

Brookhaven National Laboratory
 Brookhaven Science Associates
 Collider-Accelerator Department

SOW No. 113553
 Issue Date: 11 September 2006
 Rev. No. A
 Rev. Date: 20 December 2006

Title: Statement of Work for the EBIS Linac

QA Category: A-2

- Cognizant Engineer: _____
 L. Snyderstrup Date
- EBIS Physicist: _____
 D. Raparia Date
- Project Manager: _____
 J. Alessi Date
- Project Integrator _____
 M. Okamura Date
- Chief M.E.: _____
 J. Tuozzolo Date
- Quality Assurance _____
 D. Passarello Date

Revision Record

Rev. No.	Date	Page.	Subject
A	12/20/06	2	Paragraph 1.3.1, 4 (j): Change 'Lead Shielding' to 'X-ray Shielding'
A	12/20/06	4	Paragraph 4.3, 6.: Add X-ray Shielding design

1.0 General

- 1.1 Scope. The Statement of Work (SOW) outlines the terms of the procurement agreement between Brookhaven National Laboratory (BNL) and the IAP for an RF Linac. The Linac is to be installed in a new heavy ion preinjector at Brookhaven National Laboratory (BNL). The preinjector will serve the Relativistic Heavy Ion Collider (RHIC) and the NASA Space Radiation Laboratory (NSRL), and will include an Electron Beam Ion Source (EBIS), a RFQ, and a Linac. The scope of work includes the analysis, engineering, design, manufacture, delivery, and assistance in the installation and testing of the Linac.
- 1.2 Purpose. The purpose of the SOW is to define the requirements for project management, schedule, submittals, and delivery that are applicable to the procurement agreement. The SOW is not intended to impose unreasonable requirements on IAP. The SOW serves to protect the interests of IAP and BNL in the execution of the contract and to ensure that the Linac will be manufactured in accordance with the technical specification in an efficient, cost effective, and timely manner.
- 1.3 Responsibilities. The agreement will consist of a cooperative participation of BNL and IAP in the design, test and evaluation of the Linac. The responsibilities of each are outlined below:

1.3.1 IAP's Responsibilities

1. Particle dynamic simulations and model predictions of the Linac accelerator.
2. Design and development of the Linac cavity, drift tubes, supports, lenses, and ancillary devices.
3. Technical specifications and drawings of Linac, and any associated tooling and fixturing required for the manufacture, assembly, and installation of the Linac.
4. Manufacture and assembly of the Linac, including, but not limited to the following:
 - a. Tank or cavity.
 - b. Drift tubes.
 - c. DT supports.
 - d. Quadrupole Lenses.
 - e. Tuner(s).
 - f. Power input coupler(s).
 - g. RF Pickup(s).
 - h. Linac stand.
 - i. Spare parts, including standard and non-standard parts.
 - j. X-ray shielding.
5. Status reports.
6. Test Plan/Procedures.
7. Testing and evaluation at IAP's facility and at BNL.
8. Delivery, assembly, and alignment at BNL.

9. Collaboration with BNL in testing and evaluation at BNL.
10. Collaboration as required in the long-term evaluation of Linac after installation in EBIS facility.
11. Special Procedures (e.g., for lifting, moving, aligning, tuning).
12. Final Report.

1.3.2 BNL's Responsibilities:

1. Definition of beam parameters.
2. Installation, assembly and alignment at BNL.
3. Testing and performance evaluation at BNL.
4. Continued long term evaluation of Linac performance.

1.4 Exchange of Information

- 1.4.1 The exchange of information between BNL and IAP is mandatory in so far as it is necessary to achieve the objectives of the agreement. Parameters obtained by IAP during simulations and calculations shall be available to BNL for particle dynamic calculations for the beam line. The documentation of final measurements and test results by either IAP or by BNL is an essential part of the agreement. Information considered proprietary or confidential by either BNL or IAP shall be treated accordingly and safeguarded from public release.

2.0 Terms and Abbreviations

<u>Term or Abbreviation</u>	<u>Definition</u>
BNL	Brookhaven National Laboratory
CAD	Collider Accelerator Department
SOW	Statement of Work
P.O.	Purchase Order

3.0 Documents and Standards

- 3.1 The following documents are an integral part of the statement of work (SOW):

- 3.1.1 Specification CAD-1187, "Specification for EBIS Linac"
- 3.1.2 BNL-QA-101, "BNL Seller Quality Assurance Requirements."

- 3.2 Conflicts. In the event of a conflict between the contract, technical specification and this Statement of Work, IAP shall immediately notify BNL. BNL will determine which document takes precedence and advise IAP accordingly.

- 3.3 Revisions. Any specification and/or SOW revisions shall be documented and signed by both parties. Cost changes resulting from revisions shall be recorded and approved in writing by both parties. IAP is responsible for using the most current revision of the technical specification and statement of work.

4.0 Submittals

4.1 Schedule. A preliminary schedule with major milestones shall be submitted within 30 days of the P.O. date. Any potential program delays should be identified at this time. The schedule shall identify all aspects of the work from analysis and design through final acceptance testing at BNL, including, but not limited to, the following:

1. Physics simulations and model predictions
2. Preliminary design
3. Preliminary design review
4. Final manufacturing drawings and specifications
5. Final Design Review
6. Manufacture of components and final assembly
7. Test procedures
8. Pre-Shipment testing
9. Delivery of Linac to BNL
10. Acceptance testing
11. Final Report

4.2 Manufacturing Plan. A manufacturing plan with important manufacturing steps shall be submitted within 60 days of the P.O. date. The plan may be a process flow diagram with time durations for each step shown. The plan shall identify manufacturing processes for parts and subassemblies, showing the coordinated flow of work required to complete the final assembly. The plan shall include critical manufacturing operations (for example, plating), inspection/test milestones, and long delivery items that need to be expedited.

4.3 Preliminary Design. IAP shall submit three copies of the preliminary design documents in hard copy 2 weeks prior to the Preliminary Design Review (See 5.1). The preliminary design shall include specifications, analyses, and preliminary assembly drawings of the Linac. The preliminary drawings shall include, as a minimum, an assembly drawing of the Linac for review and evaluation, drawn to scale, showing basic configuration and all essential components. A configuration drawing of the Linac support stand shall be included. Non-standard seals for ports and flanges shall be identified at this time. The preliminary design submittal shall include a report of calculated beam parameters. This report should include, but not be limited to, the following for both Au³²⁺ and He²⁺:

1. Linac transmission vs. input beam current.
2. Linac transmission vs. input beam emittance.
3. Output emittance vs. input beam current.
4. Transmission, output transverse and longitudinal emittances vs. input beam energy.
5. Estimate of RF power requirement, Q, and shunt impedance.
6. X-Ray shielding design and estimate of X-Ray levels around the cavity.
7. LORASR input file.

An estimate of facility utility requirements needed to support operation of the Linac shall be included, such as preliminary power supply parameters and other power requirements, cooling water requirements, and pneumatic or nitrogen flow, etc. The review of the preliminary design by BNL will be completed within 2 weeks after receiving the preliminary design documents from IAP. Detailed design of the Linac shall not start until acceptance of the preliminary design by BNL.

- 4.4 Test Plan and Procedures. A test plan for preliminary testing prior to shipment shall be provided at least 1 month prior to the start of testing. The pre-shipment tests will include vacuum tests and low power RF tests. There will be no high power RF testing at this time.
- 4.5 Final Design Documents. IAP shall submit three copies of the final design documents in hard copy within 4 months after the P.O. date which includes the following:
 1. Manufacturing and assembly drawings, including the top assembly drawing(s), and detail drawings for the tank showing types and sizes of ports (for vacuum pumps and gauges, power, tuner, cooling, etc.), drift tubes, supports, quadrupole lenses, tuning devices, and other ancillary devices.
 2. Technical specifications.
 3. Spare parts list, identifying standard and non-standard replacement parts and quantities.
 4. Results of simulations and model predictions.
 5. Power supply specifications.
 6. Final list of utility requirements. Power for tuner controls or other devices, water cooling pressure, temperature, and flow requirements, pneumatic or nitrogen flow, etc.

Upon delivery of the Linac to BNL, three hard copies of updated, as-built manufacturing drawings and specifications shall be submitted. At this time computer files of the drawings shall be provided as AutoCAD 2000 .dwg or .dxf compatible. A 3D drawing of the full assembly shall be provided, preferably as a simplified representation or 'shrinkwrap' file compatible with (or can be imported into) ProEngineer, AutoCAD Desktop, or Inventor.

- 4.6 Special Procedures. Upon delivery of the Linac to BNL, IAP shall provide any special procedures, describing equipment used, fixturing, steps, and calibration methods. These procedures include, but may not be limited to, the following:
 1. Assembly and lifting.
 2. Alignment, including, but not limited to:
 - a. Method for verifying, setting or adjusting drift tube positions along the cavity length;

- b. Method for transferring inside chamber datums to outside chamber datum targets;
- c. Quadrupole lens alignment.
3. Frequency measurement.
4. Tuning method(s).
5. Cleaning.

4.7 Reports.

4.7.1 Test Report. The final test report shall include all the results of pre-shipment tests and final acceptance testing, including correlations of model predictions with test results. Any occurrences of non-conformance with the requirements of the specification shall be reported and assessed in the final test report.

4.7.2 Progress Reports. IAP shall submit a report every 3 months either as a computer file or hard copy that describes progress during the previous period. The report shall include a listing of schedule milestones that have been met or are late with revised plans for timely completion. The report shall be submitted by the 15th day of the month following the reporting period.

4.8 Quality Assurance Documentation. Material data sheets for major components, vacuum leak test results, etc. in accordance Section 4.0 of the technical specification are required.

5.0 Design Reviews

5.1 Preliminary Design Review. Within 90 days after the P.O. date a review of the preliminary design will be conducted. The review will consist of a presentation of the preliminary design at IAP's facility.

6.0 Inspections and Tests

6.1 'In Process' Testing and Inspections. Witnessing of inspection, testing, or manufacturing milestones given in the manufacturing plan may be conducted at the discretion of BNL. Reasonable notice of 15 days by IAP to BNL is required.

6.2 Rework and Repairs. The following definitions apply:

1. Repair - Restoration of an item to conform to the manufacturing drawing or an acceptable condition through BNL approved repair procedures (e.g. welding).
2. Rework - The completion or correction of an item to a conforming condition using conventional operations, which are part of the normal manufacturing process. Notification of rework is not required.

If repairs are required to any component during manufacturing, the process shall stop and BNL shall be immediately notified and plans for repair shall be submitted. BNL may at their discretion ask for retesting or additional information to support the planned repair. Proposals for repair shall include testing the effectiveness of the repair and for evaluating potential damage to the existing work. No proposed repair shall be initiated without approval of BNL, and no repair shall be considered successful without inspection and approval by BNL.

6.3 Pre-Shipment Testing. Prior to shipment to BNL, the full Linac system will be tested at IAP's facility in accordance with the test plan. Performance criteria will be demonstrated and recorded. BNL shall be provided 4 weeks notice prior to the tests to witness all or a subset of this testing.

6.4 Acceptance Testing. Upon delivery, IAP will participate in the assembly and operation of the Linac in the test line. The Linac will be operated and tested to verify conformance with the design parameters. When the Linac has met the performance specification to the satisfaction of both IAP and BNL, acceptance will be made. Assembly and acceptance testing shall take place within six weeks of delivery. The contract ends after completion of beam tests in the test line at BNL and the receipt and acceptance of the final test report.

7.0 Delivery.

7.1 Delivery shall be made at Brookhaven National Laboratory, Upton, Long Island, New York. The Linac shall be delivered within 21 months after contract award. IAP shall coordinate delivery with Collider Accelerator Department personnel.

8.0 Shipping

IAP shall design and fabricate packaging to protect against loads and environments that may be incurred during handling and shipment. Wooden containers that prevent impact damage and bending shall be used. System components shall be blocked, braced, and protected from damage using polymer blocks, 'foam-in-place' technology, or other suitable means. Two sets of recording accelerometers rated at 2 and 5 g's for three directions of motion shall be firmly attached to each susceptible truck package. The packaging shall include lifting points suitable for lifting the system skid from above as well as provisions for lifting with a fork truck. All pressure vessel openings shall be sealed. All conflat flanges shall be covered for impact protection. The Linac shall be sealed inside a new, clear polyethylene or nylon bag, IAP shall be responsible for procuring all permits, etc. necessary for the delivery of the magnet system to the BNL's facility.

9.0 Quality Assurance

9.1 The Quality Assurance applicable requirements of BNL-QA-101, BNL Seller Quality Assurance Requirements are listed in Specification CAD-1187, Section 4.0.

9.2 Subcontractors. IAP is responsible for the performance of its subcontractors. BNL may inspect the facility of any subcontractor at BNL's discretion. IAP is responsible to provide and control all specifications and drawings to be used by subcontractors. This technical documentation shall be available for review by BNL if requested.

9.3 Responsibility for Inspections and Tests. IAP shall be responsible for the performance of the Pre-Shipment Tests and all inspections. IAP shall provide the space, personnel, and test equipment to conduct the Pre-Shipment Tests and inspections. The Pre-Shipment Tests shall be performed at IAP's site or other facilities acceptable to BNL. The tests specified are the minimum required by BNL and are not intended to replace any tests and inspections normally performed by IAP to assure conformance of the Linac to the specification.

9.4 Records. Records of QA documentation, visual, dimensional and other in process inspections, tests, chemical treatment and cleaning procedures, plating operations, documentation of manufacturing irregularities and repairs, etc. shall be retained and made available for a period of one year after delivery of the Linac.

10.0 Fixtures

10.1 Handling and assembly fixtures paid for by BNL shall be shipped along with the Linac, at BNL's option.