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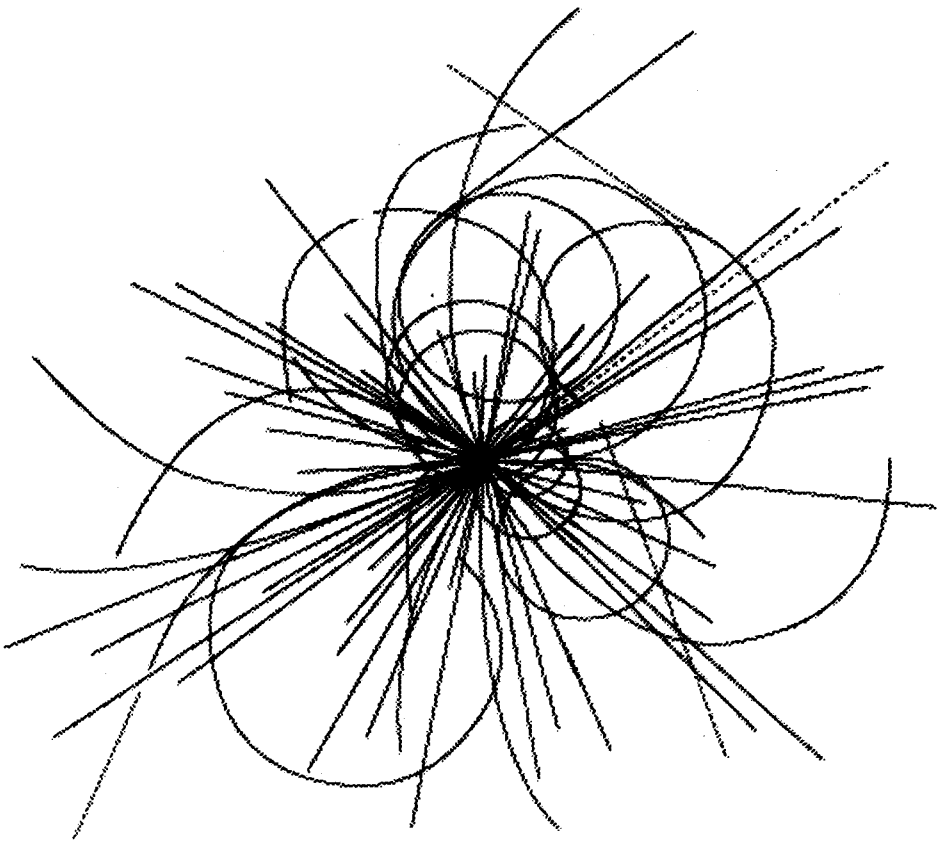

Superconducting Super Collider Laboratory

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What the Quality Philosophy Brings To a Research and Development Environment Like the SSC*

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WHAT THE QUALITY PHILOSOPHY BRINGS TO A RESEARCH AND DEVELOPMENT ENVIRONMENT LIKE THE SSC

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ABSTRACT

In achieving major schedule and performance milestones with a project as technologically advanced as the Superconducting Super Collider, many activities must be coordinated simultaneously without the luxury of a conventional design review process. Because the design may change several times prior to the delivery of a one-of-a-kind or prototype component or subsystem, close verification and monitoring of design, manufacturing and test processes are needed on a real-time basis. This verification and monitoring is performed on two levels by Quality Assurance at the SSC Laboratory; Division and General Management. The Division level is involved in day-to-day activities at the Laboratory and the Suppliers; the General Management level performs the independent oversight function for all the Laboratory quality processes. In the divisions, continuous monitoring of design, procurement, manufacturing, installation, and testing activities is performed. At the General Management level, quality program development and implementation is evaluated within each division. Critical suppliers involved in system design, manufacturing and testing are evaluated against contract and program requirements to assure systems safely perform their intended functions.

Responsibilities for quality are extended by the participation of the SSCL Quality Assurance Office in Accelerator Readiness Reviews (ARR) previously known as Operational Readiness Reviews (ORR) for each major machine developed and designed at the Laboratory. The ARR process for the Accelerator Systems String Test (ASST) provided a real test. Quality Assurance promoted continuous awareness of DOE contract requirements, SSC Laboratory Quality Assurance requirements and the Safety Analysis Report requirements which is not an easy task in the scientific community. A result has

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been a new cooperative attitude in which physicists, scientists, engineers, safety and quality professionals can work together towards a common goal .

INTRODUCTION

Designing and building the World's largest and most powerful "anything" draws considerable attention from skeptics in each part of the World, but to design and build the World's largest and most powerful scientific instrument draws significantly more attention. This increased attention not only comes from average people populating the earth's four corners, but specifically World leaders currently involved in scientific and technological research and development. The Superconducting Super Collider Laboratory (SSCL) when completed will be the World's largest and most powerful particle accelerator. A project of such magnitude and complexity requires tremendous technical and professional expertise, planning, coordination, and management controls to be a success.

Because this project is being built in the United States, there is increased attention given by the rest of the World on the project's ultimate success or failure. This will influence the World's view of the United States' commitment to quality in education, science and technology. Along with the enormous financial considerations for a project of this size, high energy physics expertise from the world's sharpest minds is needed to collectively tackle new challenges in accelerator and detector design and construction techniques. This is necessary to improve the envelope required to expand the knowledge of what we know today about the make-up of matter.

In an effort to integrate research and development practices, quality principles and DOE contract requirements, a cooperative effort needs to be exerted. To accomplish this task without limiting the creative nature of the scientists involved, the Program Management, Safety, and Quality organizations focus on the Laboratory program and contract compliance issues. Quality involvement helps provide consistency in the Laboratory's interpretation of administrative and contract requirements for the project.

QUALITY INVOLVEMENT IN THE FIRST MAJOR MILESTONE

One of the most significant achievements at the SSC Laboratory to date in terms of milestones was the installation, testing and operation of a string of superconducting magnets and inter-connecting spool pieces. This specific milestone was mandated by Congress to prove that a string of industrially manufactured magnets would function prior to being placed inside a tunnel some two-hundred feet below ground. This milestone was completed in August 1992, two months ahead of schedule. Because of the tight schedule to complete this milestone, most activities had to be monitored on a real-time basis. Verification of installation and testing activities was critical to safety, quality and operability of the String components. These steps determined the readiness to proceed with energizing the two primary hazardous energy sources, electrical power and cryogenics.

THE ACCELERATOR SYSTEM STRING TEST (ASST)

The specific major components of the ASST included five dipole magnets, one quadrupole magnet, and three spool pieces. These major components are supported by other subsystems which provide the required 6800 amperes(A) of electricity and the liquid helium temperature environment.

The milestone objectives were to cool down the String components and apply 6800A to the electrical bus and cables safely. Upon performing this test, a manually induced

quench would be initiated to test all related safety systems for de-energizing the String and compensating for the increase in heat and pressure produced during the quench event. Data is collected from various monitoring points throughout the String for input into production design and for determining component characteristics when operated as a String in tunnel conditions.

All of the activities which take place during the development, design, installation, testing and operation of the ASST must be monitored and verified in accordance with contractual and administrative requirements. The quality monitoring, verification and oversight functions are performed by two different organizations within the Laboratory; the Accelerator Systems Division (ASD) and the General Management Office (GMO).

ASD QUALITY ASSURANCE DEPARTMENT

The primary responsibilities of the ASD QA/QC include reviewing, monitoring, inspecting, and surveying all quality related activities of contractors for major components and support systems as well as division activities associated with design, construction, installation, testing and maintenance of test facility components and systems for the ASST. The design of the Superconducting Magnets is the responsibility of Magnet Systems Division (MSD).

ASD also provides technical support for the Project Management Office (PMO) who has responsibilities for technical direction, accelerator physics design, and oversight of the construction for bringing the ASST and other research and test facilities to operating status. This close interface helps provide awareness to scientists and engineers on critical items which might require independent verification to assure that we consistently demonstrate how we achieved expected or unexpected results and to document how we accomplished these activities.

GENERAL MANAGEMENT OFFICE QUALITY ASSURANCE

The responsibilities and functions of the GMO QA Office are currently twofold. The primary function of GMO QA Office is to evaluate whether the SSC Laboratory has adequately established and effectively implemented a quality assurance program which meets the requirements set forth in Department of Energy (DOE) Orders 4700.1 "Project Management System," and 5700.6C "Quality Assurance." These documents provide the primary requirements for managing and controlling administrative and technical activities of the SSC Laboratory. This evaluation is accomplished by performing system and activity audits and surveillances of activities considered important to safety of personnel and equipment and reliable operation of equipment. Audits are also performed at the facilities of key contractors responsible for providing critical services and equipment such as superconducting magnet components, spool pieces and support systems.

The other responsibilities of the GMO QA organization include developing and conducting training programs for QA awareness at the Laboratory. GMO develops upper level QA procedures which give direction to each division within the Laboratory on program activities that need to be addressed and controlled procedurally. In addition, GMO provides oversight support for Accelerator Readiness Reviews (ARR) for each major research and test facility (i.e. ASST, LINAC). In the case of the ASST, GMO QA has the organizational independence and insight to program and contractual compliance issues requiring consideration in this process.

ACCELERATOR READINESS REVIEWS (ARR)

The ARR process has been very useful in providing a forum for scientists, engineers, professionals and management personnel to collectively address technical, environmental, safety, quality and reliability issues for SSCL facilities including the ASST. The ARR process is conducted by a committee appointed by the PMO and comprised of scientists, engineers, environmental, health, safety and quality professionals from different organizations within the Laboratory. Because this committee is diverse and independent of activities necessary to make the facility physically ready for operation, members are free to identify issues which concern the readiness of the facility to be operated and shutdown safely. This may include issues identified in the Safety Analysis Report (SAR) which is the primary facilities and systems description and function document. This document also identifies and addresses mitigation actions necessary for all known facility and system safety and environmental hazards. Issues identified by the committee must be satisfactorily resolved and verified prior to the committee recommending a permit to operate the facility. The permit to operate will then be issued by PMO to the Director of the Laboratory. In turn, concurrence by DOE is required prior to conduct of operations.

The ARR Committee reviews documentation and interviews subject matter experts throughout the final readiness stages of the system and facility testing to determine if any additional hazards exist and whether the facility can be safely operated as required by DOE without undue risk to personnel or equipment. Any concerns raised by the committee are documented as "Action Items" and issued to the group leaders for the subject matter experts to resolve. After actions have been completed for all Action Items issued during this process, a final presentation is conducted to confirm facility readiness.

The quality assurance representative on the committee, just as other members of the committee, provides a different perspective and consciousness to the ARR process. Where technical representatives focus on design, operability and reliability of the systems to perform their function, the quality assurance representative focuses on processes established to assist in accomplishing the desired results safely and systematically as defined by DOE requirements and Laboratory plans. The scientists and engineers may develop, design and build a machine that works, but may not provide the evidence needed to prove the machine works the way it was intended. This information is captured in program plans, specifications, procedures, records, and analysis and test results. This evidence is a big part of what the quality assurance representative emphasizes during the process.

CONCLUSION

In a research and development environment like the SSC Laboratory, the present and future role of quality assurance will ultimately be proactive versus reactive. The Laboratory continues to establish plans and procedures to comply with DOE, industry and administrative requirements. These plans and procedures provide consistency and continuity within organizations throughout the Laboratory. By establishing performance criteria and measuring performance results, meaningful changes can be made to programs which add value to the existing processes without overburdening those processes with controls that do not affect the quality of the final product. Therefore, the goals of the SSC Laboratory Quality Assurance Organization are to promote continuous improvement by developing process controls where needed and enhance those that already exist where possible.