Engineering Standard

SAES-T-493 19 July 2020

Mobile and Fixed Radio Systems

Document Responsibility: Communications Standards Committee

Contents

Previous Issue: 14 March 2017 Next Planned Update: 19 July 2025

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Summary of Changes

No.	Paragraph No.	Change Type (New, Modification,..)	Technical Change(s)
1	2	Modify	Updated to align with MSAERs
2	3.1	Add & Modify	Added: SAES-O-208 and GI-299.110 Updated some of the standards name to the latest version
3	3.2	Add	New standards to ensure alignment with international standards: NFPA 70 / NEC and ETSI TS 101 789
4	4	Add	Updated the list of definitions used in the standard
5	5	Modify	Added the referenced standards in sec. 3.2 to the adoption sentence to make for better understanding
6	6.1.1 & 6.1.4	Add & Modify	Adding project proposal phase and editorial update to reflect the correct unit name
7	6.1.5 & 6.1.6	Add	To insure proper specification design
8	6.3.4	Add	Dust Requirement per international standards (alignment)
9	6.4	Add & Modify	Major update to specify the minimum requirement for RF study
10	6.5	Modify	Update the sentence to align with other SAES (P & Z)
11	6.6	Modify	Updated the version number to approved version
12	6.9.5 & 6.14	Add	Commentary note to clarify exempted applications
13	6.15.3	Add	To drive manufactures to adopt SNMP Traps technology for indoor repeaters
14	6.17	Add	Two sub-points to address power back up requirements
15	3.18 & 6.19	Add	Capacity planning added to ensure system reliability for new and upgrade projects. Asset management to align with SA requirement
16	7.4 & 8.9	Modify	To align with SAES-T-916 and international standards
17	7.5	Modify	Update the equipment location requirements
18	8.5	Add & Modify	Split the sub-point into two for better understanding
19	8.9	Modify	Specify examples for better understanding
20	8.11	Add	To ensure design specification and installation
21	6.2, 6.8, 6.11, 7, 7.1, 7.3, 8, 8.2, 8.7	Editorial	To make the sentence clear
22	6.16 & 6.17	Editorial	To match the standard format
23	3.1 & 8.9	Delete	SAES-911 and changed it to SAES-916

1 Scope

This standard presents minimum mandatory requirements for engineering and installation of mobile and fixed radio systems based on VHF/UHF (conventional) system or Digital Trunked Radio system. This document doesn't address process automation systems design requirements.

2 Conflicts and Deviations

Any conflict between this document and other applicable Mandatory Saudi Aramco Engineering Requirements (MSAERs) shall be addressed in writing to the EK&RD Coordinator. Any deviation from the requirements herein shall follow internal company 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 Procedures

SAEP-302	*Waiver of a Mandatory Saudi Aramco Engineering Requirement*
SAEP-744	*Preventive Maintenance and Condition Assessment for Communication Towers*

Saudi Aramco Engineering Standards

SAES-B-068	*Electrical Area Classification*
SAES-J-003	*Instrumentation and Control Buildings - Basic Design Criteria*
SAES-O-208	*Wired and Wireless Communications for Security Application*
SAES-P-100	*Basic Power System Design Criteria*
SAES-T-744	*Design Criteria and Installation of Communication Towers*
SAES-T-795	*Grounding, Bonding, and Electrical Protection for Telecommunications Facilities*

SAES-T-916	*Telecommunications: Building Cable Systems, Pathways and Spaces*
SAES-Z-004	*Supervisory Control and Data Acquisition (SCADA) System*

General Instructions (GIs)

GI-0006.008	*Restriction of Portable Electrical/Electronic Devices*
GI-1603.000	*Importation of Communications Equipment*
GI-299.110	*IT Asset Management*

3.2 Industrial Codes and Standards

Saudi Arabia Communication & Information Technology Commission (CITC)

NFP	*National Frequency Plan for Saudi Arabia*
RI011	*CITC Technical Specification - Specification for TETRA Handsets and Ancillary Equipment*
CITC Guidelines	*National Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields - Annex 6*

American National Standards Institute / National Fire Protection Association

NFPA 70 / NEC	*National Fire Protection Association 70 / National Electrical Code*

Electronic Industries Association

EIA/TIA 329.1	*Minimum Standards for Communication Antennas - Base Station Antennas*
EIA/TIA 329.2	*Minimum Standards for Communication Antennas - Vehicular Antennas*
EIA/TIA 603	*Land Mobile FM or PM Communications Equipment Measurement and Performance Standards*

ETSI ETS 100-392 Series

ETSI EN 300 392	*Terrestrial Trunked Radio (TETRA) - Voice plus Data (V+D)*
ETSI EN 300 394	*Terrestrial trunked radio (TETRA) - Conformance Testing Specification*
ETSI EN 300 395	*Terrestrial Trunked Radio (TETRA) - Speech Codec for Full-Rate Traffic Channel*

ETSI EN 300 396	*Terrestrial Trunked Radio (TETRA) - Technical Requirements for Direct Operation (DMO)*
ETSI EN 302 109	*Terrestrial Trunked Radio (TETRA) - Security - Synchronization Mechanism for End-to-End Encryption*
ETSI EN 301 489-18	*Electromagnetic Compatibility and Radio Spectrum Matters (ERM) - Electromagnetic Compatibility (EMC) Standard for Radio Equipment and Services - Part 18: Specific Conditions for Terrestrial Trunked Radio (TETRA) Equipment*
ETSI EN 301 040	*Terrestrial Trunked Radio (TETRA) - Security - Lawful Interception (LI) Interface*
ETSI EN 300 827	*Electromagnetic Compatibility and Radio Spectrum Matters (ERM). Electromagnetic Compatibility (EMC) Standard for Terrestrial Trunked Radio (TETRA) and Ancillary Equipment*
ETSI EN 303 035	*Harmonized EN for TETRA Equipment Covering Essential Requirements under Article 3.2 of the R&TTE Directive*
ETSI EN 300 812	*Terrestrial Trunked Radio (TETRA); Security aspects; Subscriber Identity Module to Mobile Equipment (SIM-ME) interface*
ETSI ES 201 962	*Terrestrial Trunked Radio (TETRA); TETRA Advanced Packet Service (TAPS)*
ETSI TS 101 789	*Terrestrial Trunked Radio (TETRA); TMO Repeaters*

UL Standards

UL 452	*Antenna Discharge Units for Radio and Television Receiving Appliances*
UL 497C	*Equipment Covered by the Standard for Protectors for Coaxial Communications Circuits*

4 Definitions

Antenna: is a transducer that converts alternating current signal into radio frequency (RF) fields or vice versa.

BER: Bit Error Rate.

DCO: Digital Communications Office.

FM: Frequency Modulation.

Full-Duplex: Both parties can communicate with each other simultaneously; the communication is in both direction in the same time.

Half-Duplex: both parties can communicate with each other, but not simultaneously; the communication is one direction in the same time.

IP: Internet Protocol.

ITED: Information Technology Engineering Department.

PED: Portable Electrical/Electronic Devices.

PM: Phase Modulation.

RF: Radio Frequency.

RL: Return loss in RF circuits is the proportion of a signal that is reflected as a result of impedance mismatch.

SCN: Switching and Control Node, a node that contains data switches and equipment for controlling, formatting, transmitting, routing, and receiving voice and data packets.

TEA1 and TEA3: TEA1 and TEA3 are air interface encryption algorithms for TETRA for Class 1 (Clear) and Class 3 (DCK, CCK & GCK) security.

TETRA: **Te**rrestrial **T**runked **Ra**dio (formerly known as Trans European Trunked Radio) is an ETSI digital Trunked Mobile Radio and two-way transceiver standard.

Trunked Radio System: "Trunked" Radio system is complex type of computer-controlled radio system that uses a "pool of channels" which is available for a great many different groups of users.

VSWR: "Voltage Standing Wave Ratio" is the ratio of the amplitude of a partial standing voltage wave at an antinode (maximum) to the amplitude at an adjacent node (minimum), in a transmission line.

5 Adoption

For voice communications radios, "ETSI ETS 100-392 series" is hereby adopted as Saudi Aramco standards for Digital Radio Trunked System. Subsequent Sections of this standard shall be adopted in addition to the above standards.

For data connectivity, the Land Mobile FM or PM Communications Equipment Measurement and Performance Standards, TIA 603; the Minimum Standards for Communication Antennas - Base Station Antennas, TIA 329.1; the Minimum Standards for Communication Antennas - Vehicular Antennas, TIA 329.2; published by Electronic Industries Association (EIA/TIA) are hereby adopted as Saudi Aramco Engineering Standard for VHF/UHF Land-Mobile and Fixed Radio Communication.

Deviations to these international standards are identified as exceptions or additions in the Design section of this standard.

6 Design

6.1 Spectrum Regulation and Approval

6.1.1 All radio equipment shall conform and comply with the CITC frequency regulations and the National Frequency Plan (NFP). Spectrum allocation request and approval shall be obtained from CITC during project proposal.

Commentary Note:

Spectrum Approval from CITC shall be obtained through IT Third Party Solutions Group, ITED.

6.1.2 All radio equipment shall adhere to all importation procedures of radio telecommunication equipment into the Kingdom. For procedures on radio equipment importation, refer to GI-1603.000.

6.1.3 New frequency assignments to Saudi Aramco shall be surveyed / scanned by the project to ensure interference-free channels prior to utilization.

6.1.4 All project proposal / detailed design packages including Wireless radio scope shall be reviewed by ITED.

6.1.5 The surge suppressor operating frequency band shall match with the operating frequency of the TETRA Radio frequency assignment.

6.1.6 Proper connectors shall be selected and used to match the frequency assignment, power, environment and RF media.

6.2 Portable Devices Use

All Radio PEDs shall adhere to the minimum requirement of GI-0006.008 in terms of restriction, labeling, and use and CITC requirement such as RI011.

6.3 Environmental Conditions

As per SAES-J-003, the following environmental requirements must be met:

6.3.1 Temperature for Fixed Devices

All radio equipment shall operate continuously under the following ambient air temperatures without any degradation of the manufacturer's guaranteed performance:

	Indoor Air Conditioned (2)	Outdoor Sheltered (1)(2)(3)	Outdoor Unsheltered (2)(3)
Maximum	35°C (95°F)	55°C (131°F)	65°C (149°F)
Minimum	10°C (50°F)	0°C (32°F)	0°C (32°F)

Notes:

1) "Sheltered" refers to permanent, ventilated enclosures or buildings, or permanently fixed sunshades with a top and three sides.

2) For devices which dissipate internal heat and are installed in custom engineered enclosures (e.g., enclosures not included in the original manufacturer's temperature certification), an additional 15°C shall be added to the above maximum temperatures. An example, for "indoor air conditioned" installation, the equipment must perform at 35 + 15 = 50°C. Similarly, for the "outdoor unsheltered" case, the equipment shall be designed for a maximum operating temperature of 65 + 15 = 80°C.

3) For the outdoor installations only, the designer can take credit for forced or passive cooling to eliminate or reduce the 15°C heat rise. No more than 15°C reduction in temperature will be given as credit. The designer shall substantiate his claim by providing the support data and calculations.

6.3.2 Temperature for Portable Devices

Portable radio devices shall operate continuously under the following ambient air temperatures (indoor or outdoor) without any degradation of the manufacturer's guaranteed performance:

6.3.2.1 Minimum temperature is 0°C

6.3.2.2 Maximum temperature is 50°C

6.3.3 Humidity

Indoor humidity design basis shall be 20% to 80% relative humidity. Outdoor design basis shall be 5% to 95% relative humidity (non-

condensing).

6.3.4 Dust

Fixed and portable radio devices shall comply with the minimum requirement of NEC 500 and NEC 505 (Ex ib).

6.4 Radio Frequency Analysis

6.4.1 An RF signal analysis study shall be developed for outdoor area showing the following information:

a) Propagation, colored coverage heat map and signal strength calculations and prediction for balanced link limiting the coverage showing surrounding infrastructures including but not limited to buildings, pipe racks and tanks
b) Link Budget
c) Frequency Analysis
d) Antenna height recommendation
e) Desensitization Analysis
f) Traffic Analysis, Calculations and Grade of Service (GoS) Level. The traffic analysis shall take into account the current traffic load from existing network and predicted addition users. It shall be designed based on a min of 5% GoS
g) Traffic & User Distribution
h) Intermodulation Analysis
i) Interference Study
j) The RF analysis report showed show the Fresnel zone size for F1, F2 and F3.
k) For process automation applications no more than 30% blockage of F1 is accepted.

6.4.2 Indoor RF signal analysis study shall be developed for key buildings or facilities requiring indoor radio coverage considering the following:

a) Penetration Study for indoor coverage.
b) Indoor Radio Coverage Plots
c) Block Diagram of Indoor Repeater Design
d) Leaky cable routing
e) Propagation Model
f) Desense Calculation indicating signal degradation on the outdoor coverage due to the indoor repeaters
g) Distributed Antenna System (DAS)

6.4.3 Minimum of 95% radio coverage availability for the agreed operational area including both outdoor and indoor.

6.5 Electrical Area Classification Design

6.5.1 All electrical equipment/components shall meet the electrical area classification of their areas of installation and/or usage.

Commentary Note:

SAES-B-068, Electrical Area Classification, is the standard used to define the electrical classified areas at Company facilities.

6.5.2 Certification of suitability for the targeted area shall be in accordance with NEC (Certificate of Compliance) or through an IECEx certificate (IECEx Certificate of Conformity), as specified in Section 8 "Electrical Area Classification Design" of SAES-P-100.

6.5.3 Label or certification shall be valid and from an approved IECEx Certification Body (ExCB) under IECEx Certified Equipment Scheme.

6.5.4 Wired connectivity between Radio equipment and other Systems at Classified / Restricted Areas shall be handled through Work Permit System.

6.5.5 All PEDs and their accessories shall be intrinsically safe "Ex ib" certified for Zone 1 classified locations.

Commentary Notes:

PEDs can only be taken to locations designated as Class I Zone 0 by following the company work permit requirements.

PEDs shall not be used in areas known to contain potentially explosive atmospheres without prior gas testing.

Defected or damaged PEDs shall not be used or taken into classified areas.

6.5.6 All manufacturers' recommended practices/requirements for hazardous areas applications shall be followed or considered during the installation and operations.

6.6 Network Management

Any new radio system project must include a Network management system based on SNMP approved version to allow remote configure, access, modify, as well as monitor communication links status, traffic loading, and network performance. The network management system shall support: Fault management (detection, isolation, and correction), Configuration management, Performance management, Security management, and Accounting management.

6.7 Communications Antennas

6.7.1 Base Station Antennas

Minimum standard is per EIA/TIA 329.1.

Commentary Note:

The antennas requirements for Radio Frequency Dispatch unit (Desktop Radio) can be derived from the Base Station Antennas requirement, since Radio Frequency Dispatch unit can be treated as a special case of Base Station Antennas requirements.

6.7.2 Vehicular Antennas

Minimum standard is per EIA/TIA 329.2.

6.7.3 All antennas, including desktop antennas, shall be installed outside the building (away from personnel work area). Desktop Radio transceiver shall be installed separately in the equipment or communications room (away from the control head). Following the CITC National Guidelines (Annex 6).

6.7.4 RF jumper cables between base station antenna connector and main RF feeders shall be factory made jumpers.

6.8 Roaming

Mobile users shall be able to roam freely within the coverage area for all types of voice and data calls. The Trunked Mobile system shall initiate an automatic site registration / de-registration process without user interference if roaming is needed.

6.9 Security

The Radio systems shall support:

6.9.1 For Digital Trunked Radio system user authentication for Dispatcher workstation shall be supported

6.9.2 Digital Trunked Radio system shall support at least two air interface encryption, namely TEA1 for Class 1 security and TEA3 for Class 3 Security.

6.9.3 Information transmitted shall be classified according to GI-0710.002.

6.9.4 All radio systems supporting industrial security applications used for transfer of voice, data, and/or video shall comply with all requirements

listed in SAES-O-208 which includes encryption and recording requirements.

6.9.5 All VHF/UHF radio systems shall support AES air encryption.

Commentary Note:

This exclude FM Broadcast, International Marine and Aviation radio systems.

6.10 Interoperability

Standard interoperability certificate shall be provided for Digital Trunked Radio systems and end-user equipment.

6.11 Recording System

All VHF/UHF Radio System including Digital Trunked Radio systems shall be provided with a recording system for voice channels.

6.12 Performance

Digital Trunked Radio systems shall be designed and provisioned to meet the following performance parameters under the intended traffic demand level (design):

6.12.1 At minimum, 95% of calls attempted shall be processed without being queued, AND the remaining 5% of call attempts shall not have queuing delay in excess of 3 seconds.

6.12.2 The maximum call setup time for talk group and individual calls within single SCN is 300 and 770 millisecond, respectively.

6.13 Anti-Jamming Detection

Jamming and interception detection shall be supported by Digital Trunked Radio systems.

6.14 Voice Services

All voice radio communication projects shall be based on Digital Trunked Radio system. The voice radio system shall support group calls, individual calls (Full Duplex voice Calls, Half Duplex voice calls), voice call Priority, Direct Mode (unit-to-unit without the use of a BS), Call Pre-emptive Priority, Emergency voice Call capabilities, and voice Calling Line and Talking Party Identity Presentation.

Commentary Note:

This exclude International Marine and Aviation radio system.

6.15 Data Services

6.15.1 Data service can be provided by Digital Trunked Radio system or VHF/UHF radio system.

6.15.2 Digital Trunked Radio system shall support IP packet data services (IP over Ethernet transmissions without the need to use of multiplexers or any other additional hardware) and short data messages.

6.15.3 It is recommended to interconnect and configure TETRA indoor repeater to send SNMP traps to Dhahran system logs server (Trap Logs)

6.16 Wireless Connectivity

Connectivity using wireless radio system may be used for remote monitoring applications. For SCADA applications, it shall adhere to SAES-Z-004.

6.17 Power Requirement

6.17.1 All digital exchange equipment requiring direct current, shall be designed to operate at a nominal voltage of -48 Vdc. The operating voltage may vary from -44 to -52 Vdc with positive polarity to ground, and the digital equipment shall be designed to operate normally within this voltage range.

6.17.2 All Radio Base Stations and Indoor repeaters shall be connected to back up power source such as uninterruptible Power Source (UPS).

6.17.3 Desktop Radios/Dispatcher consoles installed inside critical locations (Central Control Rooms, Emergency Control Rooms, and Disaster Control Rooms) shall be connected to back up power sources such as uninterruptible Power Source (UPS)6.18 Capacity Planning

6.18.1 Any capital project shall have a minimum spare capacity of 20% for future expansion.

6.18.2 Any additional element to an existing Radio system shall submit detailed capacity planning which include but not limited to traffic study, coverage study, ports availability, licensees, and number of users (total and new).

6.19 Asset Management

Asset management of radio equipment including end user devices such as handheld shall be in accordance with the requirements of GI-299.110

7 Installation

7.1 The recommended installation practices by manufacturer shall be followed.

7.2 Grounding of radio equipment and antenna shall be in accordance with SAES-T-795.

7.3 All Antennas shall install a surge arrestor as per UL 452 “Antenna Discharge Units for Radio and Television Receiving Appliances” and UL 497C “Equipment Covered by the Standard for Protectors for Coaxial Communications Circuits”.

7.4 All cabling infrastructure and installation shall comply with SAES-T-916 and latest BICSI TDMM edition.

7.5 All Base Stations equipment shall be installed in locations intended to host telecommunication equipment in accordance with SAES-T-916.

7.6 Tower installation shall comply with SAES-T-744 and SAEP-744.

8 Testing and Inspection

Field testing and inspection of the radio equipment including its cables shall be recorded in a log book and handed to Proponent Department. Field Tests shall include, as a minimum requirement, the following:

8.1 Inspecting solid connections of wires and grounds to insure safety and proper operation.

8.2 Verifying and measure the operating frequencies and frequency error of transmitters and receivers according to manufacturer specs.

8.3 Verifying RF power of transmitter and confirming coverage area of base station.

8.4 Checking RF cable and antenna matching.

8.5 Measure VSWR and RL for RF feeder (transmission cable) and antenna.

8.6 Measure Signal-to-Noise Ratio (SNR) for Base station receiver.

8.7 For Digital Trunked Radio system Bit Error Rate/Message Erasure Rate (BER/MER) shall be tested.

8.8 Visual inspection for Base station after installation to check for Physical connectivity and various indicators status.

8.9 The Contractor shall provide as-built drawings in accordance with Saudi requirements in SAES-T-916. This include but not limited to Repeater location in

building/floor plan, indoor antennas, RF cable route, RF splitter(s). All with clear labeling.

8.10 Inspecting all devices operated in hazardous areas to have a label or/and certification from an approved Saudi Aramco certifying agency in accordance with SAES-P-100.

8.11 For Digital Trunked Radio system, Project shall perform coverage verification drive test "based on agreed route with IT ". The test shall use a tool that generate a report highlighting the rout on map, to verify against coverage predication plots, showing received signal level MER/BER and successful calls ratio.

Revision Summary

13 December 2011	Major revision.
18 July 2012	Editorial revision to change the primary contact.
14 March 2017	Major revision to streamline standard's functionality by consolidating SAES-T-493 and SAES-T-492 into one document.
19 July 2020	Major revision to include Radio Frequency Analysis Study. Summary of changes shows all the update and enhancement.