

Quality Assurance Program
for the
SC Lattice QCD Computing Project Extension
(LQCD-ext)

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1 Purpose and Scope

This document describes the Quality Assurance Program and related methodologies to be followed while executing the SC Lattice Quantum ChromoDynamics Computing Extension (LQCD-ext) information technology (IT) investment project for the period FY2010 through FY2014. The LQCD-ext computing facility is an OMB 300 IT investment funded by US Department of Energy (DOE). Annual business cases for the investment are defined and presented in the Exhibit 300 Capital Asset Plan and Business Case Summary¹ document.

The scope of this mixed life cycle project is restricted to the deployment and operation of the incrementally procured computing hardware. The Development, Modernization and Enhancement (DME) portion of the project covers the new deployment of computer hardware while the Steady State (SS) portion of the project addresses the operation of the year to year deployment of the newly procured hardware for the project and the operation of the hardware procured and operated for the LQCD-ext project. Since any software development, scientific or otherwise, is out of scope for this project, software quality assurance will not be addressed in this document. Also, this document does not address quality assurance for scientific research.

The program is based on the following DOE orders:

- DOE Order 414.1C, *Quality Assurance*
- DOE Order O413.3A, *Program and Project Management for the Acquisition of Capital Assets* (dated 7-28-06) and
- DOE Guidance G 413.3-14, *Information Technology Project Guide* (dated 9-12-08).

2 List of Abbreviations

ACPM	.....Associate Contract Project Manager
ASCR	.....Advanced Scientific Computing Research
BNL	.....Brookhaven National Laboratory
CPM	.....Contract project Manager
DME	.....Deployment, Modernization and Enhancement
EA	.....Enterprise Architecture
ES&H	.....Environment, Safety & Health
FEA	.....Federal Enterprise Architecture
FERMILAB	...Fermi National Accelerator Laboratory
FPM	.....Federal Project Director
IPT	.....Integrated Project Team
LQCD	.....Lattice Quantum Chromodynamics
LQCD-ext	.....Lattice Quantum Chromodynamics Extension
MOU	.....Memorandum of Understanding

QA.....Quality Assurance
QAP.....Quality Assurance Program
QCDOC.....QCD on Chips
SC.....Office of Science
SciDACScientific Discovery through Advanced Computing
SSSteady State
TJNAF.....Thomas Jefferson National Accelerator Laboratory
WBSWork Breakdown Structure

3 Quality Assurance Program and Implementation Strategy

Quality assurance applies to all work associated with the LQCD-ext computing facility investment. The LQCD-ext QAP is implemented using a graded approach in which controls are applied based on the analysis of risks identified in areas where work is to be performed. Although general QA principles apply to all aspects of the work, specific requirements are identified, as necessary, to consistently meet the obligations defined in the project business case. Following the distributed nature of the project, whenever appropriate, specific QA program documents for each hosting laboratory are applicable to site specific activities. Each hosting laboratory is responsible for ensuring the quality, safety, health, security, cyber-security, environmental, facilities/infrastructure maintenance and performance of work.

Quality Assurance begins at project conception and runs through every phase of the project. The implementation of this QAP evolves as the project proceeds. As experienced during the execution of the previous LQCD project, it is likely that the process requirements for the project will evolve. This QAP will also change to meet changes in DOE requirements.

The implementation of QA on LQCD-ext is tailored using a graded approach, mostly guided by the LQCD Risk Management Planⁱⁱ. As the project progresses, designs and procedures may change and the QA process will be revised as appropriate to remain an integral part of the project. This synthesis of QA with the project ensures the level of product and performance quality necessary to accomplish the technical and scientific objectives of the LQCD-ext project.

4 Project Description from QA Perspective

As described in the LQCD-ext business case, the LQCD-ext computing facility project is part of the DOE Office of Science (SC) High Energy Physics (HEP) & Nuclear Physics (NP) programs to accomplish SC strategic goal ^{iii, iv, v} (SG) 6 (Deliver computing for the frontiers of science) and DOE SGs 3.1 (Scientific Breakthroughs) & 3.2 (Foundations of Science) to further the President's "Competitive" Initiative. QCD is the theoretical framework for large experimental programs in HEP & NP, and its properties can only be determined through large scale computer

simulations. The LQCD-ext computing facility project identified the need to dedicate hundreds of teraflop-years of sustained integrated computing power to the study of QCD, and other strongly coupled gauge theories expected to be of importance in the interpretation of experiments planned for the Large Hadron Collider (LHC). To achieve the capacity goals prescribed in the project business case, the LQCD-ext investment provides funds for the acquisition and operation of new hardware, and for the operation of the existing QCDOC supercomputer and LQCD clusters through the end of their life cycle. Existing LQCD distributed cluster systems and supercomputers comply with the DOE technical architecture, as will all new hardware acquired in this investment. These systems run physics applications built using optimized LQCD libraries developed by the SciDAC projects.

The HEP, NP, and Advanced Scientific Computing Research (ASCR) funded SciDAC-1 and SciDAC-2 LQCD software projects provide highly optimized LQCD codes and the SciDAC-2 project is developing new algorithms that will increase the cost effectiveness of the hardware acquired by this investment.

This Quality Assurance Plan takes into account the Federal Enterprise Architecture program^{vi}. As defined in the business case, this investment supports the Scientific and Technological Research and Innovation sub-function of the General Science and Innovation Line of Business (LoB) of the Services for Citizens Business Reference Model (BRM). In particular, LQCD-ext provides computational resources as "Services for Citizens" (001109026) in "Research for Development" (002202069).

5 QAP Elements and Implementation Strategy

Based on the DOE order for Quality Assurance, major elements of the LQCD-ext computing facility project are management, performance and assessment. The key QA management elements of the project are the QAP itself, the qualification and training of personnel, the quality improvement process, and documentation. Performance elements include work processes, design, procurement, inspection and acceptance testing. The assessment elements include management assessments and independent assessments. Implementation of each of these QA elements is described in the following sections.

5.1 Management

This section describes the implementation of QA in the management of the LQCD-ext project.

5.1.1 Criterion 1 Quality Assurance Program

This Quality Assurance Program has been developed by the Integrated Project Team (IPT). It is approved by the LQCD-ext Contractor Project Manager (CPM) and is implemented through the policies set forth in the Project Execution Plan (PEP)^{vii} for the project. The Integrated Project Team (IPT) for the LQCD-ext project is responsible for implementing the project quality assurance program. Because of the distributed nature of the facility, site managers at each of the three sites are responsible for the day-to-day quality assurance at their sites. Each site manager follows the comprehensive quality assurance program instituted at their respective site. At BNL, details are prescribed in the BNL Graded Approach to Quality Requirements^{viii} and BNL Quality Activity Guide^{ix}. The quality assurance program for Fermilab is described in the Fermilab Integrated Quality Assurance (IQA) document^x. The TJNAF quality assurance program is described in the TJNAF Quality Assurance Plan^{xi}.

Each site uses a graded approach in implementing the LQCD-ext QAP. Since the LQCD-ext project office is located at Fermilab, the Fermilab IQA is followed for overall project related quality assurance activities.

The LQCD-ext QAP is reviewed at least annually by the LQCD-ext site managers, and revised with the approval of the LQCD-ext CPM.

5.1.2 Criterion 2 Personnel Training and Qualification

The LQCD-ext PEP document contains the latest organization charts for the LQCD-ext project. The qualification of project personnel begins with the IPT. The roles and responsibilities of the IPT, as well as the responsibility for assigning personnel to team positions, are described in the PEP. The FPM, CPM and ACPM are DOE Qualified IT Project Managers in accordance with OMB PM Guidance. The experience and qualification of the scientific and technical staff are validated according to the policies maintained at each hosting institution. Hosting institutions are responsible for hiring qualified staff members and providing opportunities for personnel learning, training and professional growth to its staff members.

5.1.3 Criterion 3 Quality Improvement

The LQCD-ext CPM has the overall responsibility for effecting quality improvement throughout the project and is supported in this effort by the IPT. At the project level, the IPT takes steps to detect and prevent quality problems, identify the root cause, correct quality issues, and implement improvement measures. At the site management level, these responsibilities are carried out by the site managers following the site specific QA program documents. Site managers are responsible for developing and documenting processes, preparing technical specifications for QA related elements and carrying out QA procedures to ensure that products and procured items conform to these specifications.

The LQCD-ext CPM and ACPM consolidate overall project performance measures and review them with FPM to identify any quality issues. Performance measures defined in the LQCD-ext business case are tracked monthly and reviewed with the FPM to understand root causes of process related concerns and necessary mitigation strategies. As in the LQCD project, LQCD-ext project team plans to conduct annual user satisfaction surveys and keep track of the performance measures on a monthly basis.

5.1.4 Criterion 4 Documents and Records

Documentation and records are maintained at all levels of the LQCD-ext project.

5.1.4.1 Documents

Controlled documents are defined in the PEP and listed in Appendix D of the PEP. This and other documents are maintained in the Fermilab Computing Division's DocDB document database^{xii}. The DocDB database supports automated versioning of the documents and extensive report generation. DocDB was developed for the BTeV Project at Fermilab and is supported by the Fermilab Computing Division. This database is accessible via the World-Wide Web and document access is protected as needed. Depending on their sensitivity, documents may or may not be accessible to the public and may even have restricted access within the project. LQCD-ext controlled documents are retained under a protected topic area. Other uncontrolled documents are also maintained in this document database. Access to and support for DocDB is negotiated in a Memorandum of Understanding (MOU) between the LQCD-ext Project and the Fermilab Computing Division.^{xiii} The Computing Division maintains the software, administers the computing platforms and performs backups of the database.

The LQCD-ext CPM and ACPM oversee the document control process. Through this database, each project document is assigned a unique identification number and its versions are tracked by date and submitter, with a record of the changes made. Early versions and drafts remain accessible in the database.

LQCD-ext review documents, presentations, reports, findings and the implementation status of review recommendations or corrective actions are maintained on access-controlled web pages.

5.1.4.2 Records

LQCD-ext project records are maintained electronically using various online tools. In the foreseeable future of the LQCD-ext project, electronic records will be maintained indefinitely through electronic backups. At this time, the three host laboratories do not have any guidance on electronic records. As the formal guidance becomes available from DOE, the LQCD-ext record management process will be updated.

5.2 Performance

This section describes the implementation of QA in the performance of the LQCD-ext project.

5.2.1 Criterion 5 Work Processes

The ultimate goal of the LQCD-ext project is to deploy and operate the special purpose computing facility distributed over three national laboratories. Details of work to be done are specified in the LQCD-ext System Description Document^{xiv}. The CPM, with the support of the IPT, coordinates work on the project to ensure that the work is performed to these specifications. As defined in the DOE O413.3 document, the execution of a project is associated with various work processes that may or may not be applicable to the LQCD-ext project. In this section, applicability of these work processes is discussed. Specific execution procedures are discussed in other relevant documents.

5.2.1.1 Design Definition

The design documents are prepared and, if necessary, revised by the team of LQCD Site Managers. The Site Managers, with support from the project office, identify the appropriate technical standards to be applied to the system and prepare a schedule and budget for producing them. With the advice of the USQCD collaboration represented by the Scientific Committee and Software Committee, which includes scientists and software engineers, Site Managers select and deploy appropriate hardware and associated software including proper configuration for their sites.

5.2.1.2 Building and Infrastructure

This work process is not applicable to the LQCD-ext project, since the hosting institutions are responsible for providing space and infrastructure to install the hardware procured for the project. This is defined in the MOUs with the hosting laboratories.

5.2.1.3 Hazard Analysis

This work process is governed by the rules and regulations imposed by the hosting institutions, which are responsible for overseeing associated work processes. In general, the level of job hazards associated with the steady-state operation of LQCD-ext computing facilities is very small and does not require the generation of formal job hazard analysis (JHA) documents. JHA documents are also not typically required for new hardware deployments, since hardware installation is generally performed by vendors as part of the procurement contract. Notwithstanding, written JHAs will be developed when required by host institution rules and regulations.

5.2.1.4 Integrated Safeguard and Security Management

Site managers, with the help of safety and security coordinators from the hosting laboratories, are responsible for making sure that employees perform work in the site computing facilities

according to the Integrated Safeguard and Security Management system in place. Computer Security is a key concern for the project. Each participating laboratory must possess Accredited to Operate authorization to continue to be a part of the LQCD-ext project.

As necessary, environment, safety and health (ES&H) related work processes associated with the computing facilities are reviewed as a part of the overall ES&H reviews for each host laboratory.

Works performed by collaborating institutions are specified in three MOUs between the project and three hosting institutions. This MOU is supplemented annually by the OMB Exhibit 300 business case submitted each year.

5.2.2 Criterion 6 Design

The technology of the computing facility design for the LQCD-ext project is based on the designs used for the LQCD project and its predecessor, the SCIDAC prototype project. The LQCD-ext System Description Document provides an overview of the design and validation strategies. Each individual hardware system design is developed and reviewed by the team of site managers. Each system design is also reviewed by external reviewers during the Annual Progress Review of the project where the design is formally presented. This process assures that the LQCD-ext computing facility will achieve the specific technical and scientific objectives of the project.

5.2.3 Criterion 7 Procurement

Site specific procurements are made in accordance with the procurement policies and procedures of the respective hosting laboratories. The LQCD-ext project office keeps track of all procurement activities and maintains copies of associated documents. The procurement offices at hosting laboratories are governed by the same DOE rules and regulations. These offices perform annual self-assessments, regulatory compliance reviews, supplier surveillance and cost efficiency optimization.

5.2.4 Criterion 8 Inspection and Acceptance

Establishment of acceptance criteria and inspection procedures are important elements of LQCD-ext QA. This applies both to items that are procured and those that are fabricated within the project. LQCD-ext Site Managers assume the chief role in this process, which includes the following elements.

5.2.4.1 Establishment of Acceptance Criteria

The Site Managers develop the acceptance criteria for the system hardware using technically and scientifically defensible methodologies. This includes running prescribed set of codes on stand-

alone systems, running code on multi-node systems at supplier sites, etc. The hosting Site Manager for a given procurement, with support from IPT members with appropriate experience and expertise, establishes the acceptance criteria for items that are procured from suppliers or fabricated as part of the project. It is anticipated that all new major system deployments will be fully installed by the suppliers.

5.2.4.2 Test and Acceptance Procedures

The acceptance test designs are defined during the requisition process. The responsible Site Manager develops testing procedures for items that are procured. Any new system is released to expert users for initial testing. Once the system is validated by expert users, it is released to the general users.

5.3 Assessment

This section describes the implementation of QA in the assessment of the LQCD-ext project. The LQCD-ext project undergoes a comprehensive set of assessments, the outcomes of which are used by the project for continuous quality improvement.

5.3.1 Criterion 9 Management Assessment

The CPM and ACPM prepare a monthly report summarizing the status of the project. Each Site Manager submits detailed performance reports. The ACPM consolidates these financial and technical performance reports and submits them to the CPM for review. This report, along with issues related to technical, cost and schedule performance, is reviewed by the FPM and Project Monitor on a monthly basis.

In addition, the project prepares DOE quarterly reports according to the guidance provided by DOE for financial and technical performance reporting. During the annual All-Hands Meeting organized by USQCD collaboration, the performance of the project is presented by the CPM for review by the entire collaboration.

As a part of the routine management assessment schedule of each hosting laboratory, each individual site is assessed for computer security, physical security, quality assurance and ES&H.

5.3.2 Criterion 10 Independent Assessment

Every year, the LQCD-ext project undergoes an annual progress review sponsored by the DOE HEP and NP offices. During these comprehensive reviews, an independent, external body of assessors reviews the progress of the project from various points of view. Over the years, the focus of these reviews included science proposed and delivered, computing facility performance,

and financial and technical delivery performance. Formal review agendas and results are made available through the LQCD-ext project web site.

As a part of the DOE national laboratory system, each hosting site also undergoes various independent reviews in the areas of security and safeguards, ES&H, and performance management. Elements of LQCD-ext operations at each site may be reviewed as part of these laboratory assessments.

6 References

- ⁱ Budgeted Year FY2010 Exhibit 300: Capital Asset Plan and Business Case Summary, Date 6/1/2009
- ⁱⁱ LQCD-ext Risk Management Plan Rev 1.0, August 1, 2009
- ⁱⁱⁱ Circular No. A-11 Part 7 Planning, Budgeting, Acquisition and management of Capital Assets
http://www.whitehouse.gov/omb/circulars/a11/current_year/s300.pdf
- ^{iv} Clinger Cohen Act, 1996
- ^v Circular NO. A-130, <http://www.whitehouse.gov/omb/circulars/a130/a130trans4.pdf>
- ^{vi} FEA Consolidated Reference Model Document Version 2.3
- ^{vii} LQCD-EXT Project Execution Plan
- ^{viii} BNL Graded Approach to Quality Requirements
https://sbms.bnl.gov/sbmsearch/subjarea/73/73_SA.cfm
- ^{ix} BNL Quality Activity Guide
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- ^x Fermilab Integrated Quality Assurance, Rev. B17
- ^{xi} Thomas Jefferson Laboratory National Accelerator Facility Quality Assurance Plan Rev. 1.1
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- ^{xii} FERMILAB Computing Division Document Database Design and Interface, Date?
- ^{xiii} Memorandum of Understanding between the LQCD-EXT Project and the Fermilab
Computing Division,
- ^{xiv} LQCD-ext System Description Document, July 30, 2009