

STATEMENT OF WORK (SOW)
for
Silicon Deep Reactive Ion Etch Reactor (SiDRIE) with Single Wafer Semi-Automatic Transfer Chamber.

QA Category: A-2



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VERSION CONTROL SHEET

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1 SCOPE

This Statement of Work (SOW) will be the basis for the procurement of silicon deep reactive ion etch reactor (SiDRIE) with single wafer semi-automatic transfer chamber for the Center for Integrated Nanotechnologies (CINT) at Sandia National Laboratories (SNL). The SiDRIE will be procured by Brookhaven Science Associates (BSA) on behalf of the CINT as part of the Nanoscale Science Research Center Recapitalization (NSRC-Recap) project. The SiDRIE reactor supports microfabrication efforts for highly selective, precision etching of single crystal silicon and Silicon On Insulator (SOI) materials for the development of Mid-Infrared Photonics, MEMS and other advanced material research activities. Dual purpose Si etch capability, providing both high speed time-multiplexed, high aspect ratio/through wafer etch and plasma dicing, and also shallow etching of crystalline silicon structures in the sub-micron region with high precision. The new system will include a single 100-200mm transfer chamber, a heated reaction chamber that includes a high power inductively coupled plasma unit, a heated/CW and Pulsed LF biasing electrode with associated gas delivery, vacuum and cooling systems, optical emissions spectrometry and laser interferometry.

1.1 Background

The CINT is a user-oriented research center whose mission is to provide the scientific basis for integration of nanoscale materials and enhanced performance. Research at CINT has an emphasis on exploring the path from scientific discovery to achieving new material properties and functionalities, including the integration of nanostructures into the micro and macro worlds.

1.2 Definitions/Acronyms

ASME	American Society of Mechanical Engineers	NFPA	National Fire Protection Association
ATP	Acceptance Test Procedure	NRTL	Nationally Recognized Test Laboratory
BSA	Brookhaven Science Associates	NSRC	Nanoscale Science Research Center
CFN	Center for Functional Nanomaterials	OEM	Original Equipment Manufacturer
CINT	Center for Integrated Nanotechnologies	SNL	Sandia National Laboratories
ESH	Environment, Safety, and Health	QA	Quality Assurance
FAT	Final Acceptance Test	SBMS	Standards Based Management System
MRB	Material Review Board	SOW	Statement of Work
MRP	Material Requirements Planning	AOA	Automated Objective Aperture

2 APPLICABLE DOCUMENTS

In the event of a conflict between the Technical Specification and the SOW, the Contractor shall immediately notify the BSA Contractual Representative who shall in each instance determine which document takes precedence and advise the Contractor accordingly. Failure to notify BSA of a document conflict shall not relieve the Contractor's responsibility to ensure full compliance to all requirements.

The following documents are an integral part of the SOW; the applicable revision level will be the latest that is in effect at the time of award:

Document Number	Document Title
10CFR851	DOE Worker Safety and Health Program
BNL QA-101	Supplier Quality Assurance Requirements
ASME B30.26	Rigging Hardware
ASME B31.3	Process Piping -2015 Edition
NFPA 70	National Electrical Code – 2020 Edition http://www.nfpa.org/aboutthecodes/AboutTheCodes.asp?DocNum=70
NFPA 70E	Standard for Electrical Safety in the Workplace – 2021 Edition or the most current version in place
ASMEY14.5M-2008	Dimensioning and Tolerancing
ASME BTH-1	Design of Below-the-Hook Lifting Devices, Design Category “A”
No Doc #	Sandia National Laboratories Job Hazard Analysis Template
No Doc #	Relevant BNL SBMS Subject Areas: <u>Cryogen Safety</u> <u>Electrical Safety</u> <u>Lifting Safety</u> <u>Pressure Safety</u> <u>Personal Protective Equipment</u>

3 REQUIREMENTS

In accordance with the applicable specifications, referenced documents, and instructions as defined in this Statement of Work, the contractor shall be responsible for the engineering, purchase of all materials, manufacturing, assembly, inspecting, testing, delivering, installing, commissioning and training on the Instrument.

Safety and code compliance must be paramount at every stage of a project, from the initial concept to the final installation and use. Electrical design and installation must follow the National Electrical Code NFPA 70 and Standard for Electrical Safety in the Workplace NFPA 70E. Contractor must show, in writing, that the equipment functions within the performance parameters specified by the manufacturer(s).

3.1 Contractor Responsibilities

3.1.1 Technical Performance

In accordance with SOW/Technical Specification document and all referenced documents, the Contractor shall engineer, manufacture and assemble the Instrument. The Contractor shall first test the Instrument at the Contractor's facility first, then deliver, test and commission the Instrument at SNL. It is the Contractor's responsibility to ensure that the Instrument complies with all the specification requirements and the safety codes and standards referenced herein.

3.1.2 Tooling/Fixtures/Test Equipment

The Contractor shall be responsible for supplying all materials, including (but not limited to) the construction of all tools, jigs, fixtures, and test equipment required to complete the engineering, manufacturing, assembly, inspecting, testing, delivering, and installing the Instrument.

3.1.3 Factory Acceptance Testing

The Instrument shall be tested at the Contractor's facility in the presence of SNL and/or BSA representatives to demonstrate full compliance with the SOW/Technical Specification. The Instrument shall be fully assembled and be representative of the final as-delivered configuration for Final Acceptance Test (FAT). The tests listed in the SOW/ Technical Specification shall be conducted on the Instrument at the Contractor's facility according to the approved Acceptance Test Procedure (ATP), prior to delivery to SNL.

All test data shall be documented in the Acceptance Test reports and sent to BSA prior to the Instrument delivery. Acceptance of the test data is contingent upon data review and written approval by BSA technical representative prior to shipment of the Instrument.

3.1.4 Installation

3.1.4.1. The Contractor shall be responsible for instrument assembly, startup and qualifications. SNL will not supply personnel for installation tasks other than identified herein. Unloading of containers and trucks, and staging of the Instrument at the installation site, shall be performed by SNL riggers. The Contractor shall not be permitted to drive SNL-owned forklifts for any reason. The Contractor shall submit an installation work plan that includes all onsite installation activities in a step-by-step format at least two (2) months before the scheduled start of installation activities. This plan is a necessary prerequisite for obtaining a work permit and must be approved by SNL prior to the start of installation activities. As part of the work planning process, SNL may conduct a pre-job walk through with the Contractor or relevant subcontractor to ensure proper dimensions, approved anchor points for lifting and travel paths are determined before equipment arrives on site. The person (or persons) responsible for all onsite installation activities shall participate in the work planning process for the purpose of obtaining a work permit. The work permit must be completed prior to start of installation activities. This shall be completed during the Technical Review as well as after the Technical Review in video conferencing and/or teleconferences.

3.1.4.2. All training and safety requirements identified during the work planning process (or by SNL ES&H/Training staff members) shall be successfully completed by Contractor personnel who are participating in onsite installation work prior to issuance of a work permit and prior to installation.

3.1.4.2.1 Contractor employees, including their subcontractor, and lower tier contractor employees, who may be exposed to an electrical hazard (shock and/or arc flash) must be trained to the appropriate level per SNL's Electrical Safety Subject Area in accordance to their exposure.

3.1.4.2.2 LOTO training shall be required for all Contractor employees, including their subcontractor, and lower tier contractor employees, who “work on” systems or components requiring protection of personnel from unexpected energization or startup of machinery and equipment, or the release of hazardous energy during installation, demolition, or service and maintenance activities. Hazardous energy includes mechanical (rotational, gravitational), electrical, chemical, pressure or vacuum (hydraulic, pneumatic), ionizing and non-ionizing radiation, thermal and other energies that may cause harm. LOTO Training must be completed in compliance with SNL’s Lockout/Tagout (LOTO) for Installation, Demolition, or Service and Maintenance Subject Area.

- 3.1.4.3. CINT shall utilize SNL hoisting and rigging personnel to offload and relocate equipment as dictated by SNL work control requirements. Contractor may operate their own rigging/cranes that are installed as part of their equipment, original equipment manufacturer (OEM) components. All rigging equipment, including slings, must first be inspected by SNL. Additionally, any building anchor points intended for use by the contractor for rigging devices such as chain slings or hoists must be approved by SNL beforehand. Contractor shall be responsible for the Instrument until final acceptance.
- 3.1.4.4. Electrical tools/equipment needed for installation shall be inspected by SNL prior to use at SNL, to ensure compliance with SNL’s electrical safety standards referenced herein.
- 3.1.4.5. The Installation Work Plan shall include at a minimum:
 - a. Work instructions/ installation plan: job steps or detailed step-by-step instructions
 - b. Prerequisites: preparatory actions to be performed before work can be started and any administrative and physical requirements (for example, review/ inspection/ approval of equipment, training, etc.)
 - c. Precautions: precautions that must be observed during performance of work
 - d. Identification for hold points and other monitoring
 - e. Operational limits imposed
 - f. Coordination of tasks
 - g. Special conditions for working alone
 - h. Scheduling, coordination, and notification
 - i. Changes impacting configuration management
 - j. Post work testing and acceptance: guidance concerning post work testing to ensure proper completion of work and/or system readiness to return to service
 - k. ES&H work controls for mitigating identified hazards based on the following hierarchy, as practical:
 - i) Elimination/substitution of hazards
 - ii) Engineering controls
 - iii) Administrative controls and work practices
 - iv) Personal protective equipment
- 3.1.4.6. Work involving exposure to an electrical hazard must be planned in accordance with the requirements of SNL’s Electrical Safety Subject Area in conjunction with SNL’s Work Planning and Controls Subject Area.
- 3.1.4.7. Work involving controlling hazardous energy sources for installation, demolition, or service and maintenance must be planned in accordance with the requirements of SNL’s

Lock/Tagout (LOTO) for Installation, Demolition, or Service and Maintenance Subject Area in conjunction with Work Planning and Controls Subject Area.

3.1.4.8. Note that disposal of waste packing material shall be the responsibility of SNL.

3.1.4.9. The Contractor shall supply all bolt-on wheels, transportation carts and custom tooling required for the installation of the Instrument which will remain the property of the Contractor at Contract Completion. The Contractor shall use plywood or similar protective material to prevent damage to flooring.

3.1.4.10. During assembly of all components, proper alignment and tightening shall be assured by the use of appropriate tools (e.g., torque wrenches) and by following the procedures recommended by the manufacturer, including the use of alignment tools and bolt-tightening sequences, etc.

3.1.4.11. Installation includes hardware and software setups for computer-based remote control of the Instrument and data processing and analysis.

3.1.5 Acceptance Testing at SNL

The Instrument shall be tested at SNL by the Contractor to demonstrate full compliance with this SOW/Technical Specification documents. SNL shall witness acceptance testing and shall be given sufficient notice to ensure the appropriate staff are present. The tests listed in the SOW/Technical Specification shall be conducted on the Instrument at SNL according to the ATP, prior to final acceptance.

3.1.6 Commissioning

The Contractor shall be responsible for the commissioning of the Instrument. Commissioning shall be defined as all test and demonstration work performed on site at SNL. SNL shall witness Instrument commissioning and shall be given sufficient notice to ensure the appropriate staff are present.

Commissioning of the Instrument on site in its final configuration shall be performed with samples supplied by SNL. The Instrument shall be able to demonstrate the performance specifications as outlined in the separate Technical Specification document.

3.1.7 Training

During the commissioning phase of the contract, the Contractor shall provide hands-on training at SNL for two (2) SNL scientific and/or technical staffs for the safe operation and maintenance of the Instrument. SNL scientific and/or technical staff will review training plan prior to training and approve during the final acceptance process. This training shall be conducted at SNL for a period of five (5) working days during commissioning for the Instrument. Additionally, the Contractor shall provide two (2) sessions of hands-on user training at SNL for two (2) SNL personnel, each consisting of five (5) working days, for its operation. These training sessions will be scheduled within two (2) months of SNL approval of the final commissioning report.

3.2 Manufacturing Requirements

3.2.1 Acceptance Test Procedure

The contractor shall provide an ATP that is in accordance with this SOW/Technical Specification and all reference documents noted herein. The ATP must be approved by SNL prior to use. The ATP shall ensure that all test requirements as defined in the safety codes referenced herein are achieved.

3.2.2 Commissioning Reports

A Commissioning report shall be provided by the Contractor. The report shall include, but not limited to, the results of all tests performed including graphs, printouts, drawing updates, calibration data, and control system tuning parameters. The Contractor shall be responsible for remedying any non-compliances in regards to the requirements in this SOW/Technical Specification, subject to BSA approval. A summary sheet including demonstrated remedy of any non-compliances shall be included. Final acceptance is contingent on BSA data review and written approval by BSA.

3.3 Management

3.3.1 Program Plan

The Contractor must deliver a detailed program plan, which includes a milestone schedule defining the design validation, manufacturing, inspection, testing, installation, and commissioning phases in sufficient detail to allow regularly scheduled progress monitoring. The program plan shall list specific intermediate milestones with a clearly defined schedule that will form the basis of the regular progress meetings detailed below. It shall be submitted for review and approval by BSA within two (2) weeks after award of contract.

3.3.2 Progress Teleconference

Within (2) weeks after award of contract, monthly program technical and progress teleconferences and/or meetings between the Contractor and SNL shall be held at a mutually scheduled time. The discussions shall include the Contractor's progress, technical and contractual questions, presentations of analysis or testing results, design reviews, value engineering, trouble shooting, material status, tooling status, resources, and manufacturing issues.

3.3.3 Manufacturing/Inspection/Test Plan

A manufacturing plan shall be developed which identifies the manufacturing processes of work required to complete all efforts as identified in this SOW. It shall be submitted for review and approval by BSA within (6) weeks after award of contract. The plan may be a single document, or may make use of existing travelers or other suitable planning and control documents. It shall address the Material Requirements Planning (MRP), and at a minimum include manufacturing, inspection, and test steps including identification of critical manufacturing operations and parts/subassemblies showing integrated flow into the end item(s). If the Contractor does not have an MRP system in place, then details for purchasing all raw materials, shop loading (by work center), and a schedule for manufacturing all components and assemblies through packaging and shipping shall be provided by the Contractor.

3.3.4 Performance Reporting

Throughout the life of the contract, the Contractor shall supply a written report by the fifth of every month to the SNL technical representative and BSA contractual representative clearly detailing progress through the prior month with respect to the program. This shall include milestone charts, detailed progress, open items, problems, recommended solutions, and risk mitigation.

3.4 Documentation and Data Management

3.4.1 All the documentation provided by the Contractor shall be in English.

3.4.2 All engineering drawings shall:

- a. Be formatted in accordance with ASME Y14.5M-2008
- b. Have views shown in third angle projection
- c. Use English or Metric dimensions and tolerances
- d. Have a separate parts list

- e. Have part number designations in accordance with LT-ENG-RSI-STD-002

3.4.2 The Contractor shall provide an electronic copy (email, plus either CD ROM or USB data storage device) of all required documentation as noted in this SOW. Manufacturing drawing CAD files of all components and assemblies shall be compatible with Solidworks or Fusion CAD software in these formats: STP or IGS.

3.4.3 **End Item Documentation Package**

The Contractor shall provide an electronic copy of the End Item documentation package in accordance with the schedule set forth in this SOW. The End Item documentation package shall consist of the following documentation:

- a. Acceptance Test Reports and copies of test certificates
- b. All manuals
- c. Completed travelers (documents following instrument throughout manufacturing process)
- d. Manufacturing/ Inspection/Test data for inspections performed at incoming inspection or during manufacturing
- e. Certificate of Conformance as specified in Section 4
- f. Copies of specification/ data sheets for viewports.
- g. Copies of the Contractor's (or Subcontractors') weld certification/test reports
- h. Documentation of required proof test procedures and results for vacuum vessels
- i. Certification that all required pressure relieving devices used are approved by either the ASME or National Board of Boiler Inspectors (NBBI) Acceptance Test Reports and copies of test certificates

3.4.3.1 *Documents*

The Contractor shall provide an electronic copy (on a USB stick or BSA identified FTP site, in Microsoft Office format, or drawing format described in section 3.4 with formal "controlled copies" in PDF format) of the following documentation:

- a. All documentation identified in this SOW
- b. All parts and assembly solid models
- c. User/operational manual

3.4.3.2 *Operation and Maintenance Manuals*

The Contractor shall provide the operation and maintenance manual in electronic format with formal PDF format on a USB stick and provide two (2) hardcopies.

Operation and maintenance manuals shall include:

- a. A title to the front cover, identifying the title of the project and the date of issue
- b. A table of contents
- c. A general description of the Instrument installation
- d. Copies of any permits to use copyrighted material
- e. A technical description of each system and subsystem to allow the correct and safe operation, maintenance and repair of all systems and subsystems installed, including:
 - i. *Operating manuals for all modes of operation described in the Technical Specification document*

- ii. *Standard maintenance operations, not limited to beam alignment and adjustment of lens operations*
- iii. *Troubleshooting techniques*
- iv. *Recommendations for preventive maintenance*
- v. *Disassembly, repair, cleaning and adjustment procedures*
- vi. *List of recommended spare parts to keep on hand*
- vii. *Software documentation and source code for open source processing routines*

3.5 **Configuration Management**

The Contractor shall establish and maintain a configuration control 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.

3.6 **Software Requirements**

The Contractor shall provide and maintain the capability to receive and send CAD files compatible with Solidworks or Fusion CAD software of all components or assemblies in STP or IGS file formats at the request of SNL.

The contractor shall provide a duplicate or back-up of all software and supporting files used to operate the system by means of external hard drive.

3.7 **Environment, Safety and Health (ESH)**

The Contractor shall design and build all equipment in accordance with ESH requirements in the appropriate specifications, codes, standards, and other documents listed in Section 2 of this SOW.

3.7.1 **Contractor Work on Site at SNL**

SNL will identify and designate space necessary to safely perform staging and installation activities. Any cordons, stanchions, or barriers required to designate and isolate the Contractor's work area will be supplied by SNL. Contractor/manufacturer personnel shall follow all applicable requirements of the SNL as it relates to work control for contractor/subcontract work. The JSA must be completed by the contractor in collaboration with SNL staff and meet the SNL requirements, addressing all hazards that may be present during the work and the controls required. It must be submitted prior to on-site contractor work to the SNL technical representative for review according to the Terms and Conditions of the contract. The SNL technical representative will act as a conduit to SNL subject matter experts, as needed.

A Job Safety Analysis (JSA) including a hazard list identifying all hazardous materials associated with the instrument, including Safety Data Sheets (SDS) shall be submitted to SNL for approval with the Installation Work Plan.

3.7.2 **Electrical Safety**

- 3.7.2.1 All electrical equipment and components must be in accordance to U.S. standards, must comply with NFPA70 and shall be approved listed by a Nationally Recognized Testing Laboratory (NRTL) and the BSASNL Electrical Authority Having Jurisdiction as specified in BNL-QA-101 document, clause 3.10. Note that the CE mark is not a NRTL

certification marking. In the case that the instrument is NRTL listed prior to delivery it will be inspected once installed to ensure NRTL listing is still valid. In the case of the instrument that is not NRTL listed as delivered from the Contractor/manufacturer, a third-party Field Evaluation Body (FEB), recognized by LANL electrical Authority Having Jurisdiction (AHJ), must perform an evaluation of the equipment. Results of the FEB evaluation must be provided to LANL electrical AHJ and approved before the equipment is to be operated

All electrical work must be performed only by qualified electrical workers. Contractors who perform electrical work must meet LANL qualification requirements, including submitting proof of training such as for NFPA 70E, OSHA 10-hr, Cardio-Pulmonary Resuscitation/ First Aid, lockout/tagout, depending on the nature of the electrical work.

3.7.2.2 The contractor shall supply the following to BSA and SNL:

3.7.2.2.1 Documentation for the equipment installation, operation, service and maintenance that describes operation, shutdown, safety concerns, and nonstandard installations.

3.7.2.2.2 Schematics, drawings, and bill of materials describing power feeds, voltages, currents and parts used for construction, maintenance, and operation of the equipment.

3.7.2.2.3 Safety Requirements and emergency shutdown procedures of equipment including lockout/tagout (LOTO) requirements.

3.7.2.2.4 Documentation of specific hazards associated with the equipment.

3.7.2.2.5 Documentation shall be provided if special tools, PPEs, or other equipment is necessary for proper maintenance and operation of equipment.

3.7.2.3 The contractor shall include safety-related design concepts for electrical equipment and installations. Following methods can be considered:

3.7.2.3.1 Installing finger-safe components, covers, and insulating barriers to reduce access to exposed energized electrical conductors and circuit part due to inadvertent movement.

3.7.2.3.2 Substituting ≥ 50 volts control circuit with non-hazardous < 50 volt circuits.

3.7.2.3.3 Separate enclosures for hazardous and non-hazardous electrical conductors and circuit parts.

3.7.2.4 Contractor shall mark the equipment which includes the NRTL certification mark/Field Evaluation mark, Manufacturer, model #, manufacturing date, drawing number, current draw, power, frequency voltages entering and leaving the control cabinets, and equipment. Caution, Warning, or Danger labels shall be affixed to the exterior describing specific hazards and safety concerns. Refer to ANSI Z535, Series of Standards for Safety Signs and Tags, for more information on precautionary marking of electrical system or equipment.

3.7.2.5 All exposed electrical connections/terminations \geq volts shall be covered so that all non-insulated charged surfaces protect workers from the hazards of electrical shock during operation and when performing service & maintenance. Plexiglas® is not allowed; Lexan® may be used for inadvertent contact. Electrical insulation must be Low Smoke, Zero Halogen (LSZH), Fire Retardant, and rated for its application. Non-LSZH cables shall be permitted in length < 50 feet.

3.7.2.6 Electrical wiring must be installed in a neat and workmanlike manner.

3.7.2.7 Teflon® shall be allowed as an insulator in small quantities.

3.7.3 Pressure Safety

3.7.3.1 For process piping requirements, the contractor shall use ASME B31.3 or equivalent approved by BSA or SNL in writing. The gaseous nitrogen and cooling water lines shall be designed to ASME B31.3 requirements. Seamless and welded tubes shall be designed to ASTM A269-69 and A632-69 requirements. In all cases, 100% proof testing shall be completed on each component to 150% of the maximum working pressure for hydrostatic tests, or 110% of the maximum working pressure for pneumatic tests.

3.7.4 Fire Safety

3.7.4.1 The Contractor shall ensure that any electrical equipment or wiring minimizes combustibility by the use of flame-resistant materials.

3.7.4.2 The Contractor shall ensure that any cable tray minimizes the possibility to damage cables. All cables to be installed in a cable tray shall be rated for Cable Tray use and conform to NFPA 70 requirements. The cable shall have the TC (Tray Cable) marking and be NRTL listed. markings. If a Contractor elects to use a cable not marked for Tray Cable use, then the Contractor must justify the election of the conductor in writing. The justification must detail why the requirement cannot be met, describe the proposed alternative, and state how it is equivalent to the requirement. shall use a cable that will meet IEEE 1202 or equivalent approved by BSA in writing. BSA and SNL shall approve the use of all non-NRTL marked listed tray cables in advance of the Contractor ordering the cable.

3.7.4.3 All other cables shall be Low Smoke Zero Halogen (LSZH). Non-LSZH cables shall be permitted in length <50 feet.

3.7.5 Attachment Points and Lifting Fixtures

3.7.5.1 The Contractor shall provide lifting eyes, either permanent or removable, on each piece of equipment or stand of sufficient capacity and number to allow the equipment to be safely lifted. All lifting fixtures will be inspected and approved by SNL before use.

3.7.5.2 All lifting fixtures must meet the requirements specified in ASME B30.26 (Rigging Hardware) and ASME BTH-1 (Design of Below-the-Hook Lifting Devices, Design Category "A"). Hoist rings must meet ANSI B30.26 requirements.

3.8 Packaging

In preparation for shipping, the Instrument shall be covered or wrapped for protection against weather elements, dust, and damage to projections, shock loads, impacts, and rubbing. The Instrument shall be properly braced and cushioned within the packing so that it will not shift during handling and shipment. The method of shipping will be specified by BSA one (1) month prior to delivery.

3.8.1 After the component or piece of the Instrument has been cleaned and tested, it shall be packed to ensure that it remains clean and free from damage during both storage and shipping. All seal faces and/or knife edges should be protected. Vacuum components shall be back-filled with dry nitrogen gas.

3.8.2 Added protection against contamination and humidity shall be given to the sensors and electrical connections. Durable materials, such as clean wood, bubble wrap, or similar non-contaminating materials, are to be

used to support and protect the components from one another during transit and storage. Peanut-type material shall not be used for packaging.

3.8.3 All assemblies or sub-assemblies with *moving* parts shall be secured to prevent damage due to unwanted motion or vibration. The packaging must be designed to withstand acceleration loads in excess of twice the acceleration due to gravity ($>2g_0$).

3.8.4 Each packing crate shall be fitted with Shockwatch and Tipwatch sensors or an *equivalent* approved in writing by BSA.

3.8.5 The container shall be appropriately labeled with the listing of contents, destination, gross weight, location of center of gravity, purchase order number, and contact information.

3.9 **Warranty**

The Contractor shall provide a one-year warranty on all parts and labor commencing with SNL's acceptance of the installed and tested Instrument. A recommended spare parts list shall be available from the Contractor. Remote diagnosis and troubleshooting from Contractor shall be available upon request within 24 hours during regular workdays.

4 **QUALITY ASSURANCE**

The Contractor shall maintain and apply an effective QA program for the design, manufacture, and testing of all systems and equipment provided. The system shall meet the requirements of the ISO-9001 Standard, "Quality Management System Requirements," American Society of Mechanical Engineers (ASME) Nuclear Quality Assurance (NQA-1), or equivalent Quality Management System/QA industry standard. The Contractor shall supply the necessary documentation to demonstrate this compliance. Post-award surveys may be required and shall be supported.

4.1 **Quality Assurance Requirements**

The QA requirements form part of this SOW, specifically this includes the requirements detailed in Sections 3 and 4.

4.2 **Notification of Change to Design, Methods, or Processes**

The Supplier shall immediately notify the Buyer of any significant changes (those that may affect form, fit, function, reliability, safety, or interchangeability) in product design, fabrication methods, materials, or processing from those used by the Supplier at time of Supplier's quotation or offer to the Buyer, which resulted in the PO.

4.3 **Records**

The Supplier shall 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 procured items. These records shall be made available to the Buyer's representative for review upon request. These records shall be maintained for a minimum of three (3) years, unless otherwise specified in the procurement documentation, after the completion of the PO/contract.

4.4 Franchised/Licensed “Distributor” Traceability

Products that are not purchased directly from the Original Equipment Manufacturer (OEM)/Original Component Manufacturer (OCM) must be purchased only from a franchised/licensed distributor of the product being offered. The distributor shall ensure traceability of all products to the original equipment manufacturer by identifying the original manufacturer for each lot/date code on the Certificate of Conformance. The distributor shall provide a copy of the Manufacturer’s certificate for the lot number being supplied, along with their franchised distributor certification. The distributor shall not use unapproved brokers (any company, person, or entity who is not an OEM/OCM) for the purchase of components and parts, unless pre-approval has been granted by Brookhaven Science Associates (BSA).

4.5 Material Review Board (MRB) Authority

- 4.3.1 Unless, and until, Material Review Board (MRB) authority has been requested and received, the Contractor shall be restricted to dispositions of rework, scrap, and return-to-vendor; i.e., the contractor shall not use nonconforming materials via unique or standard repair processes, nor via use-as-is-dispositions.
- 4.3.2 The Contractor shall not delegate MRB authority to suppliers without the prior knowledge and written approval of BSA.
- 4.3.3 BSA may delegate MRB Authority to the Contractor, when requested by the Contractor. Such request shall be accompanied by: 1) the Contractor’s procedure for the identification, evaluation, disposition, and control of non-conformances; and 2) the resumes of personnel to be assigned as MRB members.
- 4.3.4 All non-conformances requiring MRB action shall be documented and sent to the BSA technical representative within five (5) working days of the decision.

4.6 QA Flow-Down

The Contractor shall ensure a proper and complete flow-down of all applicable QA requirements to its suppliers and sub-tier suppliers.

4.7 Certificate of Conformance

The Contractor shall ensure a proper and complete flow-down of all applicable QA requirements to its suppliers and sub-tier suppliers. With each shipment, the Contractor shall submit a Certificate of Conformance (C of C). In case of drop shipment, a copy of the certificate shall be submitted to BSA at the time of shipment. The certificate shall include the title of and be signed by an authorized representative of the company, and shall constitute a representation by the Contractor that:

A. Materials used are those which have been specified by BSA, and that the items delivered were produced from materials for which the Contractor 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 included as part of the PO/contract, or BSA-approved procedures or specifications;

C. The items as delivered comply with all applicable drawings, specifications, deviations/waivers and other requirements of the procurement documentation; and-

D. When specified, cleaning and cleanliness requirements have been completely satisfied. The C of C shall reference the Contractor's applicable cleaning procedures.

5 DELIVERABLES

The Contractor shall supply the following:

Item	Deliverable	Due	SNL Approval
1	Program Plan	2 weeks after award of contract	Yes
2	Technical and Progress Teleconference	2 weeks after award of contract/weekly	No
3	Performance reports	5th of each month after receipt of Program Plan within 2 weeks of key project milestones	No
4	Manufacturing/Inspection/Test plan	6 weeks after contract award	Yes
5	Installation Work Plan	26 th week after award of contract	Yes
6	Factory acceptance testing	50 th week after award of contract	Yes
7	Delivery of the Instrument	52 th week after award of contract	Yes
8	Site Acceptance Test Report	60 th week after award of contract	Yes
9	Commissioning Report	62 th week after award of contract	Yes

6 SCHEDULE/ MILESTONES

The following schedules are for planning purposes only. Schedule requirements set forth in the contract will take precedence.

Milestone	Calendar weeks after award
Delivery to NL	52 th week
Commissioning of instrument	60 th week
Training of instrument	60 th week
Delivery of End Item Documentation Package	62 th week

7 VALUE ENGINEERING

- 7.1 The Contractor is encouraged to make recommendations for changes that might lead to an improvement in performance, reliability, quality, safety, or reduction in cost. Simplicity in operation, ease of maintenance, and an improvement in the performance and reliability of the specific functions beyond the requirements of this specification are objectives which shall be considered in the production. Where it appears a substantial improvement in simplicity of design, performance, ease of maintenance or reliability will result from the use of materials, parts and processes other than those specified, it is desirable that their use be investigated. When investigations point to advantages that may be realized, the recommendation for change shall be

presented to BSA for review and, if approved, authorized in writing. An equitable agreement will be negotiated between BSA and the Contractor to share the savings of any recommended change that is approved and implemented.

