Brookhaven National Laboratory
Associated Universities, Inc.
STAR Collaboration

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STATEMENT OF WORK FOR THE FABRICATION OF THE STAR SOLENOID POLETIP TRIM COILS

1.0 General

1.1 Summary.

This statement of work outlines the necessary steps for the fabrication and delivery of the Poletip Trim Coils used in the 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 coils will each be installed into a 75 ton Poletip which will then be incorporated within a thousand ton steel yoke which will contain sensitive apparatus used in high energy and nuclear physics experiments. This detector system is a one-of-a-kind and must operate for long periods reliably. Consequently, the fabrication includes requirements for coil handling and manufacturing environment as well as detailing extensive electrical and mechanical tests during and following manufacture.

1.2 Scope.

This statement of work outlines the minimum requirements governing the material procurement, fabrication, and shipping of the poletip trim coils for the STAR detector. It should be read in conjunction with CSN #136, "Specification for STAR Solenoid Poletip Trim Coils."

The Seller shall:

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

2. Design, procure and/or fabricate fixtures, winding and insulating equipment.

3. Fabricate the coils in strict accordance with specification CSN #136, the appropriate drawings listed in that specification and the Seller Fabrication Procedure.

4. Provide and operate all testing equipment to satisfy the specification.

5. Deliver all coils to the Buyers facilities. Installation of the coils into the magnet will be accomplished by the Buyer.

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:

2.1.1 Specification for STAR Solenoid Poletip Trim Coils, CSN #136.

2.1.2 Specification for STAR Solenoid Magnet Poletip Trim Coil Aluminum Conductor, CSN #133.

2.2 Conflicts.

In the event of a conflict between the Drawings, the Specifications, 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 specifications and drawings are in "U.S. Customary" (English) units. 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 manufacturing plan containing:

a. A Fabrication Procedure - This procedure shall be a detailed description of the method by which the Seller intends to fabricate the coils. As a minimum it must cover all aspects of the procurement of materials and design of tooling, fixtures and handling equipment. It will describe the winding and insulating processes and define and describe the "in process" and final testing requirements.

b. A Coil Fabrication/Process Traveler - The traveler is a document or package of documents indicating critical manufacturing operations or processes or proposed inspection witness points with areas for dates and signatures.

c. A Facility and Personnel Description - This shall be a description of the facilities and key personnel used for the manufacture of the coils and shall include:

i. A floor plan showing location of key fabrication areas as described in the fabrication procedure.
ii. Crane description including capacities.
iii. Descriptions of other handling equipment.
iv. A description of how the coils will be moved within and outside the facilities.
v. A list of the inspection and test equipment used in the fabrication of these coils. The Seller shall indicate what equipment already exists and what must be purchased and/or leased for this program.
vi. A list of key technical and management personnel expected to oversee this project along with a description of their qualifications and experience. If subcontractors are used, they must be listed as well.

d. Manufacturing Experience - List previous experience in similar manufacturing operations and provide references to previous customers. In particular, list experience with large magnet coils and using aluminum conductor.

e. Current Workload - Outline the current and projected workload under contract or subcontract that may have impact on the timely completion of this order and the estimated completion dates for this order.

f. Conductor Material Procurement - The Seller is responsible for the procurement and quality assurance of all the aluminum conductor material. The Seller **must** present a plan for the procurement and quality assurance of this material. The plan shall include the name of the vendor(s) fabricating the material and the name and telephone number of a contact person at that facility. Additionally, the plan must describe the manufacturing method to be used and how the required testing and other quality assurance items are to be satisfied. The Seller must also demonstrate that conductor material fabricated by the proposed method has a positive long term record for use in a similar application.

g. Packaging and Shipping - The Seller shall be responsible for ensuring that the coils arrive at Brookhaven National Laboratory in good condition, damage free and ready for installation. This includes all aspects of the shipping process including the securing of required permits and the payment of any customs duty. The Seller shall provide a detailed plan of the packaging and shipping process.

h. Quality Assurance Plan - The Seller must have an existing in-process quality assurance plan which meets the requirements of this Statement of Work and the associated specifications. The Seller shall describe how this plan will be used to assure quality in the fabrication of these coils.

3.1.2 A production schedule showing task duration and milestone completion dates of the following:

a. Conductor material order placement.
b. Winding Fixture Design.
c. Review and approval by Buyer of Winding Fixture Design.
d. Winding Fixture Fabrication.
e. Impregnation Fixture Design.
f. Review and approval by Buyer of Impregnation Fixture Design.
g. Impregnation Fixture Fabrication.
h. Receipt and incoming inspection of conductor material.
i. Receipt of insulating material.
j. Finish winding.
k. Finish insulating.
l. Finish Buyer witnessing of testing and approval.
p. Packaging and shipping.

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All milestone dates shall be given as “number of weeks ARO (after receipt of order).”

3.2 Following the placement of an order, the Seller shall submit to the Buyer:

3.2.1 A production schedule showing task duration and milestone completion dates of the following:

a. Conductor material order placement.
b. Winding Fixture Design.
c. Review and approval by Buyer of Winding Fixture Design.
d. Winding Fixture Fabrication.
e. Impregnation Fixture Design.
f. Review and approval by Buyer of Impregnation Fixture Design.
g. Impregnation Fixture Fabrication.
h. Receipt and incoming inspection of conductor material.
i. Receipt of insulating material.

j. Finish winding.
k. Finish insulating.
l. Finish Buyer witnessing of testing and approval.
p. Packaging and shipping.

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All milestone dates shall be the actual dates task completion is anticipated. This production schedule MUST be submitted to the Buyer within THIRTY DAYS AFTER RECEIPT OF ORDER.

3.2.2 Copies of material certification and inspections reports.

3.2.3 Coil Test Data Sheets as described in specification CSN #136.

3.2.4 Detailed designs, for approval, of:

a. Coil winding fixture.
b. Coil impregnation fixture.
c. Coil handling fixtures.
d. Container and method of shipping completed coils.

3.2.5 Copies of the epoxy test results as described in section 11.0.

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 coil assemblies and subassemblies. The Seller shall submit to the Buyer for review and approval, all designs for tooling and fixtures. Tooling and fixture design shall be accomplished in a timely fashion consistent with the production schedules described in Section 3.

5.0 Material Procurement

The procurement of all materials used for the fabrication and packaging of the coils is the responsibility of the Seller. Material certification is required for all materials used in the coil assemblies. Certification documentation must accompany each coil. The timely acquisition and use of materials with a finite "shelf life" is mandatory.

The procurement of the aluminum conductor material is of special concern. The Seller must take all steps necessary to procure material which conforms to specification CSN #133 and must assure that all required testing is performed. The Buyer reserves the right to interact with the manufacturer of the aluminum conductor to supplement the Sellers ability to assure the quality of the conductor material.

In placing the order for the aluminum conductor, it is the Seller’s responsibility to determine and specify the minimum acceptable length requirements of each conductor piece taking into account the Seller's payoff and tensioning equipment. **No** joints in the conductor will be allowed.

Additional lengths of conductor may be required for bussing, coil spares or other purposes and the Seller shall procure this material in addition to that required for coil manufacturing as directed by the Buyer.

6.0 Fabrication Environment

The coil shall be fabricated in an environment free of metallic particles, dirt, and welding or chemical fumes. The coil and all materials used in its construction shall be protected from dirt, moisture, and damage during fabrication, handling, and storage. The insulation tape should be handled with clean gloves and all measures taken to prevent contamination with water, oil, solvent, dirt, metal chips, or other foreign matter.

One metal chip can destroy a coil; winding in a protected area as described above is mandatory.

7.0 Winding

A Poletip Trim coil is an assembly of three 2-layer pancakes. Each pancake contains two layers wound "three-in-hand" to allow continuous water paths of a reasonable length. An individual conductor, which makes up a single water path, provides 13-1/9 turns and, since the coil has nine separate water paths, the total number of turns is 118. Since each water path in a pancake requires a continuous length of conductor material with **no weld joints allowed**, it is expected that provisions will be made to "off wind" half of each conductor length onto the winding fixture while the first layer of each pancake is wound

Each pancake shall be wound using a rigid winding fixture. Suitable tension shall be applied to the conductors being wound to assure the quality of the conductor package. If the conductor material has excessive twist or other condition which will impact the coil so as to create a potential dimensional problem, it must be corrected prior to that material being wound into a pancake. Visual inspection of the coil material will be made and any harmful nicks, scratches, etc. will be removed.

8.0 Welding

Welding is required to attach bosses to the end of each water path for the attachment of screwed fittings and to electrically join water paths in series. The Seller shall submit to the Buyer for approval samples of each type of weld using the actual material to be joined.

All welding shall be performed by ASME or AWS-certified welders and inspectors.

9.0 Insulation

The electrical insulation of the coils shall be achieved by using glass fiber tape, wound around each conductor and over pancakes and assemblies and vacuum impregnated with epoxy resin. The specifics of the insulating materials are contained in specification CSN #136. The vacuum

impregnation shall take place in a mold designed to assure each coil satisfies the appropriate geometric and dimensional tolerances.

The Seller may additionally submit to the Buyer, for approval, an alternate insulating procedure. This procedure must include material sources, formulations and curing data and the Seller must formally establish that the physical properties of the materials when used in a nuclear radiation environment are equal to or better than the materials described in specification CSN #136.

10.0 Coil Leads (Tails)

The location and insulation of the coil leads requires extra care and attention to detail. Drawings of the magnet poletips (drawings MAG344-E-1 & MAG345-E-1) show the importance of lead location since each coil has nine sets of leads that must pass through holes in the poletip during coils installation. The Seller must exercise extreme care in locating these leads on the coils so that the coil drawing dimensional requirements are met.

Heat shrink material, as outlined on the drawings and in the coil specification, shall be used to insulate the leads. Care must be exercised so that the installation of this material joins with the insulation of the lead conductors as they emerge from the coil so as to create no gaps in the insulation of the leads.

Eight of the nine leads contain bolted electrical connections. Prior to bolting the connections together, the mating surfaces must be cleaned and coated with compound formulated for making aluminum-to aluminum electrical joints.

11.0 Flange Internal Bonding and Flange to Coil Bonding

The epoxy bond between the flange (drawing MAG206-E-1) and the coil must be made in a manner sufficient to withstand the mechanical, thermal and magnetic stresses imposed on the coil/flange interface. Likewise, the epoxy bonding to fabricate the flange must also resist the same stresses. To confirm the performance of the epoxy bond, the Seller shall fabricate test samples to test the tensile and shear performance of the epoxy joint. Three samples for tensile testing and three samples for shear testing shall be fabricated from the actual materials in the coil assembly (epoxy fiberglass insulated aluminum and NEMA grade FR4 plastic sheet). Surface preparation in the test samples shall be identical to the surface preparation to be used on the actual coil and flange. The Seller shall test all samples to confirm the required strength values as specified in CSN # 136. Results of these tests **must** be submitted to the Buyer for approval **prior** to bonding flange parts together and prior to bonding the flange to the coil.

12.0 Tests and Inspection

The performance of all testing is the responsibility of the Seller who must provide and operate all test equipment to satisfy the testing requirements outlined in the specification CSN #136.

The Buyer requires advance notification and reserves the right to witness all tests, however that right may be waived on a test-by-test basis.

Failures of any of the tests shall be brought to the immediate attention of the Buyer. Fabrication of the coil shall cease pending resolution of the problem. No repair shall be attempted or carried out except as provided in Section 13.0.

13.0 Repairs

Should repairs to the coil 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.

14.0 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, and coil packaging design shall be approved by the Buyer. The Seller shall be responsible for the payment of any import duties (if applicable) and procuring all permits, etc. necessary for the delivery of all coil assemblies to the Buyer's facilities at Upton, Long Island, NY, USA Containers shall be marked externally so that the particular coil inside any container is easily identified without opening the container.

15.0 Quality Assurance

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

16.0 Tooling and Fixtures

Tooling and fixtures paid for by the Buyer shall be shipped to the Buyer after the manufacture of all coils in this order.

APPENDIX I

QA-101

BNL P.R./P.O. NO. 745998

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 **Chemical and Physical Test Report:** 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 **Certificate of Conformance:** 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 **Report with Each Shipment:** Superseded by paragraph 4.10.

☐ 4.18 **First Article Acceptance:** 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 **Notification of Change to Design, Methods, or Processes:** 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 **Age/Shelf Life and Storage Control:** 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 **Serial Numbers:** 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 **Lot or Batch Numbers:** 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 **Material Traceability:** 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 **Shipment Destination Other than BNL:** 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 **Heat Treat Bars:** Superseded by paragraph 4.7.

☐ 4.26 **Burn-in:** 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.