Management Model
For Delivering High Performance and Leadership Class Computing Systems For Scientific Discovery

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Management Model for Delivering High Performance and Leadership Class Computing Systems for Scientific Discovery

The purpose of this document is to describe a model for managing the activities and tasks associated with the operation of High Performance Computing Facilities (HPCF) that enable scientific discovery as well as the delivery of next generation High Performance Production Computing (HPPC) and Leadership Class Computing (LCC) resources to the HPCF to meet established cost, schedule and performance objectives. The Management Model is robust, but sufficiently flexible to preserve unique features associated with HPPC and LCC facilities and system installations or major upgrades.

Principles

The management model is built on the 30 years of successful management of HPPC and LCC investments by the DOE Office of Science and based on the following principles:

- Incorporate national and international best practices in the management of this type of investment.
- Incorporate requirements from DOE Directives on Program/Project Management, and on cyber security.
- Comply with OMB Circulars and guidance for producing annual Exhibit 300 and Quarterly Progress reporting
- Accept and understand the short production lifespan of HPPC and LCC systems for scientific discovery.
- Use performance-based management.
- Hold line managers accountable.
- Implement a full-suite of project management tools
  - Tailor DOE O 413.3A to preserve unique features associated with the delivery of HPPC and LCC systems for scientific discovery.
  - Incorporate elements of SC review processes used to assess the status and quality of research, operation of scientific user facilities, and construction projects.
- Integrate a robust and compliant cyber security program throughout.
- Retain full responsibility and authority for DOE management of the HPPC and LCC facilities exclusively within the Office of Science.

The adoption of the principles offered in this document does not guarantee the successful delivery of a computing resource for scientific discovery. However, failure to

define and implement processes and procedures that unambiguously measure the status and the degree of progress toward objectives invite the introduction of failure modes, such as: scope creep, cost overruns, lower performance and uncertain schedules. In every case, scientific discovery will either be delayed or curtailed.

High Performance Computing Facilities

For the purpose of this document, High Performance Computing Facilities (HPCF) are defined to include Leadership Computing Class computing resources and High Performance Production Computing (HPPC) resources such as those found at the National Energy Research Scientific Computing Center (NERSC), and to include ancillary supporting infrastructure such as software, file systems, archival systems, and significant investments in specialized staff that can make these resources available to the scientific community.

In many ways, High Performance Computing Facilities are similar to other Office of Science facilities:

- the goal for the facility is to enable science by users who are mostly not employed by the facility;
- scientific projects are chosen through peer review;
- all scientific facilities go through the same four stages:
    - Justification/Planning,
    - Acquisition/Site Prep/Acceptance,
    - Transition to Operations, and
    - Operations.

High Performance Computing Facilities Upgrade Projects differ from other Office of Science projects in a few critical ways:

- "Time" is a key driver throughout the HPCF Upgrade Project. The life expectancy of computer technology is measured in years not decades. The resource must be deployed as soon as possible in order to provide the computing capability to the science community before the technology becomes obsolete by advances in the industry.
- Upgrade Projects use innovative financing mechanisms to leverage available funding and to shift the burden of risk from the Government to the vendor (e.g. firm-fixed price, Lease to Own (LTO)). These also represent interaction between the Upgrade Project and the Operations Plan to ensure management of financial risk to the entire effort.
- An HPCF Upgrade Project can have significant impact on the steady state operations at the facility, which must be ready for the transition to operations of the upgrade. The reasons for this include the level of integration required and the impact on key staff that play a role in both the operations and the Upgrade Project.

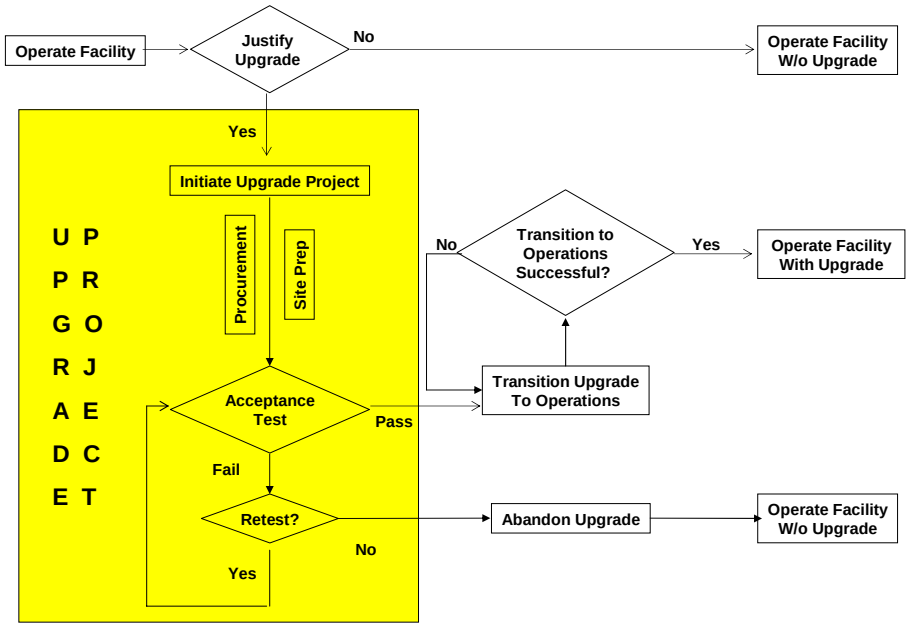
- The OMB Exhibit 300 for an HPPC or LCC Facility encompasses both the ongoing operations of the facility as well as any Upgrade Projects whereas the Exhibit 300 for a traditional capital project, such as construction of a scientific facility, covers only the construction of the facility.
- Given the level of complexity of the systems being acquired, it is possible that a given Upgrade Project may experience multiple stages of Acceptance. The concept of Acceptance in an Upgrade Project calls for precise definitions and test suites, which are incorporated into the subcontracts with the vendors.
- Finally, each HPCF Upgrade Project is unique in its objectives, deliverables and tactics, and requires flexibility in the structure of its management to successfully address the context and specific environment for each endeavor.

It is important to note that an HPPC or LCC facility will normally undergo a number of Upgrade Projects throughout its life to take full advantage of the investments in the supporting infrastructure and the staff, as seen Figure 1.

The HPCF Life Cycle

There are three major phases of a HPPC or LCC facility. The three phases are; Operations; Upgrade; and Transition to Operations. The relationship of the three phases is illustrated in Figure 1 below.

Figure 1: HPCF Life Cycle



OMB Exhibit 300 and Quarterly IT progress reporting integrates information from all phases of the lifecycle of these facilities while DOE reporting under O413.3 is focused

on the work within the Upgrade Projects. The OMB reporting that covers the entire HPCF lifecycle is:

> **ANNUALLY-** *Exhibit 300s* Annual updates to OMB Exhibit 300 are prepared by the Federal Program Manager using information provided by the Laboratory Facility Manager and the Federal Site Office Liaison. The updates reflect the most current state of the facility and serve as a streamlined business case for the facility. The Exhibit 300s are submitted to OMB with the budget request.
>
> *Operational Analysis* Annual assessments are performed by the Federal Program Manager to evaluate the performance being achieved by the facility. The review includes benefits accumulation, cost variance, schedule variance, technical performance, and user satisfaction.
>
> **QUARTERLY-** *Quarterly status reports* will be prepared by the Laboratory Facility Manager and forwarded through the Federal Site Office Liaison to the Federal Program Manager. The Federal Program Manager will use the data from these reports to inform the DOE-CIO of the status of the facility operations and explain any cost or performance deviations greater than ± 10% of the planned baseline for the reporting period.

Each of the three major phases of the lifecycle for an HPCF facility will be discussed in the following sections.

The Operations Phase

The Operations Phase of the facility is focused on operating the current portfolio of high performance computing resources and supporting systems as tools to enable scientific discovery. The most critical documentation for this phase is the Operations Plan, which lays out how the facility will deliver its existing resources to scientists. This plan must answer key questions about how the facility will deploy human and financial resources to:

1. deliver, maintain and support computing services to scientists nationwide;
2. manage cyber security;
3. manage the infrastructure;
4. manage operational risk; and
5. measure its effectiveness in fulfilling the needs of the users.

A key part of this plan will be the development of an overall Work Breakdown Structure (WBS) that includes the elements to operate the facility as well as a systematic description of how this Operations Work Breakdown Structure relates to a WBS developed for Upgrade Projects. The Operations Plan describes the Steady State, therefore, Development, Modernization and Enhancement (DME) funding will be either negligible or non-existent and residual risk associated with achieving objectives will be relatively low.

The Operations Plan will highlight the logistics of the organization such as the various responsibilities of the management team; the tasks assigned to each division within the organization, and identify expenses associated with the overall operation. The plan will also identify key deliverables, the roles, responsibilities and lines of authority in the organization, plans for operation and maintenance of hardware and software resources, user support, electricity, office space charges, technology re-fresh schedules and budgets. Typically, this plan will cover a 3-5 year time window and be updated annually to reflect the impact of current budgets, refinement of the requirements for operational reserve and the evolution of user requirements. In addition, this plan will also include one or more decision points at which the evolution of requirements or the financial advantages of equipment refresh will make initiation of an Upgrade Project attractive.

There are a number of ways to measure the progress of a facility against this plan, including the quarterly reports to the Office of the Chief Information Office (CIO) and the Office of Management and Budget (OMB), subsets of the Federal Enterprise Architecture, and the International Standard ISO 20000, which is based on the best practices developed in several countries under the Information Technology Infrastructure Library (ITIL). All of these methodologies require tailoring to measure the effectiveness of the facility in supporting peer reviewed science rather than business functions.

Facility Operations Management Review and Oversight

It is important that all interested parties be kept regularly apprised of the status of managing the operational risks and achieving the overall performance objectives of the HPPC or LCC facility.

ANNUALLY- *Exhibit 300s* Annual updates to OMB Exhibit 300 are prepared by the Federal Program Manager using information provided by the Laboratory Facility Manager and the Federal Site Office Liaison. The updates reflect the most current state of the facility and serve as a streamlined business case for the facility. Information from the Operations phase of the lifecycle is integrated with information from any ongoing or planned Upgrade Projects to produce this document

QUARTERLY- *Quarterly status reports* will be prepared by the Laboratory Facility Manager and forwarded through the Federal Site Office Liaison to the Federal Program Manager. The Federal Program Manager will use the data from these reports to inform the DOE-CIO of the status of the facility operations and explain any cost or performance deviations greater than 10% of the planned baseline stated in the OMB Exhibit 300 for the reporting period.

MONTHLY- The costs incurred in running the facility will be reported monthly by the Laboratory Facility Manager and reviewed by the Federal Site Office Liaison to determine if the facility is operating within established cost estimates. The monthly reporting format will include information regarding important operational issues that may arise and be in a format and detail agreed to by the Federal Program Manager and the contractor.

FACILITY OPERATIONS ROLES AND RESPONSIBILITIES

The following federal and non-federal positions have significant roles and responsibilities in the management of HPC facilities. A breakout of their roles is contained in Appendix A.

- Director of the Office of Science or Designee- Holds line managers accountable
- Federal Program Manager- Oversees management of the HPPC or LCC facility
- Federal Site Office Liaison- Plans, monitors and evaluates the operations of the facility
- Laboratory Facility Manager- Exercises full financial authority and accountability for the operations of the facility as delegated by DOE

The Upgrade Phase

Upgrade Projects encompass activities beginning with justification of the Upgrade Project (CD-0 equivalent) through Acquisition and ending with Acceptance of the LCC or HPPC resource. These projects may be broken into 3 stages: Pre-Acquisition, Acquisition and Acceptance.

Key attributes of the Pre-Acquisition stage are to: identify the scientific need, develop plans for the Upgrade Project, including preliminary targets for cost, schedule and performance, develop the Acquisition Strategy, and develop the request for hardware and supporting systems software. The Pre-Acquisition stage includes the following six stages of preparation and planning:

1. Define Scope
2. Create Work Breakdown Structure
3. Prepare Cost Estimate
4. Prepare Preliminary Schedule
5. Resource Load Schedule
6. Prepare Upgrade Project Execution Plan

The Acquisition stage may include the award of subcontracts by the Government-Owned, Contractor-Operated (GOCO) laboratory, taking delivery of computer hardware from vendors under the terms and conditions of those subcontracts and integrating the hardware in preparation for acceptance testing.

The Acceptance stage concludes when it has been determined, at a minimum, that the computer vendor has met all terms and conditions defined in the subcontract. At this point, the new LCC or HPPC resource will have met initial performance capabilities but will not necessarily be ready to support users and deliver scientific discovery.

Although all Upgrade Projects must be evaluated separately to ascertain the appropriate strategy and high-level structure for meeting objectives, viewing the Upgrade Project from either a subcontracting or a funding perspective can provide additional, and

possibly valuable, planning information. The completion of the acceptance stage typically signals the end of the expenditure of funds for DME.

Upgrade Project Management Reviews and Oversight

There are several critical documents that form the foundation of the Upgrade Project at various stages of execution. A description of the critical documents appears in Appendix B. As part of the launching of the Upgrade Project, the Upgrade Project Scope Statement is drafted and submitted to confirm the Mission Need, and a funding profile from the Program Office that is consistent with financial plans provided from the Office of Science. Confirmation of Mission Need and the Funding Baseline from the Program Office, as represented in the formal Scope Statement, constitutes the Upgrade Project Kickoff, and begins the Pre-Acquisition Phase.

A formal Review of the Pre-Acquisition planning deliverables may be conducted to determine if the Upgrade Project is ready to proceed to the Acquisition Phase. The Pre-Acquisition Phase deliverables include:

- Acquisition Strategy
- Acceptance Plan (v1)
- Upgrade Project Execution Plan including:
    - Work Breakdown Structure
    - Cost Estimate
    - Preliminary Schedule
    - Risk
    - Change/Configuration Management
    - Cybersecurity Plan

During the Acquisition Phase, one or more formal reviews may be conducted to confirm the Upgrade Project Baseline along with the final Upgrade Project Execution Plan and the final Acceptance Plan

Critical Topic/Issue Briefings may be requested at any point during the Upgrade Project Lifecycle to allow the Federal Upgrade Project Director and the Federal Program Manager to evaluate and assess the status of a priority issue.

It is vitally important that all interested parties be kept regularly apprised of the status and the residual risk associated with achieving the overall objectives of the Upgrade Project.

The schedule and DME costs incurred for all Upgrade Projects will be reviewed monthly and reported until the end of the Upgrade Project at Acceptance. When reporting against the preliminary schedule, maximum activity duration should be used to compute variances. Any changes requested by the Project through Configuration Management must be reported to the Federal Upgrade Project Director. In addition to providing input for the annual Exhibit 300 submission and the quarterly IT Progress reporting, the Upgrade Project will provide the following Upgrade Project specific reports:

QUARTERLY- *Quarterly status reports* will be prepared by the Laboratory Project Manager and forwarded through the Federal Project Director to the Federal Program Manager for the Pre-acquisition, Acquisition, Acceptance and Transition to Operations phases. The Federal Program Manager will use the data from these reports to inform the DOE-CIO of the status of the Upgrade Project, through established reporting mechanisms for Information Technology (IT) projects.

MONTHLY- Monthly reporting begins once the Pre-acquisition phase has been completed and ends with acceptance. The monthly reporting format will include information about the status of each activity in format and detail agreed to by the Federal Program Manager and the contractor and will include standard project reporting in PARS.

UPGRADE PROJECT ROLES AND RESPONSIBILITIES

The following federal and non-federal positions have significant roles and responsibilities in the management of Upgrade Projects. A breakout of their roles is contained in Appendix A.

- Under Secretary for Science- Acquisition Executive authority
- Director of the Office of Science or Designee- Holds line managers accountable
- Acquisition Executive- Decision-making authority for the Upgrade Project
- Program Manager- Oversees management of the Upgrade Project
- Federal Upgrade Project Director- Plans, executes and completes the Upgrade Project
- Laboratory Project Manager- Exercises full financial authority and accountability for the Upgrade Project as delegated by DOE

The Transition to Operations Phase

During the transition to operations phase, the software environment, including file systems and software libraries, may need to undergo further testing at scale before the LCC or HPPC resource is certified as ready for scientific studies. The Transition to Operations Phase may include the establishment of procedures for allocating resources and the measurement of computing performance in a steady state. Following successful transitioning, the resource will be available to the user community and begin to deliver scientific results.

The completion of the transition to operations phase could be framed in terms of completing requirements specified in an agreement between the Office of Science and

the GOCO laboratory for making the resource available to the user community for scientific discovery.

Transition to Operations Phase Review and Oversight

An independent review may be used to ascertain whether the overall capability-computer hardware, systems software, the software environment, allocation process, staffing, operations and maintenance are sufficiently ready for full science community usability. Additionally, the GOCO laboratory may conduct a "lesson-learned" assessment to improve future Upgrade Projects.

TRANSITION TO OPERATIONS ROLES AND RESPONSIBILITIES

The roles and responsibilities for the transition to operations are very similar to those of the facility operations since the success of the transition is ultimately based on integrating the new computing capability into the facility. The following federal and non-federal positions have significant roles and responsibilities in the Transition to Operations Phase. A breakout of their roles is contained in Appendix A.

- Director of the Office of Science or Designee- Holds line managers accountable
- Program Manager- Oversees management of the transition
- Federal Site Office Liaison- Plans, monitors and evaluates the transition to operations
- Laboratory Facility Manager- Exercises full financial authority and accountability for the transition to operations as delegated by DOE

APENDIX A.

Key Roles and Responsibilities

Under Secretary for Science

- Acquisition Executive authority
- Delegates Acquisition Executive authority, as appropriate

Director of the Office of Science or Designee

- Holds line accountable for applicable program and capital asset project execution and implementation of policy
- Holds line accountable for project-related site environment, safety and health, cyber security, and safeguards and security
- Delegates Acquisition Executive authority, as appropriate
- Approves Mission Need Statement documents and Acquisition Strategy

Acquisition Executive

- Approve Upgrade Project Decisions
- Approves the appointment of the Federal Upgrade Project Director
- Approves Upgrade Project Execution Plan
- Approves changes in compliance with change control levels identified in Upgrade Project Execution Plans
- Issues formal charge letter and convenes internal Upgrade Project reviews

Federal Program Manager

- Directs initial Upgrade Project planning and execution roles for Upgrade Projects Assigned by the Acquisition Executive
- Initiates definition of Mission Need and the Acquisition Strategy based on input from DOE sites, the scientific community, DOE Laboratories, and Program Offices
- Oversees development of Upgrade Project definition, technical scope, and budget to support Mission Need
- Monitors the effectiveness of Federal Upgrade Project Directors and their support staff
- Conducts quarterly Upgrade Project performance reviews
- Performs functions as Acquisition Executive when so delegated
- Develops Upgrade Project performance measures, and monitor and evaluate project performance throughout the Upgrade Project's life cycle
- Allocates resources throughout the Upgrade Project
- Serves as the Federal Upgrade Project Director until the Federal Upgrade Project

Director is appointed
- Ensures that cyber security and safety is fully integrated throughout the Upgrade Project
- Conducts annual operational analysis of the facility

Federal Upgrade Project Director

- Attains and maintains certification in concert with the requirements outlined in DOE O 361.1A before they are delegated authority to serve as a Federal Upgrade Project Director
- Plans, implements, and completes a Upgrade Project using a Project Management approach
- Initiates development and implementation of key project and Upgrade Project documentation
- Reviews and concurs with project cost, schedule, performance, and scope baselines
- Is responsible for design, construction, environmental, safety, security, health, cyber security, and quality efforts performed comply with the contract, public law, regulations, and Executive Orders
- Is responsible for timely, reliable, and accurate integration of contractor performance data into the project's scheduling, accounting, and performance measurement systems
- Evaluates and verifies reported progress; makes projections of progress and identifies trends
- Serves as the single point of contact between Federal and contractor staff for all matters relating to a project/upgrade project and its performance
- Serves as the Contracting Officer's Representative, as determined by the Contracting Officer
- Establishes and leads the Integrated Project Team and provides broad program guidance. Delegates appropriate decision-making authority to the Integrated Project Team members
- Prepares and maintains the Integrated Project Team Charter and operating guidance with Integrated Project Team support
- Approves changes in compliance with the approved change control process documented in the Upgrade Project Execution Plan
- Ensures that safety and cyber security is fully integrated throughout the Upgrade Project

Federal Site Office Liaison

- Initiates development and implementation of key facility documentation
- Reviews and concurs with cost, schedule, and performance baselines
- Is responsible for design, construction, environmental, safety, security, health, cyber security, and quality efforts performed comply with the contract, public law, regulations, and Executive Orders
- Is responsible for timely, reliable, and accurate integration of contractor performance data into the facility's scheduling, accounting, and performance measurement systems

- Evaluates and verifies reported progress; makes projections of progress and identifies trends
- Serves as the single point of contact between Federal and contractor staff for all matters relating to the facility and its performance
- Serves as the Contracting Officer's Representative, as determined by the Contracting Officer
- Prepares and maintains the Integrated Project Team Charter and operating guidance with Integrated Project Team support
- Approves changes in compliance with the approved change control process documented in the Operations Plan
- Ensures that safety and cyber security is fully integrated throughout the facility
- Oversee steady state operations of facility

Laboratory Project Manager

- Serves as the executive level manager of the design, acquisition, execution, and transition to operations for the Upgrade Project, ensuring all project requirements are fulfilled in a safe and cost-efficient manner
- Exercises full financial authority and accountability as delegated by DOE and the Laboratory to: develop cost and schedule of the Upgrade Project, control work within approved technical, cost and schedule baselines, and control changes to approved baselines in accordance with established configuration management procedures
- Manages and directs all procurements within the Upgrade Project
- Manages the human resources necessary to execute and complete the Upgrade Project
- Ensures that safety and cyber security is fully integrated throughout the Upgrade Project

Laboratory Facility Manager

- Serves as the executive level manager of the transition to operations for the Upgrade Project, ensuring all project requirements are fulfilled and the resource meets established operational capabilities
- Exercises full financial authority and accountability as delegated by DOE and the Laboratory to: develop cost and schedule of the facility, control work within approved technical, cost and schedule baselines, and control changes to approved baselines in accordance with established configuration management procedures
- Manages and directs all procurements within the facility
- Manages the human resources necessary to operate and maintain the facility
- Ensures that safety and cyber security is fully integrated throughout the facility
- Provides recurring reports regarding the performance of the facility

Integrated Upgrade Project Team

An Integrated Upgrade Project Team (IUPT) is a cross-functional group of individuals organized for the specific purpose of delivering an Upgrade Project to the completion stage. An IUPT will be established including as core members:

- Acquisition Executive (participates as schedule permits)
- Federal (HQ) Program Manager
- Federal Upgrade Project Director (Team Leader)
- Laboratory Project Manager
- Cyber Security Subject Matter Expert (CIO)

As needed, the IUPTT will call on specialists in project management/controls, safety, health, procurement, accounting, legal quality assurance, communication, and technical/scientific areas at the Site Office, Support Center, and the Laboratory.

APPENDIX B.

UPGRADE PROJECT CRITICAL DOCUMENTATION

The Upgrade Project documentation highlighted below functions as the structural framework upon which the activities and deliverables of the Upgrade Project are built. These documents are flexible to the scope, size and complexity of the Upgrade Project (note that page count guidelines are not included although content topics are).

Scope Statement

The Scope Statement outlines and identifies the priorities for the Upgrade Project at its onset, and serves as the working document in the earliest planning phases of the Upgrade Project lifecycle.

The Scope Statement should address the following questions:

- What is the objective of the HPC or LCC Upgrade Project?
- What is the science case supporting this Upgrade Project (workshops, etc.)
- How much will it cost?
- What is the schedule?
- What are the major deliverables?
- What are the risks?
- What are the cybersecurity implications and plans?
- How will the Upgrade Project be managed?

The Scope Statement provides the basis for the “Kickoff” of the Upgrade Project, and as such, is a critical foundational document.

Acquisition Strategy

The Acquisition Strategy details the strategy for acquiring the system including potential contract types, incentives, solicitations, procurement process and documentation, and the alternatives analyzed to justify the prioritized approach.

As LCC and HPPC system acquisitions tend to be unique (for example in terms of the financing requirements and/or the cutting-edge nature of the technologies to be acquired), it is critical that the Team, in conjunction with the Program Office initiate the Acquisition Strategy early in the planning phase. It is expected that there will be several versions of this strategy as the Upgrade Project matures, each version expanding the level of detail and updating the basis of estimates, as more details are available.

Upgrade Project Execution Plan

The Upgrade Project Execution Plan is the roadmap that details the path towards successful completion of objectives. Key components of the Upgrade Project Execution Plan include:

- Work Breakdown Structure
- Cost Estimate
- Schedule
- Risk
- Change/Configuration Management

These components are discussed further in the next sections.

In general, preparation of the Upgrade Project Execution Plan will be the responsibility of the Federal Program Manager within the Office of Science.

For the plan to be worthwhile, however, the Federal Program Manager should assemble a team of stakeholders, scientists, engineers, designers, and others who have vested interest in the Upgrade Project and are motivated to work toward its successful conclusion. The essential scope of work, total budget, funding profile, and even a completion date may have been formulated by the sponsoring Program Office. In fact, some of these elements might even be 'firm' constraints. In any case, these data form the outline of an initial plan. A team should assess the likelihood of success (risk of failure) embodied within this plan and then propose any necessary modifications. This point is critical—if team members don't believe in the plan, don't agree that it represents a practical approach with reasonable chances for success—they will neither 'own' it nor feel particularly responsible for making it a success. The plan should address, using a graded approach, (matching the level of effort to the Upgrade Project's scale or importance) all of the elements discussed in this document. The resulting Upgrade Project Execution Plan will then contain the technical, cost, and schedule baselines against which the team should be held accountable. In addition, its preparation will force the team to think about the important issues of planning and control. While the amount of time and effort needed to produce the Upgrade Project Execution Plan will vary depending upon the scope and the complexity of the, work on the document should begin at the inception of the Upgrade Project. It may be unreasonable to define the baselines at this point, but it is dangerous to delay.

Work Breakdown Structure

The Work Breakdown Structure (WBS) organizes and structures the Upgrade Project by work elements at several, distinct levels. The overall Upgrade Project is considered to be Level 1. Each of the Upgrade Project's major components are identified in Level 2, and assigned a separate location and designation within the level. Level 3, and beyond, decomposes Upgrade Project components into sub-components, at increasing levels of specification.

A successful WBS will identify all of the activities that need to be accomplished to achieve the objectives of the Upgrade Project. Simply put, "If it's not in the WBS, it is not in the Upgrade Project." The WBS provides a common basis for preparing the rest of the

Upgrade Project documentation, including the cost estimate and schedule, and for subsequent tracking of Upgrade Project activities.

The commonly used nomenclature for the various levels of a WBS, moving from the highest to the lowest, are Upgrade Project, major components of the Upgrade Project, task or work element, subtask or sub-work element, and so forth. Because the WBS will be used to assign cost accounts, consideration should be given to how the cost information should be broken out for Upgrade Project status tracking as well as for retrieving cost information, when needed.

Schedule

A schedule is necessary to communicate what has been agreed upon, what resources are needed, when those resources are needed; the Upgrade Project scope and methods of acquisition; time-critical activities; the relationship among tasks and activities, and Upgrade Project status.

The schedule should provide an unambiguous means for measuring the status of work elements, tasks and activities relative to Upgrade Project objectives. The schedule should clearly indicate the major stages of the lifecycle: the Upgrade Project (Pre-acquisition, Acquisition and Acceptance; and the Transition to Operations.) During the Pre-acquisition phase, the Scope, the Acquisition Strategy and the preliminary schedule for the Upgrade Project should be established. Some uncertainty in the start and/or end date for some activities are expected in the preliminary schedule. After the subcontract with the vendor has been awarded (Acquisition phase), the Upgrade Project should develop a baseline, which will be approved based on peer review. The baseline contains descriptions, costs, start dates and completion dates for each activity in the Upgrade Project. Changes to the baseline, if needed, will be made in accordance with procedures established by the Upgrade Project for configuration management.

The schedule must contain at least four pieces of information for each task or work element: a description or name, a duration in either workdays or elapsed time, relationships to other tasks or work elements (i.e., which, if any, must precede and which must follow), and the cost to accomplish the task or work element. It should be clear how each task or work element contributes to the Upgrade Project and how it tracks all the way through to the completion and it is related to all other tasks or work elements. The preliminary schedule should describe the Upgrade Project to Level 2 of the WBS. The baseline schedule should provide information to at least Level 4 of the WBS.

Cost Estimate

One of the cornerstones of the Upgrade Project Execution Plan is the cost estimate. A realistic baseline estimate is important so that

- The SC program office has the information necessary to make an informed decision about whether or not to pursue the Upgrade Project; and,
- Adequate funding can be clearly quantified and secured.

At regular intervals throughout the life of the Upgrade Project, estimates-to-complete (ETC) should be prepared to evaluate the financial health of the overall effort. The baseline for the Upgrade Project (technical, schedule, and cost) is needed at an early stage in order to set the boundaries within which the Upgrade Project's activities should remain.

Risk

Risk can be defined as any uncertain event that, should it occur, would have an effect on achieving the objectives. This introduces the dual nature of risk: uncertainty (defined as the probability that a risk might occur) and effect (the potential impact on objectives if the risk does occur). The goal is to actively manage risk throughout the lifecycle through a three phase process of (1) Identification, (2) Assessment (both qualitative and quantitative), and (3) Mitigation and Management.

The baseline will include an identification of all risks and will manage each risk element utilizing one of the following approaches:

- **Avoid—**eliminate uncertainty (change scope; choose different design or vendor, etc.).
- **Transfer—**transfer responsibility or liability to a third party (subcontract to vendor or other Lab, buy insurance, etc.).
- **Mitigate—**reduce the size of the risk exposure (order spare, add 2nd designer, etc.).
- **Accept—**recognize residual risk, plan to monitor and control (contingency planning, risk budget, schedule contingency, etc.).

Risk Management may appear as a work element at Level 2 of the WBS for the Upgrade Project. The amount of funds budgeted for Risk Management or contingency will depend on the aggregate levels of risk associated with items in the baseline for the Upgrade Project and will be validated in the baseline review. Contingency funds are not included for external factors that cannot be reasonably foreseen or quantified, such as major regulatory changes or funding shortfalls. When such circumstances occur, they are treated as "directed changes", requiring work-around plans and /or additional schedule and budget allowances.

Allocation of Contingency funds will be made through the Configuration Management process established by the Upgrade Project.

Change/Configuration Management

Configuration Management is an essential aspect of establishing a sufficient level of management oversight through the implementation of a formal change control process to continuously manage changes to deliverables. Changes to Upgrade Project milestones, the Upgrade Projects documents and other deliverables are managed by continually assessing all circumstances and approving only those changes that need to occur, and controlling attempts at ad hoc changes. Configuration management supports all Upgrade Project functional groups, including any partner organizations that have a

stake in the Upgrade Project. The objectives of Configuration Management include the following:

1. Ensure that integrity and continuity of changes are documented and recorded within the structure of technical, cost and schedule baselines.

2. Provide identification, control and status reporting necessary to assist management in achieving timely system readiness, visibility, traceability, and field support.

3. Provide managers at all levels with sufficient information for making appropriate, timely decisions throughout the life of the Upgrade Project.

4. Ensure that the evaluation of proposed configuration changes is timely and includes a thorough consideration of the change's total impact on technical, cost, schedule, operational capability, and support documentation.

Configuration Management is the process of identifying and defining items in an Upgrade Project or system, controlling changes of these items throughout their life cycles, recording and reporting the status of items and change requests, and verifying the completeness and correctness of items. Configuration Management:

- Consists of a multilayered structure including policy, process, and procedures, with each layer providing an increasing level of detail.
- Includes planning and management, configuration identification, change management, status accounting, and configuration verification and audit.
- Occurs throughout all life-cycle phases and applies to all systems, subsystems, and components of the Upgrade Project, including key documents such as the Upgrade Project Execution Plan.
- Begins with baselining of requirements documentation and ends with acceptance.
- May be applied to hardware, including power systems, software, firmware, documentation, test and support equipment, facility space, spares, training and courseware, and manuals.

Upgrade Project changes may be classified into two broad categories. First are those changes that directly impact the Performance Baseline (Total Cost, schedule, and scope). Second are those that occur within the Performance Baseline, such as changes to sub-element costs and milestones. Changes within the Performance Baseline are routinely accomplished during the development process as the design, engineering, execution and risk management efforts continue.

Thresholds for approvals of changes in the Upgrade Project configuration should be developed in a tiered manner through the organization, commensurate with the size and significance of the proposed change. Changes shall be identified, and managed through a traceable, documented process that is defined in the Upgrade Project Execution Plan. Changes caused by Congressional action, such as a funding shortfall or the addition of new requirements shall be called directed changes. Directed changes shall follow the change control process and shall be approved by the appropriate Acquisition Executive.

An example of a format for identifying control thresholds and the individuals within the organization with the authority to approve changes within those thresholds appears below:

Change Control

	Director, Office of Science (Level 0)	**Associate Director, Office of Science (Level 1)**	**Federal Program Manager, Office of Science (Level 2)**	**Laboratory (GOCO) Project Manager (Level 3)**
Technical Scope				
Schedule				
Cost				

It is expected that the Federal Program Manager at SC-HQ will enter into a partnership with his/her Federal Upgrade Project Director counterpart at the cognizant DOE Site Office and that all approvals (identified as Level 2 in the above table) will be made by that partnership. The Upgrade Project is responsible for developing a process for managing changes to the configuration. A Configuration Change Request (CCR) form is a useful mechanism for documenting change to the configuration and for managing those changes.

Acceptance Plan

Acceptance is a milestone in the subcontract between the GOCO laboratory and the computer vendor and a microcosm of the Upgrade Project. The criteria for acceptance are typically written in terms of the quality of the deliverable, the cost of fabrication, integration and developing the software stack and the schedule for testing and delivering these resources.

An Acceptance Plan usually includes:

- A list of the milestones to be achieved and deliverables to be produced
- A set of criteria and standards for the acceptance of deliverables by the GOCO laboratory
- A plan outlining how the deliverables will be reviewed by the GOCO laboratory to determine whether or not they meet the criteria and adhere to the standards set by the GOCO laboratory

APPENDIX C.

GLOSSARY

Acceptance – the third phase of an Upgrade Project that concludes when it has been determined that the computer vendor has met all terms and conditions under the subcontract, and all expenditures of Development, Modernization and Enhancement funding have ended.

Acquisition – the second stage of a project that includes planning for the entire Upgrade Project, taking delivery of computer hardware from vendors under the terms and conditions of subcontracts and integrating the hardware in preparation for acceptance testing.

Acquisition Strategy – a high-level description of the business and technical management approach to acquire an HPC or LCC system for scientific discovery. It serves as the framework for planning, organizing, staffing, managing, and leading the overall effort.

Baseline – the collective key performance, scope, cost, and schedule parameters, which are defined for the Upgrade Project (or a single phase or multiple phases of an Upgrade Project).

Contingency – the portion of the budget that is available for risk uncertainty within the scope of the overall resource. Note that the Operating Plan, the Transition to Operations Plan and the Upgrade Project Plan all have contingency associated with them.

Development/Modernization/Enhancement (DME) - those efforts and funds expended by the GOCO that are part of the project starting with the Acquisition Phase and ending with the Acceptance Phase.

Upgrade Project Execution Plan (EP) – the blueprint for delivering a High Performance Production or Leadership Class computing system for scientific discovery within specified cost, schedule and performance objectives. It contains an organization/management plan, work breakdown structure, schedule, cost estimate, risk management, configuration management, and acquisition overview and reporting. It is prepared by the laboratory (GOCO) Project Manager at the request of the Federal Upgrade Project Director or the Federal Program Manager and approved by the DOE Acquisition Executive.

Federal Upgrade Project Director – A federal employee, usually a DOE Site Office employee, responsible for hands on, day-to-day DOE management and oversight of the Upgrade Project.

IUPR (Independent Upgrade Project Review) – Independent Project Reviews are important project management tools and serve to verify the project's mission, organization, development, processes, technical requirements, baselines, progress, etc. Independent Upgrade Project Reviews are performed by reviewers from within or

outside the Program, but having no association with the Upgrade Project being reviewed.

IUPT (Integrated Upgrade Project Team) – An Integrated Upgrade Project Team is a cross-functional group of individuals organized for the specific purpose of delivering an Upgrade Project to the completion stage. The IUPT usually includes both federal and laboratory employees in its membership.

Mission Need – a DOE Office of Science statement included in the President's Budget that describes the scope and need for a specific HPPC or LCC system for scientific discovery Upgrade Project. A Congressional appropriation constitutes approval of the mission need and the Upgrade Project.

Operations Plan - will highlight the logistics of the organization such as the various responsibilities of the management team; the tasks assigned to each division within the organization, and identify expenses associated with the overall operation. The plan will also identify key deliverables, the roles, responsibilities and lines of authority in the organization, plans for operation and maintenance of hardware and software resources, user support, electricity, office space charges, technology re-fresh schedules and budgets. Typically, this plan will cover a 3-5 year time window and be updated annually to reflect the impact of current budgets, refinement of the requirements for operational reserve and the evolution of user requirements. In addition, this plan will also include one or more decision points at which the evolution of requirements or the financial advantages of equipment refresh will make initiation of an Upgrade Project attractive

Preacquisition – The first phase of an Upgrade Project where the performance goals of the HPPC or LCC system are set and the method (core computer hardware, peripheral, and related systems) of achieving these goals are determined. Preliminary planning, scoping, costs and schedules are established based on informal discussions with vendors and budgetary quotes provided by vendors.

Preliminary Schedule – The schedule developed in the preacquisition phase. It is an estimate of the schedule using the higher level WBS.

Project – an integrated set of work elements, tasks and activities under a single management organization that delivers a high performance computing or leadership class computing system by a Government-owned, contractor-operated laboratory for scientific discovery. It contains a specified beginning, end, cost and performance.

RFP (Request for Proposals) – A formal solicitation requesting that proposals be submitted for providing hardware, systems, goods, or services.

Risk Management – The process of managing risk on an Upgrade Project. Effective risk management is an essential element of an Upgrade Project. The risk management process is continuous starting early and continuing through Upgrade Project completion. Risk assessments should be performed as early as possible in the Upgrade Project life cycle and should identify critical technical, performance, schedule, and cost risks. Once risks are identified, sound risk mitigation strategies and actions should be developed and documented.

RMP (Risk Management Plan) – A short document that sets forth the plan for risk management on the Upgrade Project.