

Engineering Standard

SAES-P-116

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Switchgear and Control Equipment

Electrical Substations Equipment Standards Committee Members

Ghamdi, Mohammed A., Chairman

Carlson, Ron W., Vice Chairman

Fayez, Hamad A.

Gopal, Uarutharaja

Hartman, Ralph A.

Helfrich, Cory H.

Lowe, John L.

Maghrabi, Ibrahim M.

Nazzawi, Abdullah O.

Ojan, Jawad A.

Ramadhan, Mohammed J.

Refaee, Jubran A.

Rewatkar, Jayesh K.

Stansbury, M.C. "Chip" (ABQ PLANTS)

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 form SA 6409-ENG 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 Procedure

[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)

| | |
|-----------------------------------|--|
| <u>SAES-K-002</u> | <i>Air Conditioning Systems for Essential Operating Facilities</i> |
| <u>SAES-P-100</u> | <i>Basic Power System Design Criteria</i> |
| <u>SAES-P-101</u> | <i>Regulated Vendors List for Electrical Equipment</i> |
| <u>SAES-P-103</u> | <i>Direct Current and UPS Systems</i> |
| <u>SAES-P-104</u> | <i>Wiring Methods and Materials</i> |
| <u>SAES-P-113</u> | <i>Motors and Generators</i> |
| <u>SAES-P-114</u> | <i>Power System and Equipment Protection</i> |
| <u>SAES-P-119</u> | <i>Onshore Substations</i> |
| <u>SAES-P-121</u> | <i>Transformers and Reactors</i> |
| <u>SAES-P-126</u> | <i>Power Monitoring System</i> |

Saudi Aramco Materials System Specifications

| | |
|-------------------------------------|---|
| <u>14-SAMSS-531</u> | <i>Power Transformers</i> |
| <u>14-SAMSS-536</u> | <i>Pad-Mounted, Three-Phase Distribution Transformers</i> |
| <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-508</u> | <i>SF6 Gas Insulated Circuit Breakers, Outdoor - 34.5 kV through 230 kV</i> |
| <u>16-SAMSS-510</u> | <i>Manually Operated Pad Mounted SF6 Switchgear: 1 kV to 36 kV</i> |
| <u>16-SAMSS-512</u> | <i>Outdoor Switchrack - Low Voltage</i> |
| <u>16-SAMSS-514</u> | <i>Control and Protective Relay Panel - Indoor</i> |
| <u>16-SAMSS-517</u> | <i>Adjustable-Frequency Drive System: 1 kV and above</i> |
| <u>16-SAMSS-518</u> | <i>Low Voltage Panel Boards</i> |
| <u>16-SAMSS-519</u> | <i>Indoor Switchboard - Low Voltage</i> |
| <u>16-SAMSS-520</u> | <i>Cablebus</i> |

[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*

Saudi Aramco Form and Data Sheet

SA 6409-ENG

*Request for Waiver of Saudi Aramco Engineering
Requirement*

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-001/002](#) 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.

Commentary Note:

Effective October 31, 2000, UL 489 will cover both molded case circuit breakers and molded case switches.

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](#).

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).

Demand: Electrical load averaged over a specified time period.

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](#).

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).

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

Manually-Operated Pad Mounted Switchgear: Equipment manufactured per [16-SAMSS-510](#).

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](#).

PML: Power Measurement Limited

Commentary Note:

www.pml.com. Headquarters: Saanichton, Canada Tel: 1-250-652-7100, Fax: 1-250-652-0411. Europe & Middle East: Zaventem, Belgium, Tel: 32-2-720-19-19, Fax: 32-2-720-95-86, Asia & Pacific: Perth, Australia Tel: 61-9-345-3866, Fax: 61-9-345-3899.

Power Transformer: Equipment manufactured per [14-SAMSS-531](#).

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. These schemes have been standardized. Refer to Section 19 for standardized schemes.

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 at site.

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 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 is 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](#).

6 Selection

- 6.1 Transformers serving **industrial facilities** shall be fed from either **switchgear, 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.**
 - d) **Manually-operated pad mounted switchgear.**

Commentary Note:

*Section 13 requires **approval** to use this equipment.*

- 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).**

- 6.4 Equipment connected to the primary or secondary of a transformer shall have a continuous rating not less than the highest level of forced cooled **site rating** of the transformer.

Exception:

Firewater pump controllers.

- 6.5 **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 is not permitted).

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

Exception:

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

- 6.7 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).*

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

Exception:

Transformers.

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

Exception:

Direct replacement of existing equipment.

Commentary Note:

*For example, this prohibits the main bus of **controlgear** to be directly connected to the main bus of **switchgear**.*

- 6.10 Environmental rating of enclosures and equipment installed outdoors shall be per [SAES-P-104](#).

- 6.11 Motor controller selection shall be based upon the following criteria:

6.11.1 **Switchgear** shall not be used to control:

- a) Low voltage motors.
- b) **High Voltage** motors rated less than 5 kV.

6.11.2 Reduced voltage starters shall not be used.

Exception:

*If **approval** is obtained.*

- 6.12 Substations operating at 69 kV or above offshore or within 5 km of the coast shall be of the gas insulated type. For other locations, the use of gas insulated substations shall be evaluated. The evaluation should include optimization of maintenance, reliability, space, etc.

- 6.13 Short-circuit ratings of buses and interrupting devices shall not be less than 105% of the calculated fault current at the point of application. The calculated fault current shall include future planned conditions which are identified on the engineering documents (e.g., future motor loads, generation, etc.). The fault current shall be computed using the procedures set forth in ANSI C37.13 for
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equipment rated 600 V and below and ANSI C37.010 for equipment rated above 600 V.

- 6.14 The interrupting rating of equipment shall not be dependent upon upstream interruption devices. (i.e., **series rated** and **cascade rated protection systems** are prohibited).
- 6.15 One line configurations shall be one of the standardized schemes shown in Section 19.
- 6.16 Busduct shall not be used.

Exception:

Direct replacement for existing busduct system.

- 6.17 In **industrial facilities**, 480 V **switchgear** shall not be fed from 4160 V systems.

Commentary: It is generally not possible to meet the voltage regulation requirements in [SAES-P-100](#) if the switchgear transformations are in series.

- 6.18 **Controlgear** shall not feed **controlgear**.

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 are 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 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 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.
- 7.5 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.
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- 7.6 Motor Operated Valves (MOV)s are not required to have a local, padlockable disconnect device.
- 7.7 Protection and control equipment for **high voltage**, outdoor SF₆ 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 metering system. The SAMSS for the **high voltage switchgear** and **high voltage controlgear** specifies **PML** be installed.
- 8.5 The SAMSS for **controlgear** and **switchgear** require external power be supplied for the motor and enclosure space heater system. A separate 120 VAC branch circuit shall be supplied to the **switchgear** and **controlgear** for each motor.

9 Switchgear

- 9.1 General
 - 9.1.1 **Secondary selective switchgear** assemblies shall be one of the standardized configurations indicated in Section 19.
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- 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.

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** shall not be used to feed transformers or **fire pump controllers**.

Exception:

*It is acceptable that **low voltage controlgear** feed distribution transformers feeding **panelboards**.*
 - 10.1.4 **Controlgear** shall only be connected to one power source.
 - 10.1.5 **Controlgear** shall not feed **controlgear**.
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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**, 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**.

10.2.3 **Utilization equipment** shall not be directly fed from **switchgear**.

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 The current rating of a **switchrack** shall be a minimum of 125% of the **switchrack** maximum **operating** load.
- 12.2 **Switchracks** shall only be used in **low voltage** applications.

Commentary Note:

*The use of **switchracks** should be avoided. The preference is that **controlgear** or, **switchgear** be used.*

- 12.3 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

Application of this equipment requires **approval**.

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 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 **AFDs** 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.

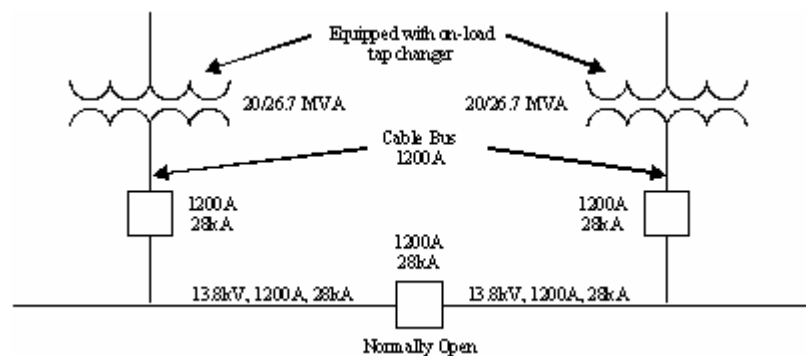
19 Standardized One-Lines

Only the following one-line configurations shall be used.

19.1 Distribution

19.1.1 Secondary Selective

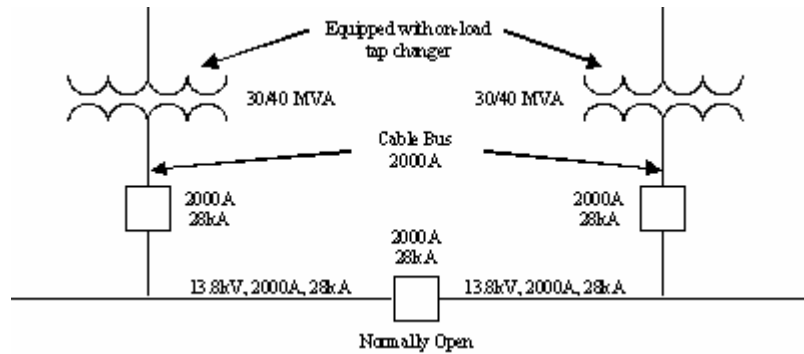
- 1) 13.8kV, 1200A, 28kA.



| | |
|------------------------------|-----------|
| Maximum Total Running Load* | 22.67 MVA |
| Largest single motor rating: | 5000 HP |

* Includes [SAES-P-100](#) provisions for future load, all 13.8kV feeder losses and largest spared motor running.

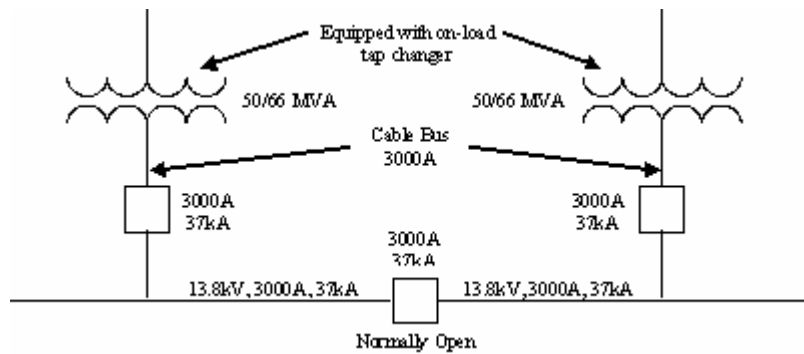
2) 13.8kV, 2000A, 28kA.



| | |
|------------------------------|---------|
| Maximum Total Running Load* | 34 MVA |
| Largest single motor rating: | 8000 HP |

* Includes SAES-P-100 provisions for future load, all 13.8kV feeder losses and largest spared motor running.

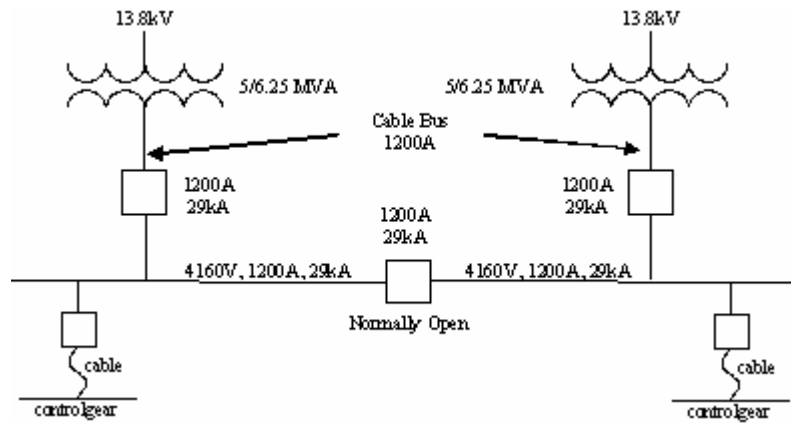
3) 13.8kV, 3000A, 37kA.



| | |
|---|----------|
| Maximum Total Running Load* | 56.6 MVA |
| Maximum motor load (including largest spared motor) | 27.4 MW |

* Includes SAES-P-100 provisions for future load, all 13.8kV feeder losses and largest spared motor running.

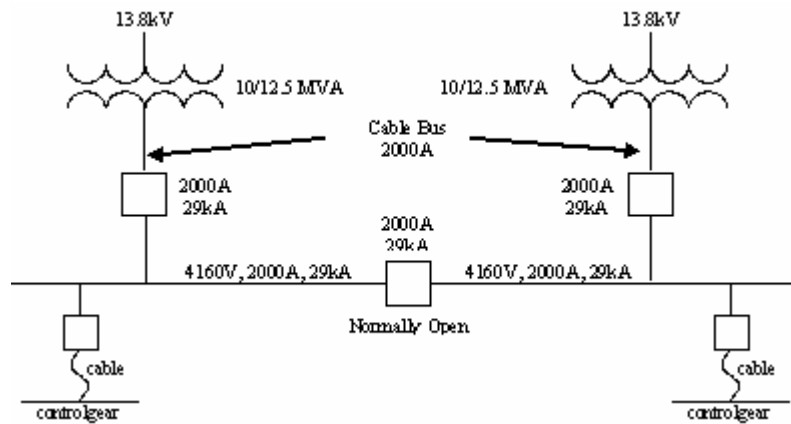
4) 4160V, 1200A, 29kA.



| | |
|---|-----------|
| Maximum Total Running Load* | 5.313 MVA |
| Largest single motor rating: | 1750 HP |
| All utilization equipment fed from controlgear | |

* Includes [SAES-P-100](#) provisions for future load, all 4160V feeder losses and largest spared motor running.

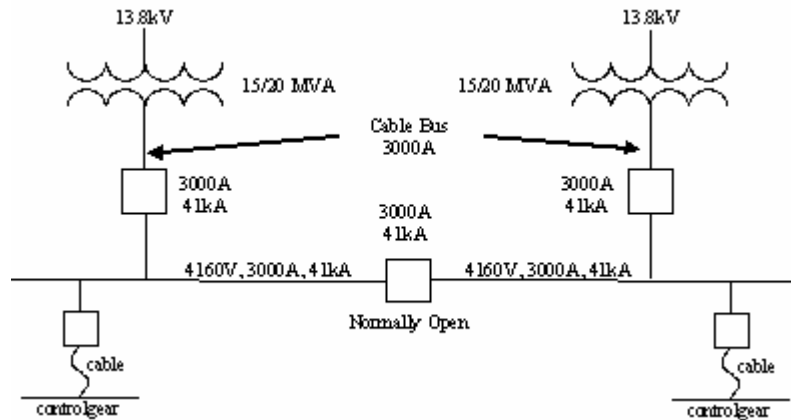
5) 4160V, 2000A, 29kA.



| | |
|---|------------|
| Maximum Total Running Load* | 10.625 MVA |
| Largest single motor rating: | 3000 HP |
| All utilization equipment fed from controlgear | |

* Includes [SAES-P-100](#) provisions for future load, all 4160V feeder losses and largest spared motor running.

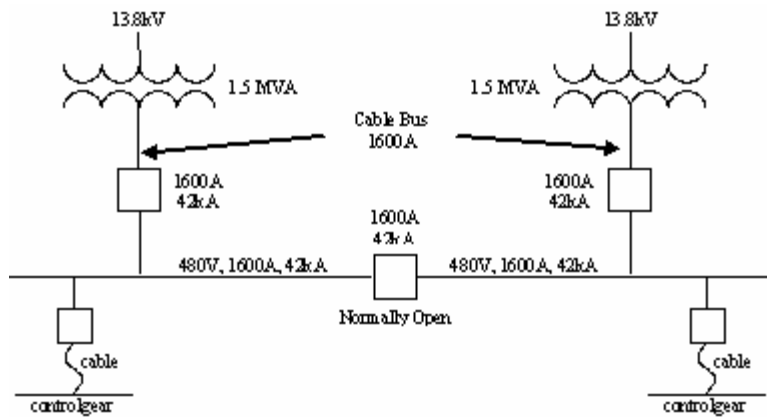
6) 4160V, 3000A, 41kA.



| | |
|---|---------|
| Maximum Total Running Load* | 17MVA |
| Largest single motor rating: | 4000 HP |
| All utilization equipment fed from controlgear | |

* Includes [SAES-P-100](#) provisions for future load, all 4160V feeder losses and largest spared motor running.

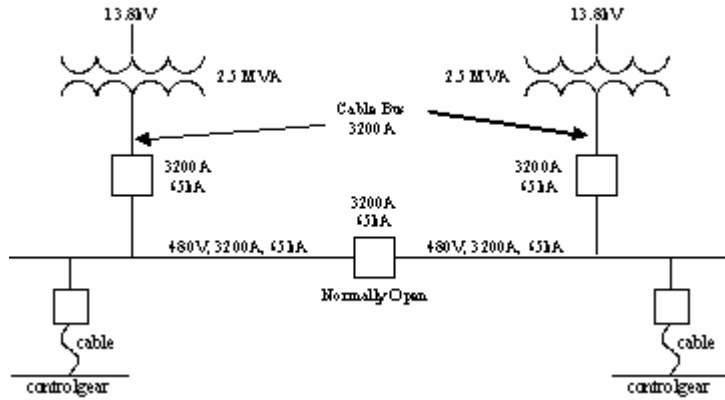
7) 480V, 1600A, 42kA.



| | |
|---|-----------|
| Maximum Total Running Load* | 1.275 MVA |
| All utilization equipment fed from controlgear | |
| Largest single motor rating: | 250 HP |

* Including [SAES-P-100](#) provisions for future load, all 13.8 kV feeder losses and largest spared motor running.

8) 480V, 3200A, 65kA.



| | |
|---|----------|
| Maximum Total Running Load* | 2.13 MVA |
| Maximum motor load (including largest spared motor) | 1.235 MW |
| Largest single motor rating: | 250 HP |
| All utilization equipment fed from controlgear | |

* Includes [SAES-P-100](#) provisions for future load, all 480V feeder losses and largest spared motor running.

29 September 2004
 28 February 2005

Revision Summary
 Major revision.
 Editorial revision.