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STATEMENT OF WORK
for the
HSR 49.2 MHz RF System Circulators

Quality Classification: A-3

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REVISION HISTORY

Revision #	Effective Date	Summary of Change
00	3/05/2026	Initial Release
01	7/09/2026	Revisions from FDR feedback.

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LIST OF ACRONYMS

ASME	American Society of Mechanical Engineers
ATP	Acceptance Test Procedure
BNL	Brookhaven National Laboratory
BSA	Brookhaven Science Associates
CAD	Computer-Aided Design
EIC	Electron-Ion Collider
ESH	Environment, Safety and Health
FA	First Article
FDR	Final Design Review
HSR	Hadron Storage Ring
ISO	International Organization for Standardization
MRP	Material Requirements Planning
MIT	Manufacturing, Inspection, and Test
NCRF	Normal Conducting Radiofrequency
PDR	Preliminary Design Review
PO	Purchase Order
QA	Quality Assurance
RF	Radiofrequency
SOW	Statement of Work

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Statement of Work for the HSR 49.2 MHz RF System Circulators

1 SCOPE

This Statement of Work (SOW) will be the basis for the procurement of the Hadron Storage Ring (HSR) 49.2 MHz Radiofrequency (RF) System Circulators to be used at the Electron-Ion Collider (EIC) at Brookhaven National Laboratory (BNL) managed by Brookhaven Science Associates (BSA). This document outlines the Contractor's responsibilities and obligations necessary for completing the requirements as set forth herein.

1.1 Background

The EIC Project will design, build, and install the accelerator hardware for a new electron storage ring, an electron injector, and modifications to the hadron ring required to produce an electron-ion collider and infrastructure. It will include one interaction region, with an allowance for a second, and one detector. The facility is designed to meet requirements to ensure high reliability and availability for the user program.

The High-Power RF (HPRF) System for the HSR 49.2 MHz RF System will be used to provide power to the 49.2 MHz Normal Conducting RF (NCRF) Cavities. These cavities will be used for the bunch splitting of hadron beams in the HSR of the EIC. During operations of the cavity, the full RF can be reflected towards the RF system requiring a circulator to protect components.

2 APPLICABLE DOCUMENTS

In the event of a conflict between the Technical Documentation and this SOW, the Contractor shall immediately notify the BSA Contractual Representative who will 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
BNL-QA-101	Brookhaven National Laboratory Supplier Quality Assurance Requirements
EIC-RFS-SPC-012	Technical Specification for the HSR 49.2 MHz RF System Circulators

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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 designing, manufacturing, inspecting, testing, and delivering one Circulator for the HSR 49.2 MHz RF System.

3.1 Contractor Responsibilities

3.1.1 Requirement Verification

The Contractor shall be responsible for providing a compliance matrix that directly correlates requirements and specifications defined in this Statement of Work and in the Technical Specification EIC-RFS-SPC-012 to the proposed work to be set forth by the Contractor. The Contractor shall indicate the conformance or exception to each element of the compliance matrix. BSA shall be notified of any deviations from the requirements and specifications that may occur as the Contractor develops the physics and engineering design. Any deviations or exceptions must be reviewed and approved by the BSA technical representative in writing before implementation.

3.1.2 Technical Performance

In accordance with this SOW, BSA Technical Specification EIC-RFS-SPC-012, and all referenced documents, the Contractor shall furnish all equipment, materials, tools, facilities and labor to perform the work necessary to manufacture and test the Circulators. The Contractor shall ensure that the resultant design & finished product meets the performance parameters and criteria in accordance with BSA Technical Specification EIC-RFS-SPC-012 and all other referenced documents.

3.1.3 Tooling/Fixtures/Test Equipment

The Contractor shall be responsible for supplying all materials, including (but not limited to) the construction of all tools, jigs, and fixtures required to meet the requirements of this SOW and the referenced technical drawings and specifications. The Contractor must also supply all test equipment to support and conduct testing of devices and deliverables for which the Contractor is deemed responsible as outlined in this document and referenced Technical Specification EIC-RFS-SPC-012.

3.1.4 Installation

BSA will be responsible for installation of the Circulator with guidance and instructions to be provided by the Contractor.

3.1.5 Materials

The Contractor shall have an effective storage and age control system for items (such as epoxy) where acceptability is limited by the age or manner of storage of the item.

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3.2 Engineering Design and Manufacturing Requirements

3.2.1 Detailed Analysis Requirements

The Contractor shall perform a comprehensive analysis of the design to verify that the equipment complies with the requirements of BSA Technical Specification EIC-RFS-SPC-012. The Contractor shall provide all analysis models, supporting calculations, and results to the BSA Technical Representative in electronic format, including the native file formats of the Computer-Aided Design (CAD) and analysis software used, as well as in a non-editable data-reporting format (e.g., PDF or equivalent). Hard copies of the analysis reports and results shall also be provided upon request.

3.2.2 Detailed Design Requirements

3.2.2.1 Preliminary Design Review (PDR) Report

The Contractor shall be responsible for providing a PDR report that reflects the state of the developed design. The PDR report shall consist of the following items to be addressed in detail and supported by preliminary calculations that shall be presented at the PDR Report for review and written approval by BSA.

- General information
- Detailed design information, including drawings, parts lists, and schematics
- Pressure Safety
- Preliminary Manufacturing, Inspection and Test (MIT) Plan
- ESH
- Installation, commissioning and operation

3.2.2.2 Final Design Review (FDR) Report

The Contractor shall be responsible for providing an FDR report that reflects the state of the developed design as it evolved from the PDR. The Contractor shall be responsible to develop the overall design of the Circulator in accordance with the applicable specifications and supporting documents as identified herein. The Contractor shall perform the tasks listed below, with the results to be included in the Final Design Review Report for review and written approval by BSA.

- General information
- Summary of significant changes since the PDR
- Detailed design information, including drawings, parts lists, and schematics
- Pressure Safety
- Manufacturing, Inspection, and Test (MIT) Plan (As described in 3.3.3)
- ESH
- Installation, commissioning and operation

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- Acceptance Test Plan (ATP) (as described in section 3.2.4)

3.2.2.3 Approval to Proceed

BSA must approve in writing the Final Design Review Report, including any modifications introduced at the Final Design Review, before the Contractor proceeds with ordering of material and components. The ordering of long-lead-time materials and components prior to the approval of the Final Design Review Report must be reviewed and approved in writing by BSA.

3.2.3 Acceptance Test Procedure (ATP)

The Contractor shall provide an ATP that is in accordance with this SOW, BSA Technical Specification EIC-RFS-SPC-012, and all referenced documents noted herein. The ATP must be approved in writing by BSA prior to use. The ATP shall ensure that all test requirements as defined in the Technical Specification document are achieved for both the production unit(s).

- Factory Acceptance Testing
- Site Acceptance Testing (at BNL)

3.3 Management

3.3.1 Program Plan

Within four weeks after award of contract, the Contractor shall deliver a detailed program plan which includes a milestone schedule defining the design validation, manufacturing, inspection, and testing phases in sufficient detail to allow regularly scheduled progress monitoring.

3.3.2 Progress Communications

Within ten weeks after award of contract, monthly technical and progress telecommunications and/or meetings between the Contractor and BSA shall be held virtually 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, troubleshooting, material status, tooling status, resources, and manufacturing issues.

3.3.3 Manufacturing, Inspection, and Test (MIT) Plan

A Manufacturing, Inspection, and Test (MIT) Plan shall be developed which identifies the manufacturing processes required to complete all efforts as identified in this SOW. The MIT Plan shall also address how these processes will be inspected and the necessary test steps to assure quality through the manufacturing and production phase. The MIT Plan shall be submitted for review and approval by BSA during the Final Design Review (FDR). The MIT plan may be a single document or may make use of existing travelers or other suitable planning and control documents. It shall include the following:

- Address the Material Requirements Planning (MRP)

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- Include manufacturing, inspection, and test steps including identification of critical manufacturing operations that have a direct impact to quality and parts/subassemblies showing integrated flow into the end item(s)
- Hold Points
- Witness Points
- Resource Planning including the sourcing of materials used in manufacturing

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 Witness Points

BSA reserves the right, after review of the Contractor's MIT plan, to designate additional manufacturing, inspection, and/or test operations as "witness" points. Contractor shall provide BSA with ten working days' notice in advance of such witness points during the manufacturing and test cycle.

3.3.5 Factory Acceptance Test Report

Prior to shipment of each unit, the Contractor shall provide the BSA with a written Factory Acceptance Test (FAT) Report documenting the results of all acceptance tests performed in accordance with the approved Acceptance Test Procedure (ATP). The BSA Technical Representative shall review the FAT Report and provide written approval prior to shipment of the respective units. BSA reserves the right to witness Factory Acceptance Testing at the Contractor's facility.

3.3.6 Performance Reporting

Throughout the life of the Contract, the Contractor shall supply a monthly written report to the BSA Technical 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 Design Reviews

3.4.1 Preliminary Design Review Meeting

A PDR meeting shall be held in accordance with the schedule set forth in Section 6 herein, to ensure compliance with this SOW, applicable specifications, interface control drawings, and to obtain BSA written approval to proceed to the Final Design Review. The Contractor shall provide, no later than ten working days prior to the scheduled meeting, a draft PDR Report that shall consist of the requirements set forth in Section 3.2.2.1. The findings of the PDR Report shall be reviewed at the PDR meeting to be held at BNL or in video conference format and shall cover all pertinent issues relating to the preliminary design of the Circulator. The Contractor shall be responsible for

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maintaining and submitting minutes of the PDR meeting and shall also incorporate any agreed-to changes into the final comprehensive PDR Report, both of which are to be submitted to BSA within ten working days of the PDR meeting for subsequent review and written approval. After written approval of the PDR Report by BSA, the Contractor shall promptly begin preparing for the FDR.

3.4.2 Final Design Review Meeting

A FDR meeting shall be held in accordance with the schedule set forth in Section 6 herein, to ensure compliance with this SOW, applicable specifications, interface control drawings, and to obtain BSA written approval to proceed to the production phase. The Contractor shall provide, no later than ten working days prior to the scheduled meeting, a draft FDR Report that shall consist of the requirements set forth in Section 3.2.2.2. The findings of the FDR Report shall be reviewed at the FDR meeting to be held at BNL or in video conference format and shall cover all pertinent issues relating to the final detailed design of the Circulator. The Contractor shall be responsible for maintaining and submitting minutes of the FDR meeting and shall also incorporate any agreed-to changes into the final comprehensive FDR Report, both of which are to be submitted to BSA within ten working days of the FDR meeting for subsequent review and written approval. After written approval of the FDR Report by BSA, the design is to be considered “frozen”, and no changes are permitted to the design, materials, processes, methods, and tooling, or component-level substitutions, without written approval from BSA Technical Representative. After written approval of the FDR Report by BSA, the Contractor shall promptly begin with the manufacturing phase.

3.5 Documentation and Data Management

3.5.1 Report/Documentation Format

All reports submitted by the Contractor shall include, at a minimum, an introduction, the body of the report, and a conclusion. Reports of sufficient length or complexity shall include a table of contents.

Analytical calculations shall clearly present all equations, with each variable, value, and unit identified and defined to facilitate independent review and verification. Supporting diagrams and figures shall be included where necessary to improve clarity. Labels and nomenclature shall be consistent with the design drawings and shall clearly identify specific features, such as vessel penetrations.

All documentation provided by the Contractor shall be written in English.
The Contractor shall provide an electronic copy (BSA-identified FTP, DVD or USB data storage device) of all documentation required by this SOW. Contractor manufacturing drawing Computer-Aided Design files of all components and assemblies shall be in one of these formats: STP, SAT, IGES, IAM, or IPT.

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3.5.2 Engineering Drawing Practices

All Contractor-generated engineering drawings shall be in accordance with ASME Y14.100, Engineering Drawing Practices. All dimensions and tolerances shall be U.S. Customary units with metric (SI) units as a secondary notation.

3.5.3 End Item Documentation Package

The Design Verification Unit and eventual Production units' delivery shall be accompanied by the documentation outlined in BNL-QA-101 clause 4.10 *End-Item Documentation Package*.

3.5.4 Records

The Contractor shall retain objective evidence, including records of the inspections and tests performed during manufacturing, testing, inspecting, preserving, packaging, and preparation for shipment of procured items. These records shall be made available to BSA for review upon request. These records shall be maintained for a minimum of five years, unless otherwise specified in the procurement documentation, after the completion of the Purchase Order (PO)/Contract.

3.6 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 Marking and Serialization

Where labeling is required, the position of serialization and/or labeling of the identification number/nameplate shall be agreed upon between the Contractor and BSA prior to acceptance of final design.

3.8 Packaging and Shipment

In preparation for shipping, the Circulators shall be covered or wrapped for protection against weather elements, dust, and damage to projections, shock loads, impacts, and rubbing. The Circulator 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 month prior to delivery. The container shall be marked or tagged with the BNL Purchase Order number, shipping address as specified within the contract, Contractor's name, components contained within each package, a "Top-side up" placard, and a "Fragile" placard. Shock sensors/indicators shall accompany the Circulator packing for shipment, and BSA reserves itself the right to perform inspection and testing for warranty purposes if any of the indicators are triggered during shipment.

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4 QUALITY ASSURANCE

4.1 Quality System and Facility Access

The Contractor shall maintain and apply an effective and documented quality assurance system for the design, manufacture, and testing of all equipment provided. The system shall meet the requirements of the ISO-9001 Standard, "Quality Management Systems Requirements", and shall provide the processes to ensure that each component produced for acceptance conforms to the requirements of this document and the applicable technical documentation. The Contractor shall supply the necessary documentation to demonstrate this compliance. Post-award surveys may be required and shall be supported by the Contractor. In addition, BSA representatives shall have access to the Contractor's facility during agreed-upon fabrication, inspection and testing processes. The Contractor shall provide ten (10) working days' notice in advanced of the agreed-upon witness points.

As set forth in BSA Form BNL-QA-101, "Brookhaven National Laboratory Supplier Quality Assurance Requirements," as amended herein, forms a part of this SOW. Specifically, this includes the following sections: 1, 2, 3, 3.1, 3.1.4 , 3.2 to 3.8, 3.21, 3.22, 4.0, 4.1, 4.2, 4.3 , 4.4 , 4.4.1 to 4.4.3, 4.5, 4.6, 4.7, 4.10, 4.10.1 to 4.10.4, 4.11, 4.12, 4.13, 4.16, 4.18, 4.18.2, 4.18.3, 4.18.4, 4.19, 4.21, 4.34, and 4.39.

BNL-QA-101 Section 2.0 Definitions use the terms Buyer and Seller. In the context of this SOW Buyer is referred to as "BSA" and Seller is referred to as "Contractor".

BNL-QA-101 Clause 4.39 "Records" is amended to require the Contractor to maintain records for a minimum of five (5) years.

BNL-QA-101 Clause 4.5 "Witness Points" is amended to require the contractor to provide BSA with ten working days' notice in advance of reaching such witness points during the manufacturing and test cycle of each item and that the BSA Technical Representative shall review and provide written approval prior to shipment.

4.2 Configuration Management

The Contractor shall establish and maintain a configuration control system to ensure that all end items are of the proper configuration, and that all approved configuration changes are incorporated at the specified effectivity points. Records verifying the configuration of each item shall be maintained for a minimum of five years from the date of acceptance of the equipment by BSA. The Contractor shall immediately notify the BSA Contractual Representative of any significant changes (those that may affect form, fit, function, reliability, safety, or interchangeability) in design, fabrication methods, material or processing.

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For changes in configuration, a request for change approval shall be submitted to BSA for consideration. Changes in configuration may be made by the Contractor only with the written approval of BSA.

4.3 Responsibility for Subcontractor

It is the responsibility of the Contractor to flow down and impose applicable technical and quality assurance requirements upon their contractors and subcontractors. BSA reserves the right to disapprove, in writing, of any contractor or subcontractor.

4.4 Inspections and Test Requirements

Unless otherwise specified in the PO/Contract, the Contractor shall be responsible for the performance of all inspections and tests specified herein. Except as otherwise specified in the PO/Contract, the Contractor shall utilize facilities suitable for the performance of the inspection and test requirements specified herein, which are acceptable to BSA. BSA reserves the right to re-perform any of the inspections and/or tests set forth in this document or referenced specifications where deemed necessary to ensure that the Circulators conforms to prescribed requirements at no cost to the Contractor. BSA and/or their representative shall have the option to witness all the tests defined in this SOW.

4.4.1 Contractor Testing and Acceptance Testing at BNL

The Circulators shall be tested by the Contractor at the Contractor's facility, the Contractor's subcontractor's facility, or a pre-approved BSA collaborator prior to shipment, using an ATP (as noted in Section 3.2.3) generated by the Contractor and approved in writing by BSA. BSA or its designee retains the right to witness all testing. Final acceptance of the Circulators shall take place following the successful completion of final testing at BNL. The time period for the final testing at BNL shall be within 90 days after receipt of the units at BNL.

4.4.2 First Article

For contracts involving multiple production units, the initial unit shall serve as the First Article (FA). The FA shall be used to verify that the design complies with the requirements of Technical Specification EIC-RFS-SPC-012. Written acceptance of the FA by BSA is required before the Contractor proceeds with the remaining production units. The FA shall be clearly identified as the First Article and shall include, at a minimum, the purchase order (PO) or contract number, part number, and part name.

4.4.3 Approval for Production

The Contractor shall not start manufacturing the production units until BSA provides production contract approval, provided in writing. The production units required by the PO/Contract shall be produced by the Contractor and the Contractor's suppliers using the same design, materials, processes, methods and tooling that were used to manufacture the approved Design Verification

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Unit. Any changes must have prior written approval from BSA. EIC Design or Scope Changes or funding delays may delay or cancel the approval for production. The Contractor should incorporate all the costs related to design of the Circulators, design and production planning, and production tooling and facilities into the Design Verification Unit cost. If the production of production units is not approved by BSA, there shall be no further cost to BSA.

4.5 Repairs

If failures occur or repairs are required to an assembly or any component during manufacturing or testing that affects form, fit, function, reliability, safety, or interchangeability, the process shall stop and BSA shall be immediately notified. BSA at their discretion may ask for retesting, additional review and evaluation to determine root causes, analyses of failure modes(s) or proposals for repair. Proposals for repair shall include adequate information for evaluating the repair, testing the effectiveness of the repair, and methods to prevent damage to the existing work. No proposed repair shall be initiated without approval of BSA. No repair shall be considered successfully accomplished without inspection and written approval by BSA. All repairs shall be at the expense of the Contractor. In addition, the Contractor shall not use nonconforming materials via use-as-is disposition without written approval of BSA.

4.6 Warranty

Notwithstanding inspection and acceptance by BSA under any provision of this SOW, the Contractor warrants that the Circulators shall be of first-class quality and shall be in accord in every respect with the description, specifications and drawings identified in this SOW and Applicable Documents. The Contractor also warrants that the Circulators shall be free from defects in design, material and workmanship. The warranty shall begin on Site Acceptance Testing and extend for a period of one year or the manufacturer's warranty period, whichever is longer. If any nonconformity appears within that time, BSA, in addition to any other rights and remedies provided by law, may require the Contractor to:

(a) Replace or repair the Circulators and/or reperform the services at no increase in price; or

(b) Reduce the Contract price to reflect the reduced value of the Contractor's performance.

When supplies are returned, the Contractor shall bear the risk of loss and transportation cost. If the Contractor fails to replace or repair the Circulators or reperform the services within 24 weeks of BSA's written notice to do so, BSA shall have the right by contract or otherwise to replace or repair the Circulators or reperform the services and charge the Contractor the cost occasioned thereby.

5 DELIVERABLES

The Contractor shall supply the following:

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Table 1: Deliverables.

Item	Deliverable	Due	BSA Approval
1	Program Plan	Four weeks after award of contract	Yes
2	Technical and Progress Reporting	Ten weeks after award of contract/ bi-weekly thereafter	No
3	Performance reports	Monthly after receipt of Program Plan	No
4	MIT Plan	Eight weeks after award of contract	Yes
5	Draft Preliminary Design Review Report	Ten working days prior to PDR	Yes
6	Preliminary Design Review Report	Ten working days after PDR	Yes
7	Draft Final Design Review Report	Ten working days prior to FDR	Yes
8	Final Design Review Report	Ten working days after FDR	Yes
9	BSA review of First Article data (If Applicable)	Prior to production run	Yes
10	Delivery of First Article	As set forth in schedule	Yes
11	End Item Documentation	As set forth in schedule	Yes
12	Delivery of Equipment	As set forth in schedule	Yes

6 SCHEDULE

The following schedule is for planning purposes only. Schedule requirements set forth in the Contract will take precedence.

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Table 2: Proposed schedule.

Milestone	Calendar weeks after award
Preliminary Design Review	12
Final Design Review	24
Delivery of First Article	36
Delivery of First Article End Item Documentation	36
Acceptance Testing of First Article	36
Approval of the start of Production Units	39
Delivery of Production Units	100
Delivery of Production Units End Item Documentation	100

7 VALUE ENGINEERING

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 design and manufacture and an improvement in the performance and reliability beyond the requirements of this specification are objectives which shall be considered in the production of the Circulators. Where it appears a substantial improvement in simplicity of design, performance, 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.