Brookhaven National Laboratory
Associated Universities, Inc.
STAR Collaboration

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Title: STAR POLE TIP CARRIAGE HYDRAULIC SYSTEM SPECIFICATION

QA Category: A3

o Cognizant Engineer______________________
I. Polk

o Approved by: ______________________ ______________________
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REVISION RECORD

Rev. No.	Date	Page	Subject	ECN
1	Jan. 26, 98		Typos	

1. General

1.1 Summary Two Pole Tip Carriages are to be used to service the STAR Detector. However, there will only be one Hydraulic Control System available to be connected to the Pole Tip Carriage that is to be operated. This specification defined the requirements for a Hydraulic Control System to operate a Pole Tip Carriage. This includes System Scope, System Requirements, Statement of Work, Proposal Submittal, and Quality Assurance Standards.

1.2 System Scope The System will consist of a Portable Console which can be rolled on wheels or be lifted an overhead crane. The Console is the control point for the Pole Tip Carriage movements and will contain the Hydraulic Pumping Systems, Control Valves, and Position Readouts for the movements described in later sections.

1.2.1 The Console will be connected to the Pole Tip Carriage with 25 foot long hydraulic hoses of appropriate diameter by quick release hose couplings and with multi conductor control cables and connectors of the same length for remote indication of the Pole Tip Carriage motions and position.

1.2.2 The following Documents and Standards are part of this Specification.

Drawings MAG 476-E-1
MAG-476-E-2
MAG-476-E-3

BNL QA - 101

Appendix - Page 1& 2

1.3 System Requirements

1.1.1 The Pole Tip Carriages are being fabricated by Ranor Inc. in Mass. and will be completed by January 16, 1998. The motions that need to be controlled are the Upper Pivot Rotation, Lower Pivot Rotation, and Longitudinal Position. Hydraulic Cylinders as described in Appendix Page 1 and in 1.3.2 will be supplied and built in as part of the Pole Tip Carriage Assembly.

1.3.2 Hydraulic Cylinder Description.

There are three hydraulic cylinder assemblies described here and further described in Appendix page 1

1.3.2.1 Upper Pivot Hydraulic Cylinders
There are 4 ea. Enerpac RCS 502 single acting hydraulic cylinders arranged in 2 banks of 2 ea. The maximum load on each bank of 2 cylinders is 106706 pounds as shown in the Appendix page 2. This requires a pressure of 5540 # per sq. in. statically and somewhat more for operation. All cylinders will be connected in parallel with pilot operated check valves closely coupled in the hydraulic piping to each cylinder.

1.3.2.2 Lower Pivot Hydraulic Cylinders
There are 4 ea. Enerpac RCS 1002 single acting hydraulic cylinders arranged in 2 banks of 2 ea. The maximum load on each bank is 178000# as shown in the Appendix page 2. This requires a hydraulic pressure of 4524 # per sq. in. statically and somewhat more for movement. All cylinders are connected in parallel with pilot operated check valves closely coupled in the hydraulic piping to each cylinder.

1.3.2.3 Longitudinal Motion Hydraulic Cylinders

There are 2 ea. Hanna Series CH MS7 hydraulic cylinders connected in parallel to the Pole Tip Carriage Baseplate to move the Carriage on Hilman Rollers on machined steel track. The calculated force to move the Carriage and Pole Tip is estimated to be 2500# per cylinder and the design pressure is 424 # per sq. in. The cylinders are described in the Appendix page 1.

1.3.3 Hydraulic Pumps:

The Upper and Lower Pivot hydraulic cylinders require a pressure about 5500 p.s.i. and the Longitudinal hydraulic cylinders require a pressure of about 500 p.s.i. A way to do this is to have two separate pump systems. The high pressure pump would be valved to either the Upper or Lower Pivot Cylinders and a lower pressure pump system would operate the Longitudinal Cylinders. BNL will supply the hydraulic pumps as indicated in the next section.

1.3.3.1 High Pressure Hydraulic Pump

This pump is an Enerpac PER 2045 with a VS -4 four way 115 volt solenoid valve and a five gallon reservoir. It has a maximum operating pressure of 10000 p.s.i. and a flow rate of 42 cu. inches per minute.

1.3.3.2 Low Pressure Pump

This pump is an Enerpac PER 4405B with a 24 volt solenoid valve and a 10 gallon reservoir. It has a maximum operating pressure of 5000 p.s.i. and a flow rate of 120 cu. inches per minute.

1.3.3.3 Hydraulic Fluid

The pump reservoirs shall be filled with non flammable hydraulic fluid such as Quantolubric 822 made by Quaker Chemical or equivalent.

1.3.4 Hydraulic Control Schematic

As mentioned earlier, there are three systems which must be actuated one at a time to control the Pole Tip Carriage position. A Flow Diagram should be developed which will have the necessary components to control the system as previously described. This is conceived to have on - off valves which would be actuated electrically from transducers on the Carriage. Manually adjustable flow control valves and/or orifices shall be incorporated in each cylinder system to set the fluid flow rate to achieve the motion in the time desired. The hydraulic pressure in the piping connecting the sets of cylinders should be able to be monitored with gauge readouts.

1.3.5 Position Transducers

The position of each of the cylinder sets is to be indicated continuously by Transducers mounted adjacent to the cylinders. Since the cylinders are in two banks, there will be two transducers , one for each bank of cylinders. The transducers on one side of the carriage will be the control and the other transducer will be used to check that the position is being read correctly. The Upper Hydraulic Cylinders have a stroke of 2.38 inches of which + or - one inch will be used. The Lower Hydraulic Cylinders have a stroke of 2.25 inches of which + or - one inch will be used. The transducers will be installed to match the cylinder stroke. The Longitudinal Cylinders have a stroke of 89 inches with transducers to indicate position over the full length of stroke. It will also be necessary to indicate the position of the Pole Tip Carriage as the Pole Tip reached its final position in the STAR Magnet. A 4” travel transducer for each Pole Tip Carriage should be supplied with appropriate cables and connectors to be connected to the Control System. The controller should be programmed so that longitudinal position of the Pole Tip Carriage can be controlled at the above end position from the output of these transducers.

1.3.6 Control System

A controller with the appropriate readout capability will be used to control the position and motion of the three systems as each is chosen. Since the fluid flow in each system is preset the controller will operate from the position transducer of the system being actuated. The zero set point of each readout can be changed as desired at the Controller. The Controller should allow incremental movement of the Pivot Systems to + or - .010 inches and the Longitudinal System to + or -.020 inches.

1.3.7 Emergency Stop

A hard wired-direct acting Emergency Stop Button shall be placed on the Control Console in a conspicuous position which when pressed will stop all motion.

1.4 Statement of Work

1.4.1 The following outlines the responsibilities of the Buyer and Seller with regard to the production of the Star Pole Tip Carriage Hydraulic System:

1.4.1.1 Design a System Schematic which will perform the functions outlined in Section 1.3. This schematic shall be approved by the Buyer.

1.4.1.2 Assemble the components in a working Portable Console. The Console overall design should be approved by the buyer.

1.4.1.3 Deliver the Console F.O.B. to BNL.

1.4.1.4 Program the Controller to control the Carriage functions as outlined in Section 1.3.

1.4.1.5 Provide the hydraulic components that will need to be mounted on the Pole Tip Carriage and work with BNL Personnel in laying out the mounting of these components.

1.4.1.6 Instruct BNL personnel in the operation and maintenance of the entire system and provide written procedures for the above.

1.4.2 The Buyer shall:

1.4.2.1 Supply the two Enerpac Hydraulic Pumps specified in Sections 1.3.3.1 and 1.3.3.2.

1.4.2.2 Work with the Seller to expediously approve the designs that are provided.

1.5 Proposal Submittal

The prospective seller shall submit a proposal describing how the requirements outlined in the Specifications will be met. This should also contain price and delivery date.

1.6 Quality Assurance Provisions

Articles furnished in compliance with this Specification shall be produced under the controls and as required by the applicable contract provision. Additional Quality Assurance requirements should be in accordance with BNL - QA 101; Sections 1, 2, 3 (including 3.1.3) And 4.14, 4.16, 4.31, 4.32, and 4.38.

I. Polk 08/27/97
Rev. 12/2/97

Hydraulic Cylinders Used in the STAR Pole Tip Carriage

(1) Upper Hydraulic Cylinders

Enerpac RCS 502   50 Ton Capacity   Single Acting   4 each

Cylinder bore 3.5”   Stroke 2.38”   Stroke Used +/- 1”   Cylinder area = 9.63 sq. in.

Volume/cylinder = 19.62 cu. in.   for 4 cylinders volume = 77.04 cu. in.

Minimum time for full stroke is 5 minutes   Displacement/min. = 15.04 cu. in./min.

Operating Pressure 5540 p.s.i.

(2) Lower Hydraulic Cylinders

Enerpac RCS 1002   100 Ton Capacity   Single Acting   4 each

Cylinder bore 5.0”   Stroke 2.25”   Stroke Used +/- 1”   Cylinder area = 19.67 sq. in.

Volume/cylinder = 39.34 cu. in.   for 4 cylinders volume = 157.36 cu. in.

Minimum time for full stroke is 5 minutes   Displacement/min. = 31.742 cu. in./min.

Operating Pressure 4525 p.s.i.

(3) Longitudinal Travel Cylinders

Hanna Series 2H MS7 End Lug Mount   2 each

Bore Dia. 3.25”   Rod Dia. 2”   Stroke = 89”

Cylinder area Rod End = 5.154 sq. in.

Cylinder area Piston End = 8.295 sq. in.

Max. volume piston end for 89” Stroke = 738.32 cu. in.   for 2 cyl. Vol = 1476.65 cu. in.

Minimum time for full stroke is 15 min.   displacement/min. = 98.44 cu. in./min.

Operating Pressure 424 p.s.i.

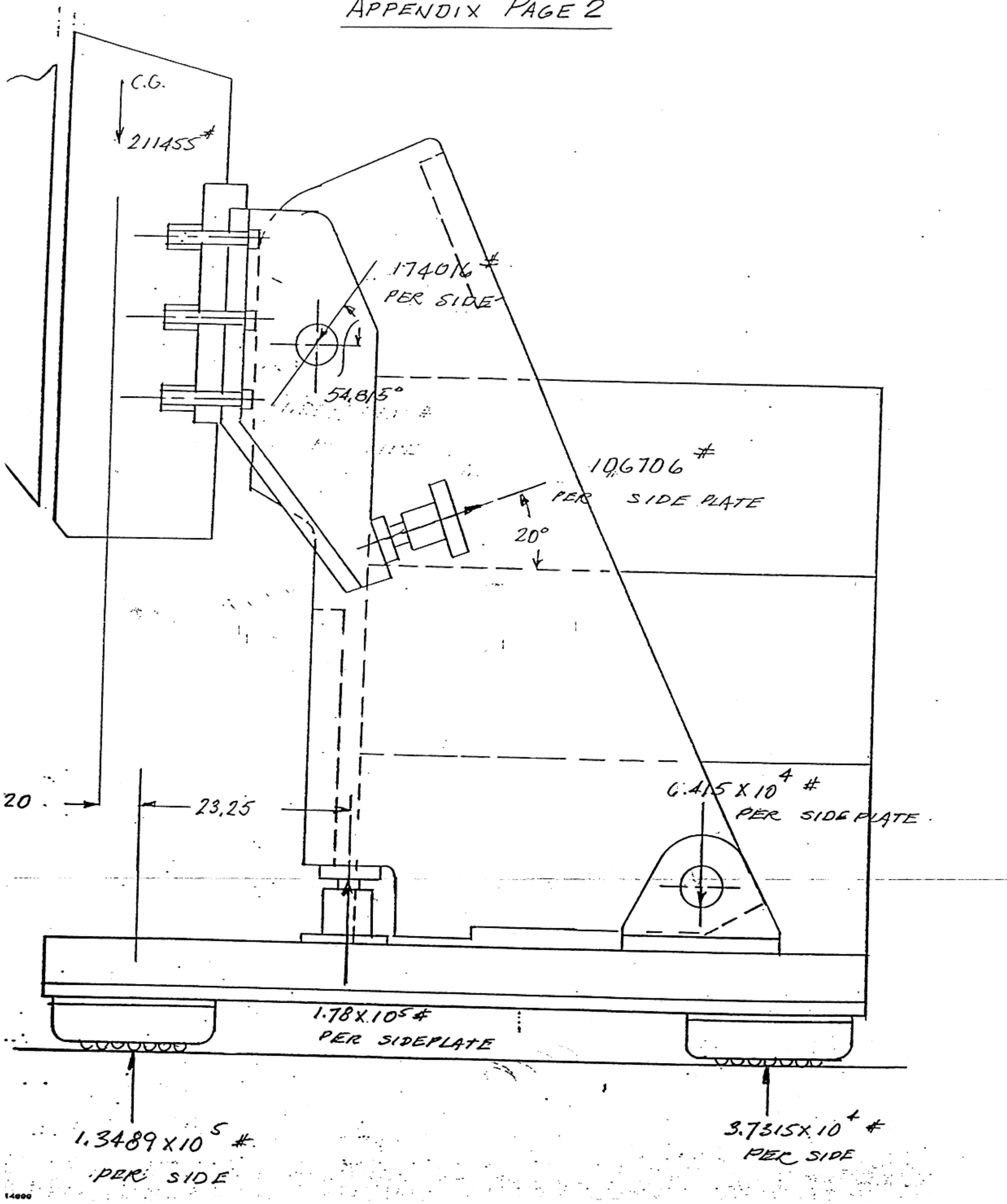
BROOKHAVEN NATIONAL LABORATORY

BY I. POLK DATE 9/10/96 SUBJECT FORCES ON CENTRAL SUPPORT ASSEMBLY. SHEET No.____ OF ____

CHKD. BY____ DATE____ JOB No.____

DEPT. OR PROJECT____

APPENDIX PAGE 2



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

BNL-QA-101
September, 1993

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.

n 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.

n 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.

n 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.

n 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.

n 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:

n 4.4.1 Identification of parts and subassemblies showing integrated flow into end item(s).

n 4.4.2 Identification of critical manufacturing operations as well as inspection and test checkpoints.

n 4.4.3 The Plan may be a single document, or may make use of existing "travelers", or other suitable planning and control documents.

n 4.4.4 Revisions or changes to the Buyer approved Plan must be submitted for the Buyer's review and approval prior to implementation.

n 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.

n 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.

n 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.

n 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.

n 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.

n 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.

n 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:

n 4.10.1 Copies of reports of all required or necessary inspections, examinations and tests, properly validated by the Seller's authorized personnel.

n 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.

n 4.10.3 Copies of nonconformance reports dispositioned as "repair" or "use-as-is".

n 4.10.4 Copies of material test reports for specified materials, showing physical and chemical properties.

n 4.10.5 A Certification of Conformance (See 4.16).

n 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.

n 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.

n 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.

n 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.

n 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.

n 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.

n 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.

n 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 of the 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.

n 4.28 **Weld/Braze Inspection Report:** A report(s) shall be submitted that indicates the complete inspection of welds or brazes from the initial fit up 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.

n 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.

n 4.30 **Non-destructive Test Reports:** All non-destructive 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 non-destructive 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.

n 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.