TENNESSEE VALLEY AUTHORITY
CHATTANOOGA, TENNESSEE 37401
830 Power Building

DEC 7 1978

Director of Nuclear Reactor Regulations
Attention: Mr. S. A. Varga, Chief
Light Water Reactors Branch No. 4
Division of Project Management
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Varga:

In the Matter of the Application of) Docket Nos. 50-327
Tennessee Valley Authority) 50-328

Enclosed is the requested package of material for your review of our change of cleaning procedures of austenitic pipe. Our need for a change of the commitment in the Sequoyah Nuclear Plant Final Safety Analysis (FSAR) was discussed in a telephone conversation with Mr. Silver of your staff on December 1, 1978. Enclosed are the FSAR draft amendment material page 5.2-38; the referenced Westinghouse specifications, 84351 NL and 597760; and the referenced Department of Energy's specification, RDT F 5-1T.

Very truly yours,

J. E. Gilleland
Assistant Manager of Power

Enclosures

B012 S/1

781212 0166 K

The process specifications which establish these rules and which are in compliance with the more current American National Standards Institute N-45 Committee specifications are as follows:

Process Specification

82560HM Requirements for Pressure Sensitive Tapes for use on Austenitic Stainless Steels.

83336K Requirements for Thermal Insulation Used on Austenitic Stainless Steel Piping and Equipment.

83860LA Requirements for Marking of Reactor Plant Components and Piping.

84350HA Site Receiving Inspection and Storage Requirements for Systems, Material and Equipment.

84351NL Determination of Surface Chloride and Fluoride on Austenitic Stainless Steel Materials. TVA will apply this specification to piping with an operating temperature over 140°F and will use the acceptance standards of paragraph F.3.2 of RDT F5.1T, January 1974 for halogen contamination.

85310QA Packaging and Preparing Nuclear Components for Shipment and Storage.

292722 Cleaning and Packaging Requirements of Equipment for Use in the NSSS.

597756 Pressurized Water Reactor Auxiliary Tanks Cleaning Procedures.

597760 Cleanliness Requirements During Storage Construction, Erection and Start-up Activities of Nuclear Power Systems. TVA will apply this specification to piping with an operating temperature over 140°F.

5.2.5.2 Solution Heat Treatment Requirements

All of the austenitic stainless steels listed in Tables 5.2-27, 5.2-28 and 5.2-32 are procured from raw material producers in the final heat treated condition required by the respective ASME Code Section II material specification for the particular type or grade of alloy.

5.2.5.3 Material Inspection Program

All of the wrought austenitic stainless steel alloy raw materials which require corrosion testing after the final mill heat treatment are tested in accordance with ASTM A 393 using material test specimens obtained from specimens selected for mechanical testing. The materials are obtained in the solution annealed condition.

5.2.5.4 Unstabilized Austenitic Stainless Steels

The unstabilized austenitic stainless steels used in the reactor coolant pressure boundary and components are listed in Tables 5.2-27 and 5.2-28.

FOR INFORMATION ONLY
DATE AUG 29 1975
(MECH ENGG BR) MR. D. R. PATTERSON

MTST

MECH'L ENGR. BR. FILE

Westinghouse Electric Corporation Power Systems

Box 355
Pittsburgh Pennsylvania 15230

P.S. 84351 NL
Rev. 3

June 15 1973

N2M-2-3
N2M-2-50

TVA AUG 27 '75
PROJECT: SEQUOYAH 1 & 2
CONTRACT 60C60-91934
NSSS N2M-2
USE:

DETERMINATION OF SURFACE CHLORIDE & FLUORIDE CONTAMINATION ON STAINLESS STEEL MATERIALS

USER: PWR

ANSWERED BY LETTER NO. 14739

1.0 SCOPE

This procedure covers the apparatus and expedient method for determining the surface concentration of chloride and fluoride on stainless steel surfaces after final cleaning in accordance with PS 597760 requirements.

2.0 TIME OF EXAMINATION

The Site chemist shall perform the sampling and test after the surface has been cleaned and in the case of surfaces to be insulated, just prior to installing insulation (insuring that the surfaces are not re-contaminated before insulation is installed). The amount of sampling for a given system or component must be sufficient to insure that the surfaces have been adequately cleaned and meet the chloride and fluoride concentration limits of acceptance listed in Section 3.0.

3.0 LIMITS OF ACCEPTANCE

3.1 Insulated Surfaces

The limit for surface concentrations on austenitic stainless steel surfaces prior to application of thermal insulation is 0.0015 mg Cl/dm^2 and 0.0015 mg F/dm^2. This level is readily attainable on smooth surfaces. However, rough surfaces such as; mill or foundry skin, welds, etc., may require repeated cleaning and retests. Conflictions shall be referred to PWR Chemistry Department for disposition.

3.2 Non-Insulated Surfaces

The limit for surface concentrations on non-insulated austenitic stainless steel surfaces is 0.015 mg Cl/dm^2 and 0.0015 mg F/dm^2. The higher chloride limit on non-insulated surfaces is permitted due to the decreased potential for chloride cracking on non-heated surfaces. Since temperature has little effect on fluoride cracking, the fluoride limit is identical for both insulated and non-insulated surfaces.

REF: Basis for above criteria was from D.D. Whyte letters SA-C-622 and SA-C-665 dated May 26, 1971, and August 5, 1971, respectively and WCAP-7333 "Chemical Analysis Procedures for Pressurized Water Reactors".

4.0 CHLORIDE ANALYSIS

4.1 Accuracy

This method is capable of determining the presence of 0.000125 mg Cl/dm^2 on the surface. The time to perform the test and analysis is approximately 35 minutes.

4.2 Apparatus

4.2.1 Hot Plate
4.2.2 Stirrers
4.2.3 No. 41 Whatman Filter Papers
4.2.4 Cheese Cloths or 4" Medical Gauze Pads
4.2.5 800 ml Beakers
4.2.6 Microburets, 5 ml with 0.01 ml graduations
4.2.7 Polyethylene Bags
4.2.8 Chloride free polyethylene or rubber gloves
4.2.9 Large Watch Glasses
4.2.10 Buechner Funnels
4.2.11 500, 1,000 and 2,000 ml Volumetric Flasks

4.3 Reagents

4.3.1 Mercuric Nitrate Standard (0.00282 N) - Dissolve 2.4200 grams of mercuric nitrate $[Hg(NO_3)_2 \cdot H_2O]$ in 50 ml of water acidified with 0.5 ml of concentrated nitric acid. Dilute to 1 liter. Filter if necessary. Dilute 5 to 1 and standardize weekly against a 0.5 ppm chloride solution. In addition this solution is prepared by diluting 5 ml of chloride standard solution (100 mg. chloride per liter) to 1 liter.

4.3.2 Sodium Chloride Standard Solution -

Dry NaCl to constant weight @ 105°C. Prepare stock solution by dissolving exactly 0.1649g of dry salt in demineralized water and dilute to 1 liters with halide free water. The resulting standard contains 100 mg of chloride per liter.

4.3.3 Mixed Indicator -

Dissolve 0.5g of crystalline diphenylcarbazone and 0.05g of bromophenol blue powder in 75 ml of methyl or ethyl alcohol (95%) and dilute to 100 ml with alcohol. Store in a brown bottle and discard after 6 months.

4.3.4 Nitric Acid -

Mix 3 ml of concentrated nitric acid with 997 ml of water.

4.3.5 Sodium Hydroxide Solution (10g per liter) -

Dissolve 10 grams of sodium hydroxide in water and dilute to 1 liter.

4.4 Sampling Procedure

4.4.1 Cut clean cheese cloth into 4" squares of 8 layers thick or use precut medical gauze pads. Using clean, plastic or rubber gloves flush each cloth square three times with about 300 ml of demineralized water per rinse to remove any chloride contamination of the cloth. Then with plastic or rubber gloves squeeze the cloths to remove excess water and place the sampling cloths in a chloride free (well rinsed with demineralized water) polyethylene bag and tie the bag to eliminate drying of the cloths. Cloths should be rewetted with demineralized water after storage for greater than 1 day. For sampling, remove two 4" square cloths from the bag using plastic or rubber gloves and proceed to wipe an area of 20 dm^2 (2 ft^2) on the surface of the pipe to be sampled with one of these cloths.
Place sampling cloth and blank cloth in individual chloride free polyethylene bags.

The sampling cloth and blank cloth are removed from the polyethylene bag and placed in individual 800 ml beakers. Cover the cloth in the 800 ml beakers with about 250 ml of demineralized water each. Cover the beakers with large watch glasses and heat to near boiling (95° to 100°C) for 10 minutes. Stir during the boiling operation. Cool the sample and blank and filter the solutions individually through No. 41 Whatman filter paper in a Buechner-type funnel (aspirator type suction can be used). The Whatman filter paper shall be rinsed with 2000 ml of demineralized water prior to use. The filtering is not necessary if the solution is initially clear. Wash the cloths repeatedly with demineralized water until about 200 mils of wash solution have been used for each. Adjust the filtered volume to 500 ml for both sample and blank.

4.5 Procedure

NOTE: Dilute mercuric nitrate solution is added to an acidified sample in the presence of mixed diphenylcarbazone - bromophenol blue indicator. The end point of the titration is the formation of the blue violet mercury diphenylcarbazone complex.

4.5.1 To 200 ml of sample and 200 ml of halide-free blank add 8 to 10 drops of mixed indicator and shake. If a blue-violet or red color develops add HNO_3 dropwise until the color changes to yellow.

Add ∿1 ml of excess acid.

If yellow or orange color forms immediately on addition of mixed indicator add NaOH solution dropwise until blue-violet color appears, then add HNO_3 dropwise until color changes to yellow. Add ∿1 ml of excess acid.

4.5.2 Titrate the sample and blank with mercuric nitrate solution until a blue-violet color persists. Use white background under flask to aid in color determination.

4.5.3 Record volume of mercuric nitrate used for each sample and for the blank.

4.6 CALCULATION

Calculate the chloride concentration as follows:

$$\text{Chloride (ppm)} = \frac{(V_1 - V_2) \times N \times 35.5 \times 10^3}{S}$$

where: V_1 = volume of titer used for sample (ml)

V_2 = volume of titer used for blank (ml)

N = normality of mercuric nitrate solution

S = volume of sample analyzed (ml)

Conversion to surface units of

$$\text{mg Cl/dm}^2 = \text{Chloride (mg/l)} \times \frac{VT}{A}$$

where: VT = total volume of sample (l)

A = area of wiped surface (dm^2)

5.0 FLUORIDE ANALYSIS

5.1 Accuracy

This method is capable of determining the presence of 0.000125 mg F/dm^2 on the surface. The time required to perform the analysis is approximately 15 minutes.

5.2 Apparatus

5.2.1 Beckman Expandomatic pH meter or equivalent.

5.2.2 Orion Fluoride Electrode Model 94-09 or equivalent.

5.3 Reagents

5.3.1 Purchase a fluoride standard and dilute to the following concentrations with reagent grade water:

0.05 ppm
0.10 ppm
0.20 ppm

5.4 Procedure

5.4.1 Measure three (3) aliquots of each at the fluoride standards prior to and at the conclusion of the test solution analyses on the required expanded scale of the pH meter. Record the millivolt reading from the pH meter.

5.4.2 Plot the standard data on semi-log paper, recording the fluoride concentration on the log scale as ppm fluoride.

5.4.3 Determine the fluoride concentration of the test solutions by measuring three (3) aliguots from each test solution with the specific ion electrode. Record the millivolt reading.

5.4.4 Determine the fluoride concentration of the test solutions from the standard curve.

5.4.5 To convert the fluoride concentration measured as ppm to surface contamination units proceed as follows:

$$\text{mg F/dm}^2 = \text{ppm fluoride} \times 2.5 \times 10^{-2}$$

NOTE: If the fluoride concentration of the test solutions do not fit on the standard curve (e.g. conc. > 0.2 ppm F), prepare 0.5 and 1.0 ppm standards and proceed as in 5.4.1 above. Do not attempt to extrapolate the standard curve.

RDT F 5-1T

Supersedes
RDT F 5-1T, February 1972

RDT Standard

CLEANING AND CLEANLINESS REQUIREMENTS FOR NUCLEAR COMPONENTS

JANUARY 1978

DEPARTMENT OF ENERGY
DIVISION OF NUCLEAR POWER DEVELOPMENT

Send copy and distribution inquiries to:

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Oak Ridge, Tennessee 37830

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FOREWORD

This standard supersedes the February 1972 issue of RDT F 5-1T and incorporates those changes to that issue of the standard that were approved and published as Amendments 1 through 4 and those changes that were approved for publication in this revision. These changes are identified by the following marginal notations:

A1	Amendment 1, April 1972
A2	Amendment 2, March 1973
A3	Amendment 3, December 1973
A4	Amendment 4, September 1974
C	Changed approved 1-25-78
D	Deletion approved 1-25-78
N	Addition approved 1-25-78
E	Editorial Change

Other editorial changes that were made during preparation of this revision are not identified.

CLEANING AND CLEANLINESS REQUIREMENTS FOR NUCLEAR COMPONENTS

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CLEANING AND CLEANLINESS REQUIREMENTS FOR NUCLEAR COMPONENTS

1. SCOPE

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

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 RDT Standards.

RDT F 2-2	Quality Assurance Program Requirements
RDT F 7-2T	Packaging, Packing, and Marking of Components for Shipment and Storage
RDT F 7-3T	Marking of Components and Parts
RDT F 11-3T	Analytical Chemistry Methods for Metallic Core Components N

2.2 Federal and Military Specifications and Standards.

O-A-51	Federal Specification for Acetone, Technical
O-A-760	Federal Specification for Ethyl Alcohol
TT-I-735	Federal Specification for Isopropyl Alcohol
O-M-232	Federal Specification for Methanol
MIL-C-81302	Military Specification for Cleaning Compound, Solvent, Trichlorotrifluoroethane
FED-STD-209	Clean Room and Work Station Requirements, Controlled Environment

PHS-956	Public Health Service Drinking Water Standards
27-CFR-212	Denaturing of Alcohol and Rum (Code of Federal Regulations, Title 27, Chapter 212) | E

2.3 American Society for Testing and Materials (ASTM).

ASTM D 512	Test for Chloride Ion in Water and Waste Water
ASTM D 1125	Tests for Electrical Conductivity of Water
ASTM D 1179	Tests for Fluoride Ion in Water
ASTM D 1192	Tests for Equipment for Sampling Water and Steam
ASTM D 1293	Test for pH of Water and Waste Water
ASTM D 1889	Test for Turbidity of Water
ASTM D 3370	Practices for Sampling Water | E

2.4 American National Standards (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-760 and which has been denatured in accordance with Formula 23A of 27-CFR-212; methanol in accordance with Federal Specification O-M-232; or isopropanol in accordance with Federal Specification TT-I-735. | E

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 operated tested and monitored in accordance with the requirements of FED STD 209.

3.4 Clean Area. A clean area is a clean work station meeting the requirements of FED-STD-209 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, and soil.

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, and cobalt-base alloys.

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, grooves, and press-fit joints.

3.11 Denatured Alcohol. Ethyl alcohol that has been denatured in accordance with Formula 23A of 27-CFR-212. | E

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. (3.2 mm), 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 13.2 oz. per square yard (when new) and has approximately 80 to 100 yarns/in. 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 and 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 aherent 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 inprocess 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-81302.

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

4. REQUIREMENTS

4.1 General. Fabrication shall be conducted so as to facilitate cleaning and inspection for cleanliness, and to minimize contamination

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, μmhos/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

[a]Power 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 carbon dioxide absorbtion, such as when retained in storage tanks, the pH requirement may be lowered to 5.8 to compensate for carbon dioxide 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.

[b]The standard methods of test of the ASTM standards listed in 2.3 shall be used for reference purposes. Samples for test shall be taken in accordance with ASTM D 3370, using equipment meeting the requirements of ASTM D 1192. | E

[c]Grade C water shall be potable water meeting the requirements of the Public Health Service Drinking Water Standards.

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 4.4.1, 4.4.2, or 4.4.3 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 rejected.

4.2 Procedures. Prior to use, detailed procedures for cleanliness control, in-process cleaning, and final cleaning of all coolant and critical surfaces shall be submitted for purchaser approval. 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 the method for determining when adequate rinsing or flushing has been achieved to satisfy the acceptance criteria specified in 5.5, including conductivity, chloride, pH, and turbidity measurements of the final flush or rinse water. |E

7. Quality control and inspection procedures to be employed to ensure that the purchaser's requirements have been met during and after cleaning operations and fabrication.

8. Acceptance standards for contamination and rust on components and equipment where such critieria 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.

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, and abrasive-blasting facilities.

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, a 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 (110 lx) on the surface 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 area 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 h, 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 occurence 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 Noncritical Surfaces. Thin films of rust are acceptable on noncritical corrosion-resistant material surfaces [those surfaces not included in 4.3.1(a)], provided there is no visible evidence |A1

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 Noncorrosion-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 in. (12.7 mm) from the area where slag entrapment has occured.

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.

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.

4.3.2 Acceptance Criteria for Halogens. The cleaning procedures developed in conformance with 4.2 are intended to reduce halogens to an acceptable level. In the event that it is necessary to evaluate a cleaning procedure or check a surface that is thought to be contaminated N

with halogens, an acceptable swab test method for determining halogens is described in Section 13 of RDT F 11-3. For most component surfaces a level of 5 $\mu g/in^2$ (8 mg/m^2) for chloride or fluoride is acceptable. For cold-worked core component surfaces, a level 0.5 $\mu g/in^2$ (0.8 mg/m^2) is acceptable. Applicability of the swab test and the acceptance criteria shall be as specified in the Ordering Data. N

4.4 Clean Room, Clean Area, and Controlled Work Area. As a minimum, a controlled work area shall be employed for the fabrication, assembly, or both of reactor coolant system components. A controlled work area is an area where some means has been provided to control environment and access. C

4.4.1 Requirements. Starting with that stage of fabrication where crevices and inaccessible surfaces are created, work area control should be by means of enclosures or barriers (permanent or temporary), environental controls, or both which will prevent deleterious contamination from being introduced to the item interior as a result of operations (such as machining, grinding, or welding). Work area cleanliness controls shall be in accordance to the requirements of 4.3 for maintenance of components cleanliness in inaccessible areas.

Where access for subsequent cleaning and inspection of all surfaces is retained, work area isolation may be by signs, gates, ropes, or other physical barriers to control access.

Controlled work areas shall be clearly defined, and shall be posted regarding restrictions on tools, materials, personnel areas, and personnel practices which will assure compliance with this standard.

4.4.2 Purchaser Options. In the event that the criteria or definition for a controlled work area, as defined in this standard, do not provide the cleanliness protection required by the purchaser, the Ordering Data shall give the specific requirements imposed which may include a clean room or clean area as defined in 3.3. and 3.4.

4.4.3 Work Area Control Procedures. The procedures required for 4.2 shall included details of work area cleanliness controls to be employed.

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 (66°C). When Grade C water is used, it shall be drained immediately after completion of the test and 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 (66°C) 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 (66°C) 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 Sensitized Stainless Steel. Austenitic stainless steel that has been exposed to elevated temperature in the range of 800 to 1600°F (427 to 871°C) for an extended period of time is said to be "furnance" sensitized. The corrosion resistance of material in this condition has been impaired. It must not be exposed to weak or strong electrolytes, such as acids, bases, and salts. The material must also be protected from exposure to salt air, weld fumes, or prolonged exposure to humid atmospheres. Austenitic stainless steels that have been exposed to this same temperature range for a brief period during welding are said to be "weld" sensitized, and the effect is confined to a narrow zone adjacent to the weld. Weld-sensitized materials must be protected from the more agressive process solutions such as those used in pickling and descaling. C

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 in. (50 mm) on each side of the joint edge preparation in accordance with the procedures approved by the purchaser (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 operation for which it is used.

Where machining, fabrication, or assembly must be performed on crevice-containing components which will contain high temperature liquid metal in service and normal precautions will not prevent the entry of lubricant into the cervices, no lubricant shall be used, except when specifically approved by the purchaser prior to use. Such approved lubricant shall be removed from the component immediately after the completion of each operation for which it is used. C

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. Pressure or vacuum gauges used for testing shall not be calibrated with mercury-containing equipment such as manometers. C

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 surfaces that come in contact with coolant surfaces, critical surfaces, or other surfaces specified by the purchaser, shall be clean and shall consist of austenitic stainless steel or other corrosion-resistant alloy, nylon, polyethylene, or other material approved by the purchaser. A4

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 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 in the component such as buttons, badges, jewelry, pens, pencils, coins, spectacles, dentures, hearing aids, respirator filters, tools, used welding rods, and other articles. An

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 (25.8 MPa).

2. At temperatures less than 300°F (149°C) with pressures up to 200 psig (1.4 MPa).

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, 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 4.2. | A1

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

4.6.14 Halogens in Processing Materials. Generally when austenitic stainless steels are being fabricated, the use of processing | N

materials formulated from halogens is to be avoided. Processing materials with residual halogens such as liquid penetrants, lubricants, cutting oils, marking materials, tapes, leak detectors, wiping cloths, and paper towels should be certified for their total halogen contents. Generally, such materials with halogens in the range of 200 ppm or less (chlorine + fluorine) are available. If a lower halogen content processing material is available and performs satisfactorily in other respects, it should be selected preferentially. Such processing materials must be removed from all surfaces as soon as their function is completed at stages compatible with the processing activity and definitely before exposure to elevated temperature or moist environments. N

4.7 Cleaning Process.

4.7.1 Cleaning Agents. Cleaning agents and solvents used for inprocess 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-81302, 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 only on corrosion-resistant materials. These tools shall have not previously been used on carbon or low alloy steel materials to preclude contamination of corrosion-resistant materials with free iron. These sets of tools shall be clearly marked to identify their intended use in accordance with a system specified by the activity performing the 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 vitrified aluminum oxide or silicon carbide grinding wheels or discs that will ensure a cleanly cut surface. Only resin-bonded or vitrified grinding wheels or discs shall be used on stainless steel. Aluminum oxide shall not be used on core components. | C

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. Power-operated brushes shall not be used for cleaning components that will later be liquid penetrant examined unless the brushed areas are ground or machined prior to liquid penetrant examination.

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 Blasing. 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, or ground to remove any embedded scale or blasting grit. | C

f. Tumbling. Tumbling may be used only when approved by the purchaser. To preclude obscuring material defects, tumbling shall not be used on surfaces which are to be subsequently liquid penetrant examined, 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, and then rinsed with Grade A or Grade B water. | A2

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 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. Such cleaning must be completed before that stage of fabrication or assembly which produces crevices or undrainable areas. Should it become necessary to clean components containing crevices or undrainable areas, the procedure must not result in contamination of the | C

crevices or undrainable areas. The procedure must be approved by the purchaser prior to use in accordance with 4.2. | C

When TCTFE is used on parts or components containing inaccessible or undrainable areas, the parts or components shall be dryed by evacuation or heated to a temperature of 120 to 140°F (49 to 60°C) 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 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 4.2. | A1

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 4.2. Components that have crevices or undrainable spaces, hardened steels with nitrided surfaces, precipitation-hardening stainless steels, austenitic stainless steel that has been furnace-sensitized, and nonmetallic parts shall not be acid cleaned. Acid cleaning may be used: | A1 | C

1. Following abrasive blasting providing the surfaces cannot be ground or polished after blasting.

2. To remove heavy heat-treat or hot-rolling scale that cannot be removed by abrasive blasting, grinding, or brushing.

3. To remove noncorrosion-resistant material embedded in the surface of corrosion-resistant material in the solution heat treated condition.

4. To passivate core components which have sensitization limited to that produced during welding. | N

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 completon 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 4.2. 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. |A1

e. Ammonia neutralization is prohibited for copper alloys.

4.7.7 Steam Cleaning. Steam cleaning may be used with purchaser approval in accordance with procedures specified in 4.2. Steam cleaning equipment shall be thoroughly cleaned of materials used in previous operations. Grade C or better water shall be used for steam cleaning operations. Austenitic stainless steel steam-cleaned surfaces shall be rinsed with Grade A or Grade B water before the component is allowed to dry. |N

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 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 3.21. |A1

5.2.1 Water to be used for flushing shall be checked for cleanliness prior to use by filtering approximately 20 gal (0.076 m^3) of water through a filter cloth, see 3.13. 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 (i.e., downstream of all hoses, pipes and fittings). |A1

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 4.2 and, if practicable, shall be equal to or slightly greater than the normal operating flow rate of the component. | A1

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 5.5.1 and 5.5.2. | A1

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 in. (0.8 mm) in any dimension, except that fine hair-like slivers or thin flakes [much less than 1/32 in. (0.8 mm) thick] may have a major dimension up to 1/16 in. (1.6 mm).

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. Type II 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. The strainer shall contain no particles larger than 1/16 in. (1.6 mm) in any dimension, except that fine hair-like slivers or thin flakes [much less than 1/16 in. (1.6 mm) thick] may have a major dimension up to 1/8 in. (3.2 mm).

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. MAINTENANCE OF CLEANLINESS AND PREPARATION FOR DELIVERY |A2

Packaging for delivery of equipment cleaned in accordance with this standard shall meet the requirement 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, 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 and subassemblies that have been cleaned in accordance with approved procedures and which have reached the stage of fabrication or assembly where internal, critical, or crevice-containing surfaces are created or become no longer accessible for further cleaning or inspection shall be sealed in accordance with RDT F 7-2 or alternate purchaser-approved procedures so as to ensure maintenance of the component or subassembly cleanliness condition. Violations of the sealing configuration, other than those which are required by the supplier's approved procedures or authorized in writing by the purchaser, shall be the basis for rejection of the component or subassembly. In the event there is an unauthorized violation of the sealing configuration, the component or subassembly shall be inspected to determine the extent to which the end item cleanliness requirement is violated. Where such inspection establishes that specified cleanliness requirements have been compromised, procedures for bringing the affected component or subassembly into conformance with the requirements of the standard shall be prepared by the supplier and approved by the purchaser prior to use. A2

8. DATA CHECKLIST

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

	Item	Paragraph	
1.	Procedures	4.2	E
2.	Acceptance criteria for cleanliness	4.3	
3.	Rust on critical surfaces	4.3.1(a)	
4.	Acceptance criteria for halogens	4.3.2	
5.	Purchaser options	4.4.2	
6.	Water used for engineering tests	4.5	
7.	Grade C water use	4.5.2	
8.	Handling of components	4.6.7	
9.	Acid cleaning	4.7.6(c)	
10.	Flushing acceptance criteria	5.5	

	Item	Paragraph	
11.	Quality assurance program	6.1	E
12.	Maintenance of cleanliness and preparation for delivery	7.	