. For example, if transformer winding OA rating is 50 MVA, maximum motor rating is 20% of 50 MVA in HP (i.e., 10000 HP)

L4 **In industrial facilities**, 480 V **switchgear** shall not be fed from 4160 V systems if the distance is 500 meters or less.

L5 Maximum **switchrack** rating is 600A.

Exceptions:

*E1 Normally Closed (N.C.) **bus tie breaker** acceptable if **switchgear assembly** is a direct replacement for an existing assembly that is operated and designed for N.C.*

*E2 Specialized transformer applications such as process heaters, desalters, **AFD** isolation transformers or captive transformers for **firepump controllers**.*

*E3 Incoming breaker on radial **switchgear assembly** is optional.*

*E4 Exception to maximum motor rating limitation is if all the **switchgear** connected to a transformer secondary winding is designated a **motor bus**.*

9.1.2 Within a room containing **high voltage switchgear**, portable, manually operated ground and test device(s) shall be provided. The type and number of these device(s) shall ensure that, within the room, there is a ground and test device which will install in any circuit breaker cubicle.

These devices shall be specified via Data Schedule 1 within the switchgear specification.

9.1.3 Each room containing **high voltage switchgear** shall be equipped with test unit(s) capable of functionally testing all the circuit breakers within the room. Test units shall be specified via Data Schedule 1 within the switchgear specification.

9.2 Circuit Breaker Vacuum Retrofits or Direct Vacuum Replacement Circuit Breakers

9.2.1 **High Voltage** Metal-clad circuit breaker vacuum retrofit or direct replacement circuit breakers shall meet the requirements of 16-SAMSS-522.

9.2.2 The information specified in 16-SAMSS-522 must be supplied to CSD for review and **approval by the Electrical Standards Committee Chairman** be obtained prior retrofitting any Saudi Aramco **High Voltage** circuit breaker.

9.3 Refer to Section 5 for requirements for expansion of obsolete **switchgear**.

10 Controlgear

10.1 General

10.1.1 As detailed within Section 7, **controlgear** shall only be installed in an indoor, **air-conditioned** environment.

10.1.2 **Panelboards** and dry-type distribution or lighting transformers shall not be installed within **controlgear** or **low voltage switchgear**.

10.1.3 **Controlgear** in substation buildings containing resident Distributed Control System (DCS) Input/Output (I/O) ports may be specified, and the system designed, so that all DCS control of the **controlgear** shall be via serial communication between the DCS communication ports(s) and the **controlgear**. If this type of design is specified, the communication protocol and topology shall be as follows:

a) Maximum **switching assemblies** per topology type shall be as follows:

i) If redundant loop topology: 10 for **high voltage controlgear**, 50 for **low voltage controlgear**.

ii) If radial topology; 5 for high voltage controlgear, 20 for low voltage controlgear.

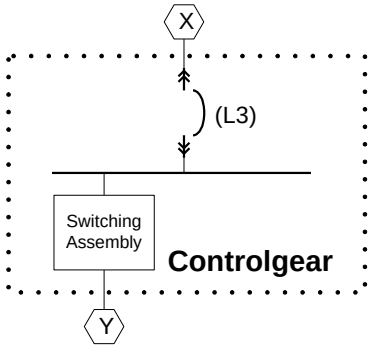
b) **Switching assemblies** for the operating and standby/redundant/spare loads shall not be on the same radial or loop service.

c) No intermediate protocol translator shall be installed in the communication circuit between the controlgear and the DCS I/O card.

Commentary Note:

Per SAES-P-119, resident DCS I/O is required in new substation buildings.

10.1.3 **Controlgear** shall be configured as follows:



Column A	B	C	D	E	F	G
Nominal Voltage	**Connection**	**Transformer winding**	**Switchgear**	**- Controlgear -Firewater Pump Controller -Switchrack**	**Motor**	**TS**

4.16kV	X	Yes	(L1)	Yes		No		N/A		No	
	Y	No	(E1)	No		No		Yes		No	
480V	X	Yes	(L1)	Yes		No		N/A		Yes	
	Y	Yes	(L2)	no		No	(E2)	Yes		No	

Limitations: L1 Secondary winding of step-down transformer.

L2 Primary winding of step-down, dry type distribution transformers.

L3 See this standard for requirements of when main disconnector is required for low voltage **controlgear**.

Exceptions:

*E1 Specialized transformer applications such as process heaters, desalters, **AFD** isolation transformers or captive transformers for firepump controllers.*

*E2 It is acceptable that **low voltage controlgear** feed distribution transformers feeding **panelboards**.*

10.2 Low Voltage Controlgear

10.2.1 For **low voltage controlgear**, the following criteria shall be used for specifying whether a **main disconnector** is used within the **controlgear** and what type it should be:

a) If fed from a circuit breaker within **low voltage switchgear**:

i) If the **controlgear** is within the same electrical room as the **switchgear** from which it is fed, no **main disconnector** shall be installed within the **controlgear**.

ii) If the **controlgear** is not within the same electrical room as the **switchgear** from which it is fed, requirement for **main disconnector** within the **controlgear** shall be as shown on the engineering documents.

iii) In all cases, no intermediate circuit breaker shall be installed between the **switchgear** breaker and the **controlgear**.

b) If fed from a **transfer switch**, and the **controlgear** is within the same electrical room as the transfer switch from which it is fed, no **main disconnector** shall be installed within the **controlgear** and the **transfer switch** shall be specified as being fully withdrawable.

10.2.2 No devices (e.g., circuit breakers, terminal blocks, relays, etc.) shall be field installed within the wireways of the **controlgear**.

10.3 Refer to Section 5 for requirements for expansion of obsolete **controlgear**.

11 Switchboards

11.1 **Switchboards** shall only be used to distribute electricity within **non-industrial facilities**.

11.2 **Switchboards** shall not be installed in a back-to-back configuration.

11.3 **Switchboards** shall only be used for **low voltage** applications.

11.4 **Switchboards** shall have a maximum rating of 2000 A.

11.5 As detailed within Section 7, **switchboards** shall only be installed in an indoor, **air-conditioned** environment.

12 Switchracks

12.1 Switchracks shall only be fed from **switchgear** or directly from the secondary of a distribution transformer.

12.2 The requirement for a main disconnector within the **switchrack** shall be as shown on the engineering documents.

12.3 The current rating of a **switchrack** shall be a maximum of 600A and a minimum of 125% of the **switchrack** maximum **operating** load.

12.4 **Switchracks** shall only be used in **low voltage** applications.

12.5 The **switchrack** specification applies whether or not the **switchrack** is completely or partially field assembled or whether it is installed as a fully assembled unit.

13 Manually-Operated Pad Mounted Switchgear

13.1 Shall only be used outdoors.

13.2 Shall only be used for **radial distribution** or **loop distribution**.

13.3 Shall not directly feed **utilization equipment**.

13.4 Shall not be used in an automatic transfer configuration.

13.5 Shall not be used in **industrial facilities**.

Exception:

Distribution of power to ESP Systems and associated support loads.

13.6 Shall be limited to a maximum of six (6) switch way positions.

14 Cablebus/Busduct

14.1 Busduct shall not be used.

Exception:

Replacements to existing busduct systems.

14.2 **Cablebus** shall be used with **power transformers** if the forced cooled **site rating** of the transformer is greater than 1200 A.

14.3 **Cablebus** shall not be used with pad-mounted transformers.

14.4 If the busduct or **cablebus** is penetrating a wall with a fire rating, the busduct or **cablebus** shall be supplied with a listed internal fire barrier and vapor barrier. The damper/barrier shall have the same, or greater, fire rating as the wall through which it passes.

15 Panelboards

15.1 **Panelboards** rated for installation in an electrically classified environment shall be installed completely filled with breakers and have 20% spare breakers. All other **panelboards** shall be equipped with a minimum of 10% spare breakers and a minimum of 10% spare pole spaces. The sizes of the spare breakers shall be representative of the connected breakers within the **panelboards**.

15.2 **Panelboards** shall only be used for **low voltage** applications.

15.3 **Panelboards** in **industrial facilities** shall be rated 400A or less.

15.4 **Panelboards** in **non-industrial facilities** shall be rated 1000A or less.

15.5 **Panelboards** shall not be installed within **controlgear**.

16 Transfer Switches

16.1 Shall only be used in **low voltage** applications.

16.2 Automatic **transfer switches** shall be installed indoors.

16.3 Shall not be used as a substitute for a **secondary-selective substation**.

16.4 If used for **emergency applications, transfer switches** shall be automatic and shall be specified to have switched or overlapping neutral contacts and maintenance bypass switches.

16.5 Closed-transition **transfer switches** shall not be used.

16.6 Refer to Section 10 for situations that require fully withdrawable pole elements.

17 Adjustable-Frequency Drives

17.1 General

The application of **AFD**s on existing motors shall be reviewed by CSD/ESD.

17.2 Harmonic Control

When installing a **high voltage AFD**, harmonic performance requirements for the power systems is specified within 16-SAMSS-517.

Commentary Note:

*To perform the harmonic study, the **AFD** system supplier will be requiring electrical system information and, possibly, be allowed access to the Saudi Aramco facility to perform system measurements, tests and benchmarking. It is necessary that all parties involved with the **AFD** system installation provide information/coordination to the drive system supplier in a timely manner.*

17.3 Low Voltage AFDs

Shall meet the requirements of either:

a) The IEC 60146 and IEC 61136 series of standards.

b) NEMA ICS 7.

17.4 **High Voltage AFD** Systems

17.4.1 Shall comply with 16-SAMSS-517. All the requirements of this specification must be fulfilled by the **AFD** manufacturer.

17.4.2 Shall be fed only from **switchgear**.

17.4.3 The **AFD** system supplier shall perform, or directly oversee the commissioning and startup of all drive systems 2000 kW and larger.

17.4.4 Bypasses shall not be incorporated around the **AFD**.

Commentary Note:

Bypass systems are generally unnecessary, are not practical for some motor designs, and may require uneconomical additions to piping and valve systems.

17.4.5 As indicated within 16-SAMSS-517, the **AFD** system supplier is responsible to provide the buyer with any specific cabling requirements to, and between the devices associated with the **AFD** system (e.g., to

and from the **AFD** isolation transformer filter, motor, etc.). The **AFD** manufacturer shall concur to the cable design and installation.

18 Firewater Pump Controllers

18.1 Firewater pumps shall be fed from the most reliable available bus.

18.2 Firewater pumps shall be controlled with a **firewater pump controller**.

18.3 For process areas, where multiple firewater pumps are required, between 33% and 50% of the motor driven firewater pump capacity shall be supplied from a system that can automatically transfer the motors to an independent power source. These sources can be either two utility, one utility feeder and one generator, or two generators.

Commentary Note:

*Automatic **TSs** or **secondary-selective** systems meet the above requirement.*

18.4 **Firewater Pump Controllers** shall be installed in accordance with NFPA 20 and NEC Article 695 requirements except as modified by this standard.

18.5 Firewater Pump Controllers shall be fed by **switchgear**.

18.6 **Firewater pump controllers** shall be specifically listed by UL 218 for electric motor driven firewater pump service and shall be installed within sight of the firewater pump motor.

Exceptions:

*1) For Sea Islands and offshore facilities covered by SAES-B-009, **firewater pump controllers** may be located in the main **switchgear** room and are exempted from NFPA 20, Paragraph 7-2.1. A sign shall be placed near the firewater pump motor noting the location of the controller.*

2) Sea Islands are not required to have listed controllers.

Commentary Note:

*Electrical equipment on existing Sea Islands is required to be suitable for hazardous locations. It is difficult or impossible to obtain listed **firewater pump controllers** that are suitable for hazardous locations.*

18.7 A jockey pump motor shall not be fed from the controller of a firewater pump motor. Jockey pump controllers are not required to be UL listed.

Revision Summary

2 June 2013 Major revision to define the correct application for this equipment.