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Space systems — Safety and compatibility of materials — Part 2: Determination of flammability of electrical-wire insulation and accessory materials

Systèmes spatiaux — Sécurité et compatibilité des matériaux — Partie 1: Détermination de l'inflammabilité verticale des matériaux

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO ~~documents~~document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

~~Attention is drawn~~ISO draws attention to the possibility that ~~some of~~ the ~~elements~~implementation of this document may ~~be~~involve the ~~subject~~use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ~~ISO should~~. ISO shall not be held responsible for identifying any or all such patent rights. ~~Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see).~~

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation ~~on~~of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC20, *Aircraft and space vehicles*, Subcommittee SC 14, *Space systems and operations*.

This second edition cancels and replaces the first edition (ISO 14624-2:2003), which has been technically revised.

The main changes are as follows:

— ~~Updated~~updated 6.3.5 "Resistance meter";

— ~~Updated~~updated the Bibliography.

A list of all parts in the ISO 14624 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

In this document, the following verbal forms are used:

— “shall” indicates a requirement;

— “should” indicates a recommendation;

— “may” indicates a permission;

— “can” indicates a possibility or a capability.

Recommended criteria are, while not mandatory, considered to be of primary importance in providing serviceable economical and practical designs. Deviations from the recommended criteria may be made only after careful consideration, extensive testing and thorough service evaluation have shown an alternative method to be satisfactory~~.~~.

Space systems — Safety and compatibility of materials —

Part 2: Determination of flammability of electrical-wire insulation and accessory materials

1 Scope

This document specifies two test methods for determining the flammability of electrical-wire insulation and accessory materials by exposure to an external ignition source in a static environment (test A) and in a gas-flow environment (test B). These tests determine if a wire insulation material, when exposed to a standard ignition source, will self-extinguish and not transfer burning debris which can ignite adjacent materials.

2 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 edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.~~

~~ISO 14624-1, *Space systems — Safety and compatibility of materials — Part 1: Determination of upward flammability of materials*~~

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
ambient conditions
test environment with an oxygen concentration of 20,9 % ± 0,2 %, a pressure of 101,4 kPa ± 5 kPa, and a temperature of 23 °C ± 5 °C

[SOURCE: ISO 14624-1:—, 3.1]

3.2
burn length
distance from the ignition location (point directly above the igniter~~, see Figure 2~~) to the farthest evidence of flame consumption damage or flame attachment point to the test specimen's insulation material as determined by visual observation, visual/physical post-test examination, video of burn, and/or other means

Note 1 to entry: See Table 1~~. Burn~~ and Figure 2. The burn length distance includes areas of partial or complete combustion, charring or embrittlement, but does not include heat affected areas which can have been damaged only by the heat of the flames emanating from sample consumption below. Heat affected areas appear as sooted, stained, warped or discoloured, or areas where the material has shrunk or melted away from the heat. In some cases, the flame ~~may~~can propagate beyond the farthest evidence of damage to the test specimen.

Table 1 — Burn length assessment characteristics and techniques summary

Burn length / Flame consumption damage	Heat affected damage area	Burn length determination techniques
Complete combustion	Sooted	Visual observation
Partial combustion	Stained	Visual post-test examination
Charring	Warped	Physical post-test examination
Embrittlement	Melted away from heat	Video of burn
Furthest flame attachment point	Shrunk away from heat	Other means

3.3
burn propagation time
time that elapses from ignition of the specimen until vertical flame propagation stops

[SOURCE: ISO 14624-1:—, 3.3]

3.4
chemical ignitor
ignitor validated to strict specifications in order to produce a flame that meets all the requirements for an ignition source

Note 1 to entry: The requirements for the ignition source are specified in 5.3.3. See Annex A for one method of producing a chemical ignitor.

[SOURCE: ISO 14624-1:—, 3.4, modified — In note 1 to entry, the cross-reference to 6.3 has been replaced by 5.3.3.]

3.5
good laboratory practice
GLP
practice which involves the testing of standard reference materials to verify data accuracy and repeatability

Note 1 to entry: In addition, the test facility shall successfully demonstrate the ability to obtain repeatable data when testing a selected material. The authority having jurisdiction shall choose appropriate GLP materials and shall determine the frequency of testing these materials for its test facilities.

[SOURCE: ISO 14624-1:—, 3.5]

3.6
~~**maximum allowable oxygen concentration**~~
~~highest oxygen concentration (volume fraction), in an oxygen/nitrogen atmosphere, at which five specimens pass the acceptance criteria of this test, without a failure, and one or more of the specimens fail the test if the oxygen concentration is increased by an arbitrary increment, typically 1 %~~

~~Note 1 to entry: See ISO 16697 for the threshold approximation procedure.~~

~~**3.7**~~
self-extinguish

phenomenon in which the *burn length* (3.2) on a *standard test specimen* (3.7) does not exceed 150 mm

~~3.10~~
[SOURCE: ISO 14624-1:—, 3.7]

3.7
standard test specimen
representative part of a wire with insulation ~~materials5.3.,~~materials, taken from a quantity of material or fabricated per required preparation method, with ~~the~~ a length of 1,2 m and an active length of 300 mm

Note 1 to entry: See 5.3.2.1 to 5.3.2.3.

Note 2 to entry: Wire configuration and end use application should be considered in determining what constitutes a representative test specimen. Features such as wire conductor size, number of conductors, insulation materials, insulation thickness can impact flammability.

3.~~11~~8
transfer of burning debris
movement of any material from a burning specimen with sufficient energy to ignite adjacent material

Note 1 to entry: The sheet of paper below the test specimen is specified in 5.3.8.

~~3.12~~
[SOURCE: ISO 14624-1:—, 3.10, modified — In note 1 to entry, the cross-reference to 6.8 has been replaced by 5.3.8.]

3.9
worst-case test configuration
test configuration that simulates worst-case anticipated use conditions including wire configuration, test pressure, test temperature, and oxygen concentration

Note 1 to entry: Worst-case represents the cumulative effect of multiple factors that increase the probability that a wire is flammable; wire configuration, increased oxygen concentration, increased pressure, increased temperature, etc. Furthermore, oxygen concentration (volume fraction) is typically the primary driver of flammability and should be prioritized over pressure when examining for worst-case conditions.

4 Test materials

As a minimum, all materials used in testing shall meet or exceed user specifications (see 6.3.2 for minimum material requirements).

Material and configured-system characteristics can be significantly compromised by sources of contamination, such as exposure to solvents, cleaning agents, abnormal temperatures, variations in humidity, environmental pollutants, particulates and handling. It is important that exposure of test specimen(s) to these and other contamination sources be sufficiently controlled to minimize variation in test results.

5 Electrical-wire insulation flammability test in a static environment (test A)

5.1 Principle

The purpose of this test (test A) is to determine if a wire configuration's insulation system, when exposed to an external ignition source, will self-extinguish and will not ignite adjacent materials by the transfer of burning debris (see 5.3.2.1 to 5.3.2.3 for additional guidance). An insulation system is determined to be flammable if the burn length of any one of the five standard test specimen replicate

samples is greater than 150 mm at an internal wire temperature of 125 °C or at the maximum operating temperature of the configuration. In addition, the ignited specimens shall not ignite the paper (produce flaming combustion) below the test samples, which indicates that the transfer of burning debris has sufficient energy to ignite adjacent materials. If, during a test, the paper used as an indication of the transfer of burning debris ignites because of burning debris, subsequent burns during the same wire test should be conducted without paper to eliminate burning paper interference.

Failure of any one specimen constitutes failure of the material in the test environment.

Test specimens shall be tested in the worst-case test ~~configuration3..~~configuration. If the worst-case oxygen concentration is uncertain, determination of the maximum oxygen concentration is recommended.

5.2 Reagents

5.2.1 Test gases. The test atmosphere shall consist of a mixture of oxygen and nitrogen, mixed thoroughly before testing a specimen. These gases ~~may~~can be premixed before introduction of the mixture into the test chamber, or the oxygen and nitrogen ~~may~~can be introduced separately into the test chamber, and then mixed inside the test chamber with a test specimen.

Oxygen gases used in test gas mixtures shall be verified to have a minimum purity of 99,5 % and moisture <7 ~~parts per million.~~µl/l[1]. Nitrogen gases used in test gas mixtures shall be verified to have a minimum purity of 99,9 % and moisture <11,5 ~~parts per million.~~µl/l. Pre and post-test gases are analysed for CO and CO_2 and post test results reported. Also, the gas mixture shall be verified for conformity with the specification (including accuracy) for oxygen concentration to within ~~plus~~ + 1 % ~~minus~~ –0 %.

5.3 Test system

5.3.1 Test chamber, large enough so that complete combustion of the specimen can occur with no more than a 5 % relative depletion of oxygen concentration. In addition, the test chamber shall not interfere chemically or physically with the test. The free space above and below the test fixture shall be at least 200 mm.

5.3.2 Measuring devices, properly calibrated.

5.3.3 Chemical ignition source, meeting the following specifications in ambient ~~conditions3.:~~conditions:

a) temperature: 1 100 °C ± 90 °C measured using a 0,81 mm (0,5 mm^2 diameter) exposed tip type K thermocouple;

b) burning duration: 25 s ± 5 s;

c) maximum visible flame height: 65 mm ± 6,5 mm.

Annex A provides a procedure for preparing, certifying and storing chemical ignitors.

NOTE This test method and the corresponding ignition source were designed to evaluate materials for use in spacecraft habitable environments with typical oxygen concentration ranges (19 % to 50 % volume fraction of oxygen). When evaluating environments outside of these typical ranges the standard ignition source ~~may~~can not be adequate. In these cases, alternative ignition mechanisms ~~may~~can be utilized but test data is reported as a non ISO 14624-1 standard.

[1] 1 µl/l = 1 part per million (ppm). The use of "ppm" is deprecated.

5.3.4 AC power supply, capable of providing ~~15A (RMS~~15 A (root mean square), connected to a bare 0~~.81mm~~,81 mm nickel-chromium wire (5.3.5) to initiate the igniter.

5.3.5 Bare nickel-chromium wire 0,81 mm (0,5 mm² diameter~~)~~), with a nominal resistivity of 2 Ω·m to 2,5 Ω·m and of sufficient length to wrap three equally spaced turns around the chemical igniter.

5.3.6 Suitable specimen holder, capable of supporting the centre third of the wire or wire bundle from one top corner of the fixture to the opposite bottom corner of the fixture at an angle of 15° ± 2° to the vertical (see Figure 1).

5.3.7 Scale, attached to one side of the specimen holder, for measurement of the burn length.

5.3.8 Sheet of paper, mounted horizontally approximately 200 mm below the specimen, but 50 mm above the bottom of the test chamber, centred directly below the specimen. The paper shall be supported by a non-flammable, non-conducting screen material. The paper shall have the following characteristics:

a) dimensions: (200 mm ± 50 mm) × (300 mm ± 50 mm);

b) surface density: between 200 g/m² and 300 g/m²;

c) type: chemical wood processed;

d) colour: uniformly white;

e) condition: clean, free from dirt spots, oil spots and foreign matter (lint, fuzz, etc.), free from holes, tears, cuts, folds and scuff marks, and containing no splices.

The sheet of paper is used to assess if burning debris from the specimen could cause ignition of adjacent materials.

5.3.9 DC power supply, capable of providing a regulated DC current (150 A maximum) to the conductor of the test specimen at the level required to reach the specified internal wire temperature.