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Space systems — Safety and compatibility of materials —

Part 7: Determination of permeability and penetration of materials to aerospace fluids

Systèmes spatiaux — Sécurité et compatibilité des matériaux —

Partie 7: Détermination de la perméabilité et de la pénétration des matériaux aux fluides aérospatiaux

Reference number
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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.

ISO 14624-7 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 system/component materials with aerospace propellants*

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

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

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Introduction

The purpose of this part of ISO 14624 is to provide procedures to determine the permeability rate and penetration resistance of materials exposed to aerospace fluids.

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Space systems — Safety and compatibility of materials —

Part 7: Determination of permeability and penetration of materials to aerospace fluids

1 Scope

This part of ISO 14624 specifies test equipment and techniques used to identify interactions resulting from exposure of a material to an aerospace fluid.

This part of ISO 14624 can be used to determine the reactivity of materials with aerospace fluids. It provides a means to determine the effects of minor amounts of aerospace fluids, such as in a splash or spill, on materials used in ground support processing operations, and in the selection of personal safety equipment.

2 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 4954, *Steels for cold heading and cold extruding*

ISO 6529, *Protective clothing — Protection against chemicals — Determination of resistance of protective clothing materials to permeation by liquids and gases*

ISO 6530, *Protective clothing — Protection against liquid chemicals — Test method for resistance of materials to penetration by liquids*

ISO 14951-3, *Space systems — Fluid characteristics — Part 3: Nitrogen*

3 Terms and definitions

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

3.1
aerospace fluid
fluid that is commonly used in the fabrication, development, processing of materials and production of aerospace and ground support equipment

EXAMPLES Cleaning agents, lubricants and solvents.

3.2
degradation
adverse physical or chemical change in a substance

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3.3
reaction
chemical change in which a substance decomposes, combines with other substances, or interchanges constituents with other substances

4 Safety precautions

4.1 Laboratory facilities

Some aerospace fluids are considered to be toxic chemicals. These chemicals shall only be exposed to room atmosphere inside an approved laboratory hood. Separate, dedicated hoods shall be used for the oxidizers and fuels.

4.2 Protective clothing

Personal protective clothing shall be worn by personnel when performing these tests. The minimum protection required is fluid-compatible gloves, laboratory apron and face shield or goggles.

5 Test procedure

5.1 Inspection of sample on receipt

When received, the test material shall be accompanied by proper identification. The minimum information required is the manufacturer, trade name, composition, specification, generic name and batch/lot number (if known). A visual inspection shall be performed and any anomalies shall be noted. A suitable sample identification form is shown in Table A.1.

5.2 Preparation of sample

5.2.1 General

The sample shall be tested in the intended use form (such as sheets or foams) and in the as-received thickness.

5.2.2 Sample cleaning

Samples shall be cleaned and dried to the end-use specifications. Contamination on the surfaces of solid, nonporous samples shall be removed by washing with deionized water and mild detergent, rinsing with deionized water, and drying with filtered, gaseous nitrogen. Particulates on the surfaces of solid, porous samples shall be removed with filtered, gaseous nitrogen meeting the requirements of ISO 14951-3.

5.2.3 Sample inspection

The sample shall be inspected to ensure it is at the specified worst-case thickness. Flaws and any residual contamination shall be noted. If the flaws result from sample preparation at the test facility, new samples shall be prepared. Samples with flaws that inordinately increase the surface area to bulk mass ratios shall not be tested. Samples shall be weighed and individually identified.

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5.3 Penetration test

5.3.1 General

This test is used to determine the possible liquid penetration of materials when exposed to aerospace fluids or other chemicals of interest.

5.3.2 Test procedure

The test procedure shall be as follows.

a) Place an appropriately sized sample of the test material (see Figure 1) over a beaker.

b) Add the test fluid, approximately 1 ml of the specified test fluid, to the centre of the sample, taking care not to expose the edges of the sample to the fluid, and start the timer.

c) Allow the test fluid to stand on the sample for the specified exposure time.

d) Add test fluid as required to maintain a liquid film on the test sample during the specified exposure time.

e) Carefully observe for the first fallen droplet at the bottom of the beaker, stop the timer, and note the time of occurrence.

f) For materials used for protective garments, observe for initial wetness underneath the test sample and note the time of occurrence.

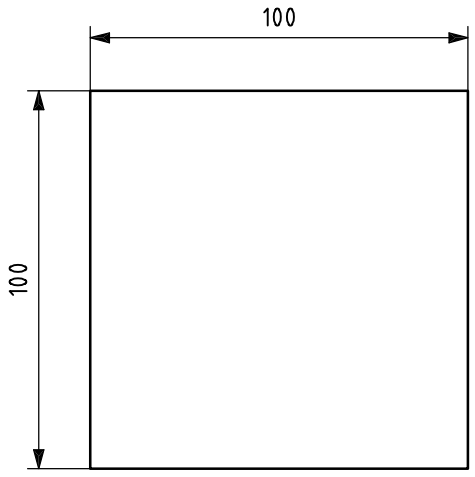
NOTE Atmospheric condensation could occasionally form underneath a sample during a test, giving a false indication of penetration. In such an event, verification can be made by applying a hypergol-compatible blotter that is known to discolour when in contact with a particular aerospace fluid.

g) Carefully blot the liquid from the sample at the end of the specified exposure time.

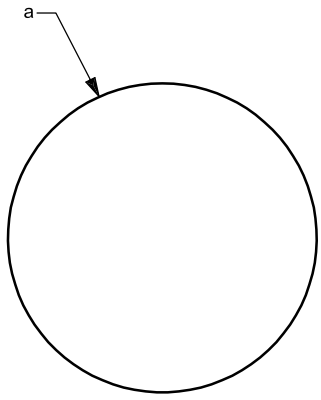
h) Rinse the sample with running water for 60 s.

i) Allow the test sample to air dry for 24 h prior to final evaluation.

Dimensions in millimetres



a) Penetration test specimen



[a] Radius as specified in ISO 6529 or ISO 6530.

b) Permeability test specimen

Figure 1 — Test specimens

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5.3.3 Report

The report shall consist of the following as a minimum (an example of a suitable form for reporting the results of this test is shown in Table A.2):

a) name of the test material, supplier, and manufacturer;

b) test temperature, pressure, duration, and sample thickness before and after the test;

c) any penetration observed during the exposure and the elapsed time of occurrence;

d) for materials used for protective garments, any wetness observed underneath the test sample during the exposure and the elapsed time of occurrence;

e) any reactivity observed during the exposure, such as burning, smoking, bubbling, frothing, charring, solubility, swelling or fracture of the sample;

f) any changes in the condition of the sample after the exposure, such as colour, flexibility, rigidity, surface condition, transparency, pitting, hardness, tackiness, friability or powder formation.

5.4 Permeation test

5.4.1 General

This test is used to determine the vapour or liquid permeation rate of a material when exposed to aerospace fluids or other chemicals of interest as specified by the requester.

Two kinds of permeability tests may be performed: conditioned and/or unconditioned. The conditioned test is performed on specimens that have been exposed to the test fluid prior to a permeability test in order to simulate used materials. The unconditioned test is performed on new, unused specimens in the as-received condition. Unless otherwise specified, the duration of the permeability test shall be 120 min.

5.4.2 Configuration requirements

The permeability tests shall be performed in accordance with ISO 6529 or ISO 6530, or other approved test methods as appropriate. Materials used for enclosed, pressurized, protective garments shall always be tested with the pressure on the collection side of the test cell maintained between 10 mm and 20 mm of water above the pressure applied on the test fluid side of the cell. If conditioned test specimens are used, the conditioned side shall be facing the test fluid side of the cell.

5.4.3 Preparation of conditioned test samples

The preparation shall be as follows.

a) Place the test specimen (Figure 1) on a flat stainless-steel or polytetrafluoroethylene base plate (see Figure 2). The side of the material that is normally exposed in service shall be in the up position. The stainless-steel base plate shall meet the requirements of ISO 4954.

b) Apply a bead of fluid-compatible grease to a template (see Figure 2) around the opening (to prevent wicking under the template).

c) Clamp the template (with the grease against the test specimen) and test specimen to the base plate. The test specimen shall be sandwiched between the template and the base plate.

d) Place sufficient test fluid on the specimen to wet the entire surface.

e) Allow the test fluid to remain in contact with the test specimen for 60 s.

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f) Carefully remove the test fluid, rinse the test specimen with deionized water for 60 s, and disassemble the test fixture.

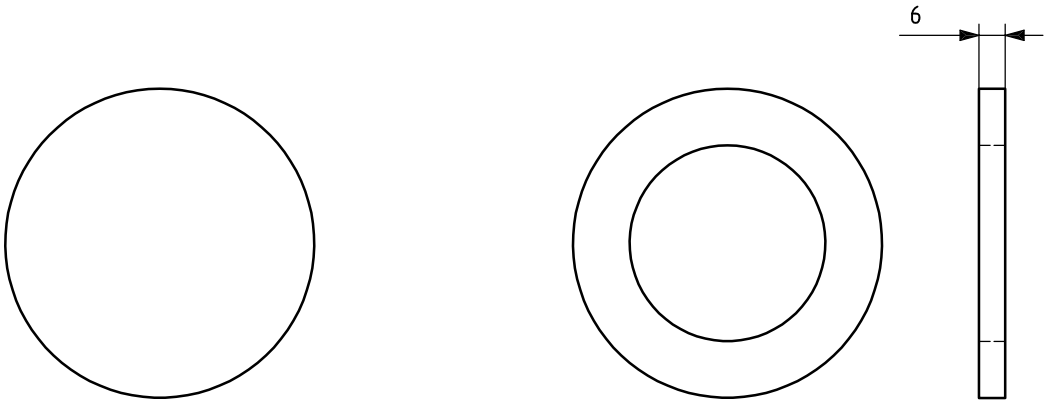
g) Wipe the grease off the test specimen, taking care not to contaminate the propellant exposed area of the test specimen.

h) Allow the test specimen to air dry for 24 h.

i) Perform this process with the same sample using, in order, monomethylhydrazine, nitrogen tetroxide and hydrazine.

j) Condition the test specimen a second time.

Dimensions in millimetres



a) Base plate **b) Template**

NOTE Items are constructed from stainless steel or Teflon, to a size specified in ISO 6529 or ISO 6530.

Figure 2 — Conditioning fixture for permeability test

5.4.4 Test procedure for oxidizer permeability

The method specified in either ISO 6529 or ISO 6530 shall be used as appropriate. The test cell shall be compatible with the oxidizer. This test shall be conducted with the test cell oriented such that the test specimen is in contact with the gas phase only.

The test procedure shall be as follows.

a) Fill the assembled test cell approximately half full with liquid oxidizer.

b) Allow the oxidizer vapours to vent freely for approximately 60 s, then seal the test cell.

c) After 120 min, open the seals and drain the oxidizer from the test cell.

d) Disassemble the test cell.

e) Decontaminate the test specimen by gently blotting any liquid from the sample and rinsing it with running water for 60 s.

f) Allow the test sample to air dry for 24 h.

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5.4.5 Test procedure for aerospace fluid permeability

The method specified in either ISO 6529 or ISO 6530, or another suitable test method, may be used as appropriate. The test cell shall be compatible with the test fluid. This test shall be conducted as in 5.4.4 except that the test cell is oriented such that the test specimen is in contact with the liquid phase only.

5.4.6 Report

The report shall consist of the following as a minimum (an example of a suitable form for reporting the results of this test is shown in Table A.2):

a) name of the test material, supplier and manufacturer;

b) test method used;

c) test temperature, pressure, duration and sample thickness before and after the test;

d) any differential pressure maintained across the test specimen;

e) condition of the test specimen at the conclusion of the test;

f) breakthrough time (min);

g) steady state permeability rate (μg/mm^2/min);

h) threshold detection level of the measuring system to the specific test fluid used in the test.

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Annex A
(informative)

Examples of forms

Table A.1 — Material identification form

Test material
Manufacturer _____
Trade name _____
Composition _____
Specification _____
Generic name _____
Batch/Lot number _____
Use temperature (minimum) _____
Use temperature (maximum) _____
Aerospace fluid exposure time (field use) _____
Manufacturer
Name _____
Address
City _____
State
Country
Supplier
Name _____
Address
City _____
State
Country
Remarks _____
_____
_____

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Table A.2 — Permeability test report form

PERMEABILITY TEST REPORT FORM		Date	Sample number
Requesting organization	Requestor	Telephone No.	Reference document
Vehicle	System		

Material name or manufacturer's ID	Special instructions
Chemical class of material	
Generic name of material	

TEST CONDITIONS

Test 1 sample per: _____

Test name: _____

Test fluid: _____

TEST DATA

Test sample description: _____

Material quantity (g): _____ Container volume (ml): _____

Media volume (ml): _____ Media exposure time (min): _____

Breakthrough time (min): _____

Steady state permeability rate (µg/mm^2/min): _____

Remarks: _____

VISUAL CHARACTERISTICS

	Pretest	Post-test
Colour		
Opaque		
Translucent		
Transparent		

Remarks: _____

BULK CHARACTERISTICS

	Pretest	Post-test
Shape		
Flexible		
Rigid		
Soft		
Hard		
Friable		
Powder		

Remarks: _____

SURFACE CHARACTERISTICS

	Pretest	Post-test
Smooth		
Rough		
Wrinkled		
Pitted		
Woven		
Matted		
Tacky		

Remarks: _____

Other observations

Analyst:	Date	Approval:

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Bibliography

[1] ISO 14951-5, *Space systems — Fluid characteristics — Part 5: Nitrogen tetroxide propellant*

[2] ISO 14951-6, *Space systems — Fluid characteristics — Part 6: Monomethylhydrazine propellant*

[3] ISO 14951-7, *Space systems — Fluid characteristics — Part 7: Hydrazine propellant*

[4] ISO 14951-10, *Space systems — Fluid characteristics — Part 10: Wate*r

[5] ASTM F739, *Test Method for Resistance of Protective Clothing Materials to Permeation by Liquids or Gases Under Conditions of Continuous Contact*

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