Accelerator Readiness Review Process for the SSC Linac*

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Abstract

As each accelerator of the SSCL is prepared for operation, it must have an Accelerator Readiness Review (ARR) in order to begin high power RF or beam operation. This review validates the Safety Analysis Report (SAR) and demonstrates to an independent review panel that 1) the systems and equipment are in place and have been fully tested with satisfactory results; 2) systems and equipment are covered as necessary by written procedures that have been reviewed and approved; 3) those who carry out the activity are fully trained and qualified. The panel will then request that the SSCL Director give permission for operation. The Department of Energy must concur for operation to commence. The SSC Linac, a series of four accelerators, will be tested and commissioned in the Linac Tunnel in series starting in the fall of 1992 and ending in the spring of 1995. The Accelerator Readiness Review process will be described as it relates to the SSC Linac in order to support the staged commissioning.

I. INTRODUCTION

The SSC is a series of accelerators: Linac, Low Energy Booster, Medium Energy Booster, High Energy Boosters, and the Collider. An Accelerator Readiness Review must be held when each of these accelerators is fully prepared for commissioning or routine operation. This review validates the SAR and demonstrates to an independent review panel that each subsystem of the accelerator is in place and has been fully tested, the operating and maintenance procedures have been reviewed and approved, and that those who perform the operation and maintenance are fully trained and qualified.

The SSC Linac consists of a Linear Accelerator [1] and a Transfer Line that routes the beam to the Low Energy Booster. The Transfer Line also contains the main beam absorbers, that are needed for tuning of the Linear Accelerator and operation independent of the LEB. The Linear Accelerator is itself a cascade of four accelerators:

1) Ion Source (35 keV)
2) Radio Frequency Quadrupole (2.5 MeV)
3) Drift-Tube Linac (70 MeV)
4) Coupled Cavity Linac (600 MeV)

Plans for commissioning the Linac [2] have the Linac installed, tested, and beam commissioned in series. Prior to availability of the Linac Tunnel, the Ion Source through DTL Input Matching Section are planned to be tested and commissioned in the Linac laboratory prior to installation and re-commissioning in the tunnel. Each of the four tanks of the Drift-Tube Linac will be installed and commissioned in sequence in the tunnel. This will be followed by the first module of the Coupled Cavity Linac and then the remainder of the Linac. The ARR process for the Linac is staged to support this commissioning and at the same time tailored to minimize the number of reviews, while demonstrating performance and verifying safety.

II. ACCELERATOR READINESS REVIEW

An ARR has four requirements:

1) validate the Safety Analysis Report
2) verify the subsystems are in place and fully tested
3) determine that the procedures are reviewed and approved
4) check that the personnel are fully trained and qualified.

To give accountability to the ARR process, a checklist was created. This checklist is a catalogue of the proof used to satisfy the four requirements of an ARR. It also includes spaces for signatures (of each item) from the Cognizant Engineer, Machine Leader, and the Readiness Review Committee. This checklist along with a letter from the Readiness Review Committee is sent through the lab management to the DOE compliance office with a request for a "Permit to Operate".

A. Safety Analysis Report

During the design process, hazard analyses are conducted to identify all potential safety hazards to equipment and personnel and to describe the manner in which the potential hazards and risks will be minimized. These are reviewed for adequacy during the design review process of the Linac. The SAR documents the identified potential hazards and presents the methods used to mitigate these hazards to the degree necessary to operate and maintain the Linac in a safe manner. Mitigation can be accomplished through adequate design safeguards, design safety features, development of operational safety procedures, planned training, and administrative controls. The SAR is reviewed and approved by the SSCL and DOE. All mitigation stated in the SAR must be validated as being in place prior to being given permission to begin commissioning the appropriate section of the Linac.

B. Subsystem Performance

A system engineering process has been incorporated into the SSCL that provides an orderly process for the documentation of the requirements in specifications, monitoring of the designs through reviews, and bringing the technical equipment into operation according to accepted test

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plans and procedures. For the Linac [3] this has led to set of specifications, where the performance requirements for the various accelerators of the Linac and their subsystems have been specified. Through a series of design reviews presented by the SSCL engineering departments or outside vendors, the Linac Group monitors the development of the designs for the technical equipment. Acceptance test plans and procedures are written by the SSCL engineering departments or outside vendors and are reviewed by the Linac Group to ensure their adequacy for verification of the performance requirements of subsystems as stated in the specifications. The Linac Group verifies that the technical components and subsystems are then installed and tested according to the appropriate plans and procedures with satisfactory results.

The ARR committee verifies that the required testing has been performed with the resulting positive statement that appropriate subsystems are functioning properly and are ready to proceed to the next phase, such as beam operation. A walk-through of the area and equipment will be conducted by the committee as a final check to verify the configuration of the facility.

C. Procedures

The ARR committee verifies that the appropriate procedures are reviewed and approved. Each subsystem must have approved operation and maintenance procedures, normally written by the engineering departments.

RF conditioning and initial beam operation of a particular section of the Linear Accelerator are continuations of the acceptance testing. These are performed according to the approved acceptance test plans and procedures, normally written by the Linac Group, for those phases of operation. These are prepared before the ARR for anticipated testing and operation. In order to ensure proper review and control of either changes to these plans or future testing, measurements, and operation, a Machine Studies Management Plan for the Linear Accelerator [4] was developed. This document stipulates the process to control and review the machine studies, which retains the maximum amount of flexibility in order to plan and conduct them, while at the same time ensuring safety and quality.

D. Personnel

The personnel that will operate or maintain the equipment must be properly trained and qualified. Lists of trained personnel are provided at the ARR, as well as the required training and procedures needed to qualify future personnel.

III. LINAC ARR SEQUENCE

Commissioning of the Linac is staged so that each section of the Linac can be tested and characterized by a set of commissioning diagnostics located after it, prior to installation of the following section. This sequence is:

In the Linac Laboratory
- Ion Source/Low Energy Beam Transport
- RFQ
- DTL Input Matching Section

In the Linac Tunnel
- Ion Source -- DTL Input Matching Section
- DTL Tank #1
- DTL Tank #2
- DTL Tank #3
- DTL Tank #4 -- CCL Input Matching Section
- CCL Module #1
- CCL Modules #2 - #9 -- Transfer Line

During the installation and commissioning of the Ion Source through the first CCL module, CCL Modules #3 - #9 and the Transfer Line are installed, the various subsystems are tested, and the cavities are RF conditioned.

In order to support this staged commissioning, the ARR for the Linac has been divided into the following sequence:

In the Linac Laboratory
- RFQ RF Conditioning
- Ion Source -- RFQ Beam Commissioning
- DTL Input Matching Section Commissioning

In the Linac Tunnel
- Ion Source -- DTL Input Matching Section Re-commissioning
- CCL #3-#9 RF Conditioning
- DTL Tank #1 Commissioning
- DTL Tank #2 Commissioning
- DTL Tank #3 Commissioning
- DTL Tank #4 - CCL Input Matching Section Commissioning
- CCL Module #1 Commissioning
- CCL Modules #2-#9 - Transfer Line Commissioning

Because of the availability of hardware, the RFQ ARR occurred in two phases. For the DTL Input Matching Section through CCL Module #1, there will be a single ARR for each, reviewing both high power RF conditioning and beam commissioning. To support the early high power RF conditioning of the CCL Modules #3 - #9, a separate ARR will be held to review the readiness of the subset of hardware needed for that activity.

To support the commissioning in the Linac laboratory, a SAR [5] was written for commissioning of the RFQ. It has been approved by the Department of Energy. An addendum to this SAR was issued covering the DTL Input Matching Section. For the commissioning in the Linac tunnel, a Preliminary Safety Analysis Report will be written that includes the Ion Source through CCL. The final SAR that also includes the Transfer Line is scheduled for completion in the fall of 1994.

The two ARR's for the RFQ have been held. SSCL management gave permission for each stage of operation and the Department of Energy approved. The RFQ is currently undergoing beam commissioning [6]. Preparations are beginning for the ARR on the DTL Input Matching Section, which is planned for this summer. The ARR for operation of the Ion Source through DTL Input Matching Section in the tunnel is planned for the fall of this year. Prior to the end of this year, approval to perform high power RF conditioning of the first CCL modules will be requested. Commissioning of the first DTL cavity will be requested early next year.

Permission to operate the entire Linear Accelerator into the main beam absorbers will be sought by the spring of 1995.

IV. CONCLUSION

A sequence of Accelerator Readiness Reviews has been established to support the staged commissioning of the Linac at the SSCL. An independent committee will validate the Safety Analysis Report and establish to its satisfaction that the accelerator, or that portion of it, is ready to operate. The committee will also verify that it will be operated and maintained safely, that the personnel are qualified to operate and maintain the accelerator, and that the controls and procedures are in place to ensure continued safe operation and training of future personnel.

V. REFERENCES

DOE 5480.25 Safety of Accelerator Facilities (Draft Guidance Section)

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[2] J. W. Hurd, "Commissioning Plans for SSC Linac," *1992 Linear Accelerator Conference Proceedings*, Vol 2, pp. 462-464.

[3] J. F. Tooker, "System Engineering in the SSC Linac," *1992 Linear Accelerator Conference Proceedings*, Vol 1, pp. 326-328.

[4] SSCL Document No. AQA-1020001

[5] SSCL Document No. DMP-000011

[6] K. Saadatmand, "Performance of SSC Volume H^- Ion Source, Preaccelerator, and RFQ System," this conference