



Member of the FM Global Group

**Examination Standard
for
Land Mobile Radios
for use in
Class I, Division 1 Hazardous
(Classified) Locations**

Class Number 3640

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Foreword

This standard is intended to verify that the products and services described will meet stated conditions of performance, safety and quality useful to the ends of property conservation. The purpose of this standard is to present the criteria for examination of various types of products and services.

Examination in accordance with this standard shall demonstrate compliance and verify that quality control in manufacturing shall ensure a consistent and reliable product.

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1 INTRODUCTION

1.1 Purpose

1.1.1 This standard states testing and certification requirements for Land Mobile Radios for use in Class I, Division 1 Hazardous (Classified) Locations.

1.1.2 Testing and certification criteria may include, but are not limited to, performance requirements, marking requirements, examination of manufacturing facility(ies), audit of quality assurance procedures, and a surveillance program.

1.2 Scope

1.2.1 This standard specifies the particular requirements for construction, test and marking for Land Mobile Radio (LMR) equipment and accessories for use in Class I, Division 1, locations as defined by the National Electrical Code, ANSI/NFPA 70. This LMR equipment, within the operational parameters specified by the manufacturer, ensures a very high level of protection that includes rare malfunctions related to the equipment or two expected malfunctions occurring independently of each other.

NOTE 1: A malfunction may result from a failure of the component parts of the electrical equipment or from anticipated externally applied influences. Two independent expected malfunctions which, separately, would not create a source of ignition, but which, in combination, do create a source of ignition, are regarded as a single rare malfunction.

NOTE 2: This LMR equipment is intended for use in Class I, Division 1, locations where ignitable mixtures of flammable gases or vapors are present frequently during normal operations.

1.2.2 This standard applies to equipment with a nominal battery voltage not exceeding 24 Vdc.

1.3 Basis for Requirements

For general basis of requirements, see FM Approvals Standard 3600.

1.4 Basis for Certification

See FM Approvals Standard 3600, Paragraph 1.3.

1.5 Basis for Continued Certification

See FM Approvals Standard 3600, Paragraph 1.4.

1.6 Effective Date

The effective date of this certification standard mandates that all products tested for certification after the effective date shall satisfy the requirements of this standard.

The effective date of this standard is eighteen (18) months after the publication date of the standard for compliance with all requirements.

1.7 System of Units

Units of measurement used in this Standard are United States (U.S.) customary units. These are followed by their arithmetic equivalents in International System (SI) units, enclosed in parentheses. The first value stated shall be regarded as the requirement. The converted equivalent value may be approximate. Conversion of U.S. customary units is in accordance with ANSI/IEEE/ASTM SI 10

1.8 Terms and Definitions

For the purposes of this standard, the terms given in the standards referenced in Clause 1.9 and the following apply:

Antenna Gain - gain produced by an antenna concentrating radiation in a particular direction

NOTE The gain of LMR antennas is frequently less than unity

Continuous Transmission - transmission where the duration of the pulse is greater than the half of the thermal initiation time

Expected Malfunction - disturbances or equipment malfunctions which normally occur in practice

Land Mobile Radio (LMR) - A LMR is hand-held or portable communication equipment that is a component of a wireless communications system based on broadcasting electromagnetic waves.

Malfunction - equipment or components which do not perform their intended function with respect to explosion protection

NOTE For the purposes of this standard, this can happen due to a variety of reasons, including:

- failure of one (or more) of the component parts of the equipment or components;
- external disturbances (e.g. shocks, vibration, electromagnetic fields);
- design error or deficiency (e.g. software errors);
- disturbance of the power supply or other services;
- loss of control by the operator (especially for handheld equipment)

Normal Operation - operation of equipment conforming electrically and mechanically with its design specification and used within the limits specified by the manufacturer.

Portable Equipment - equipment that has been designed to be readily carried from place to place and to be used while it is being carried. Portable equipment is battery powered and includes, but is not limited to:

- a) a hand-held apparatus, typically less than 1 kg, which requires use of only one hand to operate;
- b) larger equipment that can be operated by the user while it is carried either by hand, by a shoulder strap, or by a carrying harness.

Protection Concept - protection measures applied to electrical equipment for use in hazardous (classified) locations as defined by the National Electrical Code, ANSI/NFPA 70, to avoid ignition of a surrounding flammable atmosphere.

Radio Frequency - electromagnetic waves from 9 kHz to 60 GHz

Rare Malfunction - type of malfunction, which may happen, but only in rare instances. Two independent expected malfunctions which, separately, would not create a source of ignition, but which, in combination, do create a source of ignition, are regarded as a single rare malfunction.

Threshold Power P_{th} - product of the effective output power of the transmitter multiplied by the antenna gain

NOTE For LMRs, the threshold power is considered to be equal to the effective Isotropic Radiated Power (EIRP) per ITU-R BS.561-2.

1.9 Normative References

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the cited edition applies.

ANSI/ISA-60079-0, *Explosive atmospheres - Part 0: Equipment- General Requirements*

ANSI/ISA-60079-1, *Explosive Atmospheres - Part 1: Equipment Protection by Flameproof Enclosures “d”*

ANSI/ISA-60079-2, *Explosive Atmospheres - Part 2: Equipment Protection by Pressurized Enclosures “p”*

ANSI/ISA-60079-5, *Explosive Atmospheres - Part 5: Equipment Protection by Powder Filling “q”*

ANSI/ISA-60079-6, *Explosive Atmospheres - Part 6: Equipment Protection by Oil Immersion “o”*

ANSI/ISA-60079-7, *Explosive Atmospheres - Part 7: Equipment Protection by Increased Safety “e”*

ANSI/ISA-60079-11, *Explosive Atmospheres - Part 11: Equipment Protection by intrinsic safety “i”*

ANSI/ISA 60079-15, *Electrical Apparatus for Use in Class I, Zone 2 Hazardous (Classified) Locations: Type of Protection “n”*

ANSI/ISA-60079-18, *Electrical Apparatus for Use in Class I, Zone 1 Hazardous (Classified) Locations: Type of Protection – Encapsulation “m”*

ANSI/NFPA 70, *National Electrical Code*

ANSI/ISA 12.12.01, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations*

ANSI/NFPA 496, *Standard for Purged and Pressurized Enclosures for Electrical Equipment*

2 GENERAL INFORMATION

2.1 Product Information

The Land Mobile Radios covered by this standard are normally portable, hand-held, battery-powered equipment providing two-way radio communication. The radios may be powered from primary (non-rechargeable) or secondary (rechargeable) batteries or battery packs. Other designs meeting the criteria of this standard may also be considered for certification.

2.2 Certification Application Requirements

The manufacturer shall provide the following preliminary information with any request for certification consideration:

- A complete list of all models, types, sizes and options for the product or services being submitted for certification consideration;
- General assembly drawings, complete set of manufacturing drawings, materials list, anticipated marking format, electrical schematics, nameplate format, brochures, sales literature, spec. sheets, operation and maintenance procedures, and
- The number and location of manufacturing facilities.
- All documents shall identify the manufacturer's name, document number or other form of reference, title, date of last revision, and revision level. All documents shall be provided with English translation.

2.3 Requirements for Samples for Examination

2.3.1 Following authorization of a certification examination, the manufacturer shall submit samples for examination and testing based on the following.

- The test samples shall be a complete assembly with all components mounted in a manner consistent with the manufacturer's instructions and intended application.
- Sample requirements to be determined by the certification agency

2.3.2 Requirements for samples may vary depending on design features, results of prior or similar testing, and results of any foregoing tests.

2.3.3 The manufacturer shall submit samples representative of production. Any decision to use data generated using prototypes is at the discretion of the certification agency.

3 GENERAL REQUIREMENTS

3.1 Review of Documentation

3.1.1 During the initial investigation and prior to physical testing, the manufacturer's specifications and details shall be reviewed to assess the ease and practicality of use. The certification investigation shall define the limits of the final certification.

3.2 Design and Construction

3.2.1 General

The equipment shall comply with the requirements of 3.2.2 for the electrical circuits, with the requirements of 3.2.3 for mechanical ignition hazards, and with 3.2.4 for electromagnetic energy hazards.

3.2.2 Protection measures against ignition hazards of the electrical circuits

3.2.2.1 Explosion protection

The equipment shall comply with the requirements of either 3.2.2.2, 3.2.2.3, or 3.2.2.4.

3.2.2.2 Intrinsic safety as a sole means of explosion protection

Intrinsically safe electrical equipment meeting the requirements of ANSI/ISA 60079-11 for type of protection "ia" is acceptable.

NOTE Intrinsic safety "ib" or "ic" in accordance with ANSI/ISA 60079-11 may be considered as one of two independent means of protection according to 3.2.2.4.

3.2.2.3 Encapsulation as a sole means of explosion protection

Encapsulated electrical equipment meeting the requirements of ANSI/ISA 60079-18 for type of protection "ma" is acceptable.

NOTE Encapsulation "mb" or "mc" in accordance with ANSI/ISA 60079-18 may be considered as one of two independent means of protection according to 3.2.2.4.

3.2.2.4 Application of two independent types of protection otherwise suitable for Class I, Division 2 locations

Electrical equipment shall comply with the requirements of two independent protection concepts suitable for Class I, Division 2 as shown in Table 1. If one protection concept were to fail, the other protection concept shall continue to function. The independent protection concepts shall not have a common mode of failure.

Table 1 – Acceptable concepts

Protection Concept	Applicable Standard
Non-Incendive	ANSI/ISA 12.12.01
Pressurization Type Z	ANSI/NFPA 496
“nR”	ANSI/ISA 60079-15
“nA”	ANSI/ISA 60079-15
“nC”	ANSI/ISA 60079-15
“ib”	ANSI/ISA 60079-11
“ic”	ANSI/ISA 60079-11
“mb”	ANSI/ISA 60079-18
“mc”	ANSI/ISA 60079-18
“d”	ANSI/ISA 60079-1
“e”	ANSI/ISA 60079-7
“o”	ANSI/ISA 60079-6
“q”	ANSI/ISA 60079-5
“pz”	ANSI/ISA 60079-2

NOTE Combined protection concepts should depend on different physical protection principles. For example the combination of “d” and “q” both depend on the avoidance of flame propagation and may not be useful in combination. In practice, some combinations may not be useful, for example the combination of “o” and “q”.

It shall be possible for each protection concept to be tested individually (see 3.4.1).

When using two protection concepts that rely on the same parameter (for example, the creepage distance when combining “ib” with “e”), the most stringent requirement of either of the protection concepts shall be applied.

If two protection concepts are combined which both rely on an enclosure, one of the following shall be met:

- If two independent enclosures are used (one totally enclosed within the other), each enclosure shall separately comply with the requirements of the respective protection concept; or
- if only one enclosure is used, the enclosure shall comply with the impact test requirements for Group I equipment shown in ANSI/ISA 60079-0.

Examples of combinations of two independent protection concepts are as follows:

- intrinsic safety “ib” further enclosed by encapsulation “mb”;
- intrinsic safety “ib” further enclosed by a flameproof enclosure “d”;
- intrinsic safety “ib”, additionally protected by powder filling “q”;
- nonincendive circuits enclosed by a restricted breathing enclosure “nR”;
- nonincendive circuits enclosed by a static pressurized enclosure “pz”.

3.2.2.5 Cells and batteries

All primary and secondary Lithium cells shall be certified as recognized components by a Nationally Recognized Testing Laboratory (NRTL) and applied in accordance with any conditions of acceptability.

NOTE Nationally Recognized Testing Laboratories are recognized by the Occupational Safety and Health Administration (OSHA) in accordance with Section 1910.7 of Title 29 of the Code of Federal Regulations.

3.2.3 Equipment with moving parts

Operational friction or impact between equipment parts made of aluminium, magnesium, titanium, zirconium, or their alloys (with concentrations above the limits given in ANSI/ISA-60079-0) with equipment parts made of iron or steel is not permitted. Operational friction or impact between two parts made of aluminium, magnesium, titanium, zirconium, or their alloys is permitted.

3.2.4 Electromagnetic radiating equipment

The energy levels shall not exceed the values given below. The threshold power of radio frequency (9 kHz to 60 GHz) for continuous transmissions shall not exceed the values shown in Table 2.

The manufacturer shall prepare a declaration detailing:

- the maximum transmitter output power delivered to a 50 ohm load
- attenuation of all antennas to be employed with the specific LMR
- statement that each combination of LMR and antenna is below the threshold power limit

Changing of the output power to levels above those shown in Table 2, by the user, shall not be permitted.

Table 2 – RF Power Thresholds

Equipment for	Threshold power P_{th} W <i>(see definition for threshold power in Section 1.8)</i>
Class I, Group A or B	2
Class I, Group C	3.5
Class I, Group D	6

NOTE The same values are applied equally to equipment for Division 1 or Division 2 due to the large safety factors involved.

3.3 Marking

3.3.1 General

The equipment shall be marked “Class I, Division 1, Group ____, T__ “ with the ____ being the most restrictive Groups and temperature class from the protection concepts applied.

If a protection concept from one of the ANSI/ISA 60079-X standards is applied, the “Group” to be marked, as shown above, is selected in accordance with Table 4. The “Ex string” of marking specified in the ANSI/ISA 60079-X standards is not applied to equipment evaluated using this standard.

Table 4 – Group marking

Group in ANSI/ISA 60079-X	Group to be marked
IIC	ABCD
IIB + H ₂	BCD
IIB	CD
IIA	D

Electrical equipment designed for use in the normal ambient temperature range of $-25\text{ }^{\circ}\text{C}$ to $+40\text{ }^{\circ}\text{C}$ does not require marking of the ambient temperature range. However, electrical equipment designed for use outside this normal ambient temperature range is considered to be special. The marking shall then include the symbol Ta or Tamb together with both the upper and lower ambient temperatures.

3.3.2 Examples of marking

- Class I, Division 1, Groups CD, T4, $-40^{\circ}\text{C} \leq \text{Tamb} \leq +80^{\circ}\text{C}$
- Class I, Division 1, Groups ABCD, T6

NOTE 1 “Class” may be abbreviated as “CI”

NOTE 2 “Division” may be abbreviated as “Div”

NOTE 3 “Groups” may be abbreviated as “Gp”

3.3.3 Instructions

Equipment instructions shall include all necessary information for the correct installation (if applicable), operation, and maintenance of the equipment.

3.4 Type tests

3.4.1 Protection concepts

Equipment in which separate protection concepts are applied shall be submitted to the verifications and tests as specified in the respective standards for the protection concept applied. The two protection concepts shall be tested independently.

Equipment with protection concept “ia” or “ma” applied shall be submitted to the verifications and tests as specified in the respective standards for the protection concept applied.

3.4.2 Temperature evaluation

For the temperature evaluation of equipment in which separate protection concepts are applied, the worst case of either of the protection concepts shall be taken into account.

3.5 Manufacturer's Installation and Operation Instructions

The manufacturer shall provide the user with

- instructions for the maintenance and operation of the product;
- facilities for repair of the product and supply replacement parts; and
- services to ensure proper inspection or maintenance for products of such nature that it would not be reasonable to expect the average user to be able to provide such installation, inspection, or maintenance.

3.6 Calibration

3.6.1 Each piece of equipment used to verify the test parameters shall be calibrated within an interval determined on the basis of stability, purpose, and usage. A copy of the calibration certificate for each piece of test equipment is required. The certificate shall indicate that the calibration was performed against working standards whose calibration is certified and traceable to an acceptable reference standard and certified by an ISO/IEC 17025 accredited calibration laboratory. The test equipment shall be clearly identified by label or sticker showing the last date of the calibration and the next due date. A copy of the service provider's accreditation certificate as an ISO/IEC 17025 accredited calibration laboratory should be available.

3.6.2 When the inspection equipment and/or environment is not suitable for labels or stickers, other methods such as etching of control numbers on the measuring device are allowed, provided documentation is maintained on the calibration status of thus equipment.

4 OPERATIONS REQUIREMENTS

4.1 Demonstrated Quality Control Program

4.1.1 A quality assurance program is required to assure that subsequent Land Mobile Radios produced by the manufacturer shall present the same quality as the specific Land Mobile Radios examined. Design quality, conformance to design, and performance are the areas of primary concern.

- Design quality is determined during the examination and tests, and is documented in the certification report.
- Continued conformance to this standard is verified by the certifier's surveillance program.
- Quality of performance is determined by field performance and by periodic re-examination and testing

4.1.2 The manufacturer shall demonstrate a quality assurance program which specifies controls for at least the following areas:

- existence of corporate quality assurance guidelines;
- incoming quality assurance, including testing;
- in-process quality assurance, including testing;
- final inspection and tests;
- equipment calibration;
- drawing and change control;
- packaging and shipping; and
- handling and disposition of non-conforming materials.

4.1.3 Documentation/Manual

There should be an authoritative collection of procedures/policies. It should provide an accurate description of the quality management system while serving as a permanent reference for implementation and maintenance of that system. The system should require that sufficient records are maintained to demonstrate achievement of the required quality and verify operation of the quality system.

4.1.4 Records

To assure adequate traceability of materials and products, the manufacturer shall maintain a record of all quality assurance tests performed, for a minimum period of two years from the date of manufacture.

4.1.5 Drawing and Change Control

- The manufacturer shall establish a system of product configuration control that shall allow no unauthorized changes to the product. Changes to critical documents, identified in the certification report, may be required to be reported to, and authorized by, the certification agency prior to implementation for production.
- Records of all revisions to all certified products shall be maintained.

4.2 Surveillance Audit

4.2.1 An audit of the manufacturing facility may be part of the certification agency's surveillance requirements to verify implementation of the quality assurance program. Its purpose is to determine that the manufacturer's

equipment, procedures, and quality program are maintained to ensure a uniform product consistent with that which was tested and certified.

- 4.2.2** Certified products or services shall be produced or provided at, or provided from, location(s) disclosed as part of the certification examination. Manufacture of products bearing a certification mark is not permitted at any other location prior to disclosure to the certification agency.

4.3 Manufacturer's Responsibilities

The manufacturer shall notify the certification agency of changes in product construction, components, raw materials, physical characteristics, coatings, component formulation or quality assurance procedures prior to implementation.

5 BIBLIOGRAPHY

CLC/TR 50427:2004, Assessment of inadvertent ignition of flammable atmospheres by radio-frequency radiation - Guide

BS 6656:2002, Assessment of inadvertent ignition of flammable atmospheres by radio-frequency radiation - Guide

ITU-R BS.561-2, Definitions of radiation in LF, MF and HF broadcasting bands