# RDT Standards Transmittal

## Hanford Engineering Development Laboratory

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**RDT E 3-12T, Radioactive Gas Compressors, August 1973**
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RADIOACTIVE GAS COMPRESSORS

AUGUST 1973

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Division of Reactor Research and Development
United States Atomic Energy Commission
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1. SCOPE

This standard covers requirements for the design and fabrication of a positive displacement compressor for radioactive gas service, having a pressure-retaining boundary meeting the requirements of, and stamped in accordance with Section III of the ASME Boiler and Pressure Vessel Code (hereinafter identified as the Code).

1.1 Classification. The compressor shall be a positive displacement machine of the type specified in the Ordering Data. The aftercooler shall be of the type specified in the Ordering Data.

The code classification shall be as specified in the Ordering Data and references to the Code in this standard apply to the code classification specified.

1.2 Components and Services. All components and services to be provided by the supplier shall be as specified in the Ordering Data.

1.3 Definitions.

1.3.1 Accessories. Apparatus and devices furnished as a part of the compressor unit.

1.3.2 Compressor Unit. Includes the compressor, motor, aftercooler (as required) and all other components, equipment, supports and accessories necessary to meet the requirements specified herein and in the Ordering Data.

1.3.3 Service Life. The operating time before required maintenance of an item.

1.3.4 Special Tools. Those nonstandard tools and equipment necessary to carry out access, repair, or replacement procedures.

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

2.1 Exceptions. Where the materials or specifications to be employed in the manufacture of any part are not identified in this standard, the documents
referenced herein, or the Ordering Data, the supplier shall submit for purchaser approval the materials or standards he proposes to use prior to their use.

2.2 **RDT Standards.**

RDT E 15-2T Requirements for Nuclear Components (Supplement to ASME Boiler and Pressure Vessel Code, Section III)

RDT F 2-2 Quality Assurance Program Requirements

RDT F 3-6T Nondestructive Examination

RDT F 3-37T Special Requirements for Metal Products

RDT F 4-20T Operation and Maintenance Manuals

RDT F 5-1T Cleaning and Cleanliness Requirements for Nuclear Components

RDT F 7-2T Preparations 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

RDT F 8-1T Preloading Threaded Fasteners and Closures

RDT F 8-6T Hoisting and Rigging of Critical Components and Related Equipment

RDT M 6-2T Mechanical Locking Devices

2.3 **American National Standards (ANSI).**

ANSI B1.1 Unified Screw Threads

ANSI B46.1 Surface Texture

ANSI Y14 Drafting Manual

2.4 **American Society of Mechanical Engineers (ASME) Specifications.**

ASME Boiler and Pressure Vessel Code

Section III, Nuclear Power Plant Components

ASME Performance Test Code

PTC 9, Displacement Compressors, Vacuum Pumps and Blowers
2.5 **Other Documents.**

National Electric Manufacturer Association (NEMA) Standards

NEMA MG-1, Motors and Generators

AFBMA Standards of Anti-Friction Bearing Manufacturers Association

2.6 **Applicable Drawings.** (To be specified in the Ordering Data)

3. **TECHNICAL REQUIREMENTS**

3.1 **General.** The compressor unit shall be designed for safe, reliable, continuous and controllable service under all normal operating conditions, and must withstand without sustaining damage, the abnormal service conditions specified in the Ordering Data. All parts, accessories, connections and closures shall be readily accessible for inspection, service, maintenance and repair.

3.1.1 **Design Codes for Process Gas Pressure-Retaining Boundary Parts.** All pressure-retaining parts containing process gas shall be constructed in accordance with the Code. The class designation shall be as specified in the Ordering Data.

3.2 **Design and Performance Requirements.**

3.2.1 **General.** The diaphragm type compressor and aftercooler shall be supplied as a unit including a motor, housing and all other components, equipment, supports and accessories as are necessary for movement of radioactive gas through a system. The aftercooler shall be mounted as specified in the Ordering Data.

3.2.2 **Compressor Performance.** The compressor shall be capable of producing the required gas flow and pressure in accordance with the system performance requirements provided in the Ordering Data.

3.2.3 **Aftercooler Performance.** The aftercoolers shall be shell and tube, double pipe, or exposed tube type designed for use with the coolant specified in the Ordering Data. Detail design parameters, such as pressure drop, temperature drop/rise, fouling factors, etc., will be specified in the Ordering Data.

3.2.4 **Operating Condition.** The compressor unit shall be capable of continuous operation under normal conditions as well as under abnormal conditions (i.e., seismic acceleration, externally induced vibrations, specified maximum ambient temperature and pressures, gas containing sodium particles in the form of an aerosol, radiation exposure, etc.) as specified in the Ordering Data.

3.2.5 **Service Life.** The service life of the compressor unit and all of its parts, including bearings and gasketed closures, shall be as specified in the Ordering Data.
3.2.6 Leakage. The unit shall be designed such that process gas to lubricant, lubricant to process gas, and external process gas leakage do not exceed the limits established in the Ordering Data.

3.2.6.1 Diaphragm Leakage. Diaphragms shall be designed such that impending gas to lubricant and lubricant to gas leakage can be detected in time for safe shutdown of the compressor. In the event that this requirement is inconsistent with maximized diaphragm reliability at the design life specified in the Ordering Data, the supplier shall submit his recommended configuration with justification for purchaser approval.

3.2.7 Size and Weight. Size and weight of the compressor unit shall be kept to the minimum necessary to fulfill the requirements of this standard, and shall not exceed the values specified in the Ordering Data.

3.2.8 Mechanical Design and Operational Loadings.

3.2.8.1 Vibration. The compressor unit shall be designed to withstand mechanical vibrations transmitted from components to which it is connected, fluid flow induced vibrations, self-induced vibrations, and normal shock and vibrations encountered during shipping, without damage or impairment of operation. External excitation shall be as specified in the Ordering Data. Performance test results may be substituted for analytical verification of structural-dynamic integrity when approved by the purchaser. Vibrations transmitted to other components shall be suppressed as specified in the Ordering Data.

3.2.8.2 Seismic. The compressor unit shall be designed to withstand the effects of earthquake ground motion at the plant site without breaching of the fluid system integrity and without impairing the operability of the compressor unit. The seismic design requirements shall be as specified in the Ordering Data.

3.2.8.3 Foundation, Shipping and Erection Loads. Support lugs, brackets, and other attachments which will be subject to forces and moments resulting from dead load, nozzle loads, seismic forces, and other external forces shall be designed to withstand such forces without damage or impairment.

The compressor unit and its internals shall be designed to withstand loads imposed on it during shipping and erection, including loads that may be imposed when it is oriented in attitudes other than its normal operating attitude.

3.2.8.4 Nozzle Loads. The casing and nozzles shall be designed to withstand the piping loads applied to the nozzles as specified in the Ordering Data.

3.2.9 Environmental Conditions. Preoperation and operation conditions under which the compressor unit must perform, e.g., ambient temperature and pressure will be specified in the Ordering Data.
3.2.10 **Corrosion Allowance.** The corrosion allowance shall be as specified in the Ordering Data.

3.2.11 **Design for Maintainability.** As part of the design, a maintenance plan shall be developed. This plan shall define the maintenance activities that have been established as a basis for design and the methods to be used in accomplishing the maintenance activities. Recommended procedures for performing each separate activity shall be prepared and furnished in the maintenance manual. The design of the compressor unit shall include provisions for performing the identified maintenance activities using the procedures submitted to the purchaser in the maintenance manual (See 3.5.3).

3.2.11.1 **Work Space.** The minimum work space required around the compressor unit for performing the expected maintenance activities shall be determined. In determining the space requirements, consideration shall be given to the use of special tools and the execution of the procedures specified.

3.2.12 **Design for Inspectability.** Pressure-retaining boundary details shall be designed such that seams, joints, and surfaces are capable of being inspected or examined, as required by the Code and applicable RDT standards, with interpretable results. Special tools such as boroscopes, long-handled mirrors, radiographic or ultrasonic equipment required to perform inspections and examinations shall be identified and described in the maintenance manual.

3.2.13 **Spare Parts and Special Tool List.** A list of recommended spare parts to be stocked at the plant site shall be furnished. This list is to contain those parts and tools likely to be damaged or expended during delivery, plant operations, or both. When approved, these spares shall be processed and delivered in accordance with the requirements for deliverable items.

3.2.14 **Nonfunctional Performance.** Restrictions for nonfunctional performance outputs, such as noise, will be specified in the Ordering Data.

3.2.15 **Interface Requirements.** Requirements for the physical, mechanical, electrical, and structural interfaces, as applicable, will be specified in the Ordering Data.

3.2.16 **Electrical and Instrumentation Requirements.** Electrical and instrumentation components appropriate to the requirements of the Ordering Data shall be furnished. As a minimum, instruments for sensing gas discharge pressure, gas discharge temperature, lubricant pressure, lubricant temperature, and motor winding temperature shall be provided.

3.3 **Materials.** All materials used on the compressor unit shall conform to the requirements of applicable RDT standards or ASME and ASTM standards as specified in the Ordering Data.

3.3.1 **Bolting and Fastener.** Process gas pressure-retaining boundary threaded fasteners shall conform to the requirements of NB-3230 of the Code.
3.3.1.1 Screw Threads. Threaded connections shall have the unified thread form in accordance with ANSI B1.1. Special threads shall meet the requirements of ANSI B1.1. Designation of threads on drawings, fabrication requirements, and gaging of threads shall be in accordance with ANSI B1.1.

3.3.1.2 Limitations on Bolting. Capscrews or studs threaded into tapped holes shall not be used for pressure boundary closures without purchaser approval.

The minimum bolt or stud size for specially designed pressure boundary closures or flanged joints in the pressure boundary shall be as specified in the Ordering Data.

3.3.1.3 Locking Devices. Locking devices meeting the requirements of RDT M 6-2 shall be provided on all threaded fasteners used internally in the compressor unit.

3.3.1.4 Lubricants. Lubricants may be applied to threaded parts to facilitate assembly and disassembly. Lubricants shall meet the requirements of RDT F 8-1. The supplier shall obtain the approval of the purchaser before using lubricants on fasteners which may come in contact with the process fluid.

3.3.2 Carbon Steel. Carbon steel shall meet the Charpy V-notch impact test requirements of RDT F 3-37 at a temperature of -20°F.

3.4 Design and Construction.

3.4.1 Crevices and Dead Spaces. Crevices, dead spaces, and other unflushable or undrainable spaces shall be minimized in the design of the compressor unit and shall be acceptable only where they are unavoidable.

3.4.2 Housing. Compressor unit housing penetrations for electric wiring and grease leads shall be a bulkhead type of fitting. The housing thickness shall be such that a broken rotating part will not cause a breaching of the gas containment.

3.4.3 Finned Tubes. When the Ordering Data allows finned tubes in the aftercooler, the fin shall be attached to the tube by embedding in the tube wall, by machining, extruding, or other purchaser approved method.

3.4.4 Vibration Isolators. Vibration isolators shall be provided by the supplier as required. The selection of the isolator shall reflect the values developed by the seismic calculations and inherent vibration characteristics of the compressor unit.

3.4.5 Electric Motor. The electric motor shall be totally enclosed, fan cooled (TEFC) in accordance with NEMA MG-1 and with antifriction bearings designed in accordance with AFEMA Standards. Ambient temperatures, nuclear radiation, aerosol atmosphere, pressure differentials, and other conditions
for design purposes shall be as specified in the Ordering Data. These conditions will be specified as a function of time where applicable. The motor shall be rated for continuous duty with insulation capable of operating in the maximum gas temperature specified in the Ordering Data. When specified as a function of time where applicable. The motor shall be rated for continuous duty with insulation capable of operating in the maximum gas temperature specified in the Ordering Data. Where specified in the Ordering Data, two-speed motors shall have separate windings.

Thermal overload protection (embedded in the windings) shall be provided. Magnetic starters, safety disconnect switches and other motor accessories are not part of this standard unless otherwise specified in the Ordering Data.

The motor shall be rated for a service factor of 1.0 or as specified in the Ordering Data. The motor shall be designed for normal starting torque and low starting current for "across the line" full voltage starting as listed in NEMA MG-1 and as specified in the Ordering Data.

3.4.6 Motor Drive. The type of motor drive shall be as specified in the Ordering Data.

3.4.7 Seals. Seals shall be constructed using materials compatible with the process fluids and environmental conditions specified in the Ordering Data.

3.4.8 Lubrication. Where a circulating lubricant system is required, all components shall be furnished, including piping, valves, sight flow indicators at each drain where possible, pressure gages, thermometers, temperature and pressure switches, oil pump, driver, oil reservoir, filters, and oil coolers. Detailed requirements for the lubricant system shall be submitted for purchaser approval.

A brass tag firmly affixed to the lubrication lead shall bear the legend "Lube with------only". The relief lead shall be positively identified as such.

A supplier shall recommend lubricants which resist breakdown under environmental conditions of temperature coincident with nuclear radiation exposure as specified in the Ordering Data.

3.4.9 Bolted Connections. Split housing or flanged connections shall be provided with jacking bolts to permit easier dismantling. Dowel pins shall be provided where a specific orientation is required between the bolted connections.

3.5 Design Analysis, Drawings and Manuals.

3.5.1 Design Report. A design report shall be submitted showing that requirements of this standard and the Ordering Data have been satisfied. Submittal requirements shall be as specified in the Ordering Data. The design report shall include the following as a minimum:
1. A design description of the unit, including operating characteristics, operational limitations, and safety considerations.

2. A strength calculation report satisfying the requirements of this standard and the Ordering Data. Nonstandardized stress analysis procedures shall require purchaser approval.

3. Vibration analyses which consider the amplitudes and effects of vibrational motion in addition to natural frequency response.

4. Weight and center-of-gravity analyses.

5. Materials of construction.

6. Shock design analysis, when specified in the Ordering Data.

7. Surge analysis as specified in the Ordering Data.

8. Justification for using design or fabrication techniques not widely accepted by industry.

9. Heat transfer and fluid flow analyses when specified in the Ordering Data.

Information furnished in the design report shall be in sufficient detail to permit independent audit. The references from which data or formulas are taken shall be identified. The validity of the data and conclusions supporting the design shall be discussed. All computer codes used in design shall be identified by name and source and described in sufficient detail to permit independent audit and verification.

Additions and corrections to the report shall be made as necessary to keep the information current. Such additions and corrections shall be numbered and dated, and shall be submitted to the purchaser for approval.

3.5.2 Drawings. All drawings shall be arranged and prepared in accordance with the conventions and recommendations of ANSI Y14. The times and approval requirements of submittals of drawings, and the number of copies required for each submittal, shall be as specified in the Ordering Data. Reproducibles shall not be folded.

3.5.2.1 Outline Drawings. Outline drawings shall include the following information, as applicable:

1. Design and salient features, including principal and critical dimensions.

2. Information required for the preparation of supports and foundations.

3. Size and location of all connections and fittings.

4. The clear space for access.
5. Thermal and pressure movement of all connections with respect to equipment supports.

6. Special instructions necessary for hoisting, alignment, installation, and storage.


9. As-built changes.

As a minimum, outline drawings shall show the following:

1. Outline dimensions.

2. Wiring and electrical connections.

3. Dry weight and center of gravity of the assembled skid-mounted compressor unit.

4. Operating weight and center of gravity.

5. Weights and centers of gravity of subassemblies into which the compressor unit is divided for shipping.

3.5.2.2 Detail Drawings. Detail drawings shall include the following, as applicable:

1. Detailed dimensions, tolerances, surface roughness requirements for critical surfaces.

2. Tolerance block, including geometric tolerances.

3. Material specifications and special requirements concerning nondestructive examination, heat treatment, hardness, etc.

4. Fabrication instructions, including welding, hard surfacing, cleaning, and inspection symbols and reference to assembly procedure requirements.

5. All as-built changes and modifications.

3.5.2.3 Design Layout Drawings. Design layout drawings shall include the following, as applicable:

1. Dimensions establishing size, shape, fit and clearances of each major part and subassembly.

2. Identification of interfaces with adjacent components and environment, including weight, center of gravity, personnel access, maintenance services, etc.
3. A bill of material showing location, identity (drawing and part numbers) and material types including the specification to which the material is to be procured.

4. The position and type of all welds, classification of welds by common groupings as covered by specific weld procedures, and identification of the type of examination to be performed.

5. Identification of all component parts, if any, which will not be manufactured to RDT standards.

6. Identification of all component parts, if any, which will not be subjected to RDT cleanliness requirements.

7. Lubricants to be used during assembly, and where permitted.

8. Pressure and temperature data, including design pressure, design temperature, and test pressure.

9. Pertinent references to cleaning, marking, torque, locking, handling, and packaging instructions.

10. All as-built changes.

3.5.2.4 Drawing List. A drawing list shall be furnished showing, by drawing number and title, all drawings for the compressor unit. The drawing list shall be kept up to date to show the latest revisions of drawings and additions to the list at all times.

3.5.3 Manuals. Information concerning the operation and maintenance of the compressor unit, including instructions, procedures, recommended practices, etc., shall be furnished for inclusion in the plant operations manual. Maintenance manuals shall be in accordance with RDT F 4-20 as required by the Ordering Data. Such information shall reflect the as-built configuration of the compressor unit and shall include but not be limited to the following:

1. A detailed description of the compressor unit.

2. Instructions for operation, installation, preventive maintenance, and repair, including a description of any special tools required to make repairs after installation.

3. Procedures for replacing seals, gaskets, and other replaceable parts.

4. Reduced size drawings for operation, maintenance, and instructional purposes, including drawings of special tools, jigs, fixtures, and equipment required.
5. Instructions for the use of any lifting and handling fixtures, special tools, and equipment.

6. Instructions for disassembly, cleaning, preparation of items for shipment, and crating.

7. List of recommended spare parts including an essential spare part inventory and a distributor directory.

8. In-service inspection requirements, recommendations, and procedures.

9. Procedures for making and removing seal welds, where applicable.

The information shall be organized and submitted in the form of a loose-leaf or bound manual. The parts of RDT F 4-20 that are applicable and the number of copies to be submitted shall be as specified in the Ordering Data.

3.6 Fabrication. The supplier shall prepare, maintain, and conform to written procedures for welding, heat treating, bending and forming, assembly, preparation of surfaces for an application of protective coatings, cleaning and cleanliness control, materials and parts handling, and other critical operations. Copies of such procedures shall be furnished to and approved by the purchaser before they are placed in use; copies shall also be made available to representatives of the purchaser at the manufacturing site upon request.

3.6.1 Welding. Weld design, procedure and performance qualifications, and examinations shall conform to the requirements of the Code, RDT E 15-2 for the Code class specified, and the supplementary welding requirements specified in the Ordering Data. All welds, except seal welds, shall be full penetration and continuous.

3.6.1.1 Seal Welds. Seal welds shall be designed to permit cutting and rewelding without damaging the basic parts beyond the point that they can be rewelded. Seal welds shall be made only between similar materials, and shall not require preheat or post-weld heat treatment. Seal-welded joints shall be designed or located so that welding causes no distortion of threaded areas or of adjacent mating parts.

3.6.1.2 Repair of Materials by Welding. Where the applicable material standard and procurement specification allow the use of welded processes for repair of defects in the materials, repair welding shall be performed in accordance with the requirements of the Code. No repair welding of bolting material shall be permitted.

3.6.2 Heat Treatment. Heat treatment and stress relieving shall be in accordance with the requirements of the applicable material standards and as specified in the Ordering Data.

3.6.3 Bending and Forming. Thickness of materials after bending and forming shall be not less than the minimum design thickness. The
supplier shall evaluate the need for heat treatment of the material following bending and forming operations.

3.6.4 Assembly. Assembly procedures shall be prepared which shall include but not be limited to:

1. Assembly sequence.
2. Cleaning procedures to be used and sequence of cleaning operations.
3. Cleanliness control and housekeeping requirements to be employed at each step of assembly.
4. Special machining and fit-up assembly instructions.
5. Handling and storage methods and procedures.
6. Tightening torque requirements for threaded parts.
9. Drawings, photographs, or both to illustrate problem areas and assembly techniques which may present problems.

3.6.5 Cleaning and Painting.

3.6.5.1 Cleaning and Cleanliness Control. The supplier shall prepare, maintain, and conform to written procedures for cleaning and preventing contamination or recontamination of materials, parts, subassemblies, and the finished component in accordance with RDT F 5-1. Final cleaning shall be performed after all tests are completed and prior to shipment. The cleaning procedure shall be submitted to the purchaser for approval.

3.6.5.2 Painting and Protective Coatings. External carbon and low alloy steel surfaces (except machined or threaded surfaces) shall be painted with heat and radiation-resistant paint. Preparation for painting shall be in strict accordance with instructions of the paint manufacturer. Unless otherwise specified in the Ordering Data, unpainted carbon and low alloy steel surfaces shall be coated with grease or oil. Internal surfaces shall not be coated or painted. Unless otherwise specified in the Ordering Data, the type of paint or corrosion-resistant treatment shall be recommended to the purchaser and approved before use.

3.6.6 Surface Finish. The finish of machined surfaces and surfaces which will be in contact with the process fluid shall be specified on the drawings in accordance with ANSI B46.1. Surfaces which will be examined by nondestructive methods shall have a finish of 250 microrinches AA or better to permit satisfactory liquid penetrant, magnetic particle, or ultrasonic examination.
3.6.7 **Manufacturing Release.** The supplier shall not release materials, parts, or supplies for use until the purchaser has approved, as required by the Ordering Data, the applicable outline, detail, or design layout drawings, bills of material, specifications, and other documentation related to the item, including any engineering analysis or section of the design report relating to the item. The design report section may be preliminary, but shall be complete with respect to design adequacy verification.

3.6.8 **Lifting and Handling.** Lifting and handling procedures shall be developed in accordance with RDT F 8-6 to ensure that all items are furnished in an undamaged condition. The procedures shall ensure that lifting and handling devices are not overstressed and that adequate precautions, such as buffers, covering, etc., are employed to prevent damage to or contamination of items being lifted or transported during manufacture, assembly, temporary storage, or preparation for shipment, or while awaiting shipment.

Each part or subassembly weighing more than 50 lb and which must be handled individually shall be designed for or provided with means for lifting and handling using standard cranes and hoisting equipment.

3.6.9 **Identification.**

3.6.9.1 **Identification of Materials and Parts During Manufacture.** Methods and procedures for identifying and maintaining the identity and source of all materials and purchased items that will become a part of the pressure-retaining boundary or internals of the compressor unit shall be established and followed at all times during the course of manufacture. Identification shall permit accurate tracing of the item to original certification data. Methods and materials for both temporary and permanent marking shall meet the requirements of RDT F 7-3. When materials are cut or sectioned, the identification of the original piece shall be transferred to the cut or sectioned piece.

3.6.9.2 **Identification Marking of Components.** Permanent identification marking of the compressor unit shall be as specified in the Ordering Data and shall conform to the requirements of RDT F 7-3. The identification or nameplate shall include the following information:

1. Name of component.
2. Classification or type designation (if applicable).
3. Manufacturer's name and model number.
5. Contract or purchase order number.
6. Month and year of manufacture.
7. Design pressure and temperature.
8. Rated flow and pressure rise.

9. Number of applicable technical manual.

10. Motor horsepower, frame size, voltage, phase, and hertz.

11. Space for system identification number.

12. Bearing type and lubricant.

13. Other information as specified in the Ordering Data.

Identification marking and nameplates shall be located where they will not be painted or covered by insulation, attachments, etc.

4. QUALITY ASSURANCE REQUIREMENTS

4.1 Quality Assurance Program. The supplier shall establish and conform to a written program of plans and actions for assuring the quality and functional reliability of items furnished in accordance with this standard. The quality assurance program shall meet the requirements of RDT F 2-2 specified in the Ordering Data, and the additional requirements for inspection and testing of this standard. The supplier shall ensure that all requirements of the quality assurance program are transmitted to sub-suppliers.

4.2 Access to Supplier's Plant. The purchaser and his designated representative shall be permitted to visit those areas of the supplier's plant and the plants of his subcontractors to witness work being performed, to inspect materials, parts, and the completed component, to witness or conduct specified tests, and to examine applicable documentation, drawings, records, and certifications.

4.3 Purchaser Witness. The purchaser may witness examinations, inspections, and tests. Witness points for examinations, inspections and tests will be designated in the Ordering Data or in the plans to be submitted by the supplier (see 4.6.1). The purchaser may expand the list of witness points or may waive any witness point. The purchaser shall be notified at least five days in advance of the time for each designated witness point. This schedule shall be confirmed within 24 hours of the specified examination, inspection, or test.

4.4 Inspection and Test.

4.4.1 Inspection. In addition to the inspections and tests specified in the Code and other applicable documents, the following inspections and tests shall be made.

4.4.1.1 Visual Inspection. The compressor unit shall be inspected during manufacture and after completion to ensure conformance with the requirements of this standard with respect to material, workmanship,
finish, cleanliness, identification of materials and parts, marking, and other characteristics that might affect its serviceability.

4.4.1.2 **Dimensional Inspection.** All items shall be subjected to dimensional examination to verify conformance with drawing requirements.

4.4.2 **Testing.** Mercury or mercury containing instruments shall not be used during the manufacture or testing of the compressor unit or any of its parts.

4.4.2.1 **Performance Test.** Dynamic testing of the compressor shall be performed and witnessed in accordance with the ASME Performance Test Code No. 9. Data generated from the tests shall be plotted showing compressor total pressure, efficiency, brake horsepower, speed, and purchaser-supplied system curve as functions of volumetric flow. Data shall be generated at each of the motor speeds specified in the Ordering Data.

Noise level tests and the maximum sound level shall be as specified in the Ordering Data.

After installation in the facility, the compressor unit will be subjected to tests proposed by the supplier and approved by the purchaser, to determine whether the equipment performs in accordance with the requirements of this standard and the Ordering Data.

4.4.2.2 **Pressure Test.** Upon completion of the assembly, the process gas and lubricant pressure boundary of the compressor unit and the coolant side of the aftercooler shall be pressure tested in accordance with the Code class specified in the Ordering Data.

4.4.2.3 **Helium Leak Test.** After completion of pneumatic testing, a helium leak test shall be performed on the process gas pressure boundary of the compressor unit in accordance with the requirements of RDT P 3-6 and the acceptance standards as specified in the Ordering Data. The method to be used shall be as specified in the Ordering Data.

4.4.2.4 **Handling Attachment Load Tests.** Handling attachments shall be load tested in accordance with the requirements of RDT P 8-6.

4.4.2.5 **Motor Tests.** Motor tests shall be as specified in the Ordering Data.

4.5 **Verification of Procedures.** Cleaning, inspection, maintenance procedures and special processing procedures developed for purchaser approval shall be demonstrated to verify their adequacy and the adequacy of related drawings and specifications relative to correctness, clarity, and access requirements.

4.5.1 **Special Process Control.** The supplier shall provide written procedures to control each special quality assurance or production process.
Controls shall be established for welding, heat treating, nondestructive examination, cleaning, protective coating preparation and application, and assembly.

4.6 Documentation and Records. The documents listed in Table 1 and additional documents specified in the Ordering Data shall be furnished at the time and in the quantities specified in the Ordering Data. Unless otherwise specified, purchaser approval shall be obtained before using materials or performing operations affected by the documents. Document approval level shall be as specified in the Ordering Data.

### Table 1 - Document Submittal Requirements

<table>
<thead>
<tr>
<th>Paragraph</th>
<th>Document Description</th>
<th>No. of Copies</th>
<th>Approval Level</th>
<th>Time of Submittal</th>
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<tbody>
<tr>
<td>3.5.1</td>
<td>Design report</td>
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<tr>
<td>3.5.2</td>
<td>Final drawings transparencies and drawing list</td>
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<tr>
<td>3.5.3</td>
<td>Maintenance manual</td>
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<td>3.6</td>
<td>Fabrication Procedures</td>
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<tr>
<td>3.6.1</td>
<td>Welding performance qualifications</td>
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<tr>
<td>3.6.5</td>
<td>Cleaning procedures</td>
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<tr>
<td>4.4.1</td>
<td>Inspection and test plans</td>
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<tr>
<td>4.4.1</td>
<td>Nondestructive examination procedures</td>
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<tr>
<td>4.4.1</td>
<td>Certifications, examination reports, radiographs</td>
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<td>4.4.2</td>
<td>Acceptance test plans and procedures</td>
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<tr>
<td>4.6.1.1</td>
<td>Manufacturing plan</td>
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<td>4.6.1.2</td>
<td>Quality assurance program index</td>
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<td>4.6.2</td>
<td>Progress reports</td>
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<td>4.6.2</td>
<td>Nonconformance reports</td>
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<td>4.6.3</td>
<td>Final Report</td>
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<tr>
<td>5.1</td>
<td>Methods for sealing, shipment and storage</td>
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</table>
4.6.1 Plans. Plans that describe all work operations and quality assurance activities shall be prepared. Each plan shall be submitted for approval as specified in the Ordering Data, and shall include but not be limited to the following.

4.6.1.1 Manufacturing Plan. A production plan shall be prepared that identifies each manufacturing, assembly, and cleaning operation, the methods that will be employed for cleanliness control during each stage of manufacture; and the sequence, methods, and procedures that will be employed. The plan may be first submitted in preliminary form, showing in outline form the steps required and the intended organization for implementation of the plan and the proposed format. The preliminary plan shall be submitted to the purchaser for review, finalized, and submitted for approval. Purchaser approval shall be obtained before manufacturing release. The manufacturing plan shall be keyed to the quality assurance program index.

4.6.1.2 Quality Assurance Program Index. A quality assurance program index shall be prepared that identifies each quality assurance provision, describes planned activities at each state of manufacture, and the sequence, methods, and procedures that will be employed. Purchaser approval shall be obtained before manufacturing release. The quality assurance program index shall comply with the requirements of RDT F 2-2 and shall be keyed to the manufacturing plan.

4.6.2 Progress Reports. Reports of progress in design, fabrication, inspection, testing, and shipment shall be made at times specified by the purchaser. The reports shall show the progress made since the previous report, with only enough repetition to place the present report in its proper context. Progress reports shall show difficulties experienced and the efforts taken or planned to overcome them. Problems foreseen as possible disruptions of the schedule shall be brought to the attention of the purchaser as early as possible. Breakthroughs of significance shall be discussed fully. Records of all nonconformances shall be maintained including corrective action and proposed rework/repair/retest procedures. Nonconformance reports shall also be prepared and submitted separately when specified in the Ordering Data.

4.6.3 Final Report. The supplier shall submit a final report which summarizes the complete history of the design, development, fabrication, testing, and shipping of the compressor unit and its auxiliary equipment. The report should not contain proprietary information except as necessary to support the history but should include:

1. Analyses specified by this standard and the Ordering Data.

2. Copies of final as-built drawings reduced to convenient size for binding with the report.

3. Illustrations, sketches, schematic diagrams, and photographs of
major stages of fabrication, assembly, cleaning, testing, repair, packing, and shipping.

4.6.4 Procedures. A manual of policies, procedures, and work instructions shall be prepared that includes engineering and manufacturing activities specified in Section 3, quality assurance requirements specified in Section 4, and methods of packing and preparation for shipment specified in Section 5. Each procedure shall be written in a systematic standard format under the controls of the quality assurance program. Purchaser approval of the procedures shall be obtained before they are put into use.

5. PREPARATION FOR DELIVERY

5.1 Preparation for Shipment. Upon completion of all shop testing and inspection, the compressor unit shall be prepared for delivery to the designated site. Preparation shall include but not be limited to any disassembly, recleaning (if required), surface preparation, and other steps necessary to prepare the item for packaging. When specified in the Ordering Data, the compressor unit shall be purged, pressurized, and sealed in accordance with the applicable sections of RDT F 7-2.

5.2 Repair Parts and Tools. Repair parts and special tools shall be individually wrapped in moisture proof and vapor-proof envelopes in accordance with RDT F 7-2 and then boxed or crated for shipment with the compressor unit.

5.3 Routing. The routing of the compressor unit shall be established and all arrangements necessary to ship it to the designated site shall be made. When specified, routing shall be subject to approval of the purchaser.

5.4 Shipping and Storage Instructions. Instructions to the carrier for handling, in-transit storage, and unloading of the compressor unit shall be prepared.

5.5 Loading. The required shipping orientation and necessary supports, bracing, and crating shall be established, and loading of the compressor unit onto a suitable vehicle shall be supervised. Handling equipment, bracing, crates, and other items required for loading and shipment shall meet the requirements of Section 3.

5.6 Handling and Shipping Facilities. Special shipping and handling devices shall be designed for a static load of five times the normal anticipated static loads, based on ultimate material strength. Lifting, handling, and shipping fixtures attached or connected to the compressor unit made from ferritic materials shall be sufficiently ductile to permit safe handling and shipment at ambient temperature of 10°F and higher. If shipment is schedule for the winter months (October through March) and the anticipated temperature may be less than 10°F, necessary precautions shall be taken to prevent brittle fracture of such fixtures and attachments.

The locations of all permanently attached lifting and handling lugs shall be approved by the purchaser. Lifting points shall be provided on all
shipping devices to permit safe handling of both the device itself and the component with the device. Cast iron, cast steel, and bronze shall not be used in any lifting or handling device.

Shipping container skids, fixtures, and other shipping devices shall be constructed to prevent damage to the component from shock and vibration. Dynamic loadings for use as a reference basis shall be recommended by the supplier. Proof tests, when specified in the Ordering Data, shall be made and documented for all critical lifting, handling, supporting, and shipping fixtures prior to use.

5.7 Marking for Shipment. The outer wrapping of the compressor unit shall be marked in accordance with RDT F 7-2. A bill of lading, giving the same information and also stating whether the shipment is complete or partial, shall accompany each shipment.

When specified in the Ordering Data, the compressor unit shall be clearly and legible marked in as many locations as necessary with a heat-resistant paint of contrasting color in letters at least 1-1/2 in. high with the following instructions:

WARNING - DO NOT BURN, WELD, CHIP, GRIND, OR ALLOW ARC STRIKES ON THIS UNIT

CAUTION - UNIT UNDER PRESSURE - VENT BEFORE OPENING ANY CLOSURE

6. NOTES AND ORDERING DATA CHECKLIST

6.1 Compliance. The standard and the Ordering Data for the compressor unit shall be certified by a registered professional engineer representing the purchaser to be correct and complete with respect to the specified functions and operating conditions, and in compliance with the applicable sections of the Code.

6.2 Ordering Data Checklist. The detailed requirements and conditions necessary to design, fabricate, examine, test, and deliver a compressor unit in accordance with this standard shall be specified in the Ordering Data. These requirements are also indicated in the following Ordering Data checklist. The list includes topics to which the standard makes specific reference, as well as other supplemental information needing definition by the purchaser.

The applicable paragraph number of the standard is used herein to identify information and its location. Any omission of a paragraph number
indicates that the particular paragraph of the standard is believed to adequately specify the requirement.

1. Scope. This section should include a statement indicating the document is the Ordering Data which supplements this standard. In addition, include a brief presentation of basic information which will aid the supplier in performing his work. Coverage should also include:

   a. Location of installation site.
   b. Additional definitions.
   c. Owner and purchaser names and addresses.
   d. Definition of process fluid.
   e. Type and classification of compressor unit (1.1).
   f. Components and services to be furnished (1.2).
   g. Certification of Ordering Data (6.1).
   h. Code enforcement authority name and address.

2. Applicable Documents. List all documents and drawings which are specifically called out in Sections 3, 4, or 5 of the Ordering Data.

3. Technical Requirements.
   3.1 General operation conditions.
   3.1.1 Code class designation.
   3.2.1 Aftercooler mounting.
   3.2.2 Performance requirements.
   3.2.3 Aftercooler design parameters.
   3.2.4 Operating conditions.
   3.2.5 Service.
   3.2.6 Leakage.
   3.2.6.1 Diaphragm leakage.
   3.2.7 Size and weight.
   3.2.8 Vibration requirements (externally produced excitation frequency, vibration switches).
   3.2.8.1 Seismic requirements.
   3.2.8.2 Seismic requirements.
   3.2.8.4 Nozzle loads.
   3.2.9 Environmental conditions.
   3.2.10 Corrosion allowance.
   3.2.11.1 Access openings and closures.
   3.2.14 Nonfunctional performance.
3.2.15 Interface requirements.
3.2.16 Electrical and instrumentation requirements.
3.3 Materials.
3.3.1.2 Bolting.
3.4.5 Electrical motor requirements (maximum torque, service factor, speed, accessories).
3.4.6 Type of drive motor.
3.4.7 Shaft seal requirements.
3.4.8 Lubrication radiation environment.
3.5.1 Design report.
3.5.2 Drawings.
3.5.3 Manuals.
3.6.1 Welding requirements.
3.6.3 Bending and forming.
3.6.5.2 Painting and protective coating requirements.
3.6.7 Manufacturing release.
3.6.9.2 Identification marking requirements.

4.1 Subcomponents that require quality verification only.
4.3 Purchaser witness points.
4.4.2.1 Performance test requirements.
4.4.2.1 Sound level requirements.
4.4.2.2 Pressure tests.
4.4.2.3 Helium leak test requirements.
4.4.2.4 Handling attachment load test.
4.4.2.5 Motor tests.
4.6 Document submittal requirements.
4.6.2 Nonconformance reports.
4.6.3 Final report.

5. Preparation for Delivery.
5.1 Preparations for shipment.
5.3 Routing approval.
5.6 Lifting device proof test.
5.7 Marking for shipment.