High Luminosity Accelerator Upgrade Project
Supplemental Quality Assurance Plan

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0	Initial release	Aug 11, 2020

1 Introduction

The purpose of the Large Hadron Collider High Luminosity Accelerator Upgrade Project (HL-LHC AUP) is to design, build, test, and deliver to CERN, components for an upgrade to the LHC. Fermilab is the lead lab, working with Thomas Jefferson National Accelerator Facility (TJNAF), (Brookhaven National Laboratory (BNL), and Lawrence Berkley National Laboratory (LBNL), to provide the deliverables to CERN.

2 Purpose

This Supplemental Quality Assurance Program (SQAP) provides guidance regarding the Quality Assurance (QA) expectations and practices for the HL-LHC AUP. The focus is on QA requirements specific to the HL-LHC AUP, as referenced in the HL-LHC AUP Quality Assurance Plan document. Many of the common topics regarding quality assurance and quality planning are already covered by the existing TJNAF Quality Assurance Program Description (QAPD). Additionally, TJNAF's Superconducting Radio Frequency Operations (SRF Ops) Department uses a Quality Management System which is also a supplement to the TJNAF-QAPD.

Collectively, the fundamental objectives of this SQAP and various associated quality systems are to:

- Meet the requirements of Fermilab, the lead lab, and the end-customer, CERN,
- Provide a 'Road-map' of the necessary lab-specific processes and requirements to ensure consistent product quality delivered to collaborating labs, as well as adequate protection of human safety and prevent environmental hazards, and
- Support effective and efficient project implementation to achieve overall project goals.

3 Scope

The scope of this SQAP covers three main areas: Quality Planning, Work Processes, and Documentation. The level of detail in the SQAP is appropriately defined to address the QA requirements of the HL-LHC AUP. Specific instructions for the actual processes belong in the working-level procedures and are therefore excluded from this document. Plans for addressing unique HL-LHC AUP requirements, not covered in the TJNAF-QAPD, are explicitly addressed in this document. Plans for additional QA requirements that are beyond the existing scope of the project will be evaluated on a case-by-case basis and included in subsequent revisions to this SQAP.

Exception Note: In reference to the sources of requirements section in the HL-LHC AUP Quality Assurance Plan (US-HiLumi-doc-80, Rev 3), TJNAF is disclosing the fact that it is not contractually obligated to the requirements of DOE Order 414.1D. That being said, the TJNAF QAPD remains aligned to the structure and quality system requirements referenced in the Order.

4 Quality Planning

4.1 Organizational Structure

The organizational structure for the HL-LHC AUP within TJNAF is designed for mission success in meeting project goals in a safe and effective manner. The project management process, as well as the line of communication, primarily flows from top-down to the working level. The TJNAF Project Manager guides the team where project goals, requirements, schedule, and costs are continually reviewed for progress tracking. As with many common types of projects involving cross-functional groups, including those from inter-department and/or external collaborators, information exchange and two-way communication are necessary to ensure project success.

4.1.1 Roles & Responsibility

TJNAF accepts the project and defines the roles and responsibilities for effective and efficient project implementation.

4.1.2 Project Manager

The Project Manager is responsible for project organization, planning, measure, and control. For a project of this size, the Project Manager performs the role of Control Account Manager, Project Engineer, and Production Leader.

4.1.2.1 Control Account Manager (CAM)

The CAM is responsible for managing the implementation of their respective body of work within the Work Breakdown Structure. The CAM is responsible for regularly communicating project status to the Project Manager and the project team.

4.1.2.2 Project Engineer

The Project Engineer provides technical support for design requirements, functional performance, and fabrication of the Radiofrequency Dipole (RFD) Cavity Ancillaries. The project engineer works closely with the internal project team as well as the external collaborators to ensure design goals are met.

4.1.2.3 Production Leader

The Production Leader is responsible for developing and implementing the manufacturing plan for the RFD Cavity Ancillaries. The production leader works with the project team to ensure functional and QA/QC requirements are met within the production process. Externally, the production leader works with the staff at partner labs to align manufacturing practices between the two manufacturing sites.

4.1.3 Environmental and Safety Manager

The Environmental and Safety Manager is responsible for ensuring that the appropriate environmental and safety requirements are met for the project. This includes both internal TJNAF requirements as well as those required for the HL-LHC AUP.

4.1.4 Procurement Manager

The Procurement Manager ensures that procurement functions are properly supported for the HL-LHC AUP. The Procurement Manager monitors the procurement process throughout the stages of project implementation and performs TJNAF's internal procurement functions as well as those with the partner labs.

4.1.5 QA Manager

The QA Manager develops and maintains a Quality Assurance Plan for the HL-LHC AUP and ensures alignment between the quality systems and quality practices from the lab to the project. The QA Manager advises the project team of quality matters, provides QA services and recommendation in the planning, development and production processes for the HL-LHC AUP. The QA Manager conducts evaluation and quality audits of the QA/QC processes for the project, as needed.

4.2 Communication

Good communication is an essential element for project success. Listed below are some of the typical forums for reviewing the statuses of the HL-LHC AUP. Depending on the type of reviews, the frequency and format could be defined by a DOE order, by operating manual, governing policy, or established solely by the individual program need.

- Project Level - Collaboration meetings, and other high level reviews are used for project communication.
- Implementation Level - Communication tools include production planning meetings and Quality Board Reviews. Process assessment and audits are conducted as needed to ensure acceptable project performance.

4.3 Graded Approach

For the HL-LHC AUP, TJNAF follows the graded approach process per the QA25kd Graded Approach Procedure. This procedure provides direction for determining the degree of control, verification, and documentation to meet Environment, Safety, and Health (ES&H) requirements at the appropriate programmatic risk level. Instilling an overabundance of control on a minor task could paralyze a project; however, applying too little control could result in injury. The goal is to apply an appropriate level of mitigation to reduce or eliminate unfavorable conditions.

4.4 HL-LHC AUP Design

. The design ownership for the RF characteristics of the RFD Cavity Ancillaries belongs to the HL-LHC AUP, and as a result the HL-LHC AUP is responsible for the configuration control of the RF portions of the design. TJNAF is responsible for the mechanical design characteristics of the RFD Cavity Ancillaries and as a result TJNAF is responsible for the configuration control of the mechanical portions of the design. Configuration management will follow the requirements of Design Change Management (US-HiLumi-doc-2308) and the Configuration Management Plan (US-HiLumi-doc-1067).

4.5 Product Verification

Product verification ensures that the RFD Cavity Ancillaries meet the specified requirements. The production team is responsible for implementing the process of qualification, testing, and acceptance checks. This may include certain acceptance criteria to be integrated into the process travelers and/or other types of acceptance documentation that have been agreed upon by the customer. The verification process is reviewed by the project team to ensure that a common agreement exists among the partner labs. During the construction process, the documents and test results from the verification process are filed in a secured location and be made readily retrievable when needed. Project deliverables will be transmitted to CERN using the Manufacturing and Test Folder (MTF).

4.6 Procurement

Procurements for the HL-LHC AUP follow the guidance of the TJNAF Acquisition Policy Manual (APM) and the Procurement Operations Manual (POM). Formal plans, reviews, and approvals are part of the standard procurement process. Quality Assurance requirements are included in the procurement documentation process.

5 Work Control Processes

5.1 Work Control

Work control processes are necessary to enable safe, effective, and efficient production of the intended products. The Production Leader is responsible for developing and implementing a Manufacturing Inspection Plan (MIP) for the production of the RFD Cavity Ancillaries. The MIP includes a set of work control processes to ensure traceability of material as well as control of non-conforming material. The plan also includes a process for documentation and records control to facilitate usage of the latest document versions.

5.2 Travelers

The SRF procedure on document control process (Document Control QA-P-001) is used for work center processing of the RFD Cavity Ancillaries. This procedure includes a formal traveler

approval and revision control process. Travelers specify the appropriate processing/functional parameters, the product acceptance criteria, work flow details, and references to any processing documents, instructions, or procedures. Typical information recorded in travelers includes inspection data, raw test data, converted data, process information, and/or other file attachments. To obtain maximized benefit of the traveler system, staff members complete their respective duties in all parts of the traveler processing cycle in a timely fashion.

5.3 Control of Non-conforming Product

The SRF procedure for controlling non-conforming product (Control of Nonconforming Product MAI-P-004) is followed. Process actions are documented, and the non-conforming product is controlled until a disposition is made by the responsible staff. Reworked products are subject to re-verification to demonstrate conformity to the requirements. All Nonconformance Reports will be communicated to HL-LHC AUP in accordance with Handling of Discrepancies and Nonconformances (US-HiLumi-doc-2484).

The project team has established, using a graded approach, the characteristics of standard and non-standard nonconformities that may require technical review and joint resolution by TJNAF and HL-LHC AUP.

5.3.1 Standard Nonconformities Internal to SRF

TJNAF generates Nonconformance Reports in the normal course of product assembly, fabrication, and testing. Most of these Nonconformance Reports are resolved through standard practices such as high-pressure rinse, lapping, or product replacement, and the final disposition results in a conforming product. These are handled internally through the controls described in the procedure referenced above and do not require HL-LHC AUP review or approval.

5.3.2 Non-Standard Nonconformities Requiring HL-LHC AUP Involvement

The Dressed Bulk Niobium Radio-Frequency Crab Cavities specification (LHC-ACFDC-ES-0002) list critical criteria that, when not met, must result in an NCR with HL-LHC AUP approval of disposition.

Other NCRs considered by TJNAF as non-standard or meet the definition of “significant nonconformance” as defined in Handling of Discrepancies and Nonconformances (US-HiLumi-doc-2484**)** will be shared with HL-LHC AUP for review, approval, or both. It is impossible to predict these NCRs, but examples may include damage to a sensitive part that is likely to prevent a successful test described in the Dressed Bulk Niobium Radio-Frequency Crab Cavities specification (LHC-ACFDC-ES-0002).

5.4 Inventory Control and Material Traceability

The SRF inventory control procedure (Inventory Control PR-P-005) is used for inventory control and material traceability. All materials are handled with care, cleanliness maintained where appropriate, and protected from damage throughout the production cycle. A plan for part-identification and serialization is established for the HL-LHC AUP. Requirements for identification of incoming material are included in the Statement of Work of the vendor procurement process. Examples of requirements include but not limited to the serialization scheme, marking type, method, and location. Except for those where the differences between nominally identical parts would have negligible impact on product functions, individual part traceability is maintained throughout the production process, from incoming receiving, to assembly and test, and to the final shipment of the RFD Cavity Ancillaries.

5.5 Product Shipment

Shipment to the HL-LHC AUP is conducted in such a way as to protect the RFD Cavity Ancillaries from shipping damage, to maintain the same level of product cleanliness, and to preserve the "As-built" functions and performance of the RFD Cavity Ancillaries.

5.6 Corrective Action and Continuous Improvement

The SRF procedure for corrective, preventive, and continuous improvement actions (Corrective, Preventive, and Continuous Improvement Actions MAI-P-001) is used for issues management arising from production. Issues can be identified and addressed in numerous ways. The general guidelines within this document are followed for the HL-LHC AUP. Corrective and improvement actions are documented using the appropriate set of available tools.

6 Documentation

6.1 Document Control

The SRF document control procedure (Document Control QA-P-001) describes the process used for this project to control certain production documents and prescribes a formal mechanism for the review and approval by authorized staff.

The project team will exchange design documents using the FNAL Sharepoint site to ensure availability of accurate documents and versions at the appropriate time and point-of-use locations.

6.2 Record Retention

The SRF records retention procedure (Records Retention QA-P-002) is used to provide objective historical evidence and the results of project requirements, both in product performance and compliance to regulatory requirements. With certain types of documents, the official records reside in the responsible TJNAF department or division (i.e. Procurement Office, Project Management Office, Finance, etc.)

6.3 Assessments/Audits

Assessments and audits are conducted to ensure that the project requirements are met for processes internal to TJNAF as well as those of the vendors. For the HL-LHC AUP, assessments and audits are conducted following the guidelines of the TJNAF QAPD. In addition, independent project-level assessments may apply at the appropriate stages of the project.

7 References

No.	Title, document number:
1	US HL-LHC Accelerator Upgrade Project Quality Assurance Plan
2	TJNAF Quality Assurance Program Description (QAPD)
3	TJNAF Project Control System Manual
4	TJNAF QA25kd Graded Approach Procedure
5	TJNAF Acquisition Policy Manual
6	TJNAF Procurement Operations Manual
7	TJNAF Document Control QA-P-001
8	TJNAF Control of Nonconforming Product MAI-P-004
9	TJNAF Inventory Control PR-P-005
10	TJNAF Corrective, Preventive, and Continuous Improvement Actions MAI-P-001
11	TJNAF Records Retention QA-P-002