Engineering Standard

SAES-T-151 22 April 2012

D.C. Power Systems

Document Responsibility: Communications Standards Committee

Saudi Aramco DeskTop Standards

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1 Scope

This Standard presents the minimum mandatory requirements of Communications Power Systems for the use in Saudi Aramco communications facilities such as central telephone switching offices, microwave terminals, repeater stations and UHF/VHF radio equipment.

2 Conflicts and Deviations

Any deviations, providing less than the mandatory requirements of this standard require written waiver approval as per Saudi Aramco Engineering Procedure SAEP-302.

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-068	*Electrical Area Classification*
SAES-B-069	*Emergency Eye Washes and Showers*
SAES-K-002	*Air Conditioning Systems for Essential Operating Buildings*
SAES-K-003	*Air Conditioning Systems for Communications Buildings*
SAES-P-103	*Direct Current and UPS Systems*
SAES-P-123	*Lighting*
SAES-S-060	*Saudi Aramco Plumbing Code*
SAES-T-795	*Communications Facility Grounding Systems*

Saudi Aramco Materials System Specifications

17-SAMSS-511	*Stationary Storage Batteries*

17-SAMSS-514 *Battery Chargers*

General Instruction

GI-0355.003 *Disposing of Hazardous Material*

3.2 Industry Codes and Standards

American Petroleum Institute

API RP 500 *Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities*

Institute of Electrical and Electronics Engineers, Inc.

IEEE 450 *Recommended Practice for Maintenance, Testing and Replacement of Large Lead Storage Batteries for Generating Stations and Substations*

IEEE 485 *Recommended Practice for Sizing Large Lead Storage Batteries for Generating Stations and Substations*

National Electrical Manufacturers Association

NEMA PE-7 *Communications Type Battery Chargers*

National Fire Protection Association

NFPA 70 *National Electrical Code*

NFPA 496 *Purged and Pressurized Enclosures for Electrical Equipment*

Underwriters Laboratories, Inc.

UL 924 *Emergency Lighting and Power Equipment*

4 Design

4.1 Battery Rooms - Ventilated

4.1.1 The battery rooms shall be ventilated, either by a natural or induced ventilation system, to prevent accumulation of hydrogen and to maintain the design temperature. The ventilation system shall limit hydrogen accumulation to less than 2% by volume. Maximum hydrogen evolution rate is 0.000269 cubic feet per minute per charging ampere per cell at 25°C. The worst condition exists when forcing maximum current into a fully charged battery. Battery rooms shall be vented to the outside air. Ventilation shall provide at least one complete air change every three hours as a minimum. Return air ducts of air conditioning systems from a battery room are prohibited. (Reference: HVAC Standard SAES-K-002 Section 6, Battery Rooms or SAES-K-003, Communications Buildings).

4.1.2 A battery room which meets the ventilation criterion of paragraph 4.1.1 at all times is considered to be a non classified area. Therefore, explosion proof enclosures are not required for the electrical appliances in these rooms.

4.1.3 Room lighting shall be in accordance with SAES-P-123.

4.2 Battery Rooms - Non Ventilated

4.2.1 If sealed batteries are used in a sealed battery room (such as a passively cooled communication shelter) the individual cells shall be permitted to contain a venting arrangement or pressure-release vent to prevent excessive accumulation of gas pressure, or the battery/cell shall be designed to prevent scatter of cell parts in event of a cell explosion.

The room for storage batteries (either sealed or non-sealed) shall be provided with ventilation openings located so as to permit the circulation of air for dispersion of hydrogen gas that may be generated under abnormal battery or charging conditions. Openings at seams, joints, and splices in typical fabrication processes plus the use of porous building materials normally will be considered to provide required ventilation for dispersion of battery gases. The use of a manifold system or recombinators may be utilized to reduce the emission of hydrogen. Whenever the adequacy of ventilation is in question, a determination shall be made by measurement of gas concentration as described under Testing and Inspection, section 6.4 of this standard.

The battery room may be equipped with a hydrogen detection system. This alarm detection system shall alert personnel of the presence of hydrogen prior to entry into the battery room. The hydrogen sensor shall be installed on the battery room ceiling or located within 155 mm of the ceiling. Placed on the battery room door the following permanent indelible sign shall be provided in both English and Arabic: “Keep Door Open for Five Minutes before Entering”

4.2.2 A battery room which is sealed and does not meet the ventilation criterion of paragraph 4.2 is considered to be a classified area. The battery room shall be considered Class 1, Division 1, Group B, and explosion proof enclosures shall be installed for all appliances in these rooms.

4.2.3 Battery room doors shall open outward away from the room. No hasp, padlock or other device shall be installed which will hinder operation of the emergency door.

4.2.4 Room lighting shall be in accordance with SAES-P-123.

4.3 Location

Batteries shall not be installed in Class I Division I areas. If the batteries are installed in Class I, Division II areas, the battery room shall be pressurized and purged and shall meet the requirements of NFPA 496. Classified areas are defined by SAES-B-068. By definition Class I, Division I, are locations in which ignitable concentrations of flammable gases are expected to exist under normal operating conditions. Class I, Division II are locations in which flammable gases may be present, but normally are confined within closed systems. (Reference: API RP 500).

4.4 Working Space about Batteries (Wet Cells)

The dimension of the working space in the direction of access to live parts of the battery cell shall be a minimum of 1 m.

The dimension of the working space shall not be less than 762 mm wide in front of each battery cell. The 30-inch wide front working space is not required to be directly centered on each battery cell where it can be assured that the space is sufficient for maintenance purposes.

The minimum headroom of working space about the battery room shall be 1.98 m from the floor or platform (raised floor) if utilized.

For battery plants enclosed in a battery room, there shall be provided one entrance with measurements not less than 610 mm wide and 1.98 m high. If only one entrance is provided, the entrance provided shall be so located that the edge of the entrance nearest the battery equipment is a minimum of 914 mm.

4.5 Battery Selection

4.5.1 Batteries shall comply with 17-SAMSS-511.

4.5.2 Battery selection shall depend on the type of application.

4.5.2.1 For central switching offices and locations where environment can be controlled by air conditioning systems, batteries such as lead calcium pasted plate batteries are most suitable.

4.5.2.2 For remote locations where air conditioning systems are not adequate and deep cycling is anticipated, batteries such as multitublar lead-antimony or nickel cadmium batteries are most suitable.

4.5.2.3 For special applications, such as passive cooling shelters where ventilation is limited or where a separate battery room or closet is not practical sealed batteries are most suitable. The sealed batteries shall not contain free-liquid electrolyte. The electrolyte shall be in the form of a gel or absorbed within a microporous matrix. Sealed batteries shall comply with testing and construction requirements of UL 924.

4.5.3 The battery system shall be designed for a service life of 20 years for lead acid batteries, and nickel-cadmium batteries. For lead-antimony (including tubular), lead calcium, and sealed cell batteries the design service life shall be 10 years.

Service life is valid only if the battery systems are operated at 25°C with full float charge. Temperature of the battery is extremely important. Except for nickel-cadmium batteries, if the cell temperature remains at an elevated level for an extended period of time, the expected life is reduced by 50% for each 8°C above 25°C. Whenever battery life expectancy is considered, it is most important to take into account the exact specification of the cell concerned, the application, method of operation, standard of maintenance, ambient temperature, and any other parameters relevant to a particular application.

4.6 Battery Sizing

4.6.1 The battery reserve shall be large enough to sustain operation of the communications load under busy hour conditions (hereinafter called "full DC load") for a period of 8 hours where standby AC power is available. The battery reserve shall be for a period of 12 hours for unattended remote offices. The full DC load can be derived from actual measurements of a system if in service, or from estimates based on calculated loads as an alternative. Batteries are sized based on maximum system voltage required, the minimum allowable voltage, and the duty cycle. (Reference: IEEE 485).

4.6.2 Final battery cell voltages shall not be less than 1.75 volts per cell for lead-acid, or 1.1 volts per cell for Nickel Cadmium.

4.6.3 The battery reserve shall be sized as determined by the following equation:

$$AH = L \times BT \times TC \times AC \times DF \qquad (1)$$

where:

AH - Ampere-hour capacity of battery

L - Full DC load, continuous amperes

BT - Backup time (specified battery reserve, 8 or 12 hours)

TC - Temperature compensation factor (1.19)

AC - Age compensation factor (1.25)

DF - Design factor (1.10)

4.6.4 The minimum number of series-connected cells and the end-of-discharge voltage per cell shall be in accordance with SAES-P-103.

4.7 Battery Chargers

4.7.1 Battery chargers shall comply with NEMA PE-7, Communication Type Battery Chargers, with the following additions:

a) The battery chargers shall have sufficient capacity to carry the full DC load as well as recharging the batteries to 90% capacity in 16 hour's time at locations having a back up generator and 8 hours at locations without a backup generator.

b) The calculated station full load shall be increased by 15% to provide a nominal allowance for contingency at all locations.

c) A minimum of three battery chargers shall be used at central switching offices (see 4.7.2).

d) A minimum of two battery chargers shall be used for remote stations. Each charger shall be capable of carrying the full DC communications load plus 15%.

e) An equalizing timer shall be provided for automatic return to float charge mode.

4.7.2 The full load current rating of each battery charger shall be determined by the following equation:

$$FLC = \left(\frac{S.F.xL}{R-1}\right) + \left(\frac{BIFxAH}{RxH}\right) x \frac{1}{Ka} x \frac{1}{Kt} \quad (2)$$

where:

FLC - Charger Full Load Current rating

S.F. - Service Factor (1.15)

L - Full DC load, continuous amperes

BIF - Battery Inefficiency Factor: 1.15 for lead acid and 1.4 for nickel-cadmium batteries

AH - Ampere-hour capacity of the battery

H - Specified recharge time, hours

R - Number of parallel chargers

Ka - Altitude derating factor:

to 1000 m	Ka	=	1.00
to 1500 m	Ka	=	.90
to 3000 m	Ka	=	.60

Kt - Temperature derating factor:

to 50°C	Kt	=	1.00
to 55°C	Kt	=	.90
to 60°C	Kt	=	.60

Note: *If the charger is used in ambient temperatures higher than 50°C, the charger's DC ampere specification shall be increased using the Kt factor above.*

4.7.3 Battery chargers shall be provided with individual alarms with isolated contact closure for the following conditions:

a) AC failure

b) Charger failure

c) DC Output failure

d) High DC voltage

e) Low DC voltage

f) Breaker Trip (could be integrated with "b" above

g) Equalizer/float mode status

4.7.4 A low voltage disconnect device shall be provided to disconnect the load from a discharged battery and shall be set at 40.6 ± 2.5% volts DC (39-41.6 Vdc) with a 48-volt system and 20.3 ± 2.5% volts (19.8-20.8 Vdc) with a 24-volt system. Additionally, the maximum allowable depth of discharge shall not exceed the manufacturer's specifications.

4.8 Racks - Liquid Cells

Configuration of the battery rack is determined by the cell dimension, the number of cells, the dimensions of the battery room, the maximum weight allowance per square foot of floor, and the cell access requirements for periodic maintenance such as adding water to the electrolyte. No compromise shall be made that affects the accessibility of the cells. Maintenance personnel shall be able to service any cell without being crowded by adjacent cabinets or other facilities. All battery racks shall have side and end rails to restrain the battery cells from sliding off the bottom rails.

4.9 DC Power Distribution

The main control panel of the DC power distribution system shall incorporate a load ammeter, ammeter shunt, battery voltmeter, alarm circuits, voltage control circuits, alarm/status indicating lamps and control breakers and shall comply with 17-SAMSS-514.

4.10 Redundant UPS system shall be used on sensitive communications facilities where operation damages can occur during the period of surges or power source failure.

5 Installation

Wiring and Grounding

5.1 Wiring shall be in accordance with NFPA 70 (National Electric Code), and SAES-T-795 (Communications Facility Grounding Systems). Connectors between cells and between rows of cells shall be corrosion resistant and resistant to fumes from the electrolyte.

5.2 The positive bus of the DC system shall be connected to the Master Ground Bar. See Figures 1 and 2 for typical DC power connections for central offices and remote locations, respectively.

6 Testing and Inspection

6.1 Safety Requirements

6.1.1 The following warning signs shall be posted near the batteries:

	SIGN
1	Danger Caustic/Acid
2	Danger No Smoking

3	Eye Washing Facilities

6.1.2 Eye wash facilities shall be provided in accordance with SAES-B-069.

6.1.3 A dry chemical fire extinguisher shall be made available. Installation on the outside of the battery room is preferred.

6.1.4 Water facilities shall be provided for rinsing spilled electrolyte in the battery room.

6.1.5 Neutralizing solutions are required in battery rooms where liquid electrolytes are in use or stored.

6.1.6 Drains shall comply with SAES-S-060. Drains are not required for sealed battery installations.

6.1.7 A Battery Operation and Maintenance Instruction Card provided by the battery manufacturer shall be kept in a prominent position close to the battery, where it can be read easily. This card shall contain condensed instructions and general information on care and maintenance of the battery system. This card shall include information on charge and discharge status, float charge, cell readings and the location of battery maintenance records.

6.1.8 The following safety items shall be installed or made available for immediate use in the battery rooms:

	SIGN
1	Chemical worker's goggles
2	Face shield
3	Apron
4	Acid and alkali resistant gloves
5	Wall-mounted hooks or boxes for storage of safety equipment.
6	A supply of bicarbonate of soda to neutralize battery acid.
7	A supply of citric acid to neutralize potassium hydroxide in nickel-cadmium battery rooms.
8	Cell lifting straps and strap spreaders to properly handle cells.
9	Thermometer to measure electrolyte temperature.
10	Hydrometer with a temperature correcting scale to measure density of battery electrolyte. Although the density of the electrolyte in nickel-cadmium batteries does not vary with the charge, a hydrometer will show contaminated electrolyte.

6.1.9 Battery Disposal

Batteries, such as Lead Acid and Nickel-Cadmium cells, shall be considered as hazardous waste. Disposal of batteries shall be in accordance with GI-0355.003.

6.2 Battery Test

Batteries shall be tested per IEEE 450. Although IEEE 450 does not refer to sealed batteries or nickel cadmium cells, the tests are applicable.

6.3 Charger Test

Chargers shall be tested per NEMA PE-7.

6.4 Ventilation Test for Sealed Battery Rooms

To determine if batteries and associated battery charging equipment complies with ventilation requirements of paragraph 4.1, the battery system shall be tested as follows:

a) A battery system shall be discharged for 24 hours while connected to maximum rated load. The automatic cutoff circuit for the discharge of the battery shall not be defeated. This will insure that the depth of discharge does not exceed the battery manufacture's recommendation (usually 75-80%) thus reducing the possibility of permanent damage to the batteries.

b) Following the discharge, the battery is to be recharged for the time specified by the manufacturer for maximum charge condition.

The maximum hydrogen gas concentration is to be no more than 2.0% by volume when measured during step (b) above. Measurements are to be made by sampling the atmosphere inside the battery room (shelter) at 75 and 125% of the specified recharge time. Samples of the atmosphere within the battery room (shelter) are to be taken in the uppermost location in the battery compartment. The hydrogen concentration measurement shall be completed by the use of an aspirator bulb or similar device provided with gas detection equipment.

Revision Summary

5 June 2011	Revised the "Next Planned Update." Reaffirmed the content of the document, and reissued with editorial revision to change the Primary Contact Person.
22 April 2012	Editorial revision to change the primary contact.

Figure 1 – Communication Standby Battery System
Central Office Typical One Line Diagram

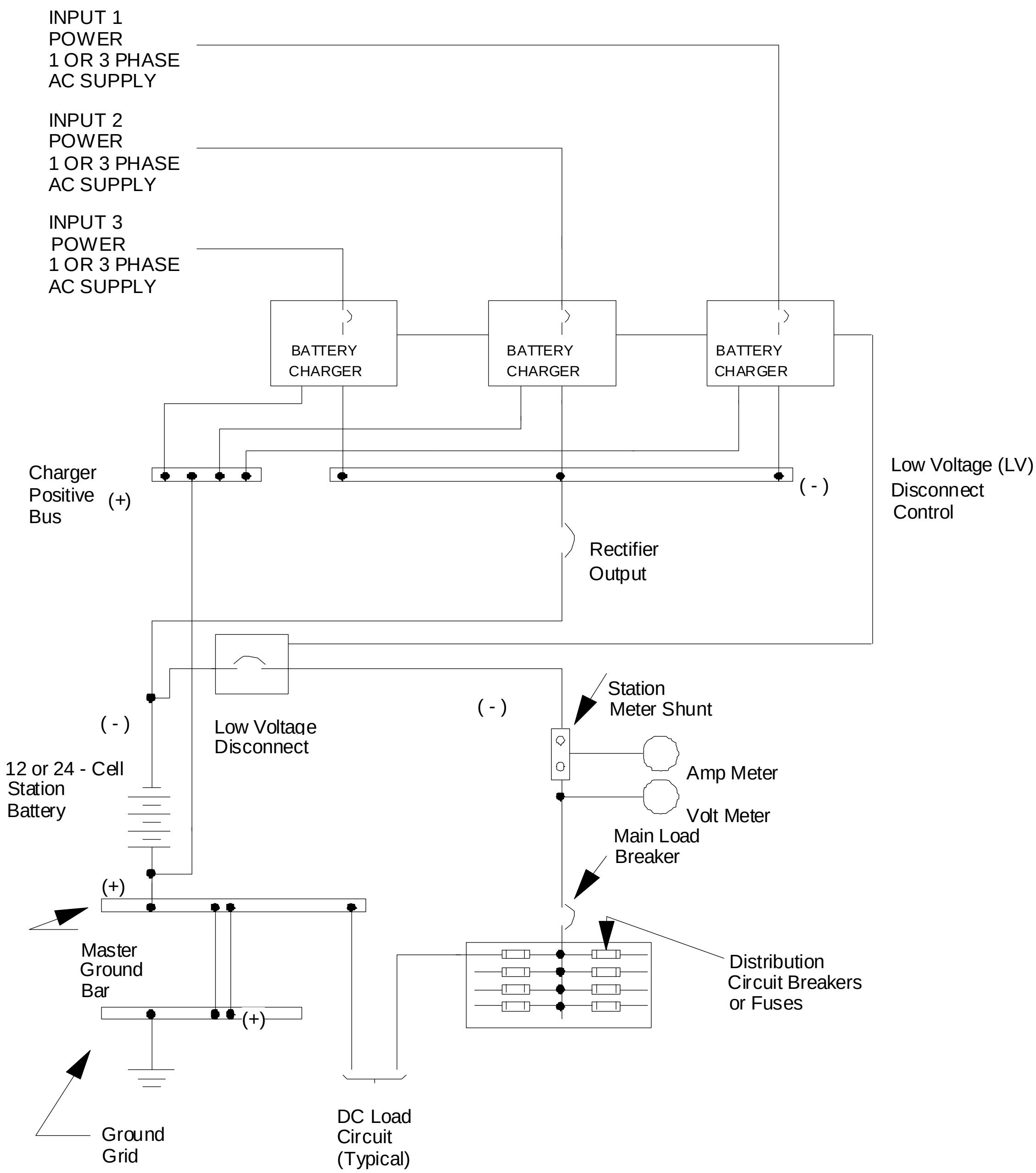

Figure 2 – Communication Standby Battery System Remote Typical One Line Diagram