Engineering Standard

04 September 2022

SAES-T-151
Telecommunications D.C. Power Systems

Document Responsibility: Communications Standards Committee

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Summary of Changes

Paragraph Number		Change Type (Addition, Modification, Deletion, New)	Technical Change(s)
Previous Revision (15 June 2018)	**Current Revision** (04 September 2022)		
1	3	Modification	Update preferences.
NA	4	Addition	Added Terminology section.
4.3	6	Modification	Align with SAES-P-103, 17-SAMSS-511 and BICSI for Telecommunication specific equipment.
4.3.3	6.2.1	Modification	Added notes to reference solar power.
4.5	7	Modification	Alignment with SAES-P-103 and BICSI TDMM applicable for Telecommunication or Industrial grade.
4, 5, 6	5-10	Modification	Alignment with related SAES/SAMSS, specified in each section/subsection, as well as BICSI TDMM specific for Telecommunication application.
4	6, 10	Addition	Emphasis on Preventive maintenance.

1 Scope

This standard provides the minimum mandatory requirements of Communications Power Systems for the use in Saudi Aramco telecommunications facilities.

2 Conflicts and Deviations

Any conflicts between this document and other applicable Mandatory Saudi Aramco Engineering Requirements (MSAERs) shall be addressed to the EK&RD Coordinator.

Any deviation from the requirements herein shall follow internal company procedure SAEP-302.

3 References

All referenced specifications, standards, codes, drawings, and similar material are considered part of this engineering standard to the extent specified, applying the latest version, unless otherwise stated.

3.1 Saudi Aramco References

Saudi Aramco Engineering Procedures

SAEP-302	Waiver of a Mandatory Saudi Aramco Engineering Requirement
SAEP-350	Regular Maintenance and Testing for Industrial Stationary Batteries

Saudi Aramco Engineering Standards

SAES-P-103	UPS and DC Systems
SAES-P-104	Wiring Methods and Materials
SAES-T-795	Grounding, Bonding, and Electrical Protection for Telecommunications Facilities
SAES-P-128	Off-Grid Solar Photovoltaic (PV) System with Battery Storage

Saudi Aramco Materials System Specifications

17-SAMSS-511	Stationary Storage Batteries
17-SAMSS-514	Rectifier/Charger
17-SAMSS-516	Uninterruptible Power Supply (UPS) Systems

Saudi Aramco Best Practices

SABP-P-002	Selection and Design of Battery Monitoring System
SABP-P-024	Guidelines for Minor and Major Preventive Maintenance (PM) of UPS Systems

3.2 Industry Codes and Standards

Building Industry Consulting Services International

TDMM	Building Industry Consulting Services International, TDMM (Telecommunications Distribution Methods Manual)

National Electrical Manufacturers Association

NEMA PE-7	Communications Type Battery Chargers

National Fire Protection Association

NFPA 70	National Electrical Code (NEC)

Underwriters Laboratories, Inc.

UL 924	Emergency Lighting and Power Equipment

Institute of Electrical and Electronics Engineers, Inc.

IEEE 485	Recommended Practice for Sizing Large Lead Storage Batteries for Generating Stations and Substations, Rev 2010

4 Terminology

4.1 Acronyms

AC: Alternating Current

DC: Direct Current

UPS: Uninterruptible Power Supply

PM: Preventive Maintenance

VLA: Vented Lead Acid

FLA: Flooded Lead Acid

VRLA: Valve-Regulated Lead Acid

4.2 Definitions

Rectifier/Charger: Changes the ac input to dc, which is fed to the DC-powered loads and used to charges batteries.

5 Design Requirement

The design shall comply with SAES-P-103 standard in the below sections, with specific recommendation shown in each subsection.

- Battery Installation
- Battery Rooms Construction
- Ventilation of Battery Room
- Battery Racks and Cabinets

Additionally, follow BICSI TDMM Battery Racks and Cabinets section in chapter 9 for specific guideline for communication application

6 Battery Selection and Sizing

6.1 Battery Selection

6.1.1 It shall comply with 17-SAMSS-511 standard

6.1.2 Types of Battery Cells for Telecommunications application include:

6.1.2.1 Alkaline
For remote locations where air conditioning systems are not adequate, battery such as type of alkaline cell, NiCd cell is suitable. It performs well in applications that involve temperature extremes, and has a long-life expectancy

6.1.2.2 VLA, which is also known as FLA
For communication building offices and locations where environment can be controlled by air conditioning systems, batteries such as lead "calcium pasted" plate batteries are most suitable

6.1.2.3 VRLA (Gelled electrolyte cells are part of this classification)
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 batteries shall be VRLA gel type. Sealed batteries shall comply with testing and construction requirements of UL 924

6.1.3 Battery Type Selection for Industrial Grade shall be in accordance with SAES-P-103 standard guidelines.

Note:

Refer to BICSI TDMM manual for further requirements and clarifications regarding this sec.

6.2 Battery Sizing

6.2.1 The battery reserve shall be large enough to sustain operation of the communications load under busy hour conditions (hereinafter called "full DC load").

Battery Sizing		
Full DC load	8 hours	Standby AC power is available
Full DC load	12 hours	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).

> ***Note:*** *1. Refer to SAES-P-100 for sizing of the electrical system which will be based upon using 110% of the sum of the operating load plus all known future loads.*
>
> *2. For Solar PV system with battery storage, the SAES-P-128 standard shall be adhered.*

6.2.2 Final battery cell voltages shall not be less than 2 volts per cell for lead-acid, and for and for an alkaline cell, 1.2 V. Cells are connected in series to increase voltage.

6.2.3 The battery reserve shall be sized as determined by SAES-P-103

6.2.4 The minimum number of series-connected cells and the end-of-discharge voltage per cell shall comply in accordance with SAES-P-103 standard requirements, these includes:

- The minimum number of series-connected battery cells
- The maximum number of series connected cells
- The end-of discharge voltage for each cell
- The cell end-of-discharge voltages

6.2.5 Battery 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.

- Battery racks specifications, installation requirements and procedures shall comply with SAES-P-103 standard.

- Grounding and bonding of battery rack shall comply with SAES-P-103 standard.

7 Battery Charger/Rectifier

7.1 Comply with NEMA PE-7

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

7.1.1 The battery chargers shall have sufficient capacity to carry the full DC load as well as recharging the batteries to 90% capacity in 10 hours.

7.1.2 The calculated station full load shall be increased by 10% to provide a nominal allowance for contingency at all locations.

7.1.3 A minimum of three (3) battery chargers shall be used at central switching offices, Main Communications Buildings, and telecommunication Shelter.

7.1.4 A minimum of two (2) battery chargers shall be used for remote stations. Each charger shall be capable of carrying the full DC communications load plus 10%.

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

7.1.6 The rectifier/charger shall be monitored remotely and be equipped as per SAES-P-103 standard.

7.1.7 The rectifier/charger enclosure for outdoors mounting shall be completely weather-proof, dust-tight and rain-tight, refer to SAES-P-103 standard for details.

7.2 Full Load Current Rating

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 1,000 m Ka = 1.00
		to 1,500 m Ka = .90

		to 3,000 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.

7.3 Battery Chargers Alarms

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

7.3.1 AC failure

7.3.2 Charger failure

7.3.3 DC Output failure

7.3.4 High DC voltage

7.3.5 Low DC voltage

7.3.6 Breaker Trip

7.3.7 Equalizer/float mode status

7.4 Low Voltage Disconnect Device

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.

8 DC Power Distribution and Systems

8.1 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.

8.2 Installation

8.2.1 Wiring shall be in accordance with NFPA 70 (National Electric Code), SAES-P-104 (Wiring Methods), and SAES-T-795 (Groundings). Connectors between cells and between rows of cells shall be corrosion resistant and resistant to fumes from the electrolyte

8.2.2 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

8.2.5 Cable Routing

8.2.5.1 Design the cable routes or bus ducts so that tight or excessive bends are avoided. The bending radius must not be less than eight times the overall diameter for unshielded power cable.

8.2.5.2 When a connection is made to an overhead bus or cables and are routed on raceways in free air, the cable shall be terminated in the direction of the current flow and avoid cables “coming back” on themselves.

8.2.5.3 Run equal numbers of dc positive and dc negative cables together in the same raceway (such as in a conduit, trough, cable ladder) to aid the cancellation of transient effects

8.2.6 Terminating

8.2.6.1 A compression-type connector is mandatory compared to a mechanical connector. In a situation where mechanical connectors are used, it shall be tighten to the recommended torque.

8.2.6.2 Mixing of aluminum terminating devices with copper cable is not permitted. It is recommended to use two-hole lugs, which will make a better mechanical and electrical connection

8.2.7 Grounding (Earthing)

Ground (earth) the dc system at the main switchboard dc positive busbar for a positively grounded system. Ground (earth) the dc negative busbar for a negatively grounded system, using cable of appropriate size. Refer to BICSI TDMM for further requirements

8.2.8 Batteries shall be installed as per area of classification as defined in SAES-P-103 standard

9 UPS Systems

9.1 Redundant system shall be used on critical Communications Buildings or facilities where operation damages can occur during the period of surges or power source failure

9.2 DC UPS Input / Output Specifications

Note:

The requirements stated in 17-SAMSS-514 shall be adhered

9.3 For IT UPS applications such as modular or scalable UPS system, refer to 17-SAMSS-516

10 Testing and Inspection

10.1 Safety Requirements

10.1.1 Safety Equipment requirements shall comply with SAES-P-103 standard.

10.1.2 Safety Signs requirements shall comply with SAES-P-103 standard.

Additional Requirement: Water facilities shall be provided for rinsing spilled electrolyte in the battery room.

10.1.3 Battery Disposal requirements shall comply with SAES-P-103 standard.

Additional Requirements:

10.1.3.1 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.

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

10.1.4 Drains shall comply with SAES-S-060 standard, "Chapter 8 – Indirect and Special Wastes.

Note: Drains are not required for sealed battery installations.

10.1.5 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.

10.1.6 For general and comprehensive Preventive Maintenance and safety requirement guideline, refer to SAEP-350 and SABP-P-024.

Note:

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

10.2 Battery Test

Comply with the requirements as per SAES-P-103 standard.

10.3 Charger Test

Chargers shall be tested per NEMA PE-7.

10.4 Ventilation Test for Sealed Battery Rooms

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

10.4.1 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.

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

10.4.3 The maximum hydrogen gas concentration is to be no more than 2.0% by volume when measured during step (Section 10.4.2). 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.

Document History

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.
20 April 2014	Editorial revision to change the primary contact.
15 June 2018	Major revision to align with SAES-P-103 standard and provide applicable changes to IT/Communications needs.
04 September 2022	Major revision in alignment with SAES-P-103 standard, 17-SAMSS-511, and BICSI TDMM manual (address to installation requirements, battery types and etc.).

Figure 1 – Communication Standby Battery System

Central Office Typical One Line Diagram

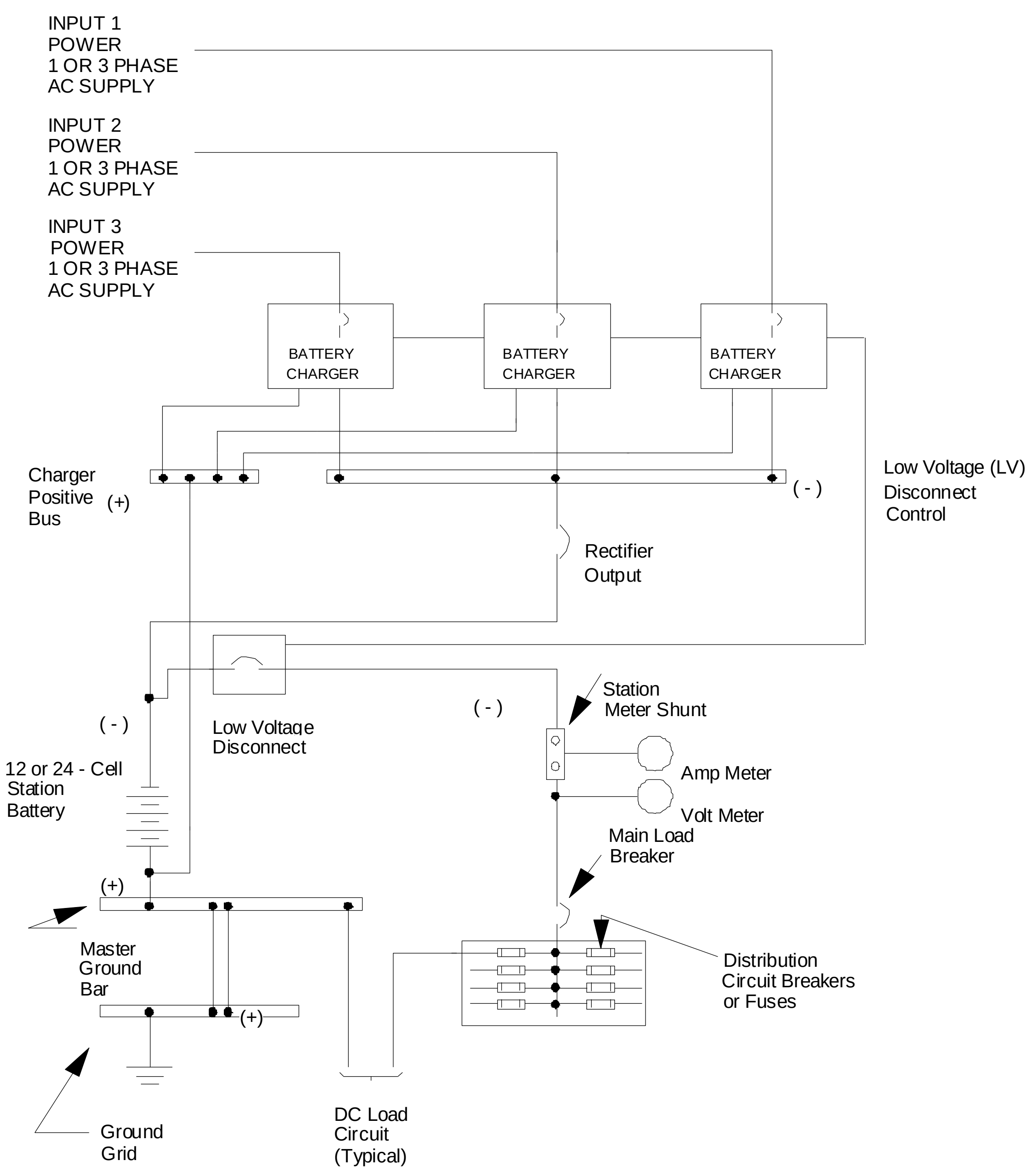

Figure 2 – Communication Standby Battery

System Remote Typical One Line Diagram