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RDT F 5-1T

Supersedes
RDT F 5-1T, March 1969

RDT Standard

CLEANING AND CLEANLINESS REQUIREMENTS FOR NUCLEAR COMPONENTS

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CLEANING AND CLEANLINESS REQUIREMENTS FOR NUCLEAR COMPONENTS

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CLEANING AND CLEANLINESS REQUIREMENTS FOR NUCLEAR COMPONENTS

1. SCOPE

This standard covers minimum requirements for cleaning and cleanliness during fabrication and assembly of vessels, heat exchangers, pumps, piping, valves, and other components for nuclear service. The standard does not cover requirements for the cleaning of mill products, cleaning or cleanliness control of fuel elements, or in-place cleaning of installed systems.

2. APPLICABLE DOCUMENTS

The following documents are a part of this standard to the extent specified herein. The issue of a document in effect on the date of invitation to bid, including any amendments also in effect on that date, shall apply unless otherwise specified. Where the standard appears to conflict with the requirements of the reference document, such conflict shall be brought to the attention of the purchaser for resolution.

2.1 AEC-RDT Standards.

RDT F 2-2T, "Quality Assurance Program Requirements"
RDT F 7-2T, "Preparation for Sealing, Packaging, Packing, and Marking of Components for Shipment and Storage"
RDT F 7-3T, "Requirements for Identification Marking of Reactor Plant Components and Piping"

2.2 Federal and Military Specifications and Standards.

O-A-51F, Federal Specification for Acetone, Technical.
O-E-760b, Federal Specification for Ethyl Alcohol.
TT-I-735a, Federal Specification for Isopropyl Alcohol.
O-M-232E, Federal Specification for Methanol.
MIL-C-81302B, Military Specification for Cleaning Compound, Solvent, Trichlorotrifluoroethane.
FED-STD-209a, Clean Room and Work Station Requirements, Controlled Environment.
PHS-956, Public Health Service Drinking Water Standards 1962.
26-CFR-212, Denaturing of Alcohol and Rum (Code of Federal Regulations, Title 26, Chapter 212).

2.3 American Society for Testing and Materials (ASTM).

ASTM D510, Standard Methods of Sampling Industrial Water.
ASTM D512, Standard Methods of Test for Chloride Ion in Industrial Water and Industrial Waste Water.

ASTM D1125, Standard Methods of Test for Electrical Conductivity of Water.
ASTM D1179, Standard Methods of Test for Fluoride Ion in Industrial Water and Industrial Waste Water.
ASTM D1192, Standard Specifications for Equipment for Sampling Industrial Water and Steam.
ASTM D1293, Standard Method of Test for pH of Industrial Water and Industrial Waste Water.
ASTM D1889, Standard Methods of Test for Turbidity of Industrial Water.

2.4 American National Standards Institute (ANSI).

ANSI A11.1, Practice for Industrial Lighting.

2.5 American Association for Contamination Control (AACC).

AACC CS-1T, Standard for HEPA Filters.

3. DEFINITIONS

For the purposes of this standard, the following definitions are applicable.

3.1 Alcohol. Ethyl alcohol in accordance with Federal Specification O-E-760b and which has been denatured in accordance with formula 23A of 26-CFR-212; methanol in accordance with Federal Specification O-M-232E; or isopropanol in accordance with Federal Specification TT-I-735a.

3.2 Chemical Reagents. All reagents referred in this shall be of technical grade or better unless otherwise specified.

3.3 Clean Room. A room which is designed, operated, tested, and monitored in accordance with the requirements of FED-STD-209a.

3.4 Clean Area. A clean area is a clean work station meeting the requirements of FED-STD-209a or a temporary enclosure operated to meet the same requirements as a clean room.

3.5 Component. A part, combination or parts, subassembly or complete assembly.

3.6 Contamination. Material that is not an inherent part of the component in question, such as grit, metal particles, oil, grease, slag, scale, residual films, soil, etc.

3.7 Controlled Work Area. A work area to which access of personnel, tools, and materials is limited and physically controlled. Temporary enclosures may be used where adjacent activities produce contamination which is detrimental to the job.

3.8 Coolant Surface. Surfaces that are exposed to or in communication with a working fluid of the system.

3.9 Corrosion-Resistant Material. A material that inherently resists oxidation or chemical attack in air, water, or the operating environment, including austenitic stainless steels, precipitation-hardening stainless steels, nickel-base alloys, cobalt-base alloys, etc.

3.10 Crevice. Any narrow opening in a surface or any open juncture between mating surfaces in which dirt or liquids can be trapped and not readily removed; including the annular space in threaded connections, socket weld assemblies, tube-to-tube sheet joints, tube-to-tube support joints, gooves and press-fit joints.

3.11 Denatured Alcohol. Ethyl alcohol that has been denatured in accordance with formula 23A of 26-CFR-212.

3.12 Critical Surfaces. Surfaces, such as small orifices, bearings, bellows, journals, seating surfaces and tubing of thickness equal to or less than 1/8 in., which when corroded or otherwise roughened can impair the function or cause the component to become inoperable.

3.13 Filter Cloth. Cloth through which flushing water is passed to determine the acceptability of a flush. A bleached cotton fabric of "nainsook" (muslin) construction that weighs between 2.8 and 3.2 oz. per square yard (when new) and has approximately 80 to 100 yarns per inch in both the warp and fill directions.

3.14 Final Cleaned Surface. The surface condition after all surface finishing and cleaning operations have been performed prior to placing the surface in service.

3.15 Flushes.

3.15.1 Once-Through. Where water is introduced, flushed through a component under pressure at a prescribed velocity, and discharged from an outlet through a filter cloth.

3.15.2 Recirculating. Where a single batch of water is recirculated under pressure at a prescribed velocity in a closed path through a strainer in the flushing system.

3.15.3 Proof. A flush to demonstrate that a component is free of gross contaminants.

3.16 Inaccessible Areas. Areas or openings in a component that are not readily accessible for cleaning or inspection during or after fabricating, and where dirt, liquids or other contaminants may be trapped during fabrication.

3.17 Noncorrosion-Resistant Material. Materials, such as martensitic chromium stainless steels, carbon steels and low-alloy steels that inherently do not resist oxidation or chemical attack in air or water.

3.18 Rust. Corrosion products, consisting largely of hydrous ferric oxide, formed on the surface of iron and iron-base alloys. Such oxides may vary in color from red to black or may form a loosely adherent heavy covering to a tightly adherent light film. Pitting or general surface roughening may or may not be present.

3.19 Technical Grade. A designation for chemicals produced in bulk by ordinary commercial processes and having a nominal composition and purity which is confirmed by in-process quality assurance tests, but which is not certified by tests on each lot or batch of material shipped. Composition is usually certified to meet a typical composition range as shown on the label of the container, or to meet a certain nominal or generic composition.

3.20 TCTFE Solvent. Trichlorotrifluoroethane meeting the requirements of Military Specification MIL-C-81302B.

3.21 Water Grades. The requirements for the various water grades to be used in conjunction with this standard are summarized in Table 1.

Table 1

WATER GRADES^{a,b}

Property	Grade		
	A	B	C
Chloride, ppm maximum	0.1	1.0	(c)
Fluoride, ppm maximum	0.1	0.1	(c)
Conductivity, μ mhos/cm maximum	2.5	20.0	(c)
pH	6.0 to 8.0	6.0 to 8.0	(c)
Turbidity, Jackson Candle Units, maximum	1.0	1.0	5.0

^aPower plant condensate and distilled water may meet the requirements for Grade B water. Demineralized water may meet the requirements for Grade A water. Where water has been subjected to possible CO₂ absorption, such as when retained in storage tanks, the pH requirement may be lowered to 5.8 to compensate for CO₂ pickup. Where a particular grade of water is specified in this standard (e.g., "rinse with Grade C water) it shall be understood that the use of a higher grade is acceptable.

^bThe standard methods of test of the ASTM standards listed in paragraph 2.3 shall be used for reference purposes. Samples for test shall be taken in accordance with ASTM D510, using equipment meeting the requirements of ASTM D1192.

^cGrade C water shall be potable water meeting the requirements of the Public Health Service Drinking Water Standards.

4. REQUIREMENTS

4.1 General. Fabrication shall be conducted so as to facilitate cleaning and inspection for cleanliness, and to minimize contamination during fabrication. Shop dust, debris, and contaminants such as cutting fluids, welding slag, and other processing compounds shall be removed at intervals compatible with the fabrication or assembly operation and the requirements specified in 4.4.2, 4.4.3, or 4.4.4 for the environmental control specified. Surfaces that have been final cleaned shall be maintained in a clean condition up to and including their assembly into the components.

Items furnished in accordance with this standard shall be suitable for installation at the construction site without additional cleaning. Items that do not meet the requirements of this standard and the acceptance criteria specified by the purchaser shall be subject to rejection.

4.2 Procedures. The supplier shall submit for purchaser approval prior to use, detailed procedures for cleanliness control, in-process cleaning, and final cleaning of all coolant surfaces and all critical surfaces. Detailed procedures for other surfaces specified by the purchaser shall also be submitted to the purchaser for approval prior to use. Procedures shall include, but are not limited to, the following:

1. The general cleaning procedures to be employed.
2. Descriptions and drawings designating inaccessible areas and critical surfaces involved.
3. Specific cleaning methods to be employed for inaccessible areas and critical surfaces.
4. Precautions to be taken before, during and after assembly to maintain cleanliness of incoming materials, components and the completed item through final preparation for delivery.
5. Required purity levels of cleaning reagents, solvents and lubricants.
6. Flushing and rinsing procedures and method for determining when adequate rinsing or flushing has been achieved to satisfy the acceptance criteria specified by the purchaser, including conductivity, chloride, pH, and turbidity measurements of the final flush or rinse water.

7. Quality control and inspection procedures to be employed during and after cleaning operations and fabrication, to ensure that the purchaser's requirements have been met.
8. Acceptance standards for contamination and rust on components and equipment where such criteria are not contained in this standard.
9. Drying methods to be employed on cleaned equipment.
10. Inhibitors employed for minimizing corrosion when applicable and procedures for their removal.
11. Base metal or metals covered by the procedure.
12. Compatibility tests which are necessary prior to the cleaning operation to avoid deleterious effects on components or assemblies containing differing materials.
13. Precautions to be taken during the cleaning operation to avoid deleterious effects on components or assemblies containing differing materials, e.g., swelling of elastomers, etc.
14. A list and description identifying the types of equipment to be used, such as cleaning tanks, spray systems, air compressors, filters, drying ovens, tumblers, abrasive-blasting facilities, etc.
15. Identification of the use of a clean room, clean area, or controlled work area at applicable stages of fabrication and assembly.

4.3 Acceptance Criteria for Cleanliness. Unless otherwise specified, components submitted for final inspection shall be clean to the extent that no contamination of any surface is visible, without magnification, to a person with normal visual acuity, natural or corrected. In addition, wiping technique shall be used to determine the cleanness of coolant surfaces, critical surfaces, or other surfaces specified by the purchaser; the cleanness of the surfaces shall be evaluated by wiping with a clean lint-free unbleached cloth, either dry or moistened (but not saturated) with technical grade alcohol or acetone. Discoloration of the wiping cloth or a change in the appearance of the wiped surface shall be cause for rejection except where it can be shown that the discoloration is not due to harmful contaminants (i.e., metal oxides other than rust, which may cause discoloration, are generally not considered harmful. Illumination in inspection areas shall provide a glare-free light intensity of at least 100 ft-candles on the surfaces being inspected (see ANSI A11.1). Components which do not meet these requirements shall be rejected.

4.3.1 Rust.

a. Rust on Critical Surfaces. When specified by the purchaser, surfaces of corrosion resistant materials defined as critical by the purchaser shall be checked for complete removal of free iron by a wet-cloth test. The areas in question shall be wrapped with a clean cloth that has been moistened with Grade B water or, when specified by the purchaser, Grade A water. If no rust occurs within 6 hours the surface shall be considered satisfactory. If after the wet cloth test, there are rust spots that can be removed by wiping with a clean dry cloth, and no corrosion pits are visible, the surface shall be considered acceptable when all rust has been removed. The occurrence of rust on clean corrosion-resistant surfaces may indicate that something is wrong with the material (e.g., improper heat-treatment or material composition), and the cause of the rust should be determined before proceeding with fabrication.

b. Rust on Non-Critical Surfaces. Thin films of rust are acceptable on noncritical corrosion resistant material surfaces (those surfaces not included in 3.2.3.1(2), provided there is no visible evidence of corrosion pitting and the total area involved does not exceed 1% of the estimated total surface of components.

Thin films of rust are defined as superficially corroded areas of red, brown or black discoloration. The rust observed may be either localized or general; that is, the rust may be present in spots or streaks or as a continuous film. Where localized rusting is involved, the total included area (the rusted area plus the included unrusted area) shall be used to determine the percentage involved rather than the actual area observed. These films of rust are not necessarily adherent. In many cases, it may be possible to remove the rust by rubbing with a clean dry cloth.

c. Rust on Non-Corrosion Resistant Materials. Acceptance criteria for rust on carbon and low-alloy steels shall be specified by the purchaser. Slight rusting is occasionally observed in the neighborhood of backup rings, socket weld joints, canopy welds and similar parts, where welding slag entrapment causes rusting as a result of exposure to water. Unless otherwise specified, rust observed in such areas should not normally be considered detrimental provided the rust occurring in such areas is uniform in appearance and shows no visible thickness. Such forms of rust usually do not extend more than 1/2 inch from the area where slag entrapment has occurred.

d. Pitting. The following criteria shall be used to determine if pitting has occurred, and the presence of one or more of these conditions shall provide the basis for rejection or repair. These criteria are:

(1) The presence of pit-like indications in which the voids are visible,

(2) The buildup of corrosion products in a circular manner outlining the area of the pits (actual void of pit may not be visible), this type of buildup is usually considerably thicker than the surrounding rust and is almost always associated with pitting; and

(3) The presence of annular rings of discoloration surrounding the core of the pit (these rings do not usually show any visible thickness; however, they are generally of different colors).

e. Temper Films. Irridescent temper films resulting from heat treatment and tightly adherent black oxide films that occur on the backside of welds need not be removed.

4.4 Clean Room, Clean Area, and Controlled Work Area.

4.4.1 Requirement for Use. A clean room or clean area shall be employed for reactor coolant system components, and for other items specified by the purchaser, starting with that stage of fabrication or assembly where internal, critical, or crevice-containing surfaces are created or become no longer accessible for further cleaning or inspection. Consideration should be given to the use of a controlled work area during earlier stages of fabrication. The procedures of 4.2 should identify the use of a clean room, clean area, and controlled work area as applicable.

4.4.2 Clean Room. The clean room shall consist of a complete enclosure that is designed, operated, tested, and monitored in accordance with FED-STD-209a. The type of clean room (laminar flow or nonlaminar flow) and air cleanliness class (Section 5.1 of FED-STD-209a) shall be appropriate for the type of operation to be conducted in the clean room and as specified by the purchaser. Environmental conditions shall be in accordance with the recommendations of Section 30 of FED-STD-209a unless otherwise specified by the purchaser or it can be shown that those recommendations are inappropriate for the type of operation to be conducted in the clean room.

4.4.3 Clean Area. A clean area may be used for final assembly of clean components where it is not practical to use a clean room. A clean area may be a clean work station meeting the requirements of FED-STD-209a or a temporary enclosure operated to meet the same requirements as a clean room as specified in 4.4.2.

4.4.4 Controlled Work Area. A controlled work area may be required where subsequent access for cleaning of the item makes special environmental control (such as a clean room or clean area) unnecessary. Where work is carried out in a common shop, an area designated as a controlled work area shall be isolated by signs, gates, ropes, or other physical barriers, and subjected to special controls to ensure that the restrictions on tools, materials, personnel access, and personnel practices of this standard are achieved. The limits of the controlled work area shall be clearly defined, and the access, operational, and other conditions pertaining to the area shall be (1) listed on signs posted at the perimeter of the area; and (2) included in the procedures approved by the purchaser (para. 4.2).

4.5 Water Used for Engineering Tests. Unless otherwise specified by the purchaser, Grades A, B, or C water may be used for hydrostatic, performance, and other engineering tests conducted at water temperatures below 150°F. When Grade C water is used, it shall be drained immediately after completion of the test and the component shall be flushed immediately with Grade A or B water before the internal surfaces dry. All grades of water shall be filtered immediately before use in testing or flushing and shall be checked to verify that the turbidity requirements of Table 1 have been met.

4.5.1 Grade A or B water shall be used for engineering tests of austenitic stainless steel components at water temperatures of 150°F or higher, and Grade B or better purity shall be maintained throughout the tests. After completion of the test the component shall be thoroughly dried to ensure the complete removal of all water.

4.5.2 Grade C water may be used for engineering tests of components made of materials other than austenitic stainless steels at water temperatures of 150°F and higher unless otherwise specified by the purchaser. On completion of the test the component shall be drained and flushed with Grade A or B water.

4.6 Precautions.

4.6.1 Stainless Steels. For austenitic stainless steels which may have been sensitized by exposure to temperatures in the range of 800°F to 1600°F, precautions shall be taken to avoid intergranular attack or stress corrosion in the sensitized areas should the component be subsequently exposed to oxidizing agents such as nitric acid or halide environments such as salt air.

4.6.2 Welding and Brazing. Precautions shall be taken to control spatter and to remove smoke and fumes produced by welding and brazing operations. Anti-spatter and rust-preventive compounds shall not be used unless approved by the purchaser. The base material shall be cleaned for a distance of at least 2 inches on each side of the joint edge-preparation in accordance with the procedures approved by the purchaser (para. 4.2).

4.6.3 Exposure to Contaminated Atmospheres. Metals and components shall be protected from the general shop atmosphere, or other contaminated atmospheres such as salt air or blowing dust, insofar as possible during fabrication and temporary storage.

4.6.4 Heating. Precautions shall be taken to prevent contamination of surfaces during or prior to heat-treating, welding, hot-forming, and other high-temperature operations.

4.6.5 Use of Lubricants. A lubricant may be employed during machining, fabrication, and assembly operations provided the lubricant does not contaminate any crevice or inaccessible area that cannot be subsequently cleaned, and provided that the lubricant is removed after completion of all operations for which

it is used. Where machining, fabrication, or assembly must be performed on components containing crevices, and normal precautions will not prevent entry of lubricant into these crevices, only Grade A or Grade B water or a lubricant approved by the purchaser shall be used. In the case of components containing crevices, which cannot be protected by normal precautions, water or an approved lubricant shall be removed immediately after completion of each operation for which it is used.

4.6.6 Mercury Control. During the manufacturing processes, tests, and inspections, the component or system shall not have come in direct contact with mercury or any of its compounds nor with any mercury-containing devices employing a single boundary of containment. It is not the intent of this standard to prevent the use of permanent fluorescent lighting fixtures or fixtures employing mercury vapor lamps which contain the equivalent of or less mercury per lumen than a comparable fluorescent lamp so long as the fixture or lamp is fitted with a continuous panel or diffuser to prevent pieces of the lamp from dropping on the component in the event of lamp breakage. Portable lighting fixtures employing fluorescent or mercury vapor lamps such as drop lights are prohibited unless specifically approved by the purchaser. When calibrating test equipment such as manometers, a single boundary may not be achievable; in such cases a cold-trap shall be used and the instrument proven to be free of mercury contamination after calibration and prior to use.

4.6.7 Handling of Components. In general, cleaned surfaces may be handled with clean hands; however, clean lint-free cotton, nylon, or dacron cloth or polyethelene film gloves shall be used when handling final-cleaned coolant surfaces, critical surfaces, and other surfaces specified by the purchaser. Handling equipment that comes in contact with coolant surfaces, critical surfaces, and other surfaces specified by the purchaser shall be made of austenitic stainless steel.

4.6.8 Exclusion of Foreign Materials. Extreme care shall be taken during fabrication to prevent contamination by foreign materials. Temporary plugs or seals conforming to the requirements of Section 7.2 of RDT F 7-2 shall be installed to keep contaminants out of a clean component during subsequent fabrication and storage. Precautions shall be taken to prevent such temporary plugs and seals from being inadvertently left in the component when shipped. Special attention shall be given to the clothing worn by personnel working on clean components in which there are openings; precautions shall be taken to eliminate the possibility of accidental loss of articles such as buttons, badges, jewelry, pens, pencils, coins, spectacles, dentures, hearing aids, respirator filters, tools, used welding rods, and other articles in the component. Any inventory control shall be instituted for all tools, wiping cloths, supplies, and equipment small enough to fit inside openings of the component; insofar as practicable, such articles shall be attached to the user or to a fixed object by a lanyard, and shall be formally accounted for at all times.

4.6.9 Lead, Sulfur and Aluminum. Lead or lead compounds, sulfur or sulfur compounds, or materials containing lead or sulfur as a basic chemical constituent shall not be used in direct contact with the final cleaned surface of nickel base alloys.

Aluminum shall not be used either as soft pads or hammers to reduce marring during assembly and handling of nickel-base or stainless steel alloy components. Aluminum pipe caps and seals shall not be used on stainless steel or nickel-base alloy components. Zinc, cadmium, or other low-melting-point metals shall not be allowed to come in contact with final-cleaned stainless steel.

4.6.10 Pipe Joint Compounds and Sealers. Pipe joint compounds, teflon tape or sealers, other than colloidal graphite in isopropanol (neolube or equivalent) to prevent galling, shall not be used in making up temporary or permanent joints of flushing systems or other attachments to the component unless approved by the purchaser. Teflon-inserted jam nuts may be used to seal threaded connections only in temporarily installed support systems and under the following conditions.

1. At ambient temperatures with pressures up to 3750 psig.
2. At temperatures less than 300F with pressures up to 2000 psig.

4.6.11 Corrosion Inhibitors. Corrosion inhibitors shall not be allowed to come in contact with materials intended for coolant surfaces; however, inhibitors may be employed for minimizing corrosion of metals and parts intended for noncritical applications during fabrication, shipment and storage and installation.

4.6.12 Paint on Corrosion-Resistant Materials. Painting of corrosion resistant materials is prohibited. If paint is inadvertently applied to such materials, it shall be removed by a procedure approved by the purchaser and which conforms to the requirements of 3.2.2.

4.6.13 Marking. Temporary and permanent markings on parts, sub-assemblies and components shall meet the requirements of RDT F 7-3.

4.7 Cleaning Process.

4.7.1 Cleaning Agents. Cleaning agents and solvents used for in-process cleaning or for final cleaning shall be technical grade or better. Unless specifically approved by the purchaser, halogenated cleaning agents and solvents, except TCTFE meeting the requirements of Military Specification MIL-C-81302b, shall not be used for cleaning or degreasing of austenitic stainless steel. Grade C or better water shall be used for mixing cleaning solutions. When rinsing or flushing is required as a final step in final cleaning, Grade C water may be used for preliminary rinses or flushes, but Grade B or better water shall be used for the final rinse or flush.

4.7.2 Safety. Some of the materials required for use in this standard are hazardous. Every precaution shall be taken to protect personnel from materials that may present fire hazards, cause burns and skin irritations, or have toxic effect when breathed. Local safety organizations shall be consulted for specific instructions.

4.7.3 Mechanical Cleaning. Mechanical cleaning shall be performed in such a manner that particles will fall away from the equipment to preclude particles from entering the component. Where mechanical cleaning cannot be performed in a manner that particles fall away from the equipment, a vacuum hose or dirt catcher shall be employed. A vacuum hose may also be employed near the work to remove fine airborne particles. Completed components shall be cleaned as required to remove any particles resulting from operations such as grinding, polishing, filing, deburring and brushing.

a. Mechanical cleaning tools such as grinding, polishing, filing, deburring and brushing tools shall be clean and shall not have been used on aluminum, copper, lead or materials containing lead or lead compounds, or other low melting point materials. Separate sets of tools shall be maintained and used as follows:

(1) One set of tools shall be used on carbon and low alloy steels only.

(2) One set of tools shall be used on corrosion resistant materials only. In order to preclude contamination of corrosion resistant materials with free iron, these tools shall not have previously been used on carbon or low alloy steel materials. These sets of tools shall be clearly marked to identify their intended use in accordance with a system specified by the activity performing work and shall be segregated according to their intended use.

b. Grinding and Polishing. Grinding and polishing shall be performed with resin- or rubber-bonded aluminum oxide or silicon-carbide grinding wheels or discs that will ensure a cleanly cut surface, except only resin-bonded tools shall be used on stainless steel.

c. Brushing. Brushing shall be performed with clean austenitic stainless steel brushes. Power-operated brushes shall not be used on seal membranes, seal welds, or thin sections such as bellows, etc. Power-operated brushes shall not be used for cleaning components that will later be liquid-penetrant inspected unless the brushed areas are ground or machined prior to liquid-penetrant inspection.

d. Filing and Deburring. Filing and deburring shall be performed with carbide-tipped or tool-steel tools. Rotary files used on austenitic stainless steel shall be faced with tungsten carbide or titanium carbide.

e. Abrasive Blasting. Abrasive blasting shall be used only when approved by the purchaser. Surfaces that have been descaled by abrasive blasting shall be subsequently acid cleaned, machined, brushed, or ground to remove any embedded scale or blasting grit.

f. Tumbling. Tumbling may be used only when approved by the purchaser. In order to preclude obscuring material defects, tumbling shall not be used on surfaces which are subsequently to be liquid penetrant inspected, except when followed by machining or grinding. The tumbling equipment shall be thoroughly cleaned of materials used in previous operations. After the tumbling operation, the surfaces shall be cleaned with a tampico or stainless steel brush, rinsed with Grade C or better water, and then rinsed with Grade A water.

4.7.4 Degreasing Requirements. Unless otherwise approved by the purchaser, degreasing of austenitic stainless steel surfaces shall be accomplished using technical grade or better acetone, alcohol, or TCTFE. Parts or components containing crevices or undrainable areas shall be cleaned by immersion, by spraying, or by wiping with a clean lint-free unbleached cloth that has been saturated with one of these solvents.

When TCTFE is used on parts or components containing inaccessible or undrainable areas, the parts or components shall be dried by evacuation or heated to a temperature of 120°F to 140°F and flushed with dry, oil-free air or inert gas until no further indication of the solvent is found in the effluent air or gas, using a halogen leak detector. When acetone or alcohol is used for degreasing, drying shall be specified in accordance with paragraph 4.2 and approved by the purchaser prior to use.

4.7.5 Detergent Cleaning. Surfaces containing no crevices and which are fully accessible and drainable may be cleaned with trisodium phosphate detergent using a procedure approved by the purchaser before use in accordance with 3.2.2.

4.7.6 Acid Cleaning. Acid cleaning shall not be used as a standard procedure and, when necessary, shall be done only with purchaser approval and in accordance with procedures approved by the purchaser prior to use in accordance with 3.2.2. Components that have crevices or undrainable spaces, hardened steels with nitrided surfaces, precipitation-hardening stainless steels, austenitic stainless steel weldments and materials that have not been solution annealed, and non-metallic parts shall not be acid-cleaned. Acid cleaning may be used (a) following abrasive blasting providing the surfaces cannot be ground or polished after blasting; (b) to remove heavy heat-treat or hot-rolling scale that cannot be removed by abrasive blasting, grinding, or brushing; or (c) to remove non-corrosion-resistant material embedded in the surface of corrosion resistant material.

a. All components shall be degreased prior to acid cleaning by an appropriate method in accordance with this standard. The surfaces shall be free of grease, oil, and foreign matter to ensure adequate surface contact by the acid and to prevent the contamination of acid solutions.

b. Tubular items shall be given special attention during acid cleaning as restricted movement of the acid may accelerate corrosion and cause pitting.

c. Critical surfaces and other surfaces specified by the purchaser shall be masked during acid cleaning. Masking materials shall be removed immediately after completion of acid cleaning.

d. Acid-cleaned surfaces shall be rinsed immediately, before they can dry, using a procedure approved by the purchaser before use in accordance with 3.2.2. The final rinse water shall have a pH between 6.0 and 8.0. If acid cleaning is the final cleaning operation for the surface, the final rinse shall be with clean Grade A or B water. Surfaces shall not be permitted to dry between successive steps of the acid-clean and rinse procedure.

e. Ammonia neutralization is prohibited for copper alloys.

4.8 Drying. Drying after completion of final cleaning may be accomplished by still or forced clean dry oil-free air or inert gas, in a drying oven, or by evacuation. The dew point of the air or inert gas shall be as specified in the cleaning procedure approved by the purchaser (4.2). Purging and use of desiccants preparation to packing for shipment shall be in accordance with Sections 7.3 and 7.4 of RDT F 7-2.

4.8.1 When using vacuum pumps for evacuation, cold-traps shall be employed to prevent contamination of cleaned surfaces by oil vapors. When forced air or inert gas is used, it shall be passed through a trap to remove oil, water, and particulate matter before use.

4.8.2 There shall be no water marks on dried surfaces.

5. COMPONENT PROOF FLUSHING

5.1 Applicability. These provisions apply to flushing components by the vendor when proof flushing with water is required by the applicable purchase document. The requirements and cleanliness criteria for the use of filter cloths specified herein apply only to the final flushes to demonstrate that the component is free of particulates.

5.2 Water Purity. The purity of each grade of water used for flushing is defined in 3.2.2.

5.2.1 Water to be used for flushing shall be checked for cleanliness prior to use by filtering approximately 20 gallons of water through a filter cloth, see 3.2.2. The resulting cloth shall be completely free from foreign material. This check shall be performed immediately prior to starting the flush, and the filter cloth shall be as near as practicable to where the flush water enters the system (that is, downstream of all hoses, pipes and fittings).

5.2.2 The grade of water for flushing shall be as approved by the purchaser.

5.2.3 Flushing procedures shall be sequenced and care taken to preclude the flushing of contaminants from one part of the component into larger, lower velocity flow regions unless otherwise approved by the purchaser.

5.3 Velocity of Flushes. The flushing velocity shall be as specified in the procedures approved prior to use by the purchaser in accordance with 3.2.2, and, if practicable, shall be equal to or slightly greater than the normal operating flow rate of the component.

5.4 Duration of Flushes. Flushes shall be of duration or quantity of water as specified in detailed flushing procedures. Flushes shall be repeated until two successive filter cloths or strainers meet the applicable clean cloth or clean strainer criteria specified in 4.6.1 and 4.6.2.

5.5 Flushing Acceptance Criteria. The acceptance criteria for flushing of components shall be in accordance with either Type I or Type II, as specified by the purchaser.

5.5.1 Type I Flush Acceptance Criteria. Type I flush acceptance criteria shall be as follows:

- a. The general/appearance of the filter cloth shall be that of a clean white wet cloth showing no more than slight speckling and no more than slight soiling or staining of any kind from rust to dirt.
- b. There shall be no particles on the cloth larger than 1/32 inch in any dimension, except that fine hair-like slivers or thin flakes (much less than 1/32 in. thick) may have a major dimension up to 1/16 in.
- c. Readily apparent quantities of unusual impurities in the exit flush water or on the cloth, such as resin particles, abrasive grit, or other foreign matter, shall be reason for non-acceptance of the flush.

5.5.2 Type II Flush Acceptance Criteria.

- a. The general appearance of the filter cloth shall be that of a clean white wet cloth showing no more than slight speckling and no more than slight soiling or staining of any kind from rust to dirt.
- b. The strainer shall contain no particles larger than 1/16 inch in any dimension; except that fine hair-like slivers or thin flakes (much less than 1/16 in. thick) may have a major dimension up to 1/8 in.
- c. Readily apparent quantities of oil, brazing flux, pipe dope or sealers, preservatives, or other foreign matter on the strainer or in the flush water after recirculation shall be reason for non-acceptance of the flush.

5.5.3 Drying. Following proof flushing, components shall be dried in accordance with 4.8.

6. QUALITY ASSURANCE PROGRAM

6.1 Unless otherwise specified, the provisions of RDT F 2-2 shall apply in the application of the requirements of this standard.

6.2 Except as otherwise specified, facility certification and approval shall be obtained from the purchaser prior to the start of cleaning of any component.

6.3 Cleaning procedures specified in 4.2 shall be reviewed and approved by the purchaser prior to use.

6.4 Monitoring of clean rooms, clean areas, controlled areas, and cleaning operations and facilities to verify that cleanliness is in compliance with the provisions of this standard is a requirement of this standard.

6.5 Records. The supplier shall maintain a current and complete file of all records of inspection, examination and monitoring data pertaining to cleaning, clean room and clean area operation.

6.6 Access. The purchaser or his agent shall have access to any area where work associated with component cleanliness is performed and to all records pertaining to the cleaning or cleanliness of components under the contract.

7. PREPARATION FOR DELIVERY

Packaging for delivery of equipment cleaned in accordance with this standard shall meet the requirements of RDT F 7-2 unless otherwise specified. Components shall be prepared for delivery as soon as practicable after cleaning, drying, and examination except as approved by the purchaser. Rust-preventive or organic materials shall not be placed on internal surfaces of components, or on external surfaces of corrosion-resistant components.

7.1 The number of removable items such as desiccant bags, pipe plugs, etc., shall be noted so that an accounting can be made in the field to prevent inadvertently introducing such items into the installed system. Warning notices shall be placed on the shipping container or component to specify the location and number of humidity-indicating cards, the location of gas bottles, gas bleeders, and pressure gages, and the type of inert gas. Any markings on metal surfaces of the component shall meet the requirements of RDT F 7-3.

7.2 Components shall be capable of being reinspected at the destination to assure conformance to the requirements of this standard. Components that do not meet the requirements of this standard shall be subject to rejection.

8. DATA CHECK LIST

The following items shall be considered in preparing detailed procedures based on this standard.

1. Detailed cleaning procedures for other than coolant and critical surfaces. [4.2]
2. Flushing procedures. [4.2(6)]
 - a. Acceptance criteria for flushing [5.5]
 - b. Quality of water used for flushing [5.5.2]
 - c. Velocity and duration of flushes [5.3 and 5.4]
3. Detailed rinsing procedures. [4.2(6)]
 - a. Quality of water for rinsing. [4.7.6.d]
4. Cleanliness acceptance criteria additional to that specified in 4.3.
5. Water quality for wet-cloth test. [4.3.1.b]
6. Clean room or clean area for final fabrication and assembly. [4.4.1]
 - a. Air cleanliness class and clean room type. [4.4.2]
 - b. Environmental conditions required beyond those recommended in FED-STD-209a. [4.4.2]
7. Need for controlled work area for earlier stages of fabrication. [4.4.1]
 - a. Conditions for access and control in controlled work area. [4.4.4]
8. Quality of water required for engineering tests. [4.5]
9. Permissibility of using temporary lighting fixtures with fluorescent or mercury-vapor lamps. [4.6.6]
10. Permissible cutting and machining lubricants in the fabrication of liquid metal system components. [4.6.5]
11. Requirement for the use of gloves in the handling of final-cleaned surfaces other than coolant or critical surfaces. [4.6.7]
12. Permissibility of using abrasive blasting. [4.7.3.e]

13. Permissibility of using acid cleaning. [4.7.6]
 - a. Surfaces to be masked during acid cleaning. [4.7.6.c]
14. Exceptions to or waivers of quality assurance requirements of RDT F 2-2. [6.1]
15. Requirements additional to those of RDT F 7-2 for packing and preparation for delivery. [7.]

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SIGNATURE

R. A. Schmidt

R. A. Schmidt, Reactor Standards Office

CLEANING AND CLEANLINESS REQUIREMENTS FOR NUCLEAR COMPONENTS

A M E N D M E N T 1

This amendment forms a part of RDT F 5-1T
dated February 1972

1. Change cross-reference paragraph numbers as follows:

<u>Page</u>	<u>Paragraph</u>	<u>Line</u>	
7	4.3.1-b	3	Change 3.2.3.1(2) to 4.3.1(a)
11	4.6.12	4	Change 3.2.2 to 4.2
13	4.7.5	4	Change 3.2.2 to 4.2
13	4.7.6	4	Change 3.2.2 to 4.2
14	4.7.6-d	3	Change 3.2.2 to 4.2
14	5.2	2	Change 3.2.2 to 3.21
14	5.2.1	3	Change 3.2.2 to 3.13
15	5.3	3	Change 3.2.2 to 4.2
15	5.4	4	Change 4.6.1 to 5.5.1
			Change 4.6.2 to 5.5.2
17	2.-b	-	Change 5.5.2 to 5.2.2
17	5.	-	Change 4.3.1-b to 4.3.1-a