Engineering Standard

SAES-P-100 18 September 2012

Basic Power System Design Criteria

Document Responsibility: Electrical Systems Designs & Automation Standards Committee

Saudi Aramco DeskTop Standards

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1 Scope

This SAES prescribes mandatory design bases and performance criteria of electrical power systems. This SAES is intended to assist engineers and designers in those areas not specifically referenced in other Saudi Aramco SAESs, SAMSSs, etc.

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.

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.

- Saudi Aramco References

  The following is a list of Mandatory Saudi Aramco Engineering Requirements (MSAERs) which are specifically related to the design, specification, and installation of electrical power systems and equipment. In addition, other MSAERs for related disciplines shall be used in conjunction with those listed below as required.

  - Saudi Aramco Engineering Procedure

    SAEP-302 *Instructions for Obtaining a Waiver of a Mandatory Saudi Aramco Engineering Requirement*

- Saudi Aramco Engineering Standards

SAES-A-112	*Meteorological and Seismic Design Data*
SAES-B-009	*Fire Protection & Safety Requirements for Offshore Production Facilities*
SAES-B-014	*Safety Requirements for Plant and Operations Support Buildings*
SAES-B-017	*Fire Water System Design*
SAES-B-064	*Onshore and Nearshore Pipeline Safety*
SAES-B-068	*Electrical Area Classification*
SAES-K-001	*Heating, Ventilating and Air Conditioning (HVAC)*
SAES-K-002	*Air Conditioning Systems for Essential Operating Facilities*
SAES-O-202	*Security Fencing*
SAES-O-207	*Power Supply for Security Systems*
SAES-P-103	*Batteries and U.P.S. Systems*
SAES-P-111	*Grounding*
SAES-P-114	*Power System and Equipment Protection*
SAES-P-116	*Switchgear and Control Equipment*
SAES-P-123	*Lighting*

- Saudi Aramco General Instruction

GI-0002.717	*Procedures and Guidelines for Handling Polychlorinated Biphenyls (PCB's)*
GI-0002.721	*Electrical Arc Flash Hazard Mitigation*

4 Definitions

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

Base Voltage: The bus voltage calculated by starting with the **nominal voltage** at the swing bus and calculated for each bus based on the transformer turns ratios.

Bus Tie Breaker: A breaker used to connect the two busses of **secondary-selective** system**.**

Captive Transformer: A transformer whose output is dedicated to a single piece of **utilization equipment**.

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: Are loads:

a) Where a single contingency failure could cause a loss of power which would create an immediate hazard to human life.

b) Security systems classified in SAES-O-207.

c) Which cannot be shut-down for a minimum of five consecutive days annually for scheduled maintenance on upstream power supply equipment.

Examples of critical loads are: major computer centers, critical care areas in clinics and hospitals, major office buildings, process units in gas plants and refineries.

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.

ESD Coordinator: Coordinator, Electrical Systems Division, Consulting Services Department.

High Voltage: Voltages 1000 V or greater unless otherwise designated in a specific MSAER or referenced international standard.

Commentary Note:

> *The term **medium voltage** is no longer being used in most North American and essentially all European (IEC) standards. Where used, it generally refers to system voltages greater than 1 kV but less than 100 kV. As used in Saudi Aramco, **medium voltage** generally refers to voltages 2.4 kV and above but less than 34.5 kV.*

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.

Inside-Plant: Facilities within the perimeter security fencing installed per the SAES-O series of standards.

Low Voltage: Voltages less than 1000 V, unless otherwise designated in a specific MSAER or referenced international standard.

MSAER: Mandatory Saudi Aramco Engineering Requirements.

Examples of MSAERs are Saudi Aramco Materials System Specifications (SAMSSs), Engineering Standards (SAESs) and Standard Drawings (SASDs).

Nominal Voltage: Refer to Table 1.

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.

Outside-Plant: Facilities outside of the perimeter security fencing installed per the SAES-O series of standards.

PCB free: Containing less than 1 ppm Polychlorinated biphenyl.

Plant: Facility requiring perimeter security fencing installed per the SAES-O series of standards.

SAMSS: Saudi Aramco Materials System Specification.

SBC: Saudi Building Code

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).

These schemes are standardized. Refer to SAES-P-116 for standardized schemes.

Secondary-selective Substation: A substation fed by two independent power sources (different transmission or distribution lines) which consists of one or more sets of two transformers and associated **secondary-selective switchgear**. Also referred to as a "double-ended" substation.

Severe Corrosive Environment: As described in Section 9 of this standard.

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

Switchrack: Equipment manufactured per 16-SAMSS-512.

UPS: Uninterruptible Power Supply.

Utilization device/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.).

Vital Equipment: As defined by the Saudi Arabian Government High Commission for Industrial Security. The definition is stated in Sections 4.9 of SAES-O-202.

5 General

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

5.2 Basic Design Codes

Electrical power systems shall be designed and constructed in accordance with the latest edition of Volume 4 of **SBC**, NFPA 70 (National Electrical Code), NFPA 70 E (Standard for Electrical Safety in the Workplace) and ANSI C2 (National Electrical Safety Code), as supplemented or modified by the Saudi Aramco Engineering Standards. In general, **SBC** supersedes other codes except when specifically stated within any of the **MSAER** documents.

5.3 **Low voltage** AC distribution systems shall be protected by circuit breakers. Fuses shall not be used.

Exception:

> *Molded case circuit breakers with integral current limiting fuses are permitted and fuses are permitted for protection of circuits fed from UPS systems.*

5.4 All interrupting devices shall be fully rated for the short circuit duty. Refer to SAES-P-116 for additional details and exceptions.

Commentary Note:

> *This means, for example, that designs based upon series-rated or cascade-rated equipment shall not be used.*

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

Exception:

> *Critical facilities 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 are permitted with **approval.***

5.6 Loads to be supplied by standby power or emergency power include the following:

Commentary Note:

> *Regardless of how standby or emergency power is defined in other standards or codes, this section covers alternative continuous power supply when the normal power of a facility – typically received from power utility, third party IPPs, or in-house generation – is lost.*

- Security system loads specified in SAES-O-207.
- Occupied rooms intended for use during emergencies such as emergency control room or disaster response room.
- HVAC and air handling control equipment for pressurized buildings as specified in SAES-B-014 and SAES-K-002.
- Emergency lighting as mandated in SAES-P-123, if DC power or UPS is not sufficient for the intended purpose.
- Essential loads that cannot be supplied from **UPS** or DC system when **approved** by **ESD Coordinator**.

5.7 Sizing of the electrical system shall be based upon using 110% of the sum of the **operating load** plus all known future loads.

5.8 Electrical equipment for fire pump installations shall meet the requirements of NFPA 20 except as modified by the following **MSAER**s:

SAES-B-009	*Fire Protection & Safety Requirements for Offshore Production Facilities*
SAES-B-017	*Fire Water System Design*

SAES-P-116 *Switchgear and Control Equipment*

5.9 Existing equipment containing PCB shall be handled in accordance with GI-0002.717. Insulating materials, insulating liquids, etc., in new equipment shall be PCB-free.

5.10 Interfaces with communications systems shall be in accordance with SAES-T- and SAES-Z-Series.

5.11 "Approval" or "authority having jurisdiction" issues contained with the **SBC** or other codes shall be referred to the Consulting Services Department / Electrical Systems Division for resolution.

6 Design Basis

6.1 System Voltage and Frequency

6.1.1 The frequency of alternating current electrical power systems shall be 60 Hz.

Exception:

*Existing facilities with 50 Hz power systems (including 50 Hz systems with **nominal voltages** which do not comply with Table 1) and additions, replacements, etc., to these systems that do not result in a requirement to add 50 Hz generation capacity, are permitted.*

6.1.2 The primary distribution within **industrial facilities** shall be 13.8 kV, three-phase, three-wire. Secondary distribution shall be either 4160 V, three phase, three wire and/or 480 V, three phase three wire.

Exception:

*A 4160 V primary distribution system is acceptable if derived from a transformer(s) fed at a **nominal voltage** of 69 kV or greater.*

6.1.3 The following describes the nominal system voltage and grounding which shall be used at the respective voltage listed in Table 1.

Table 1 – Nominal Voltage Levels

Nominal Voltage	Phase	Wire	Type of System Grounding	Specific Note(s)
400Y/230	Three	Four Wire	Solid	S1
400	Three	Three Wire	Solid	
480	Three	Three Wire	Solid	

Nominal Voltage	Phase	Wire	Type of System Grounding	Specific Note(s)
4,160	Three	Three Wire	Low Resistance	S3, S5
13,800	Three	Three Wire	Low Resistance	S3, S6
34,500	Three	Three Wire	Solid	S2
69,000	Three	Three Wire	Solid	S2
115,000	Three	Three Wire	Solid	S2,S4
132,000	Three	Three Wire	Solid	S2
230,000	Three	Three Wire	Solid	S2
380,000	Three	Three Wire	Solid	S2

General Notes:

G1. Existing ungrounded systems and existing systems with different voltage levels (e.g., 2.4 kV) are not required to be changed retroactively.

G2. Additions or extensions to existing systems with different voltage levels that increase the MVA capacity of the system is not permitted. The exception is if the new or replacement equipment has a dual voltage rating with a voltage level in Table 1. Transformers that are replacements to transformers operating at a different voltage level, be dual voltage rating with a voltage level in Table 1.

G3. Steady-state service and utilization voltage ranges shall be per Voltage Range A, ANSI C84.1 for the above nominal voltages. For Saudi Aramco installations, the service voltage is defined as the voltage at the secondary of a supply transformer having a primary voltage of more than 600 volts.

G4. See SAES-P-111 for specific system grounding requirements and for grounding requirements for special applications such as downhole pump motors.

G5. SEC nominal distribution voltages may be used on the **high voltage** side of transformers fed directly from a SEC distribution system.

G6. These nominal system voltage requirements do not apply to **captive transformers** in specialty applications such as supplying submersible pump motors and high voltage adjustable frequency drive applications. Voltages for **captive transformer** applications shall be reviewed by the **ESD Coordinator**.

G7. Power supply dedicated for specialized systems (such as medical equipment, labs, shops, and packaged systems), industrial, control systems, instruments, and communication devices may utilize other voltage levels.

Specific Notes:

S1. 400/230 V is only acceptable at sub-distribution levels (for example, general power supply inside buildings, distribution transformer to panelboards feeding lighting, receptacles, etc.). Saudi Aramco material specifications prohibit neutral busses for **low voltage switchgear** and **controlgear.**

S2. Not an acceptable voltage for **inside-plant** distribution of power. Acceptable for delivery of power from **inside-plant** to **outside-plant** or from **plant** to **plant;** provided the distance is 3 km or greater.

Exception:

Radial circuits feeding power transformers.

S3. Solidly grounded system shall be specified for feeders feeding overhead lines. If the system is feeding combination of overhead lines and other loads, dedicated transformer or special transformer shall be considered and **approved** by **ESD Coordinator**.

S4 This also includes system operating at 110 kV.

S5. 400 A, 10 second resistor.

S6. 400 A or 1000A, 10 second resistor.

6.2 Steady state voltage range, under all study conditions, shall be as follows:

6.2.1 **Low Voltage** Systems

i) At branch circuit/distribution equipment connection points (e.g., **switchgear**, **controlgear**, panelboards, **switchracks**, etc.): 95% to 105% of **nominal voltage**.

ii) At light fixtures: 91.7% to 104.2% of **nominal voltage**.

iii) At **utilization equipment** other than lights: 90% to 104.2% of **nominal voltage**.

6.2.2 **High Voltage** Systems

i) Originating and ending in the same **plant**:

a) At branch circuit/distribution equipment connection points (e.g., **switchgear**, **controlgear**, etc.): 97.5% to 105% of **nominal voltage**.

b) At the utilization device: 90% to 105% of **nominal voltage**.

ii) Originating and ending in different **plants** or facilities.

- At main distribution equipment (e.g., **switchgear**): 95% to 105% of **nominal voltage**.

6.3 Voltage Drop associated with Motor Starting

6.3.1 When a motor is started, the voltage at every **utilization device**, anywhere in the electrical system, shall not drop below 85% of the **nominal voltage**. Where the utilization equipment is modeled as lumped load at the distribution bus, the voltage at the distribution equipment level shall not drop below 90% of the nominal voltage.

6.3.2 When a motor is started, the voltage at the terminals of the motor being started shall not drop below 85% of the rated motor voltage.

Exception:

*For **high voltage** motors, when **approved**, a drop to 80% of rated motor voltage is permitted at the terminals of the motor being started.*

6.4 Direct Current Systems

Maximum total voltage drop for main, feeder, and branch circuits shall not exceed 5%. The average voltage drop in branch circuits shall not exceed 2% with a maximum of 4% at the most distant load.

7 System Studies

System studies are required for new facilities and major additions to existing facilities. If uncertain whether the additions to existing facilities are "major," contact the **ESD Coordinator**. The Electrical Transient Analyzer Program (ETAP) shall be used to conduct the studies outlined in Section 7.5. Input and output data files shall be furnished to the facility proponent's engineering organization for new facilities and any (major or minor) addition to existing facilities. Alternative software may be used without a need for waiver or **approval** if the network database (load flow, dynamic data, and network diagrams) can be read directly by ETAP without a need for any middleware tools. Written statement by the contractor or design office shall be provided indicating that data files are directly inter-faceable with ETAP.

7.1 Actual system data and constraints shall be used for all studies.

Commentary Note:

The ultimate, maximum, and minimum short circuit levels at utility interface point should be obtained prior of commencing system studies.

7.2 When modeling the system for different studies, it is acceptable to assume that the off-load transformer taps can be set one step off the neutral position. In this case, all studies shall use the same transformer tap position.

7.3 It is acceptable to use on-load tap changer, which will automatically regulate the voltage level to the nominal voltage, as long as the tap position does not exceed mid-range on either side of the neutral position.

7.4 Unless the actual impedance of a transformer is known from the transformer tests, 7.5% transformer impedance tolerance shall be used so that the specified design impedance is increased by 7.5% for load flow and motor starting calculations and decreased by 7.5% for short circuit calculations.

7.5 The following studies shall be performed to verify proper design of the electrical power systems and equipment:

7.5.1 Load-Flow

7.5.1.1 Maximum system voltage levels shall be determined, assuming all motor loads are disconnected, and in the case of secondary-selective substations that both transformers are operational, and the bus tie breaker is in its normal state.

7.5.1.2 Normal system voltage levels shall be based upon operating load.

7.5.1.3 Minimum voltage of each circuit shall be based on the normal operating load plus the operating load of the largest spare (standby) motor if the spare motor is not interlocked to prevent starting while the primary motor is running. Minimum voltages downstream of secondary-selective substations shall be calculated assuming that one transformer is out of service and the bus tie breaker is closed.

7.5.2 Short-Circuit

7.5.2.1 For short circuit studies, the maximum ultimate 3-phase short circuit fault-current shall be used with a pre-fault voltage of 102% of the bus base voltage.

7.5.2.2 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 equipment rated 600 V and below and ANSI C37.010 for equipment rated above 600 V. Similarly, IEC method shall be used for IEC equipment.

7.5.2.3 Short circuit studies for secondary-selective substations shall be evaluated assuming:

- One incomer breaker is open and the bus tie breaker is closed (i.e., one transformer is supplying the entire load).
- With the normal operating load plus the operating load of the largest spare (standby) motor if the spare motor is not interlocked to prevent starting while the primary motor is running.

- For existing normally close system, all incomers and bus tie breakers are closed (i.e., normal system configuration).

7.5.3 Arc Flash Analysis

The design of all new electrical distribution equipment rated up to 38 kV shall include an arc flash hazard analysis in accordance with IEEE 1584, to determine the Arc Flash Protection Boundary and the incident energy a worker may be subject to. For DC equipment the Arc Flash Hazard Analysis shall be based on NFPA 70E. Personal protective equipment (PPE) to be worn shall be based on NFPA 70E.

The maximum allowable incident energy shall not exceed 8 Cal./cm^2. The analysis shall be performed in conjunction with both short-circuit and protective relay coordination analysis during the detailed design phase. However, a preliminary analysis shall be conducted at early stage to identify the scope and possible mitigations strategies.

Commentary Notes:

Equipment operating at less than 240 V and fed from 125 kVA or less transformer is designated to Hazard Risk Category (HRC) 0.

The analysis should include minimum and maximum utility fault contribution as well as no load and full load motor contribution.

7.5.4 Motor Starting

7.5.4.1 The maximum source impedance (i.e., minimum available short circuit current at the utility and the scenario described in paragraph 7.5.1.3 if applicable) shall be used to calculate the associated voltage drops and acceleration requirements during motor-starting studies.

7.5.4.2 Motor starting studies shall be performed on the following **high voltage** motors:

- Largest motor on each **switchgear**.
- Largest motor on each **controlgear**. If there are more than one **controlgear** fed from one switchgear, then only one study is sufficient for the largest motor connected to any of these **controlgears**.

7.5.4.3 When a new **high voltage** motor is added to an existing plant, the motor starting study requirements apply to both existing and new motors connected to the same bus or at the upstream bus.

Commentary Note:

> *Impact on the distribution system due to motor start is the intention of this study. Motor acceleration performance based on actual loads and motor dynamic parameters are the responsibility of the supplier of the motor and/or driven equipment.*

7.6 The following additional studies shall be performed on a case-by-case basis. The **ESD Coordinator** should be contacted early enough in the project cycle to assist in determining the need to conduct these studies and the criteria for the analysis.

7.6.1 Transient Stability

For facilities with generation greater than 10 MW, transient stability study shall include the following scenarios:

- Load rejection in terms of close by faults in main buses.
- Load rejection in terms of transmission line trip while exporting power.
- Load rejection in terms of loss of major load or major load center.
- Load shedding scenarios such as loosing utility line while importing or loss of generation.
- Major upgrade to the network, transmission line additions, etc.
- Specific system simulations stated in Section 12 of SAES-P-114.

7.6.2 Harmonic Analysis

If significant non-linear load (e.g., AFD, Power Convertors, etc.) is added to the power system, ETAP or other softwares may be used for this study provided that the condition of Section 7 on compatibility with ETAP is satisfied. A frequency scan analysis shall be conducted in order to discover potential harmonic resonance issues. Consequently, recommendations shall be made to avoid any harmonic resonance in the system.

Baseline measurements shall be conducted at each bus and feeder where a harmonic load to be added. Initial study shall be conducted to validate the model using the baseline measurements.

Harmonic distortion results shall be within the harmonic limits stated in the latest revision of IEEE 519. The Point of Common Coupling shall be considered at the switchgear bus feeding multiple MCCs or controlgears.

Commentary Note:

With HV AFDs, the AFD manufacturer is responsible to provide harmonic mitigation.

7.6.3 Insulation Coordination and Switching Transient Analysis including TRV (Transient Recovery Voltage).

If supply is significantly affected by induced capacitive switching transients which includes:

- Shunt capacitor banks
- 34.5 kV and above systems.
- Motors fed from autotransformers or captive transformers
- Large motors.

Acceptable softwares for this study shall have the ability to model electromagnetic and electromechanical systems in the time domain.

7.6.4 Relay Coordination Study as mandated in Section 4 of SAES-P-114.

7.6.5 Induced voltage and touch potential study as mandated in Section 7.6 of SAES-B-064.

7.6.6 Ground Grid and Lightening Protection Studies as mandated in SAES-P-111.

8 Electrical Area Classification Design

8.1 Hazardous area classification shall be in accordance with the requirements of SAES-B-068.

8.2 In hazardous (classified) areas, electrical equipment shall be labeled, listed or certified by any of the agencies in the Approved IECEx Certification Bodies (ExCBs) under the IECEx Certified Equipment Scheme.

8.3 Installations in hazardous locations shall be per the National Electrical Code, with the following additions and exceptions:

8.3.1 IEC or Ex labeled equipment meeting requirement of IEC 60079 and certified by one of the agencies in the Approved IECEx Certification Bodies (ExCBs) under IECEx Certified Equipment Scheme is acceptable. Class and Zone markings are not required on Ex marked equipment but method of protection must be marked and must correspond with NEC Article 505 requirements for suitable protection method(s) for the hazardous area where the equipment is applied. Markings based on other schemes or directives such as ATEX are not acceptable.

8.3.2 Equipment suitable for Class 1, Zone 0 locations may be used in Class 1, Division 1 locations.

8.3.3 Increased safety (protection type "e") motors and terminal boxes are not permitted in Zone 1 locations.

Commentary Note:

The "e" protection method is acceptable if it is used in combination with the "d" protection method, if d" is the primary protection method.

8.3.4 Flameproof enclosures EEx d II are permitted in Class I, Division 1 locations as meeting the NEC requirements for approved enclosures, provided:

i) NEC requirements for cable entry are met;

ii) the overall enclosure is flameproof EEx d II (explosion-proof) as a whole (not only its components);

iii) the enclosure is constructed of a conductive metal or has an integral metal bonding device that ensures a positive low-resistance bond between conduits or/and cable armors entering or terminating at the enclosure; and

iv) if used outdoors, the enclosure is rated a minimum of IP54.

8.3.5 The equipment selection, approval and labeling requirements in the NEC for Division 2 installations also apply to Zone 2 installations.

9 Environmental Conditions

9.1 The following locations shall be deemed as "severe corrosive environments" for the purposes of selection of electrical equipment:

9.1.1 Outdoor offshore locations

9.1.2 Outdoor onshore locations within one kilometer from the shoreline of the Arabian Gulf

9.1.3 Outdoor onshore locations within three kilometers from the shoreline of the Red Sea.

9.1.4 All of the Ras Tanura Refinery and Terminal.

9.1.5 Location where chlorine or other corrosive chemicals are being handled (e.g., sulfur plants, waste water treatment, water treatment, R.O. facilities).

9.2 Electrical equipment shall be rated in accordance with the requirements of the SAES-P or SAMSS specific to the equipment and its installation. When not covered in these documents:

9.2.1 For ambient temperature:

The temperature criteria shown in Table 2 shall be used to establish equipment rating.

9.2.2 For other environmental data refer to SAES-A-112.

Table 2 – Temperature Criteria

	Ambient Temperature	
Location	**Average Monthly Normal Maximum (°C)**	**Maximum Daily Peak (°C)**
Outdoors (Air)	45	50
Earth (Soil)	40	40
Ocean (Water)	30	30
Indoors in Well-Ventilated Buildings	40	50
Indoors in Air-Conditioned Buildings	See Note 1 below	See Note 1 below
Non-ventilated Enclosures Exposed to the Sun	56 See Note 2 below	56 See Note 2 below

Notes:

1. Per the design temperature of the air conditioning system (see SAES-K-001) or 30°C, whichever is greater.

   Commentary Note:

   Stationary storage batteries are normally rated for operation in 25°C ambient. See SAES-P-103 for battery rating and ambient temperature requirements and SAES-K-001 for battery room design temperature requirements.

2. “Effective” ambient temperature inside an equipment enclosure due to combined effects of a 45°C ambient outside the enclosure, 8°C rise from solar radiation, and an assumed 3°C rise caused by an internal heater or other heat producing device.

Revision Summary

15 August 2012	Major revision.
18 September 2012	Editorial revision.