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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 2: Détermination de l'inflammabilité des systèmes d'isolation des fils électriques, et des matériaux accessoires

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 14624-2 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 14, *Space systems and operations*.

ISO 14624 consists of the following parts, under the general title *Space systems — Safety and compatibility of materials*:

— *Part 1: Determination of upward flammability of materials*

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

— *Part 3: Determination of offgassed products from materials and assembled articles*

— *Part 4: Determination of upward flammability of materials in pressurized gaseous oxygen or oxygen-enriched environments*

— *Part 5: Determination of reactivity of materials with aerospace propellants*

— *Part 6: Determination of reactivity of processing materials with aerospace fluids*

— *Part 7: Determination of permeability of materials to aerospace fluids*

Introduction

Throughout this part of ISO 14624, the minimum essential criteria are identified by the use of the imperative or the key word “shall”. Recommended criteria are identified by the use of the key word “should” and, while not mandatory, are 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 part of ISO 14624 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).

2 Conformance

The tests shall be performed in an accredited test facility (see Annex A for guidelines).

The authority having jurisdiction, or the test requester, shall provide properly identified material(s) for testing. Alternatively, accredited test facilities may be authorized by the test requester to procure the appropriate material(s).

3 Normative references

The following referenced documents are indispensable for the application 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*

4 Terms and definitions

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

4.1
burn length
maximum distance over which the insulation has been damaged due to flame impingement

NOTE This distance includes areas of partial or complete combustion, charring or embrittlement, but does not include areas which are sooted, stained, warped or discoloured, or areas where the insulation has shrunk or melted away from the heat.

4.2
self-extinguishing
phenomenon wherein the burn length of a wire insulation system is less than 150 mm when exposed to an external ignition source

4.3
transfer of burning debris
movement of burning particles from a burning specimen to adjacent materials

4.4
good laboratory practice
GLP
practice which involves the testing of standard reference materials to verify data accuracy and repeatability

4.5
worst-case environment
combination of test pressure, oxygen concentration and temperature that make the material most flammable

5 Test materials

The minimum quantities of materials required to perform each test properly are summarized in Table 1. Actual test configurations and material quantities for material forms other than those listed (e.g. sleeving, cable clamps, etc.) shall be established and approved by the responsible procuring activity/user materials organization.

Table 1 — Minimum quantities of materials required for testing for each atmosphere

Form of material	Test	Minimum quantity
Insulated wire	A	10 m in length
	B	7 m in length

As a minimum, all materials used in testing shall meet or exceed user specifications.

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 material(s) to these and other contamination sources be sufficiently controlled to minimize variation in test results.

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

6.1 Principle

The purpose of this test (Test A) is to determine if wire insulation and accessory materials, when exposed to an external ignition source, will self-extinguish and will not ignite adjacent materials by the transfer of burning debris. Electrical-insulation accessories include electrical wire, sleeving, heat-shrinkable tubing, solder sleeves, bundle ties, cable clamps, identification tape, etc. For a wire insulation system to be considered self-extinguishing, the burn lengths of at least three standard-sized replicate specimens (diameter 0,90 mm) shall be less than 150 mm at an internal wire temperature of 125 °C or at the maximum operating temperature of the wire. In addition, the ignited specimens shall not propagate a flame by the transfer of burning debris. Failure of any one specimen constitutes failure of the material. These tests shall be conducted on specimens of insulation use thickness. The test conditions (total pressure, wire temperature and oxygen concentration) shall simulate the worst-case environment in which the insulation material is to be used. The configuration (for example, wire bundles) or the use of another wire gauge can cause a variation in the test results.

6.2 Reagents

6.2.1 Test gases, premixed before exposing the specimen to them and verified for conformity with the specification (including accuracy) for oxygen concentration to within $^{+1}_{0}$ % .

6.3 Test system

6.3.1 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.

6.3.2 Measuring devices, properly calibrated.

6.3.3 Chemical ignition source, meeting the following specifications under ambient conditions:

a) energy: 3 000 J;

b) temperature: 1 100 °C ± 90 °C;

c) burning duration: 25 s ± 5 s;

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

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

Alternative ignition mechanisms may be utilized if they meet the requirements outlined in a) to d) above.

6.3.4 AC power supply, capable of providing 15 A (RMS), connected to a bare 20 AWG nickel-chromium wire (6.3.5) to initiate the igniter.

6.3.5 Bare nickel-chromium wire 0,90 mm in diameter, with a nominal resistivity of 2,3 Ω·m and of sufficient length to wrap three equally spaced turns around the chemical igniter.

6.3.6 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).

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

6.3.8 Sheet of paper, mounted horizontally approximately 200 mm below the specimen holder, having the following characteristics:

a) dimensions: 216 mm × 280 mm;

b) mass of 1 000 sheets (size 650 mm × 770 mm): between 100 kg and 150 kg;

c) type: chemical wood index;

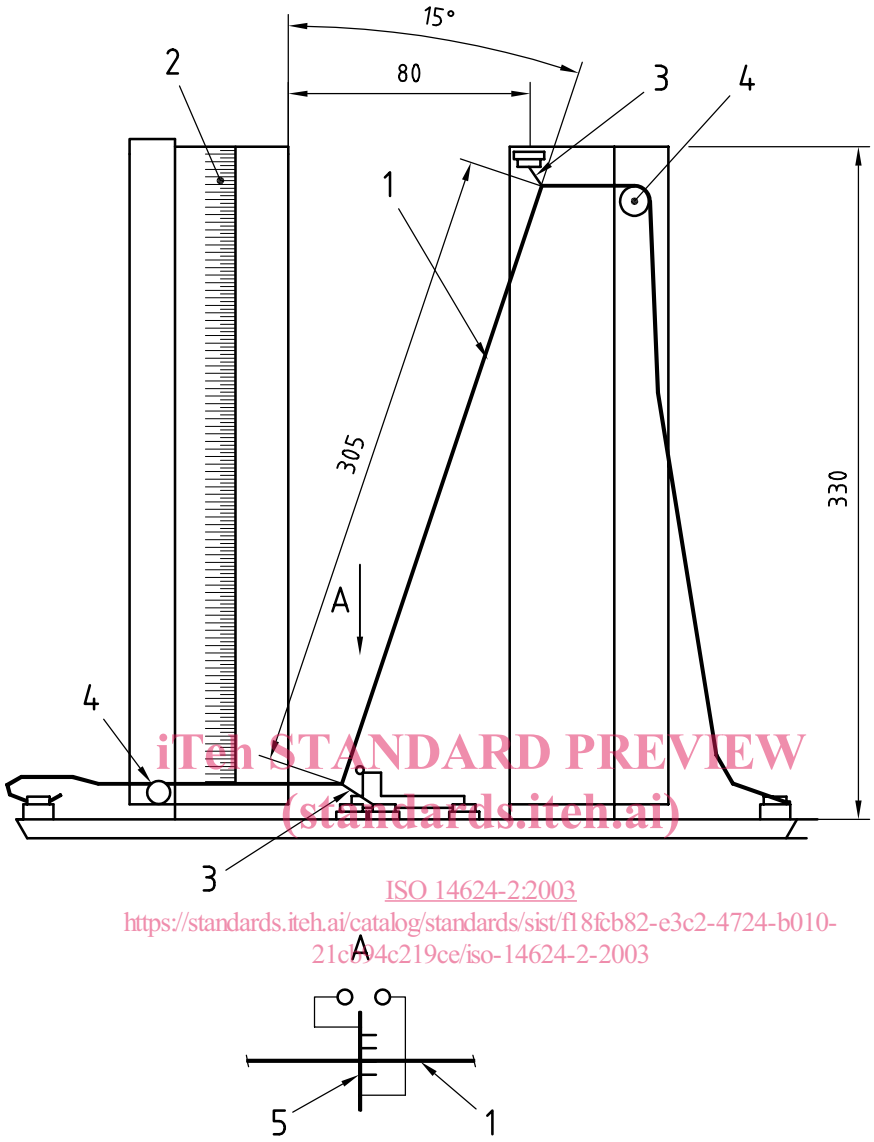
d) colour: uniformly white;

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 would cause ignition of adjacent materials.

6.3.9 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.

Dimensions in millimetres



Key

1 specimen
2 scale
3 insulating ceramic-fibre thread
4 ceramic insulator
5 ignitor

Figure 1 — Standard specimen holder and specimen configuration

6.4 Test specimens

6.4.1 Reception and inspection of material

6.4.1.1 Receive and visually inspect the test material: when received, it shall be accompanied by proper identification. Any flaws shall be noted. Specimens should have been cleaned and dried to the end-use specifications prior to receipt at the test facility.

6.4.1.2 If required, prepare specimens to the proper dimensions.

6.4.1.3 If specimens are received with obvious contamination, clean them. All cleaning methods shall be approved by the test requester prior to use. Surface contamination should be removed by washing with deionized water and mild detergent, rinsing with deionized water and drying with filtered nitrogen gas. As a minimum, particulates on the surfaces of solid porous specimens should be removed with filtered nitrogen gas.

6.4.1.4 After preparation and/or cleaning at the test facility, inspect the specimens and note any flaws and any residual contamination. If the flaws result from specimen preparation at the test facility, new specimens shall be prepared. Specimens shall be weighed and individually identified.

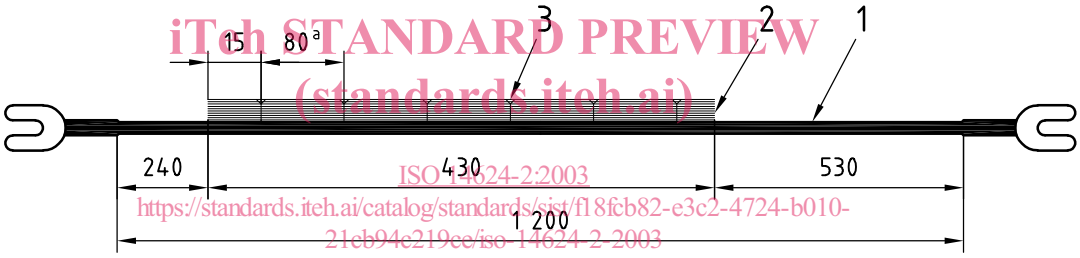
6.4.2 Preparation of test specimens

6.4.2.1 To prepare a standard test specimen, cut a single conductor to a length of 1,2 m and remove 10 mm of insulation from each end of the wire using an appropriate wire stripper. Attach appropriate non-insulated crimp spade lugs to the ends of the wire.

6.4.2.2 To prepare an optional variation of the standard test specimen using a multiwire configuration, cut out six additional wires of length 430 mm. Place the active conductor on the perimeter of the multiwire configuration. Lace the active conductor and the six additional wires tightly together using appropriate non-flammable wire ties placed 80 mm apart (see Figure 2).

6.4.2.3 Duplicates of actual-use electrical harnesses and accessories, with or without connections, may be used in lieu of the specimen described in 6.4.2.2. Mating connections shall be supplied where applicable.

Dimensions in millimetres



Key

1 active conductor
2 wire bundle
3 wire tie

[a] Typical distance.

Figure 2 — Optional wire bundle configuration

6.5 Procedure

WARNING — Burning of materials may produce smoke and toxic gases, which can affect the health of operators. The test area shall be cleared of smoke and fumes by suitable means.

6.5.1 Before testing

6.5.1.1 Before testing, record all pertinent information (including pressure, specimen identification, insulation thickness, pre-test mass, and wire gauge and configuration). All specimens should be photographed.

6.5.1.2 Determine the amount of current required to obtain the internal wire temperature specified for the test. This is done by mounting the specimen diagonally in the test fixture with the power supply attached to the conductor. The test fixture shall be in a draft-free environment at ambient temperature. Hypodermic microthermocouple probes (0,18 mm) shall have been inserted so that the microthermocouples are in contact with the active conductor. The wire temperature measurements should be performed in at least three locations: in the middle of the wire and at approximately 30 mm from centre in both directions. The electrical current should be raised until the test temperature of the wire is attained (as measured at the three locations).