Brookhaven National Laboratory
Brookhaven Science Associates
STAR Collaboration

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Title: Statement of Work for the Fabrication of STAR SVT Electronics Carriers

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Cognizant Engineer: ______________________________
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Approved by: ______________________ ______________________
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STATEMENT OF WORK FOR THE FABRICATION OF THE STAR SVT ELECTRONICS CARRIERS

1.0 General

1.1 Summary.

This statement of work outlines the necessary steps for the fabrication and delivery of the electronics carriers and used in the Silicon Vertex Tracker (SVT) which will be mounted in a large solenoid detector magnet known as STAR (Solenoidal Tracker at RHIC). This magnet will be installed in the Relativistic Heavy Ion Collider (RHIC), a particle accelerator currently under construction at Brookhaven National Laboratory.

These parts will be used to mount and water cool hybrid electronics packages that will be wire bonded to a precision array of silicon wafers. This assembly will then be incorporated within the STAR detector and used in high energy and nuclear physics experiments. The SVT portion of the detector system is a one-of-a-kind which will be assembled to a high degree of positional accuracy and must operate for long periods reliably, therefore, all drawing dimensional tolerances must be strictly met. This document includes requirements for fabrication, testing and quality assurance which are in addition to those indicated on the appropriate drawings.

1.2 Scope.

This statement of work outlines the minimum requirements governing the material procurement, fabrication, testing and shipping of the electronic carriers for the STAR SVT detector.

The Seller shall:

1. Procure all materials necessary to fabricate, handle, and safely transport the electronics carriers. It is the Seller's responsibility to assure that all materials used in the manufacture of these parts conform to the appropriate material specification.

2. Design, procure and/or fabricate any necessary fixtures.

3. Fabricate the parts in strict accordance with the appropriate drawing and this statement of work.

4. Provide and operate all measurement and testing equipment to fully inspect and test each part.

5. Deliver all parts to Brookhaven National Laboratory.

1.3 Access.

Designated representatives of the Buyer shall be allowed access to the production and test areas of the Seller's facilities, and, if applicable, the Seller's subcontractor facilities during the progress of work called for by this statement of work. The Seller shall assist and facilitate inspection visits of the Buyer.

2.0 Documents and Standards

2.1 The following documents are an integral part of this statement of work:

1. Drawings numbered SVT312-E-1 and SVT313-E-1.
2. Form QA-101, which list the quality assurance requirements of this order, as found in Appendix I.
3. Brush Wellman material specification SR-200

2.2 Conflicts.

In the event of a conflict between the Drawings and this Statement of Work the Seller shall immediately notify the Buyer. The Buyer in each instance shall determine which document takes precedence and advise the Seller accordingly. Failure of the Seller to so notify the Buyer in any given instance shall not relieve the Seller of the obligation to comply with the Buyers determination of precedence at no additional cost to the Buyer.

2.3 Dimensional Units.

All dimensions provided in the drawings are in "U.S. Customary" (English) units. All dimensions and tolerances shall be interpreted in accordance with ANSI Y14.5M-1982. Should the Seller wish to work in S.I. or metric units, he shall submit to the Buyer for approval duplicate drawings containing the units of choice.

2.4 Revisions.

Any and all specification and/or drawing revisions shall be documented and negotiated by both parties. Any cost differential shall be recorded and approved in writing by both parties.

3.0 Submissions and Approvals

3.1 In response to the Request for Quotation (RFQ), the Seller shall submit to the Buyer:

3.1.1 A Technical Proposal containing the following:

3.1.1.1 A Production Schedule showing the following:

a. Completion of all tooling fabrication.
b. Receipt of material.
c. Completion of the “first article” as described in Section 11.
d. Completion of the interim shipment as described in Section 11.
e. Completion of the entire order.

3.1.1.2 An Electronics Carrier Fabrication/Process Traveler - The traveler is a document or package of documents indicating critical manufacturing operations or processes and proposed inspection witness points with areas for dates and signatures. The name of each individual performing a manufacturing step shall be recorded. Where parts are grouped and fabricated in batches, the batch number shall also be recorded.

3.1.1.3 A Packaging and Shipping Plan to accomplish the requirements of Section 12.0.

3.1.1.4 Quality Assurance Plan - The Seller must have an existing in-process quality assurance plan which meets the requirements of this Statement of Work.

4.0 Tooling and Fixture Design

It is the responsibility of the Seller to design all tooling and fixtures for the fabrication and handling of the parts. Following the fabrication of all parts, the Seller shall store the tooling for reuse for a period of not less than five years. As an alternative to storing the tooling, the Seller may ship the tooling to Brookhaven National Laboratory for storage.

5.0 Material Procurement

The procurement of all materials used for the fabrication and packaging of the parts is the responsibility of the Seller. The timely acquisition and use of materials with a finite "shelf life" is mandatory.

The procurement of the beryllium material is of special concern. Material certification is required for all beryllium used and must include:

- Chemical composition. The material must contain a minimum of 98.5% beryllium.
- Mechanical properties including tensile and yield strength values.
- Conformation that the material shall have no radioactive components. Radioactive material is material which has become activated beyond ambient levels.

The flatness of the finished parts is also of special concern. The Seller shall, by the procurement of suitable material and/or the use of appropriate fabrication processes, assure that all flatness tolerances are met. The design of the base, cover and core are symmetrical end to end, therefore it is expected that the Seller shall orient the stackup of these parts so that any bowing will tend to be cancelled out.

6.0 Coating

Prior to epoxy bonding, all parts shall be coated with BR 127 Corrosion Inhibiting Primer from American Cyanamid (Cytec). The coating thickness shall be not less than 0.0004 inches and not greater than 0.0006 inches. Beryllium surface preparation and application method shall be per the coating manufacturer’s recommendations. The Seller may hold the base, cover and core on the outside edges during the application of the coating, therefore uncoated areas on these edges are allowed. There shall be no coating on the surface of screw threads.

7.0 Epoxy Bonding

All parts shown on the appropriate drawings are to be bonded together using Hysol Brand EA9309.3 epoxy with 0.005-inch diameter glass beads. The bonding shall take place after application of the BR-127 coating described in Section 6. It is the Seller's responsibility to determine the appropriate surface preparation, cure time and temperature required to successfully bond the BR-127 coated beryllium pieces. Bonding success will be determined by both visual inspection and by passing the vacuum, pressure and flow tests described in Section 9.

When assembled and bonded with epoxy, the electronics carriers will have an internal channel used to contain flowing water, which will cool sensitive electronic devices. The integrity of the cooling channel is of great concern, therefore, **when epoxy bonding the pieces of the electronics carrier, extreme care must be exercised to minimize the spread of epoxy beyond the bond areas.** Excess epoxy can reduce the water flow, which will tend to severely reduce the effectiveness of the water cooling process.

8.0 Tapped Holes

All tapped holes shall be clear of any chips, lubricants or applied coating. Buyer supplied mating screws shall engage all internally threaded holes with appropriate ease.

9.0 Tests and Inspections

9.1 <u>Inspections and tests.</u>

The following inspections and tests are required for all parts. The Buyer reserves the right to observe, and/or independently perform, any and all tests and inspections prior to shipping and/or acceptance.

9.1.1 Dimensional Inspection:

The Seller shall perform a dimensional inspection on all parts to assure they are within the tolerance limits as specified on the appropriate drawings. A written inspection report recording actual dimensions shall be submitted to the Buyer prior to shipping and/or acceptance of any parts.

9.1.2 Dye Penetrant Test:

In addition to the dimensional inspection, the Buyer shall further inspect the parts by performing a dye penetrant test. This test will be performed following all machining operations that are completed prior to application of the BR-127 coating. Results of this test shall be included in the inspection report.

9.1.3 Fluid Tests:

Following the assembly of all parts and the drilling and tapping of the #0-80 tapped holes, the following fluid tests will be performed:

9.1.3.1 Vacuum test:

A vacuum test shall be performed by evacuating the internal channel of the electronics carriers and testing with a helium sensitive, mass spectrometer leak detector. A test failure is a leak that exceeds $1x10^{-9}$ std. cc/sec. Results of this test shall be included in the inspection report.

9.1.3.2 Pressure Test:

The pressure test shall be performed by pressurizing the internal channel of the electronics carriers with an approved fluid to a gage pressure of 2 atmospheres (30 psig). Approved fluids are helium, dry nitrogen and clean water. The channel shall be pressurized two times and the pressure released. The channel shall be pressurized a third time and the pressure maintained for a period of one hour minimum. A test failure is the external presence of water (water test) or the presence of bubbles when checked with a soap solution (helium or nitrogen test) after the one hour pressurization. Results of this test shall be included in the inspection report.

9.1.3.3 Flow Test:

The flow test shall be performed by flowing clean water through an electronics carrier from a reservoir with a fixed hydraulic head of 48 inches. The discharge from the electronics carrier shall be to atmosphere. The flow rate will be determined by collecting the flow for a period of not less than two minutes. The flow rates for the first five pieces of each electronics carrier size will be averaged to determine a baseline flow rate for each size. A test failure will be flow rates that deviate from the average by more than 5%. Results of this test shall be included in the inspection report.

10.0 Repairs

Should repairs to the parts be required due to test failure or any other reason, the fabrication shall stop and the Buyer shall be immediately notified. The Buyer at his discretion shall ask for retesting, additional study, or entertain proposals for repair if possible.

Proposals for repair shall include adequate means for testing both for the success of the repair and for the absence of damage to the existing work. No proposed repair shall be initiated without the approval of the Buyer. No repair shall be considered successfully accomplished without inspection and approval by the Buyer.

All repairs shall be at the expense of the Seller.

11.0 Order of Production and Shipping

The Buyer desires to receive all parts in as short a time as possible. In addition, the receipt of parts in a certain order provides the best opportunity for the timely installation of the parts into the SVT assembly. The following shows the desired order of production:

11.1 “First Article” Acceptance – One each of each part number shall be produced using the production tooling. **Further fabrication of the remaining pieces of the order shall not proceed until these pieces are accepted.**

11.2 Interim Shipment – A quantity of four each of the two part numbers shall be produced and shipped next.

11.3 Balance of Order – The remaining parts to complete the order shall then be produced and shipped.

12.0 Shipping

The Seller is responsible for the proper packing or crating to ensure that damage is not incurred during shipment and shall be in accordance with transportation industry standards. The packaging design shall be approved by the Buyer. All packaging materials must be suitable for use with beryllium (i.e. no chlorides). Containers shall be marked externally so that the particular parts inside any container are easily identified without opening the container. Finished parts shall be shipped to:

Attention Robert Soja
Brookhaven National Laboratory
Bldg. 510-A, Room 2-198
Upton, NY 11973

13.0 Quality Assurance

The Quality Assurance requirements of this Statement of Work are shown on Form BNL-QA-101 (see Appendix I).

APPENDIX I

QA-101

BROOKHAVEN NATIONAL LABORATORY
SELLER QUALITY ASSURANCE REQUIREMENTS

1.0 SCOPE

1.1 This document, when invoked by purchase order or contract, establishes quality assurance requirements to which sellers to Brookhaven National Laboratory (BNL) shall conform during the performance of work required by the purchase order, or contract.

1.2 This document contains two main sections. Section 3.0 covers the general requirements that are applicable to all sellers. Section 4.0 contains special quality assurance requirements that are applicable only when specifically invoked by the purchase order.

2.0 DEFINITIONS

2.1 The term Purchase Order means the purchase order, contract, subcontract or other written agreement with the Seller (supplier) in which the requirements of this document are incorporated by reference.

2.2 The term Buyer means Associated Universities, Inc. operating Brookhaven National Laboratory, acting by and through its Division of Contracts & Procurement issuing the purchase order.

2.3 The term Seller means the legal entity which is the contracting party with the Buyer with respect to the purchase order.

2.4 The term article or item means a product and/or a service.

3.0 GENERAL REQUIREMENTS

Unless otherwise specified in the purchase order, the following General Requirements apply:

3.1 **Seller Quality Assurance Program/Inspection System**
The Seller shall have and maintain an effective quality assurance program or inspection system that will, as a minimum, comply with all of the requirements of the specification designated below:

☐ 3.1.1 MIL-Q-9858 "Quality Program Requirements" or ISO 9001 "Quality Systems- Model for Quality Assurance in Design/Development, Production, Installation, and Servicing" (Latest revision as of the date of purchase order issuance).

☐ 3.1.2 MIL-I-45208 "Inspection System Requirements" or ISO 9002 "Quality Systems- Model for Quality Assurance in Production and Installation" (Latest revision as of the date of purchase order issuance).
In the "MIL" specifications designated above add "Brookhaven National Laboratory" wherever the word "Government" appears.

☒ 3.1.3 Conformance to Manufacturer's Specifications.

☐ 3.1.4 Other: Refer to requirements stated on P.R./P.O. documentation.

Note: ***In the event that Requirement 3.1.1 or 3.1.2 is specified, and the Seller's quality assurance program or inspection system does not comply with the specified requirement, the Seller shall submit with his quotation a description of his existing quality assurance program or inspection system that will apply to this order. The description will be evaluated by the Buyer prior to award.***

3.2 **Audit by Buyer**
The Seller's Quality Assurance Program or Inspection System shall be subject to audits by the Buyer's Representative(s) for conformance with the requirements of the purchase order.

3.3 **Conformance to Requirements**
All items furnished to the Buyer shall conform with all requirements of the purchase order. No change(s) shall be made to any Buyer requirements without the prior written approval of the Buyer.

3.4 **Responsibility for Subcontractors**
It is the responsibility of the Seller to impose applicable quality assurance requirements upon their subcontractors. Additionally, the Buyer reserves the right to approve, in writing, any subcontractor.

3.5 **Responsibility for Conformance**
Neither audits, surveillance, inspection and/or tests made by the Buyer or its representatives at either the Seller's or Buyer's facility, nor the Seller's compliance with all applicable Quality Assurance Requirements shall relieve the Seller of the responsibility to furnish items which conform to the requirements of the purchase order.

3.6 **Protection of Material and Equipment**
The Seller shall employ procedures which assure adequate protection of material and equipment during shipment and while in storage. Such protection shall include special environmental packaging, as necessary.

3.7 **Certification of Conformance**
By making shipment under this purchase order, the Seller automatically certifies that the articles shipped, the materials (except when the materials are furnished by the Buyer) used in the articles shipped, and the processes applied to such articles comply with the applicable drawings, specifications and requirements of the purchase order. The Seller agrees to retain objective evidence, including records, of the inspections and tests performed in the course of manufacturing, testing, inspecting, preserving, packaging, and preparation for shipment of said articles. These records shall be made available to the Buyer's representative for review upon request.

3.8 **Measuring and Test Equipment Calibration**
The Seller shall establish and maintain a documented system for the calibration of measuring and test equipment used in the fulfillment of the purchase order requirements. As a minimum, the Seller shall calibrate measuring and test equipment against certified standards which have known valid relationships to national standards. The calibrations shall be performed at established periods to assure measuring and test equipment accuracy at the time of use.

4.0 SPECIAL REQUIREMENTS

The following Special Requirements are applicable only when specifically invoked by purchase order, or as indicated by check mark hereon.

☒ 4.1 **Q.A. Program or Manual:** The Seller shall submit a copy of his Quality Assurance Program or Manual with his proposal for review and evaluation.

☒ 4.2 **Configuration Control System:** The Seller shall establish and maintain a system to assure that all end items (including spares) are of the proper configuration, and that all approved configuration changes are incorporated at the specified effectivity points. Records shall be maintained verifying the configuration of each item.

☒ 4.3 **Process Sheets, Travelers, etc.:** The Seller shall maintain a system of process sheets, shop travelers, or equivalent means to define the sequence of manufacturing, inspection, installation and test activities to be performed. Flow sheets, or equivalent, shall provide for sign-off by designated inspection personnel at specified inspection and test points, to assure completion as well as proper sequencing of required operations.

☐ 4.4 **Manufacturing/Inspection/Test Plan:** Sixty (60) days prior to fabrication the Seller shall prepare and submit for the Buyer's review and approval a manufacturing/inspection/test plan for the item(s) to be produced, which satisfies the following:

- ☐ 4.4.1 Identification of parts and subassemblies showing integrated flow into end item(s).
- ☐ 4.4.2 Identification of critical manufacturing operations as well as inspection and test checkpoints.
- ☐ 4.4.3 The Plan may be a single document, or may make use of existing “travelers”, or other suitable planning and control documents.
- ☐ 4.4.4 Revisions or changes to the Buyer approved Plan must be submitted for the Buyer's review and approval prior to implementation.

☐ 4.5 “**Witness” Points:** The Buyer reserves the right to designate selected manufacturing, inspection, and/or test operations as “witness” points. The Seller shall provide the Buyer with five (5) working days notice in advance of reaching such witness points during the manufacturing and test cycle of each item.

☐ 4.6 **Test and Inspection Procedures:** Test and inspection procedures required to demonstrate satisfactory completion of purchase order requirements shall be prepared by the Seller and submitted to the Buyer for review and approval sixty (60) days prior to use of such procedures.

☐ 4.7 **Special Process Procedures:** Special processes (e.g. welding, brazing, bonding, plating, chemical machining, chemical coating, chemical cleaning, precision cleaning, heat treating, radiographic inspection, ultrasonic testing, pressure or leak testing) shall be performed in accordance with detailed written procedures. These procedures shall specifically describe the exact manner in which the processes are to be performed.

- ☐ 4.7.1 Copies of special process procedures shall be available for review by the Buyer's representative upon request.
- ☐ 4.7.2 At least sixty (60) days prior to use on items deliverable to the Buyer, the Seller shall submit to the Buyer copies of all applicable process procedures for review and approval. Revisions or changes to Buyer approved special process procedures must be submitted to the Buyer for review and approval prior to implementation.

☐ 4.8 **Qualification of Special Process Procedures, Facilities and Equipment:** The Seller shall, prior to use, qualify the procedures/specifications, facilities and equipment that will be used for the performance of special processes. Records of such qualification shall be available to the Buyer's representative upon request.

☐ 4.9 **Qualification of Special Process Personnel:** The Seller shall provide for the qualification of personnel, prior to their use, to ensure competence in the use of the special process procedures or specifications. Records of such qualification shall be available to the Buyer's representative upon request. Only those personnel who have been qualified to perform a specific special process shall be used to perform that process.

☒ 4.10 **End Item Documentation Package:** The Seller shall provide a documentation package for each shipment of the item(s) supplied, which consists of objective evidence of compliance with purchase order requirements. This documentation package shall be complete, legible, indexed, and traceable to the item supplied, and shall contain the following, as applicable:

- ☒ 4.10.1 Copies of reports of all required or necessary inspections, examinations and tests, properly validated by the Seller's authorized personnel.
- ☒ 4.10.2 A listing of the as-built configuration of each delivered item; this may be defined by the use of drawing numbers and revisions, unique parts lists or other such means of positive identification.
- ☒ 4.10.3 Copies of nonconformance reports dispositioned as “repair” or “use-as-is”.
- ☒ 4.10.4 Copies of material test reports for specified materials, showing physical and chemical properties.
- ☒ 4.10.5 A Certification of Conformance (See 4.16).

☐ 4.11 **Release for Shipment:** The Seller shall provide the documentation package required in 4.10, for review by the Buyer's representative prior to release of the item for shipment.

☒ 4.12 **Shipment of Documentation Package to Buyer:** Three (3) copies of the documentation package shall be shipped to the Buyer with or prior to each shipment of the purchased items.

☐ 4.13 **Failure Reporting, Analysis and Corrective Action:** The Seller shall maintain a failure reporting, analysis and corrective action program to determine and report what reliability or safety problems may exist in the equipment, define their nature and cause, and recommend and implement the necessary corrective actions.

The Seller's failure reporting, analysis, and corrective action program shall, as a minimum, evaluate and analyze failures occurring during qualification, first article and end-item acceptance testing and inspection. To determine the true cause of failure, the analysis should include, as appropriate, the disassembly or dissection of the failed item(s). The results of all failure evaluations and analyses shall be documented and available for review by the Buyer.

☐ 4.14 **Source Inspection/Surveillance:** Items to be delivered under this purchase order require inspection, tests or surveillance by the Buyer's representative at the Seller's facility. Five (5) work days notice of acceptance inspections and tests shall be given by the Seller to the Buyer to permit scheduling of source inspection.

☒ 4.15 **<u>Chemical and Physical Test Report:</u>** One copy of actual chemical and physical test report(s) for each heat, batch or lot shall accompany each shipment. Test reports shall list the actual parameters tested, and shall contain the actual readings taken during test.

☒ 4.16 **<u>Certificate of Conformance:</u>** With each shipment of items covered by this purchase order, the Seller shall submit a certificate of conformance. In case of drop shipment, a copy of the certificate shall be submitted to the Buyer at the time of shipment. The certificate shall be signed by an authorized representative of the company, and shall constitute a representation by the Seller that:

A. Materials used are those which have been specified by the Buyer, and that the items delivered were produced from materials for which the Seller has on file reports of chemical or physical analysis, or any other equivalent evidence of conformance of such items to applicable specifications;

B. Processes used in the fabrication of items delivered were in compliance with applicable specifications forming a part of the purchase order, or Buyer approved procedures or specifications;

C.The items as delivered comply with all specifications and other requirements of the purchase order.

☐ 4.17 **<u>Report with Each Shipment:</u>** Superseded by paragraph 4.10.

☒ 4.18 **<u>First Article Acceptance:</u>** Buyer acceptance of first article(s) is required prior to the production run. The first article(s) shall be identified as such, including the purchase order number, part number and part name. The Seller is required to:

☒ 4.18.1 Submit the first article(s) to the Buyer's representative for test/inspection to be conducted at the Seller's facility by the Buyer's representative;

☐ 4.18.2 Submit the first article(s) to the Buyer for test/inspection by the Buyer at the Buyer's facility;

☐ 4.18.3 Submit the first article(s) to the Buyer together with documents showing data representing results of the Seller's first article(s) test/inspection, including the actual dimension or value for each specified characteristic;

☒ 4.18.4 After Buyer acceptance of first article(s), all of the remaining units required by the purchase order shall be produced by the Seller and the Seller's suppliers using the same design, materials, processes, methods and tooling that were used to manufacture the approved first article(s). Any changes must have prior approval from the Buyer.

☒ 4.19 **<u>Notification of Change to Design, Methods, or Processes:</u>** The Seller shall immediately notify the Buyer of any significant changes (those that may effect form, fit, function, reliability, safety or interchangeability) in product design, fabrication methods, material or processing from those used by the Seller at time of Seller's quotation or offer to the Buyer, which resulted in the purchase order.

☒ 4.20 **<u>Age/Shelf Life and Storage Control:</u>** The Seller shall have an effective storage and age control system for items whose acceptability is limited by the age or manner of storage of the item. The system must include a method of identifying the age of such items, and provisions for the rotation and purging of stock.

The Seller shall show on each container of materials having a limited or specified shelf life (both Seller's in-plant containers and containers in which material is delivered to the Buyer) the cure or manufacture date, expiration date, lot or batch number, and special storage and handling conditions applicable to the contents. This information shall be in addition to the normal identification requirements of name, part or code number, specification number, type, size, quantity, etc. If cure or manufacture date is coded, Seller shall provide decoding information. Special handling conditions shall be recorded on certifications and shipping documents covering the material delivered to the Buyer.

At the time of receipt, the material shall not have less than three-quarters of its shelf life remaining, without prior written approval from the Buyer for each shipment.

☐ 4.21 **<u>Serial Numbers:</u>** The Seller shall assign a separate and distinct serial number to each end item furnished under this purchase order. Where impractical to stamp individual items due to size or shape, the serial number shall be stamped on identifying tags or the smallest unit package. No two items having the same part number are to be identified with the same serial number. Records of serial numbers for each part number must be maintained by the Seller.

☐ 4.22 **<u>Lot or Batch Numbers:</u>** For items furnished under this purchase order, the packing list, certifications and other applicable documents must be identified by manufacturing lot or batch number. Where impractical to stamp individual parts due to size or shape, the lot or batch number shall be stamped on identifying tags or the smallest unit package.

☒ 4.23 **<u>Material Traceability:</u>** Materials used must be identified by material type, applicable specification and revision number, and be traceable to their lot number(s) and heat number(s). Traceability records shall be available for review by the Buyer's representative.

☐ 4.24 **<u>Shipment Destination Other than BNL:</u>** The material ordered against this purchase order is to be shipped to other than the Buyer's facilities. Copies ofthe Quality Assurance data required by this order shall accompany the shipment; in addition, one copy of such data shall be mailed to the Buyer on the same day that shipment is made.

☐ 4.25 **<u>Heat Treat Bars:</u>** Superseded by paragraph 4.7.

☐ 4.26 **<u>Burn-in:</u>** Burn-in shall be performed on each completed item per the procurement specification. Records of the burn-in testing, repairs and test results shall be maintained, and shall be available to the Buyer's representative upon request.

☐ 4.27 **Welding Procedures:** Superseded by paragraph 4.7.

☐ 4.28 **Weld/Braze Inspection Report:** A report(s) shall be submitted that indicates the complete inspection of welds or brazes from the initial fitup stage through the final inspection. Inspection reports shall be accompanied by all radiographic films, filler metal reports, etc. The reports shall contain the signature or stamp, and title of an authorized Seller representative.

☐ 4.29 **Radiographic Quality Requirements:** Items requiring radiographic inspection shall be radiographed and processed in accordance with Seller special process procedures that satisfy design specifications, standards or other purchase order requirements. Personnel reading and interpreting film shall have been subjected to examination and certification. Responsibility for this certification shall rest with the Seller, whether the Seller does the work or subcontracts to a specialized laboratory. Findings shall be reported on an appropriate form, including the name of the reader and the signature of a responsible representative. The radiographic film and a reproducible copy of the report shall accompany each shipment. An adequate method of identifying and cross referencing each film exposure, report, and item shall be provided. When parts are serialized, serial numbers shall appear on the report and the film.

☒ 4.30 **Nondestructive Test Reports:** All nondestructive testing shall be conducted in compliance with Seller special process procedures that satisfy the applicable provisions of the design specifications, or other purchase order requirements. Personnel and equipment utilized in performance of such tests shall have been evaluated and certified for the type of test performed.
Seller shall furnish with, or prior to, each shipment reports of such nondestructive examination of material or items furnished. These reports shall be identifiable to the respective item or material including the specific section, joints or views of the item furnished. These reports shall contain the signature and title of an authorized Seller representative. When items are serialized, the serial numbers shall appear on the reports.

☒ 4.31 **Pressure or Leak Test Reports:** Test reports shall be prepared for all pressure and leak tests. Such reports shall state the requirement, the Seller's test procedure number, and the observed result for each item, joint or connection tested. When items are serialized, the serial numbers shall appear on the report. The reports shall contain the signature and title of an authorized Seller representative, and shall accompany each shipment.

☐ 4.32 **Cleaning Certification:** Each shipment shall be accompanied by a certification which states that all Buyer requirements relative to cleaning and cleanliness have been completely satisfied. The certification shall reference the Seller's applicable cleaning procedure(s) identification number(s), and shall also contain the signature and title of an authorized Seller representative.

☐ 4.33 **Calibration Certification:** The Seller shall submit with each instrument/system a certification that the instrument/system has been calibrated and is ready for use. The certification shall contain, as a minimum, the identity of the instrument/system, the identification of the calibration procedure used, identification of the standards and/or equipment utilized for the calibration, and a statement that the calibration of the standards and/or equipment used is traceable to the National Institute of Standards and Technology (NIST) or some other recognized national standard. Detailed support data shall remain on file with the Seller and shall be available for review by the Buyer. The certification shall also contain the signature and title of an authorized Seller representative.

☐ 4.34 **Operating-Maintenance Manual:**
Documentation containing operating procedures, maintenance instructions, spare parts lists, and handling procedures shall be submitted with the shipment of the first item.

☐ 4.35 **Computer Software Configuration Management:** The Seller shall develop and implement a software configuration management system that ensures an orderly development of software. The system shall establish requirements for placing software under configuration control, provide for the positive identification of software, and the control of all software baseline changes. The Seller shall submit a copy of his software configuration management procedure(s) with his proposal for review and evaluation.

☐ 4.36 **Computer Software Design Control:** The Seller shall develop written procedures describing the controls applied to the design of software, and the verification of the design through independent technical review. The procedures shall provide for documentation of review activities, including requirements for documenting comments and resolutions of comments. Seller software designs and review documentation shall be subject to review and approval by the Buyer.

☐ 4.37 **Computer Software Verification Testing:** The Seller shall test and verify computer software developed or modified to fulfill the requirements of the purchase order. The verification testing shall be accomplished by a comparison of test results with those from other verified software, or by a comparison with results from analytical solutions or Buyer approved alternatives.

☐ 4.38 **Electrostatic Discharge Control:** Items that are susceptible to electrostatic discharge shall be handled and packaged to protect them from damage. Items and/or packages shall be labeled to indicate the susceptibility to electrostatic discharge.