INTERNATIONAL STANDARD

ISO 14952-6

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Space systems — Surface cleanliness of fluid systems —

Part 6: Precision-cleaning processes

Systèmes spatiaux — Propreté des surfaces en contact avec des fluides —

Partie 6: Procédés de nettoyage fin

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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 14952-6 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 14, *Space systems and operations*.

ISO 14952 consists of the following parts, under the general title *Space systems — Surface cleanliness of fluid systems*:

— *Part 1: Vocabulary*

— *Part 2: Cleanliness levels*

— *Part 3: Analytical procedures for the determination of nonvolatile residues and particulate contamination*

— *Part 4: Rough-cleaning processes*

— *Part 5: Drying processes*

— *Part 6: Precision-cleaning processes*

Introduction

This part of ISO 14952 defines precision-cleaning processes for fluid equipment and components used in space fluid systems. The purpose of this part of ISO 14952 is to establish procedures and processes for use in the cleaning, analysis and verification of launch vehicles, spacecraft and ground support equipment.

Space systems — Surface cleanliness of fluid systems —

Part 6: Precision-cleaning processes

1 Scope

This part of ISO 14952 specifies precision-cleaning processes for parts, components and systems used in flight-critical fluid applications. It can be used on equipment for ground support equipment, launch vehicles and spacecraft.

This part of ISO 14952 identifies precision-cleaning processes and procedures that can be used on parts and components used in fluid systems and is applicable equally to ground support equipment, launch vehicles and spacecraft.

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 14951-3:1999, *Space systems — Fluid characteristics — Part 3: Nitrogen*

ISO 14951-10:1999, *Space systems — Fluid characteristics — Part 10: Water*

ISO 14952-1:2003, *Space systems — Surface cleanliness of fluid systems — Part 1: Vocabulary*

ISO 14952-3:2003, *Space systems — Surface cleanliness of fluid systems — Part 3: Analytical procedures for the determination of nonvolatile residues and particulate contamination*

ISO 14952-5:2003, *Space systems — Surface cleanliness of fluid systems — Part 5: Drying processes*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 14952-1 apply.

4 Precision-cleaning requirements

4.1 General

All parts, components, assemblies, subsystems, systems or related equipment for use in ground support equipment, launch vehicles and spacecraft requiring cleaning shall be cleaned to the specified cleanliness level and inspected in accordance with this part of ISO 14952. Subsystems and systems may require disassembly to permit cleaning. Any part or component that might be damaged during cleaning shall be protected or removed before cleaning and cleaned as a separate item. Cleaning or disassembly operations on

precision components shall be performed only by competent personnel who have been trained and certified to perform these functions. The designs for systems and system components should, where practical, include the capability to remove all valves and components from the system for precision cleaning.

4.2 Environmental, health and safety considerations

This part of ISO 14952 allows the use of materials, processes, and equipment that may be hazardous, toxic and/or detrimental to the environment. This part of ISO 14952 does not purport to address all of the environmental, health or safety problems associated with precision-cleaning processes. It is the responsibility of the cleaning organization to determine and establish the appropriate environmental, health and safety practices that are in compliance with applicable regulations.

a) Hazardous materials

It is the responsibility of the cleaning organization to store all hazardous materials and inform the local emergency planning organization as to the quantity on hand and the storage location. Records shall be maintained by this organization as to the mass of hazardous material used and what happened to the material consumed in the product, released to the environment (spilled, air emission, land discharge, water discharge, underground injection), used for energy onsite, used for energy offsite, recycled offsite, recycled onsite, treated offsite or treated onsite.

b) Waste minimization (recycling)

It is the responsibility of the cleaning organization to implement waste reduction practices. Materials, especially test fluids, shall be recycled where applicable.

4.3 Precision cleaning

All critical surfaces of system hardware shall be precleaned to remove dirt, grit, scale, corrosion, grease, oil and other foreign matter prior to any final precision-cleaning process. Metallic items shall be surface treated (cleaned, passivated and/or coated), as applicable, to prevent latent corrosion and contamination. Assembled items that do not lend themselves to this type of treatment shall be treated prior to assembly. Surface-treated areas degraded during subsequent fabrication and assembly shall be reprocessed, as required, to restore the original surface finish.

Critical surfaces of system hardware that have been precleaned shall be visually clean prior to proceeding to any precision-cleaning operation. Scale-free discoloration due to welding or passivation shall be permitted.

All critical hardware surfaces shall be precision cleaned to meet the requirements specified by the customer. Precision-cleaning operations shall be performed in an environment compatible with the component cleanliness requirements to preclude adverse effects on the functional performance. Exemptions may be requested for hardware which, due to size or other considerations, cannot meet this requirement. Precision cleaned articles shall be packaged immediately after verification and drying operations, or suitably protected prior to leaving the controlled environment.

Solvents identified in ISO 14952-3:2003, Table 1, as having low threshold limit values are not suitable for precision-cleaning processes conducted in enclosed environments, such as cleanrooms, due to their toxicity unless the facility is especially designed for their use.

4.4 Cleaning process approval

Cleaning processes shall be left to the discretion of the cleaning organization; however, the process shall not be detrimental to the hardware being cleaned. Process approval shall be obtained from the customer prior to cleaning and handling. To obtain approval, the cleaning organization shall submit to the customer the following information:

a) customer-specified cleanliness levels or proposed cleanliness levels, including analysis and rationale for the selected cleanliness levels;

b) description of items to be cleaned, including identification of materials;

c) processing materials, to include as applicable, trade names, specifications, chemical and physical properties, and compatibility information as specified;

d) processing equipment and cleaning procedures to be used;

e) quality assurance provisions to be utilized; this shall include in-process control procedures to prevent contamination, latent corrosion, or other degradation of surfaces and open systems or vessels;

f) controlled environment levels to be maintained for cleaning and handling;

g) preservation methods and materials;

h) verification methods; see ISO 14952-3 for recommended verification procedures.

4.5 Materials

The selection of materials used in processing shall be left to the discretion of the customer. However, the fluids shall be compatible with the items being cleaned. The following compatibility issues, as applicable, shall be considered and evaluated in the selection of processing materials:

a) corrosion;

b) stress corrosion cracking;

c) embrittlement;

d) leaching;

e) masking of crack-like indications;

f) residue;

g) crazing (nonmetallics);

h) reversion (nonmetallics);

i) hydrolysis (nonmetallics)/water absorption;

j) chemical activity.

4.6 Final rinsing solutions

The final rinsing solution shall meet or exceed the cleanliness requirements for which they are intended. They shall also meet or exceed the following specific requirements.

a) There shall be no particles greater than 175 µm in any dimension and no more than 5 particles per millilitre between 100 µm and 175 µm per 500 ml. Particle corrections by subtracting the test solvent particles from the final particle count are not allowed.

b) Nonvolatile residues shall not be greater than 10 mg per 500 ml.

c) If water is used as the final rinse fluid, it shall meet the requirements of ISO 14951-10.

d) The final rinsing solution shall be compatible with the fluid in the system being cleaned.

4.7 Verification

Precision-cleaned parts, components, systems and vessels shall be visually inspected and verified to meet the required cleanliness in accordance with ISO 14952-3. Alternative verification procedures and/or corresponding cleanliness levels may be used only upon demonstration of equivalence and upon written approval by the customer. Verification shall be performed in an environment that is compatible with the environment in which the cleaning was performed.

4.8 Packaging and protection

4.8.1 Approved coverings

All critical surfaces or openings to critical surfaces shall be protected from contamination by sealing the surfaces or openings with approved coverings, and securing with tape or other approved methods. Protected components shall be placed in clean bags, fabricated from packaging materials listed in ISO 14952-3:2003, Table 2, which have been cleaned internally and verified in accordance with ISO 14952-3:2003, 4.6. The interior of the bags and parts shall be purged with dry nitrogen meeting the requirements of ISO 14951-3, Type A. The bags shall be completely sealed to ensure the storage package is inert. Bags shall be over-packed and double-bagged to prevent damage during storage and handling.

Other packaging materials compatible with the applicable service media may be used with the approval of the customer. However, gas purging and over-packaging requirements shall be as given above.

If desiccants are required for additional corrosion protection, they shall not be placed in such a manner as to contaminate cleaned surfaces. Provisions shall be made for monitoring desiccants, such as indicating the type.

4.8.2 Packaging operations

Packaging operations involving cleaned and verified components should be accomplished within the same environmentally controlled area in which verification was performed. However, where it is impractical to package in the same environment, the environment shall not compromise the cleanliness of the hardware/component. Outer wrapping and over-packing may be performed outside the controlled area.

4.8.3 Certification tags

Appropriate certification tags shall be placed between the inner and outer bags or layers of protective packaging film, where practical. If the tag cannot be placed between the inner and outer packaging film, the tag shall be enclosed in a plastic bag or between layers of plastic film and securely taped to the outside of the package. Tags shall be serviceable and of sufficient size to contain the following information:

a) part or identification number;

b) manufacturer’s serial number;

c) customer identification;

d) date of cleaning;

e) cleanliness level, and number and revision of this part of ISO 14952;

f) service medium or intended use of component;

g) acceptance stamps.

4.9 Excepted components

Excepted components shall consist of items and systems that cannot be processed per the requirements of this part of ISO 14952. Components that cannot be cleaned and certified using normal procedures or facilities because of the size, construction, materials of construction, etc. may be processed as excepted components.

Excepted components shall require written approval of the process and verification procedures by the customer. These items shall be cleaned as to the intent of this part of ISO 14952, as far as is practical, and identified as “EXCEPTED” on all tags and documentation.

4.10 Cleaning in the field

Cleaning in the field (ground test only) shall be performed only when one of the following criteria is met:

a) the item is part of a fixed installation and cannot be removed to a remote cleaning site;

b) cleaned spare parts are not available and removal to a remote site would unduly impact operations.

4.10.1 Preparation prior to field cleaning

4.10.1.1 Approvals

Prior to the beginning of the cleaning processes, all cognizant activities or onsite agencies having jurisdiction shall be advised of the scheduled procedures, and the necessary appropriate approvals and permits shall be obtained.

4.10.1.2 Decontamination

All systems, subsystems, components and equipment that have been exposed to toxic propellants or hazardous materials shall be decontaminated to the required level of safe handling prior to initial cleaning operations. Under no circumstances shall propellant-contaminated systems, subsystems or components be cleaned or transported directly to a cleaning facility prior to decontamination. Decontamination shall be accomplished by the use of established and proven methods for the removal and neutralization of propellant residues in place, or removed to an area specifically devoted to decontamination operations. Decontaminated items shall be clearly and legibly marked to indicate that they have been decontaminated. No items shall be accepted for cleaning without proof of decontamination.

4.10.1.3 Component removal

All subsystems, systems or other related field equipment components that could entrap fluids or be harmed if subjected to the cleaning process shall be removed prior to cleaning. These components shall be cleaned and tested in accordance with 4.3. All removed components shall be replaced by temporary hardware. Decontamination of the subsystem, system or other related field equipment may be accomplished, as applicable, prior to removal.

4.10.1.4 Installation of temporary hardware

All temporary hardware necessary to perform or validate the cleaning process shall be compatible with the processing materials and the subsystem, system or other related field equipment that is to be cleaned.

Temporary hardware and all surfaces near openings resulting from the removal of components shall be visibly clean of contamination, such as dirt, scale and grease, prior to the installation of temporary hardware.

4.10.1.5 Marking of temporary hardware

All temporary hardware installed in, on, or attached to, an item to be cleaned shall be legibly marked or otherwise identified as temporary hardware to ensure its removal from the item prior to final acceptance by the customer. The marking system shall not compromise the cleanliness of the item to be cleaned.

4.10.1.6 Validation of system integrity prior to cleaning

Unless otherwise specified, the integrity of the subsystem, system or other related field equipment shall be validated by a pressure test using water, pneumatics (nitrogen, compressed air, etc.) or a solvent after the

installation of all temporary hardware and prior to the beginning of the cleaning process if corrosive or hazardous fluids are to follow. The system integrity test pressure shall be at least 110 % of the maximum (anticipated) cleaning process working pressure, and it shall be held for a minimum of 5 min. Under no circumstances shall the working pressure of the original subsystem, system or other related field equipment be exceeded without prior written approval of the customer.

4.10.1.7 Hydrostatic testing

Functional items, such as flexhoses, tube assemblies, vessels and systems that require hydrostatic test, shall be tested prior to the final or precision-cleaning operation using an appropriate test fluid at the specified temperature and pressure.

4.10.2 Field-cleaning equipment

4.10.2.1 Materials

All materials used in the closed-loop or spraying operation for cleaning shall be known and shall be unaffected by the cleaning operations so that the cleanliness of the items being cleaned will not be compromised.

4.10.2.2 Closed-loop cleaning equipment

The following equipment shall be required for cleaning and testing subsystems, systems or other related field equipment by recirculation of the media in a closed loop:

a) containers of sufficient capacity to store, retain or recirculate the process materials used on the item being cleaned;

b) heating and heat transfer equipment having sufficient capacity to control and maintain the specified temperatures of the process materials at the specified flow rate; there shall be no dilution of solutions during heating;

c) circulation pumps, valves and other components of sufficient size and capacity to minimize pressure losses in the cleaning system and capable of maintaining the required flow rates;

d) calibrated flow measuring equipment to measure the liquid flow rates required to achieve specified velocities;

e) calibrated pressure gauges capable of interpretation in the middle 50 % to 80 % of the scale, and accurate to 1,5 % of full scale.

4.10.2.3 Spray equipment

In addition to the equipment specified in 4.10.2.2, spray equipment (such as spray wands and rotating-head spray machines) shall be required for impinging process solutions onto and wetting all internal surfaces of large items (such as storage vessels or large-diameter pipes) that cannot be cleaned by closed-loop circulation. Spray equipment shall be capable of delivering process solutions to provide a spray pattern that forcibly impinges process solutions onto and completely wets the entire interior surface of the item being cleaned. Rotating or transversing spray wands shall be used.

4.10.2.4 Cleaning by closed-loop circulation of solution

The circulation of cleaning solution in a closed loop shall be used only on items in which the total volume can be filled by the solution, and all critical surfaces can be wetted by the solution. Equipment for use in closed-loop circulation shall meet the requirements of 4.10.2.2.

4.10.2.5 Cleaning by solution spraying

Items having a size or configuration that cannot be cleaned by circulating a fluid through the item shall be cleaned by the use of spray equipment. Equipment for use in solution spraying shall meet the requirements of 4.10.2.3.

4.11 Mechanical cleaning

This method shall be used only when contaminants so generated can be removed and when physical damage to the item being cleaned will not occur. Mechanical cleaning may be accomplished by brushing, shot preening, grit blasting, tumbling or grinding. Long runs of piping or tubing may also be cleaned by pulling, pushing or blowing a slug (mole or tampon), either as is or covered with an absorbent material wet with a solvent, through the run. Corrosion-resistant steel surfaces shall be cleaned by brushing with a corrosion-resistant steel brush, grinding or using abrasive material. Abrasive materials used on corrosion-resistant steel surfaces shall contain no ferrous or ferric materials. The use of the same corrosion-resistant steel brush for corrosion-resistant steels and carbon steels shall not be permitted. All loose dirt, scale and other debris shall be completely removed from the item by vacuum cleaning, brushing, blowing or flushing with clean water or solvent.

4.12 Recleaning operational systems

Systems that have successfully passed the specified quality assurance tests for initial acceptance and have been placed in operation shall be recleaned only when analysis of the operational fluids shows that the delivered fluid does not meet specified requirements. Operational systems that are delivering fluids of an acceptable level of cleanliness shall be recleaned only at the discretion of the customer.

4.13 Drying

After cleaning, all cleaned items shall be verified as to cleanliness level using methods described in ISO 14952-3 and dried using methods described in ISO 14952-5.

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