Advanced Scientific Computing Research
High End Computing and
High Performance Networking
Scientific User Facilities Management Plan

Office of Advanced Scientific Computing Research
Office of Science
U.S. Department of Energy

Date:

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ASCR Facilities Management Plan
Versions Summary

Version	Creation Date	Description	Approval Date
1.0		Original Facilities Management Plan	June, 2012
2.0	August, 2015	Updated to added sections on joint procurements and process for projects under $10M	July, 2016
3.0	November, 2019	Revised to tailor provisions for high performance networking and to account for administrative change 4 to DOE Order 413.3B	Issued as draft
3.1	January, 2023	Incorporated technical corrections and information regarding DPAS contract and phased acceptance risk management practices	January, 2023

1.0 PURPOSE

The Advanced Scientific Computing Research (ASCR) High End Computing (HEC) and High Performance Networking (HPN) scientific user facilities are essential research infrastructure in meeting the Department of Energy (DOE) Office of Science (SC) mission needs. Many stakeholders— the DOE/SC Program Offices, DOE National Laboratories, industry, and academia—depend on these resources to achieve their research goals.

The purpose of this document is to describe ASCR's management principles for facility upgrade projects, the transitions from the project phase to operations, and conduct of operations.

To accomplish this purpose, this plan includes the ASCR program and project management tailoring of the following guiding principles:

- DOE Program and Project Management Order 413.3B.
- SC Tailoring of the DOE Order.
- DOE Integrated Project Team Guide.
- OMB Circulars A-11 (Planning, Budgeting and Acquisition of Capital Assets), A-123 (Management's Responsibility for Internal Control), and A-131 Value Engineering).

The primary audiences for this plan are the ASCR Facilities Division, the SC Office of Project Assessment, the National Laboratories that host the ASCR user facilities (Argonne, Lawrence Berkeley, and Oak Ridge National Laboratories), and the respective DOE Site Offices at those locations.

2.0 OVERVIEW OF ASCR USER FACILITIES

2.1 Mission

The Mission of the ASCR program is to advance applied mathematics and computer science; deliver, in partnership with disciplinary science, the most advanced computational scientific applications; advance computing and networking capabilities; and develop, in partnership with U.S. industry, future generations of computing hardware and tools for science.

2.2 User Facilities

SC defines a user facility[1] as a federally sponsored research facility available for external use to advance scientific or technical knowledge under the following conditions:

- The facility is open to all interested potential users without regard to nationality or institutional affiliation.
- Allocation of facility resources is determined by merit review of the proposed work.
- User fees are not charged for non-proprietary work if the user intends to publish the research results in the open literature.
- Full cost recovery is required for proprietary work.
- The facility provides resources sufficient for users to conduct work safely and efficiently.
- The facility supports a formal user organization to represent the users and facilitate sharing of information, forming collaborations, and organizing research efforts among users.
- The facility capability does not compete with an available private sector capability.

The ASCR user facilities fall into two categories: High End Computing (HEC) and High Performance Networking (HPN).

2.2.1 High End Computing Facilities

The DOE and its predecessor organizations have long played a key role in advancing U.S. computing capabilities in partnership with U.S. computing vendors and researchers. Computing is a fast-paced industry, but sustained progress depends upon significant gains in numerous areas of fundamental research including: advanced lithography, nanoscale materials science, applied mathematics and computer science—areas where DOE has provided long-term investments and world-leading capabilities. DOE partners with vendors to accelerate and influence the development of commodity parts; these research investments impact computing at all scales, ranging from the largest scientific computers and data centers to mid-range computing clusters to consumer laptops.

ASCR HEC user facilities comprise two different classes, namely, a high-performance production class and a leadership class. The DOE High-End Computing Revitalization Act of 2004, Public Law (PL 108-423) defines a High-end Computing System as a computing system with performance that substantially exceeds that of systems that are commonly available for advanced scientific and engineering applications. PL 108-423 further identifies a specific class of

[1] https://science.osti.gov/-/media/_/pdf/user-facilities/memoranda/Office_of_Science_User_Facility_Definition_Memo.pdf

high-end computing systems as Leadership System that are among the most advanced in the world in terms of performance in solving scientific and engineering problems.

ASCR's high-performance production class facility, the National Energy Research Scientific Computing Center (NERSC) at the Lawrence Berkeley National Laboratory (http://www.nersc.gov/), provides high-end computing for basic scientific research to many thousands of users with a wide variety of use-cases. NERSC's mission is to accelerate the pace of scientific discovery by providing high-end, high-performance computing, information, data, and communications services for SC-sponsored research activities.

ASCR's Leadership Class Facilities (LCF) are world-leading HEC resources dedicated to breakthrough science and engineering, providing very large allocations of computing resources to the science community, including users not funded by DOE. The LCFs each support approximately 100 projects and 1,000 users per year. ASCR's two LCFs are

- Oak Ridge Leadership Computing Facility (OLCF) (http://www.olcf.ornl.gov/)
- Argonne Leadership Computing Facility (ALCF) (http://www.alcf.anl.gov/)

The ASCR HEC user facilities are heavily over-subscribed and enable a wide range of scientific research spanning many disciplines, as well as industrial research. Allocation of computer time at ASCR facilities follows the peer-reviewed and open-access model used by other SC scientific user facilities. The HEC facilities regularly gather requirements from the other SC research programs through a robust process to inform upgrade plans. These requirements activities are also vital to planning for SciDAC and other ASCR efforts to prioritize research directions and inform the community of new computing trends, especially as the computing industry moves toward exascale computing.

The lifecycle of an HEC system is roughly 3-5 years; international competition for leadership in computing technology and software is intense and HEC Upgrade Projects are typically under intense pressure to balance performance breakthroughs against budget constraints. Increasing demands for electrical power and cooling for future HEC systems drive site improvement projects that typically accompany or are a component of HEC Upgrade Projects.

2.2.2 High Performance Network Facility

ASCR's HPN facility is the Energy Sciences Network (ESnet) operated by Lawrence Berkeley National Laboratory (http://es.net). ESnet delivers highly-reliable data transport capabilities optimized for the requirements of large-scale science. In essence, ESnet is the circulatory system that enables the DOE science mission. ESnet currently maintains one of the fastest and most reliable science networks in the world with a 400 gigabit per second (Gbps) "backbone" network that spans the continental United States and the Atlantic Ocean. ESnet interconnects the DOE's national laboratory system, dozens of other DOE sites, and ~200 research and commercial networks around the world—enabling tens of thousands of scientists at DOE laboratories and academic institutions across the country to transfer vast data streams and access remote research resources in real-time. ESnet also supports the data transport requirements of all SC user

facilities. ESnet's traffic continues to grow exponentially—roughly 66% each year since 1990—a rate more than double the commercial internet.

Costs for high performance networking are dominated by operations and maintenance, including continual efforts to maintain dozens of external connections, benchmark future needs, expand capacity, and respond to new requests for site access and specialized services. As a user facility, ESnet engages directly in efforts to improve end-to-end network performance between DOE facilities and U.S. universities. Approximately 80% of the traffic on ESnet originates or terminates outside of the DOE complex.

Massive science data flows require different network capabilities than network traffic generated by email, video, and web browsing. If capacity fails to stay ahead of demand, the result is undesirable *packet loss*; a small rate of packet loss (less than 0.01%) in a continental-scale network causes hugely disproportionate effects (> 50X reduction) on data transfer speeds for large flows, due to characteristics of TCP, the dominant Internet transport protocol. For this reason, the high performance network is designed to be *lossless,* to the extent possible. Commercial networks do not have the same design objectives, because the flows they support have much lower throughput and travel much shorter distances than DOE science flows. ESnet's special capabilities include virtually lossless data transport, bandwidth guarantees that can span multiple network domains, and a distributed performance-monitoring platform. ESnet is also architected to be resilient, redundant and decentralized: the network's ring topology ensures that no single backbone segment failure will cause an outage to a site.

The ESnet HPN user facility also operates a continental-scale network research testbed for the purpose of conducting research in a range of high performance networking topics. Recent research projects have included software defined networking architecture, post-TCP protocol dynamics, and identification and improved performance of high-throughput science data flows.

3.0 GUIDING PRINCIPLES

Every major federal stakeholder—ASCR, SC, DOE, OMB, and Congress—pursues a common goal of fulfilling DOE mission objectives while protecting the value of taxpayer dollars. ASCR, as the federal entity responsible for management and oversight of its funded activities, is responsible for drawing a coherent picture of the formal guidance emanating from these multiple governance levels through statute, regulation, and policy guidance. Communicating clear requirements and expectations to its user facilities is essential to sustaining the public trust in the enterprise and empowering the facilities to achieve a high level of innovation and operational excellence.

This section describes the guiding principles of ASCR, SC, DOE, OMB, and Congress relevant to ASCR user facility upgrade projects and operations. It is important to note that the guiding principles and reports discussed in this section are documented more fully elsewhere, and that references to sources should be studied for a complete picture of the subject requirements.

3.1 Federal Statute and Congressional Intent

All ASCR activities are subject to relevant federal statutes and to congressional direction delivered through the annual appropriations process.

The DOE High-End Computing Revitalization Act of 2004 (P.L. 108-423, 15 U.S.C. 5541 et seq.) stipulates that DOE:

- Develop and deploy high-end computing systems for advanced scientific and engineering applications.
- Support both independent and multidisciplinary teams of investigators.
- Provide sustained access by the research community in the U.S. to high-end computing systems and to Leadership Systems, including provision of technical support to the users of such systems.

In addition, Congress provides specific direction through the annual appropriations process, typically in the form of report language accompanying the passage of appropriations law.

3.2 Office of Management and Budget

The Office of Management and Budget (OMB) is responsible for budget development and execution for the executive branch of the U.S. government to ensure that funds requested support the agency mission and provide value to the taxpayer. ASCR activities are subject to rules, regulations, and instructions promulgated by OMB to federal agencies.

- OMB Circular A-11, Preparation, Submission, and Execution of the Budget, contains a detailed supplement entitled, Capital Programming Guide: Planning, Budgeting and Acquisition of Capital Assets. The supplement provides guidelines for management of the entire life-cycle of a capital asset (see the glossary for OMB definition of capital assets). OMB states clearly in the introduction to the supplements that agencies have flexibility in how they implement the key principles and concepts of the guide.
- OMB Circular A-11 stipulates that agencies report on major information technology (IT) and non IT investment capital asset projects using OMB Exhibit 300: Capital Asset Plan and Business Case Summary. The Exhibit 300 has been in use for several years as part of the Federal Government's capital planning control process. OMB provides guidance to agencies on the preparation of Exhibit 300s[2]; agencies must provide a strong business case for the investment, and proposed cost, schedule, and performance goals for the investment if funding is obtained. In addition A-11 calls for a yearly operational analysis report.

3.3 Department of Energy

The Department of Energy project Order 413.3B, Program and Project Management for the Acquisition of Capital Assets, is the Department's primary framework for managing capital asset projects. The order's objective is to deliver every project at the Performance Baseline (PB), on schedule, within budget, and fully capable of meeting mission performance, safeguards and

[2] http://www.whitehouse.gov/omb/circulars/a11/current_year/a11_toc.html

security, sustainability, and environmental, safety, and health requirements. The Order is designed to be consistent with OMB directives.

The DOE Order principles for successful project execution include the following:

- Line management accountability.
- Sound, disciplined, up-front project planning.
- Well-defined and documented project requirements.
- Development and implementation of sound acquisition strategies that incorporate effective risk handling mechanisms.
- Well-defined and managed project scope and risk-based project baselines.
- Development of reliable and accurate cost estimates using appropriate cost methodologies and databases.
- Properly resourced and appropriately skilled project staffs.
- Effective implementation of all management systems supporting the project; e.g., integrated safety management, risk management, change control, performance management and contract management.
- Early integration of safety into the design process.
- Effective communication among all project stakeholders.
- Utilization of peer reviews throughout the life of a project.

Order 413 also explicitly states that tailoring of the Order's requirements is necessary for the efficient delivery of each project and that tailoring should take into account the project's size, complexity, cost, and risks. Tailoring may involve consolidation or phasing of Critical Decisions (CDs), substituting equivalent documents and concurrency of processes; adjusting the scope of Independent Project Reviews (IPRs) and delegation of acquisition authority. Major tailored elements must be specified in the Project Execution Plan (PEP) approved by the Acquisition Executive.

3.4 Office of Science

Although the Office of Science holds an exemption from Order 413[3], SC elects to implement Order 413 principles and processes because of their demonstrated strong positive influence on project outcomes. In turn, because ASCR High End Computing and Networking resources are considered scientific user facilities, we adhere to the principles described in Order 413.

DOE/SC has program management policies and procedures in place that provide guiding principles for all ASCR activities, including upgrade projects. These guiding principles help ensure that ASCR Facilities achieve SC program goals on time and within budget.

- The DOE/SC program goals include the following:
  - Facility Operations: Maximize the performance, reliability, dependability, and availability of the SC scientific user facilities.
  - Future Facilities: Build future and upgrade existing facilities and experimental capabilities to ensure the continuing value of the SC scientific user facilities.

[3] https://science.osti.gov/~/media/opa/pdf/processes-and-procedures/sc/SC_Order_Delegation_final.pdf

DOE/SC has developed a laboratory appraisal process in conjunction with the Performance Evaluation Management Plan (PEMP) to manage its laboratories including those that contain ASCR's HEC and networking facilities. This process allows ASCR to establish fiscal year notable outcomes for its facilities and provide input to the yearly assessment process.

- The SC Office of Project Assessment (OPA) is the SC Project Management Support Office (PMSO) and provides independent advice to the Director of the Office of Science (SC) relating to those activities essential to managing projects such as facility upgrades. OPA conducts independent reviews of ASCR facility projects.
- The SC Management System (SCMS) provides guidance on SC Budget and Financial Management System (as well as Program and Project Management), and its purpose is to assure that the Office of Science is exemplary in its stewardship of fiscal resources. Funds are distributed on a routine basis in an efficient and effective manner and subsystems and controls are in place to ensure that Congressional and Administrative Funding Control Points are not exceeded. The SCMS states that the SC Program Offices are to provide the following:
  - Establish and maintain effective systems for the administrative control of funds allotted.
  - Ensure that funds are not obligated in excess of available budgetary resources.
  - Ensure funds are used for the purposes for which they were appropriated.

3.5 Advanced Scientific Computing Research (ASCR) Program

ASCR facility upgrade projects are based on formal assessment of scientific mission need and operational capability gaps, which are determined by frequent interactions with the research community and the SC Science Program Offices. For HEC and high performance networking upgrade projects, ASCR tailors the project management approach outlined in Order 413 (see section 6).

As mentioned, ASCR receives congressional appropriations for user facilities operations and upgrade projects. ASCR provides oversight of the HEC and HPN facility balance of plant issues, which include power, cooling, site preparation, cyber security, property protection (given the cost of the facilities), sustainability, environment, safety, and health. ASCR typically conducts annual operations reviews and Independent Project Reviews of each ASCR Facility.

In addition, ASCR requires each facility to implement a formal risk management methodology for both operations and upgrade project activities. This approach also includes assessing and managing opportunities to attain cost savings and operational efficiencies, achieve higher performance or additional scope, and identify and implement actions to capture those opportunities. Risk management is discussed in more detail in Appendix A.

4.0 USER FACILITIES LIFE-CYCLE OVERVIEW

The ASCR HEC and HPN user facilities are critical to DOE mission objectives, and therefore are operated and upgraded with an eye to continuous availability. An "upgrade project" is defined as a major activity exceeding $25 million that provides significant new capabilities to a facility. ASCR articulates the life-cycle of its user facilities in three phases: the upgrade project, transition to operations, and management-in-use or operations.

It is important to note that the federal budget process for ASCR upgrade projects differs from other major SC projects in the following way: both the executive and legislative branches elect to not parse ASCR user facility operations and upgrade project funding. This unified approach to project and operations funding provides ASCR with the flexibility to plan and execute successive upgrade projects and provides the ASCR Facilities with the agility to manage risk and opportunity with respect to rapid evolution of information technology.

4.1 High End Computing Facilities Life-Cycle

The life-cycle of an HEC user facility is illustrated in Figure 1. These phases are briefly defined below and explained in greater detail in later sections of this document. Compared to other research infrastructure, such as accelerator-based facilities, reactors, and telescopes, HEC technology has a short life-cycle of only a few years owing to the constant innovation in the semiconductor industry. Due to the short life cycle, it is typical that at any given time an HEC user facility is in more than one phase.

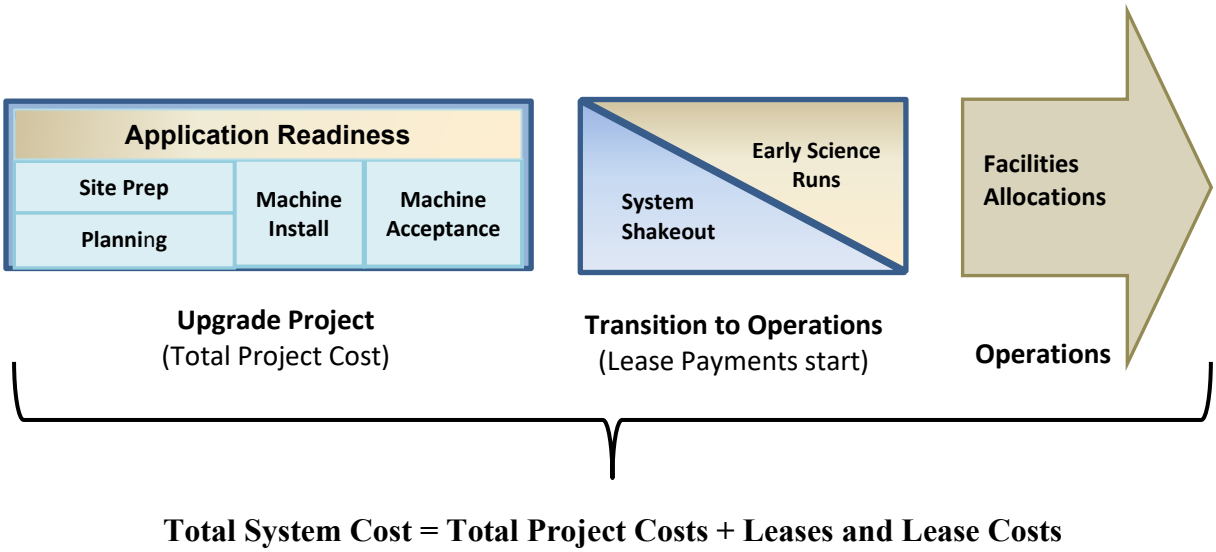

Figure 1: HEC User Facility Management Phases

4.1.1 HEC Upgrade Projects

Any major activity related to providing new system capabilities to existing HEC facilities is considered an "upgrade project." Each HEC upgrade project is unique in its objectives, deliverables, and tactics, and requires flexibility to successfully manage risk and address the vendor environment at that moment in time. ASCR tailors the structure and management of the project to achieve success.

HEC upgrade projects typically involve two primary components:

(1) a large non-recurring engineering (NRE) contract with a core vendor who provides the computational hardware that makes up the heart of the machine. Interaction with this core vendor system integrator is a defining aspect of HEC Upgrade Projects. Due to the very large capital costs of producing semiconductor processors, there are typically only a handful of U.S. firms capable of fulfilling the requirements to build an HEC machine. Each HEC upgrade project must balance technological innovation against the constraints imposed by broader market forces. Managing risk through the mechanisms of the contract while sustaining a strong partnership with the vendor integrator is paramount to project success.

(2) In addition, project expenditures for the development of new capabilities are classified as Development, Modernization, and Enhancement (DME) costs and include planning for system upgrade; preparing the site for the new capabilities; and installing, testing and accepting the new machine. The upgrade project ends once the new machine has passed acceptance as defined in the statement of work (SOW) between the vendor and the site.

It is important to note that ASCR HEC scientific user facilities upgrade projects have the following characteristics:

- Because the useful life of HEC technology is so much shorter than that for other SC user facilities, upgrades must be deployed as soon as practical to provide the capability to the science community before the technology is made obsolete by advances in the semiconductor industry.
- Large HEC upgrade projects use firm-fixed price, Lease-To-Own (LTO) contracts for HEC equipment. Lease payments after system acceptance are part of operations and not part of the upgrade project.
- Milestone payments to the vendor prior to system acceptance are considered part of project costs. However, a project may incorporate multiple acceptance tests to make some lease or incremental payments to the vendor prior to full acceptance of the machine.
- Acceptance testing is a contractual issue between the HEC Facility and the vendor to verify that the delivered system meets the specifications of the contract. Among other tests, acceptance testing involves running representative science codes and software to ensure it will meet performance needs. Phased acceptance, in which partial payments are issued to the vendor for defined scope, can provide advantages for managing financial and schedule risks for both the system vendor and the laboratory.

The Defense Production Act Authority

In order to mitigate supply chain risks it is appropriate and advisable for upgrade projects to include provision in system acquisition contracts for authorities under the Defense Production Act of 1950, Pub. L. No. 81-774, §101a [50 U.S.C. 4511(a)], delegated to the Secretary of Energy in Executive Order 13603 and the Department of Commerce (DOC) Defense Priorities and Allocations System (DPAS) Delegation 2.

Most recently, the Department of Energy invoked these authorities in 2021 for the system acquisitions undertaken under the Exascale Computing Initiative.[4]

4.1.2 HEC Transition to Operations

Once the upgraded system is accepted, the Transition to Operations phase begins and lease payments to the vendor commence. During the Transition to Operations, the HEC system undergoes further testing at scale to confirm that the system and facility are ready to release the new capability to the Facility's user community With the concurrence of ASCR, HEC facilities solicit proposals for early science users to conduct scientific research while "shaking-out" any issues prior to going to full production. The criteria for successful completion of the transition to operations period is defined in the Project Execution Plan (PEP) for each facility.

4.1.3 HEC Management-in-Use or Operations

Effective Management-In-Use or operations of the new capability asset begins after transition to operations and requires the continuous monitoring of the entire facility to ensure it continues to support the facility's mission and objectives. Operations is generally the longest phase of the investment or asset life-cycle and ownership costs, such as operations, maintenance (including service contracts), energy use, and lease costs in the case of ASCR's facilities, can often consume more than 80 percent of the total life-cycle costs. ASCR's HEC facilities normally have a portion of the facilities continually in the operations phase.

Management-in-use also comprises a number of core activities that connect to long term planning:

> **User requirements gathering:** ASCR and the HEC facilities work closely with the SC science programs and other DOE stakeholders to understand current and future HEC requirements. ASCR and the HEC facilities work directly with scientists and federal program leadership through formal requirements gathering processes, including workshops and ad hoc meetings.
>
> **User support and outreach:** Each HEC facility engages directly with current users to maximize productive use of facility resources and with prospective users to explore the potential scientific benefit of HEC resources. Through regular oversight, ASCR and the HEC facility distill insight into strategic issues affecting users, which in turn feed ASCR's long term HEC strategy.

[4] The Department deemed the ECI as requiring operating supplies to support the Department's Atomic Energy Programs, which is an approved Department of Energy program (E2) under 15 C.F.R. Part 700, Schedule 1.

Performance monitoring: ASCR requires each HEC facility to regularly monitor and report a variety of operational performance metrics.

Innovation: As part of its core operations, each HEC facility advances the state-of-the-art in HEC hardware, software, and support systems to drive operational efficiency and new capabilities for users.

4.2 High Performance Network Facility Life-Cycle

A high performance wide area network facility is an integration of thousands of components in hundreds of locations; large-scale HPN networking is about systems engineering, managing partner and vendor relationships, and integration of services and components. The technology life cycle for the HPN facility is driven by the goals of scaling to accommodate exponential traffic growth; maintaining a *lossless* and resilient network infrastructure; and making intelligent use of available network resources.

Compared to other research infrastructure, such as accelerator-based facilities, reactors, and telescopes, networking technology has a shorter life-cycle (from five to seven years) owing to the constant innovation in the optical and semiconductor industries as well as the increasing use of automation and orchestration in network operations. The ESnet high performance networking facility is a distributed yet highly integrated infrastructure that is constantly maintained and expanded while remaining in operation.

The life-cycle of the high-performance network facility consists of three phases: Upgrade Projects, Transition to Operations, and Sustaining Engineering and Operations (management in use). These phases are briefly defined below and explained in greater detail in later sections of this document.

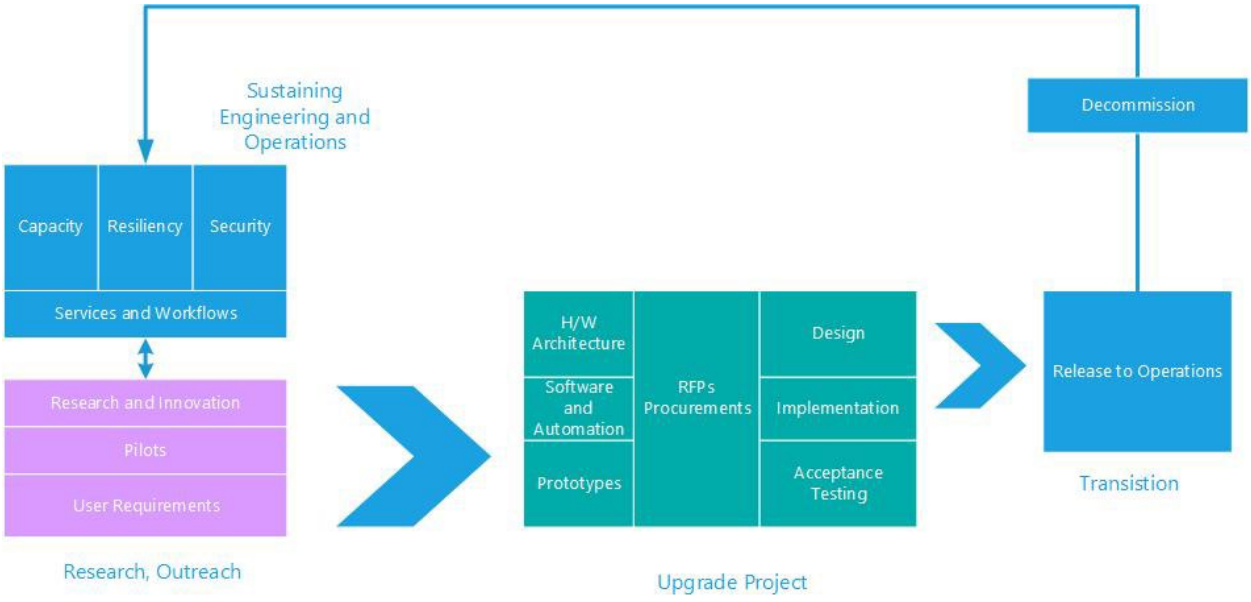

Figure 2: HPN Facility Management Phases

4.2.1 HPN Upgrade Projects

Upgrade projects are essential to enhancing the network's core capabilities, migrating to more advanced technology, implementing new services, and avoiding the operational and security risks associated with technology end-of-life. Upgrade projects may be focused on one or more component(s) of the HPN facility. Each upgrade project is unique in its objectives, deliverables, and tactics, and requires flexibility to successfully execute the project while managing risk. ASCR tailors the structure and management of upgrade projects to achieve success. The key defining constraint in each upgrade project is to ensure minimal disruption to the current integrated HPN facility and critical networking services.

HPN upgrade projects typically fall into two categories:

- Greenfield Network: A complete new, integrated networking facility is built, which may include a new fiber footprint. Migrating to a new optical fiber across the entire network footprint is a fairly rare occurrence, and will well exceed $25 million.
- Technology Upgrade: Key technology components are upgraded/replaced across the entire facility infrastructure. An example might be a project to replace all of the core routers, or a major upgrade of the orchestration software package. This type of project may exceed $25 million.

Incremental additions of capacity, establishing peerings to other networks, connections to new sites, or implementation of new services are considered an aspect of management-in use, and are not upgrade projects. Similarly, targeted upgrades of components are a natural part of activities to sustain operations.

It is important to note that ASCR High Performance Networking user facility upgrade projects have the following characteristics:

- Because the HPN user facility is mission-essential "always on" research infrastructure, planning for executing the transition from the current network to the "new" network without service disruption is a defining aspect of upgrade projects and the transition to operations.
- The high performance wide area network facility is an integrated system of multiple technologies and software provided by a number of suppliers. HPN facility upgrade projects consist of multiple contracts that include a mix of contracted services and equipment that ESnet engineers directly implement and integrate into a working system. Each of these contracts could have options for buying more equipment over time at a negotiated price schedule over a longer term, allowing for flexible deployment, operational growth of capability over time and is particularly useful for projects that span several years.

4.2.2 HPN Transition to Operations

The transition to operations phase consists of tests to validate network performance and the movement of production data traffic from the current network infrastructure to the new or upgraded networking infrastructure. As network uptime is critical, transition to operations may be staged over many weeks to months to facilitate transition coordination with the dozens of connected sites. During this transition phase, both the current and upgraded networks and technology components will be carrying production traffic. The transition to operations is complete when connected sites are using the upgraded network or technology components for their production connectivity.

Once the upgraded network is carrying production traffic from all sites, the older infrastructure, as well as other contracted services not carried over from the former network to the upgraded network, will be decommissioned. Decommissioning typically includes removing network equipment distributed across multiple sites, terminating contracts that are no longer needed, and balancing traffic across the network.

4.2.3 HPN Management-in-Use or Operations

Operations, or "management-in-use" of HPN user facilities is the provision of resources to users to enable scientific discovery: planning, developing, delivering, maintaining, and supporting high performance networking services to scientists globally. The HPN user facility is in continuous operations; any appreciable down time would hamper the DOE science mission. Effective Management-In-Use of the facility begins after transition to operations and requires the continuous monitoring of the entire facility to ensure it continues to fulfill mission objectives. Operations is generally the longest phase of the investment or asset life-cycle and includes: 24x7 monitoring and operations, maintenance (including service contracts), regular capacity planning, procurement and deployment of additional equipment to meet capacity needs, and executing expenditures for energy consumption and hardware/software update costs.

Management-in-use also comprises a number of core activities that connect to long term planning:

User requirements gathering: ASCR and the HPN facility work closely with the SC science programs and other DOE stakeholders to understand current and future HPN requirements. ASCR and the HPN facility work directly with scientists and site network and system administrators through formal requirements gathering processes, including workshops and ad hoc meetings.

Capacity management: The HPN capacity management process aims to continually align demand with current network utilization, as well as provide adequate network resiliency. The goal is to provide additional capacity "just in time" to meet science data movement demands within the facility's operating budget. Capacity planning is also a key element of long term budget planning. ASCR reviews and approves the highest cost and/or highest risk capacity and connection expansions prior to execution.

Governance: The HPN facility is accountable both to the connected sites and to ASCR for its operational performance. ASCR establishes the governance framework through

which ASCR, the facility, and the connected sites interact and resolve issues. The chartered ESnet Site Coordinators Committee (ESCC) is the primary forum for these interactions; the ESCC is the de facto user organization for the connected sites.

Research Testbed

In vivo network research is a critical aspect of HPN facility operations because it expands options for the next generation of the facility and attracts talented network innovators to the enterprise. ASCR operates a network research testbed within the HPN facility, available to researchers from DOE, universities, and industry. The testbed is logically separate from the production network and allows for potentially disruptive wide-area network research in areas of new network protocols, including alternatives to TCP/IP; automatic classification of large bulk data flows; and high-throughput middleware and application development. It is a realistic continental-scale environment for innovative network research and innovation as well as a framework for testing new network architecture and services.

A high-latency environment such as seen in production transcontinental networks would be impossible for most researchers to create in their labs. The testbed includes mechanisms to make it easy for researchers to manage their custom host images, including tools to create, modify, save, and restore test environments. It offers researchers maximum flexibility as they get "super-user" rights to all hosts, "bare metal" host access, their own boot image with root access, the ability to install custom operating systems on hosts, a controlled environment that supports reproducible results, and complete control of every packet on the network.

5.0 GUIDANCE FOR MANAGEMENT-IN-USE OR OPERATIONS

Operations, or "management-in-use" of ASCR scientific user facilities is the provision of resources to users to enable scientific discovery: delivering, maintaining, and supporting high end computing and networking services to scientists nationwide.

OMB Circular A-11[5] identifies two key management objectives during the Management-in-Use phase: 1) to demonstrate that the existing investment is meeting the needs of the agency, delivering expected value or that the investment is being modernized and replaced consistent with the Agency's enterprise architecture; and 2) to identify smarter and more cost effective methods for delivering performance and value. Further it recommends a yearly operational analysis to examine specific areas such as: Customer Results, Strategic and Business Results, and Financial Performance.

ASCR implements this recommendation through its annual Operational Assessment Review (OAR) of each user facility. ASCR's OAR evaluates the facility's mission impact and operational health in the areas of customer results, business results, strategic results, innovation, safety, and security. Note that financial performance is reviewed through a separate process discussed below. ASCR issues formal guidance for the scope of the OAR and instructions to the facilities; in response each facility prepares an OAR report document that encapsulates the operational performance for the subject time period.

ASCR leverages external peers to review the annual operational assessment report of each facility. The OAR reviewers assess the status and quality of operation of scientific user facilities and to provide constructive feedback on what areas each facility should focus on for improvement. Each year, on a rotational basis, ASCR conducts one OAR on-site. During each of the intervening three years, ASCR conducts a virtual or mail review.

ASCR defines successful operations as delivering:

- Effective user support [OAR §1]
- Operational performance [OAR §2]
- Effective management of resource allocation [OAR §3]
- Effective management of innovation [OAR §4]
- Effective risk management [OAR §5].
- Effective management of Environment, Safety, and Health practices [OAR §6].
- Effective management of cyber security practices [OAR §7].
- Strategic results [OAR §8].

ASCR defines policies and practices in certain areas that provide a framework for achievement of these goals.

[5] http://www.whitehouse.gov/sites/omb/circulars_all_current_a11_toc

5.1 User Support

Providing effective user support throughout the life-cycle of a user project is an essential aspect of successful operations. ASCR requires each facility to track and report defined metrics and anecdotal information to drive continuous improvement in user administration and engagement. Utilization of some form of annual user satisfaction survey is typical.

The SC definition of a user facility also includes the tenet that, "the facility supports a formal user organization to represent the users and facilitate sharing of information, forming collaborations, and organizing research efforts among users."

5.2 Operational Performance

ASCR establishes annual operational uptime targets for each facility. Operational performance encompasses a variety of metrics and practices that are holistically evaluated through the annual OAR and through continuous interactions between ASCR and its Facilities.

5.3 Allocation Processes

5.3.1 High End Computing Facilities Allocation Processes

The primary objectives of ASCR's, peer-reviewed, HEC Allocation Policy and Procedure are the following.

- Provide substantial allocations for a small number of high-impact, grand-challenge scientific research projects at LCFs through the Innovative and Novel Computational Impact on Theory and Experiment (INCITE) program.
- Provide allocations for SC supported research through the Energy Research Computing Allocations Process (ERCAP) at NERSC.
- Provide allocations for projects directly related to the Department of Energy and to broaden the community of users capable of using leadership computing resources through the ASCR Leadership Computing Challenge (ALCC).
- Provide allocations for startup or scaling and benchmarking activities as well as strategic partnerships, through the center reserves' Director's Discretionary and ERCAP programs.

The ASCR HEC Allocation Policy is available at:
https://science.osti.gov/ascr/Facilities/Accessing-ASCR-Facilities.

There are four primary allocation programs:

1. The **Innovative & Novel Computational Impact on Theory and Experiment (INCITE)** program seeks computationally intensive, large-scale research projects with the potential to significantly advance key areas in science and engineering. The program supports high-impact scientific research on some of the world's most powerful supercomputing resources through the use of ALCF and OLCF. 60% or more of the resources at ALCF and OLCF are reserved for INCITE. The proposals undergo a peer review process to assess scientific merit and to identify research projects that would not be possible without the world-class computing capabilities and computational support. The peer review process also includes

computational readiness reviews to assess whether the proposed work can effectively utilize large fractions of the LCFs. The call for proposals, review, and award is conducted by the LCF Facilities. The awards are for up to three years, with annual review and renewal. The proposals are typically due in June for allocations the following calendar year.

2. The **ASCR Leadership Computing Challenge (ALCC)** program allocates up to 30% of the computational resources at ALCF, OLCF, and up to 10% at NERSC. Open to scientists from the research community in national laboratories, academia and industry, the ALCC program is for high-risk, high-payoff simulations in areas directly related to the DOE energy mission, such as advancing the clean energy agenda and understanding the Earth's climate, for national emergencies, or for broadening the community of researchers capable of using leadership computing resources. The process is conducted by ASCR. Although the call for proposals is open all year, it is typical that proposals submitted by early February will be considered for allocations in that calendar year. Applications submitted will be subjected to peer review and will be evaluated against the following evaluation criteria from 10CFR605: (1) Scientific and/or Technical Merit; (2) Appropriateness of the approach; (3) Qualifications of the personnel and Adequacy of facilities; and (4) Reasonableness and Appropriateness of the request.

3. The **NERSC Energy Research Computing Allocations Process (ERCAP)** provides programmatic allocations of processor hours and data storage to accelerate the pace of scientific discovery in the SC community: Advanced Scientific Computing Research, Basic Energy Sciences, Biological and Environmental Research, High Energy Physics, Fusion Energy, and Nuclear Physics. Also NERSC provides allocations for the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) program office to involve small businesses. Fundamental to the mission of NERSC is enabling computational science at scale, in which large, interdisciplinary teams of scientists address fundamental problems in science and engineering that require massive calculations and have broad scientific and economic impacts. Examples of these problems include astrophysics, climate modeling, combustion modeling, computational biology, and fusion. The award decisions are made by the SC Programs, based, in part, on the peer reviews performed by the SC Programs. The proposals are due during the 4th quarter of the Fiscal Year.

4. **Director's Discretionary Allocation:** ASCR authorizes each HEC Center Director to reserve up to 10% of the capacity for allocations issued directly by the facility under the Director's authority. Proposals may be submitted at any time to the respective Centers and allocations may be made any time during the year. Examples of these awards include:
   - Exploration of a new research area;
   - Development of new programming techniques that take advantage of novel hardware;
   - Development of new algorithms that provide new capability to users;
   - Startup accounts for newly funded SC projects; and
   - Porting, tuning, scaling and benchmarking activities.

5. **Strategic Project Allocation:** As circumstances dictate, ASCR may direct the HEC Center Directors to allocate dedicated time to projects of strategic importance to ASCR.

	INCITE	ALCC	ERCAP	Facility Director's Discretion
Typical Size of an Allocation	Very Large	Large	Medium	Small
Typical Duration of an Allocation	Multi-year	One year	One year	Up to one year
Frequency of Call for Proposals	Annual	Annual	Annual	Any time
Closeout Report Required?	Yes	Yes	No	Yes

Table 1: Types of project requests available on ASCR's HEC scientific user facilities.

5.3.2 High Performance Network Facility Allocation Processes

Allocation of HPN resources occurs in three distinct ways:

1. Allocation of network bandwidth;
2. Provision of network capacity, capability, and resiliency improvements for the network backbone and connected sites; and
3. Allocation of access to the Research Testbed.

Allocation of network bandwidth

ASCR does not apportion or allocate high performance network bandwidth, but it does ensure that capacity and site connection requests pertaining to DOE science mission activities receive priority.

When the Department created ESnet in 1986, it naturally inherited the service model for the newly launched global Internet, which was *variable and ad hoc*. This *variable and ad hoc* model is the predominant model used to allocate capacity on ESnet's backbone network. Resilient network connections from ESnet's backbone to each DOE Laboratory, linked through peering connections to the public Internet and other research and education networks, provide the

fundamental interconnection between SC-funded scientists. In this sense, one may assume that the vast majority of SC-funded scientists and SC laboratory researchers are ESnet users.

As the science data flows carried by ESnet began to diverge from commodity Internet flows in their scale and service requirements, ESnet pioneered, developed, and deployed a *fixed and reserved* networking service model. Massive science data flows are better served, generally, when migrated from the *variable* to the *fixed and reserved* model. Network reservations are a finite resource, and it's possible to "oversubscribe" a network path. ESnet therefor also provides *fixed and reserved* networking services to meet high data volume, network-intensive science workflow requirements who have requested dedicated bandwidth services. In addition, ESnet's On-Demand Secure Circuits and Advance Reservation System (OSCARS) provides multi-domain, high-bandwidth virtual circuits that guarantee end-to-end network data transfer performance for the most demanding applications. OSCARS gives ESnet the ability to engineer, manage and automate the network according to user-specified requirements for using scientific instruments, computation, and collaborations.

Provision of network capacity, capability and resiliency improvements
ASCR provides core operations funding for ESnet to continually scale capacity to accommodate the exponential traffic growth of DOE science activities, and to continuously improve the resiliency and security of the network. To this end, ESnet is both proactive in capacity planning and responsive to specific improvement requests from individual laboratories, sites, and projects.

On an ongoing basis, ESnet evaluates opportunities for network capacity, capability, and resiliency improvements. ESnet prioritizes these opportunities based on science mission impact; in some circumstances ESnet may consult with ASCR, or ASCR may direct ESnet to execute specific improvements based on DOE strategic objectives.

Allocation of Access to the Research Testbed
Access to the ESnet Research Testbed is determined in accordance with policies for the Office of Science User Facilities. User project proposals are subject to merit review and review outcomes play a major role in determining access to the Testbed; ESnet manages these processes directly.

5.4 Innovation

ASCR drives the Facilities to pursue innovations that improve operations, focusing especially on operations practices that result in:

- new or enhanced opportunities for scientific discovery;
- cost savings or operational efficiencies;
- enhanced user experience;
- enhanced operations management insight.

ASCR notes that impactful innovations can occur in all areas of operations. Improvements in energy efficiency, safety practices, workforce recruitment & retention, cyber security, and management systems are all potential areas for innovation, just as much as modifications to core operations systems and practices.

ASCR also promotes its Facilities' engagement in research activities that are advancing the state-of-the-art of science and/or technology that will likely impact the next generation Facility and its users. Participation in research projects, professional community activities, such as conferences, workshops, standards committees, outside user groups, community software projects, etc. achieve this goal.

5.5 Risk Management

Effective and timely risk management is essential to successful Facility operations. ASCR requires that each Facility maintain a Risk Management Plan (RMP) and employ an integrated approach to managing enterprise risk across core operational (program) activities and upgrade project activities (see Section 6.1.3).

5.6 Environment, Safety, and Health

DOE has a strong and enduring commitment to operate its Facilities in a manner that protects its employees, contractors, the public, and the environment. Environment, Safety, and Health (ES&H) is a primary responsibility of the cognizant DOE Site Office. ASCR regularly assesses whether and how Office of Science Field Operations safety policies are implemented at the Facilities.

5.7 Cyber Security

Cyber security is a rapidly evolving landscape with many policy and management challenges for DOE Facilities. ASCR evaluates its Facilities compliance with DOE cyber security policies, innovation in operation cyber security practices, and responses to cyber security events and challenges.

5.8 Strategic Results

Strategic Results relate to (1) the methods and practices the Facility employs to monitor its contributions to the DOE mission – including maintaining a vibrant US effort in science and engineering- and ASCR strategic goals via science accomplishments, (2) the quality of its engagements with strategic stakeholders (such as other DOE programs, and partner laboratories, etc.), and (3) operating in a manner that most enables facility and DOE mission success.

5.9 Budget Formulation and Execution

Sound budget formulation and execution is vital to mission delivery and long-term success. As the federal sponsor, ASCR is responsible for defining effective and efficient budget formulation and execution processes, and monitoring and assessing the financial performance of the facilities on a regular basis.

Annual fiscal year budgets to fund each user facility are formulated by the ASCR Associate Director in consultation with Facilities Division Director and program managers. To facilitate

budget formulation, ASCR conducts one or more Budget Planning meeting with each user facility to acquire understanding of the facilities' needs for funding in upcoming fiscal years; the timing of these meetings depends on the timing of congressional appropriations, but typically they occur in the second and fourth quarters of the fiscal year. The President's Budget Request includes narratives developed during this process that describe ASCR program and facilities at a high level; e.g., Mission Needs, scientific capabilities, upgrades, and scientific accomplishments.

Prior to the start of a new fiscal year, usually in late July or early August, ASCR facility program managers, in coordination with the Facilities Division Director, review their facility's spend plan and management of carryover funds for the coming fiscal year. Based on the spend plan, a portion of the funds, either as operating or capital equipment funds or both, are provided to the facility through the initial annual financial plan (AFP) for their respective laboratory. The facility program manager may send additional funds, providing there are funds to allot, or modify the allocation of capital and operating funds at any time by submitting a new AFP to the ASCR Finance Officer.

ASCR uses lease agreements to finance HEC upgrade projects and lease payments are part of operation costs. The OMB A-11 allows Alternative Financing and hence each HEC site typically use firm-fixed price, Lease-To-Own (LTO) financing for HEC equipment, which has the following benefits:

1. Upfront capital cost is shifted from the Federal Government to the lease holder, at a cost of paying leasing fees.
2. Flexibility in payment schedules to deal with changes to federal budgets.
3. Lease payments do not start, in general, until after successful acceptance testing. Advanced payments are sometimes authorized after delivery of the HEC equipment, but before Acceptance Testing and in that case are included as part of the upgrade project.

As a matter of prudent fiscal management, it is a generally accepted principle that user facilities should maintain at least two months operations carryover at all times in order to mitigate the risk of a potential lapse in federal appropriations. ASCR ascribes to this principle.

Monthly Reporting

ASCR requires each facility to submit monthly operations reports that address progress on performance goals and spending. Explanations are provided by the facility regarding fluctuations from the original spend plan.

6.0 GUIDANCE FOR UPGRADE PROJECTS

Upgrades to the ASCR user facilities are necessary in order to achieve DOE mission goals, meet the evolving needs of the users, and maintain global scientific leadership in strategic areas. The ASCR user facilities define their upgrade projects through a variety of strategic planning activities. The facilities gather user requirements through workshops, surveys, and direct interactions with users, program leaders, and other stakeholders.

The Department has a rich legacy of achievement in major projects, and the Office of Science has cultivated a deep commitment to effective project management. The Department enshrines its project management philosophy in DOE Order 413.3B (Order 413), entitled "Program and Project Management for the Acquisition of Capital Assets." This section describes the life-cycle of ASCR projects and the tailoring of SC's implementation of Order 413 requirements and processes.

It is important to highlight at the outset that ASCR upgrade projects differ from other SC and DOE capital asset projects in some fundamental ways:

1. The ASCR HEC and HPN user facilities are complex integrated systems—engineered for science mission needs—of specialized commodity information technology; while this technology is by no means inexpensive, each individual component has a small cost and short lifecycle compared to physical infrastructure; ASCR user facilities are therefore not considered capital assets.
2. ASCR upgrade projects are both a driver of and dependent upon U.S. semiconductor, optical technologies and network and information technology industry vendors;
3. The rapid turnover of technology in the industry places time pressure on each upgrade project to deploy as soon as practical;
4. Owing to the factors articulated above, Congress, OMB, and DOE CFO afford ASCR the flexibility of budgeting for facility operations and upgrade projects from one operations funding account.

6.1 Project Management and DOE Order 413

Order 413 articulates the project life-cycle through a set of Critical Decisions (CDs), progressing from a broadly-stated mission need to well-defined requirements resulting in operationally effective systems and products:

- **CD-0** is Approve Mission Need. There is a need that cannot be met through other means.
- **CD-1** is Approve Alternative Selection and Cost Range. The selected alternative and approach is the optimum solution.
- **CD-2** is Approve Performance Baseline (PB). Definitive scope, schedule and cost baselines have been developed.
- **CD-3** is Approve Start of Construction/Execution. The project is ready for implementation (e.g. the procurement contract is approved). CD-3 may be split into
  - **CD-3A**: Approve long-lead procurement.
  - **CD-3B**: Approval to start construction/execution.

- **CD-4** is Approve Start of Operations or Project Completion. The project is ready for turnover or transition to operations at the successful completion of the acceptance test.

The five CDs are major project milestones that require approval by the Acquisition Executive (AE). Each CD marks an authorization to increase the commitment of resources by DOE and requires successful completion of the preceding CD. The time between decisions depends on many factors and can vary significantly between projects. In tailoring, one or more of the CD steps may be combined based on the status of the technology, budget and timeline.

6.1.1 Key Project Documents

Order 413 stipulates the creation, review, and approval of formal project elements (documentation) on the occasion of Critical Decisions and other significant project events. The key project elements are summarized below; a more detailed description can be found in the glossary:

- **Mission Need Statement (MNS)** articulates the Department's mission basis for pursuing the project, the capability gap the project could fulfill, and a first look at the technical prospects for achieving the mission need.
- **Performance Baseline (PB)** defines the definitive cost, scope and schedule of a project.
  - **PB Deviation** occurs when the approved total project cost, CD-4 completion date, or performance and scope parameters cannot be met.
  - **PB Change** represents an irregular event.
- **Key Performance Parameters (KPPs)** define the project's scope, including specifications, which, if not met, would have a major deleterious impact on the system or facility performance, schedule, cost and/or risk. Projects typically have Threshold KPPs, which are the minimum criteria for achievement of CD-4, and Objective KPPs, which one may regard as achievable stretch goals.
- **Acquisition Strategy (AS)** is the project's overall plan for satisfying the mission need in the most effective, economical and timely manner.
- **Alternatives Analysis (AA)** includes the basis for the alternative selected for the upgrade and the assumptions made when making the selection.
- **Project Execution Plan (PEP)** is the core document for the management of a project and identifies the project baseline, high level milestones and work breakdown structure, life cycle costs and the change control process.

Templates for many of these core documents may be found on the Office of Science OPA website[6].

6.1.2 Cost Estimation

[6] https://science.osti.gov/opa/Project-Management/Processes-and-Procedures

A cost estimate, or cost range, should be provided at each CD gateway, but the degree of rigor and detail for a cost estimate may vary, depending on the degree of confidence in project scale and scope that is reasonable to expect at that stage. Whatever figure or range that is provided should explicitly note relevant caveats concerning risks and uncertainties inherent in early estimates at CD-0 and CD-1 stages given the immature requirements definition at this juncture. Any changes to CD-0 that do not impact the mission need are considered minor and can be documented in the Project Execution Plan (PEP) and Acquisition Strategy. These minor changes in cost, scope and schedule are typical for projects as more information becomes available. Despite the sequential numbering of the CDs, they are not required to occur sequentially as will be discussed later in this section. The CDs are summarized below, a more detailed description can be found in the glossary:

Order 413 allows early CD-3 approval, namely CD-3A, for Long-Lead item procurement. If facility site preparation involves substantial improvements to third-party-owned buildings, prior approval must be obtained from the appropriate authorities at the site office, headquarters and/or OMB. While there is potential risk in procuring equipment before the design is complete, the resulting schedule improvement may be significant and more than compensate for the risk. If CD-3A is anticipated, the need for this decision and the process should be documented in the Project Execution Plan (PEP). When exercising Long-Lead procurement, the Federal Project Director (FPD) must consider design maturity and the associated project risk. Activities such as site preparation work, site characterization, limited access, safety and security issues are often necessary prior to CD-3, and may be pursued as long as project documents requesting funds to procure the Long-Lead items and funding approvals are in place.

6.1.3 Risk Management

Risk management is an essential aspect of project management. A risk is an uncertain event that, were it to occur, would impact the project cost, schedule, and/or scope. The purpose of risk management is to provide a formal process for anticipating and planning for potential problems and opportunities, which in turn enables better understanding and control of project outcomes. Risk management must be analytical, forward looking, structured and continuous. The benefits of risk management include[7]:

- Better manage project costs and schedules
- Better manage risks, including prioritizing risks to mitigate
- Increase confidence in project outcomes and decision-making
- Increase collaboration among team members; facilitate knowledge exchange across organization
- Communicates project cost/schedule uncertainty to organization, team members & other stakeholders

Risk assessments are started as early in the project life-cycle as possible and should identify critical technical, performance, schedule, and cost risks. Once risks are identified and

[7] Keith Molenaar, "Risk Identification" presentation to DOE Project Leadership Institute, May 16, 2017.

prioritized, sound risk mitigation strategies and actions, including risk acceptance, are developed and documented in the Risk Register. Post CD-1, the risk register, including new risks, should be evaluated at least quarterly.

Risks and their associated confidence levels are dependent on multiple factors such as complexity, technology readiness and strength of the IPT. Risks should be analyzed and reflected in contingencies, budgetary requests, and funding profiles. Upgrade PB changes may need to be included in budgetary requests and funding profiles. Also, there is a risk of loss arising when resources are irreversibly committed for one opportunity and a better opportunity presents itself. This is called an opportunity risk and these are also considered and tracked as needed in the risk register.

6.1.4 The Integrated Project Team

The Federal Project Director (FPD) serves as the lead point of contact between Federal and contractor staff for all matters relating to the upgrade project, including risk management. The FPD works closely with the ASCR Facility Program Manager (PM) and the Project Director and Project Manager.

The FPD shall organize and lead the Integrated Project/Program Team (IPT). The IPT is an essential element in DOE's acquisition process and is involved in all phases of a project. This team consists of professionals representing diverse disciplines with the specific knowledge, skills and abilities to support the FPD in successfully executing a project. The team size and membership may change as a project progresses from CD-0 to CD-4 to ensure that the necessary skills are always represented.

Since ASCR upgrade projects are not capital assets, the SC Office of Project Assessment (OPA) is invited to attend the IPT conference calls and is provided monthly project reports in lieu of Quarterly Project Reviews, annual IPRs, and quarterly project reports.

The IPT membership may be full or part time, depending upon the scope and complexity of a project and the activities underway. However, the identified personnel must be available to dedicate an amount of time sufficient to contribute to the IPT's success. Qualified staff (including contractors) must be available in sufficient numbers to accomplish all contract and project management functions. Project staffing requirements should be based on a variety of factors, including project size and complexity, as well as the management experience and expertise of the project staff. Regardless of the methodology used, once the appropriate staff size has been determined, programs should plan and budget accordingly.

The FPD and the team will prepare and maintain an Integrated Project Team (IPT) Charter that describes:

- Membership
- Responsibilities and authority
- Leadership

- Meeting schedule
- Reporting
- Operating guidance

The IPT will:

- Support the Federal Project Director.
- FPD works with the Contracting Officer and Federal IPT members to develop a project Acquisition Strategy
- Develop the PEP.
- Ensure that project dependencies are identified, defined and managed to completion.
- Identify, define and manage to completion the project environmental, safety, health, security, and risk requirements.
- Identify and define appropriate and adequate project technical scope, schedule and cost parameters.
- Identify project risks and maintain a risk register, within the context of the project Risk Management Plan.
- Perform periodic reviews and assessments of project performance and status against established performance parameters, baselines, milestones and deliverables.
- Plan and participate in project reviews, audits, and appraisals as necessary.
- Review all CD packages and recommend approval/disapproval.
- Review and comment on project deliverables (e.g., drawings, specifications, procurement, and construction packages).
- Review change requests and support Change Control Boards.
- Participate in Operational Readiness Reviews.
- Support preparation, review and approval of project completion and closeout documentation.
- Ensure safety is effectively integrated into design and construction.

The Federal IPT develops the Acquisition Strategy (AS), which is then documented in writing. The AS represents a high level plan which is approved through the CD review and approval process, and provides greater focus on the analysis and strategies needed to appropriately execute procurements in accordance with sound business practices, statutory, regulatory and policy requirements.

Alternative approaches always need to be considered in the project. For each project, a clear and concise Alternatives Analysis shall be developed as part of the Acquisition Strategy, to include the basis for the alternative selected, how the alternative meets the approved mission need, the functions and requirements that define the alternative and demonstrate the capability for success, and the facility performance requirements, planning standards and life-cycle cost assumptions.

The PEP should clearly and concisely describe the Key Performance Parameters (KPPs) that will define the project's scope. The AA and/ or PEP shall describe the following.

- Scope required satisfying the Program mission requirements.
- Project feasibility.
- Attainment of specified performance levels.

- Assessment of project risks and identification of appropriate risk handling strategies.
- Reliable cost and schedule range at CD-1 or the final estimates. Any non-recurring engineering costs on the critical plan should also be included in the project's cost estimate
- Project design parameters. Project design is developed in the context of the overall budget or Design to Cost to help eliminate requirements creep. Impact on the site Sustainability Plan.

6.2 ASCR Tailoring of DOE Order 413 Requirements

Order 413 explicitly directs projects to tailor the implementation of 413 principles, processes, and requirements:

> "Tailoring is necessary for the efficient delivery of projects and should be applied to all projects considering size, complexity, cost, and risks. Tailoring does not imply the omission of requirements, and requirements must be addressed to the extent necessary and practical. Tailoring may involve consolidation or phasing of CDs, substituting equivalent documents, using a graded approach to document development and content, concurrency of processes, or creating a portfolio of projects to facilitate a single CD or Acquisition Strategy (AS) for the entire group of projects. Tailoring may also include adjusting the scope of Independent Project Reviews (IPRs) and External Independent Reviews (EIRs), delegation of acquisition authority, and other elements. Major tailored elements such as consolidating or phasing CDs or delegation of Project Management Executive (PME) duties must be specified in the Project Execution Plan (PEP) or the Tailoring Strategy and approved by the PME."

ASCR's tailored Order 413 process, including the minimum documentation requirements, is as follows:

- **CD-0:** Mission Need
  - Documents required:
    1. Mission Need Statement (MNS)

- **CD-1/3A:** Approve site preparation and issuance of Request for Proposal (RFP), if needed.
  - Documents required:
    2. Analysis of Alternatives (AoA).
    3. Acquisition Strategy (AS)
    4. Preliminary PEP (PPEP)
    5. Conceptual Design (CD)
    6. Preliminary Hazard Analysis Report (HAR)
    7. Risk Management Plan (RMP), including the Risk Registry tied to cost and schedule contingencies.
    8. Other documents as required

- **CD-2/3B:** Approve Performance Baseline and review Acceptance Testing Criteria.
  - Documents required:

9. Project Execution Plan (PEP), including Work Breakdown Structure (WBS), WBS Dictionary, and Key Performance Parameters (KPPs), typically in the form of acceptance testing parameters; the PEP is likely to be modified several times over the life of the project; KPPs are typically specified at both the "threshold" (minimum acceptable) and "objective" (higher performance) levels.
10. Detailed Project Cost Estimate and contingencies, including general Funding Profile, time-phased budget details, and assumptions; e.g., vendor quotes, historical data, and engineering judgments.
11. Resource loaded Schedule with contingencies, Critical Path, and near Critical Path items.
12. Updated HAR
13. Preliminary and Final Design
14. Other documents as required

- **CD-4:** Acceptance Testing completed.[8]
  - Documents required:
    16. The results of an independent review to verify the conditions for CD-4 have been met.
    17. Finalized HAR
    18. Draft Lessons Learned report.
    19. Draft Project Closeout Report

The post-CD-4 documentation includes the project Closeout Report, the final draft of the Lessons Learned report, and the closeout of the project in PARS.

6.2.1 High End Computing Facilities Upgrade Projects

ASCR High End Computing facility upgrade projects have several defining characteristics:

(1) Owing to the rapid turnover of technology in the semiconductor industry, each upgrade project must be deployed as soon as practical to provide the capability to the science community before the technology is made obsolete by advances in the industry;
(2) the project definition emerges from interactions with the limited number of U.S. vendors capable of designing and building a high end computing system, and considerations of U.S. competitiveness in the global semiconductor industry;
(3) with respect to (1) and (2), each HEC upgrade project is unique in its objectives, deliverables, and tactics, and requires a flexible project management structure to successfully navigate the context and specific industry environment at that time; and
(4) unlike any other SC project, HEC upgrade projects typically use a firm-fixed price, Lease-To-Own (LTO) contract structure for HEC equipment.

[8] CD-4 may be split into multi-stage acceptance tests (CD-4A, CD-4B, etc.) in order to make some payments to the vendor prior to full acceptance of the machine.

For HEC upgrade projects, ASCR uses a Design-Build project delivery method whereby a single contract is awarded for both design and construction (where construction covers both site preparation activities and the computer system). The Design-Build approach requires the development of a functional design and clearly stated operating requirements that provide sufficient information to allow prospective contractors to prepare bids or proposals. It also allows the flexibility to implement innovative design and construction approaches, value engineering, and other cost and time savings initiatives. The overall objective of the Design-Build approach is the following:

- Enhance efficiencies in project design integration into construction execution.
- Reduce the total project cost to DOE.
- Deliver projects faster than by using the traditional Design-Bid-Build approach.

ASCR tailors Order 413 to promote achievement of these goals. Since the technical requirements are well-defined early in the process and much of the cost and schedule information and key design criteria are known, CD-1, CD-2, or CD-3 may be accomplished simultaneously. Essentially, when requesting simultaneous approval of multiple CDs, the IPT is asserting the following:

- The project functions and requirements are well known.
- A cost and schedule baseline can be established.

If upgrades to both leadership class facilities (LCFs) are expected in the same timeframe, the LCFs may elect to write one joint Mission Need Statement covering both projects, and may elect to develop a joint Analysis of Alternatives that reflects the need for architectural diversity between the two facilities. In all other respects each site will then execute its own separate upgrade project.

Major Project Reviews

There are two categories of major project reviews: design (or technical) reviews, and Independent Project Reviews (IPRs). Design/technical reviews are conducted by the project and empanel an external group of HEC subject matter experts to examine the technical facets of the project design and execution. The IPRs are conducted by SC's Office of Project Assessment and focus primarily on the project management aspects of the project. One or two member(s) of the design review teams serve on the IPR panel and provide input on the proposed technical design solution and reviews the sites' responses to the recommended corrective actions.

Figure 2 illustrates the sequence of major reviews under ASCR's typical tailoring approach for HEC upgrade projects. A design or technical review is conducted by the upgrade project before each SC Office of Project Assessment Independent Project Reviews (IPR) for CD-1/3a, CD-2/3b, and CD-4.

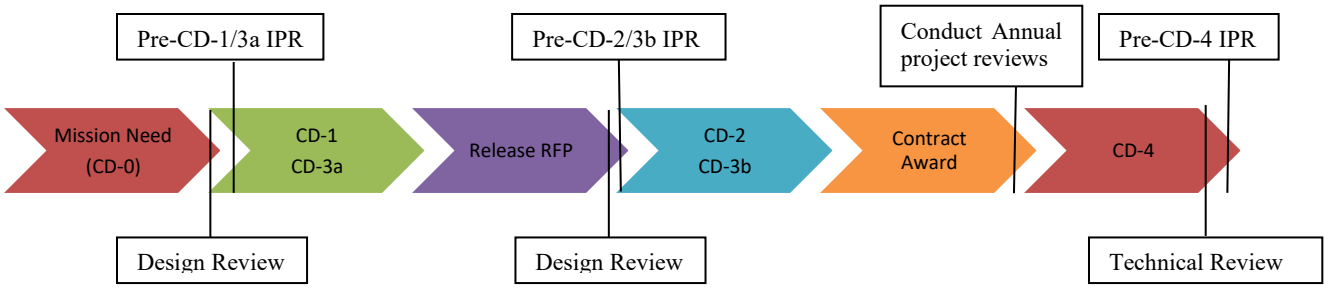

Figure 2: Steps and independent project reviews involved for most ASCR upgrade projects. ASCR considers the end of a project at the acceptance of the machine.

The design review held prior to the CD-1/3a Independent Project Review (IPR) examines the technical specifications to be included in the Request for Proposal (RFP) for the proposed upgrade. The second design review, held prior to the CD-2/3b IPR, examines the proposed statement of work with the selected vendor to insure that the technical specifications and scientific needs will be met. The reports from these design reviews serve as critical input to the succeeding IPR.

A CD-2/CD3b IPR is conducted to approve the Performance Baseline (PB) which sets the scope, schedule and cost baselines for the project. Upon successful completion of the CD-2/3b IPR, the final contract can be negotiated and signed with the vendor signaling the start construction/execution. A Non-Recurring Engineering (NRE) contract may also be negotiated with the vendor and depending on the nature of the NRE, these costs may or may not be included in the project baseline costs.

One last technical review may be held to evaluate the results of the acceptance test specified in the statement of work and to make a recommendation to accept or reject the machine. This technical review serves as input to the CD-4 IPR. The CD-4 IPR is conducted to verify that all the conditions for CD-4 have been met.

6.2.2 High Performance Networking Upgrade Projects

HPN upgrade projects have defining characteristics distinct from the HEC upgrade projects:

(1) A network cannot cease to operate for any appreciable length of time; ESnet, as the Department's circulatory system for the movement of large-scale scientific data, provides essential real-time services to many thousands of users across the entire DOE complex;

(2) The network's system configuration is in a state of constant change; at any given time ESnet is assessing and addressing dozens of requests from sites and stakeholder communities, and performing continuous capacity management to ensure science workflows flow friction-free;

(3) Based on (1) and (2), the switchover of the current network to the subsequent generation network is a significant operational management challenge;
(4) The mean time between major HPN facility upgrades has historically been ~5-10 years, compared to the ~3 year cycle of the HEC upgrades;
(5) The project team is the project system integrator; an HPN upgrade project typically involves multiple major procurements from different vendors for hardware and/or services, as well as (possibly) significant internal software development, and the direct performance of systems integration, test, and acceptance tasks by the project team.

The tailoring of Order 413 requirements articulated for HEC upgrade projects in the preceding section holds for HPN projects, with the following differences:

- The design review held prior to the CD-1/3A Independent Project Review (IPR) examines the conceptual design for the proposed upgrade. The second design review, held prior to the CD-2/3B IPR, examines the proposed final design to insure that the technical specifications and scientific needs will be met. The reports from these design reviews serve as critical input to the succeeding IPR.
- Management of operational risk through a phased transition of operations from the current network to the upgraded network is paramount. Definition of project scope and KPPs may hinge on successful implementation of core network capabilities and the migration of a selection of connected sites, rather than a full "cutover" of all sites to the upgraded network.
- Upgrading a continuously operating facility demands an integrated approach to management of the upgrade project and the core operations of the facility. HPN upgrade projects therefore utilize a project performance management approach that promotes an efficient and holistic approach to risk and financial management of the project and core program.

6.2.3 Upgrade Projects with Total Project Cost Less than $50M

Order 413 does not apply for upgrade projects with a TPC of less than $50M. However, in the interest of executing such acquisitions in the spirit of Order 413, ASCR has developed the following tailoring plan.

- The Project Execution Plan (PEP) will be expanded to include a detailed discussion of the Mission Need and Alternative Analysis; combining the three documents into one.
- The expanded PEP, with Mission Need and Alternative Analysis, will be approved by the ASCR Acquisition Executive.
- CD-0 and -1, Approval of Mission Need and Alternatives Analysis, will be combined (CD-0/1) and approved by the ASCR AE.
- ASCR's AE will delegate acquisition executive authority to the manager of the facility's site office prior to CD-2, -3, and -4.
    - Note: Order 413 (Appendix B) and OPA's SC Project Decision Matrix allows for this delegation of authority.

- Prior to establishing the project baseline (CD-2), the facility will conduct a local Red Team Review of its baseline.
- CD approvals by site office AE will be based on the project documenting completion of the CD and FPD's recommendation.
- Based on the preliminary TPC (< $50M), the project will not be reported on PARS-II.
- Earned Value Management will be used to measure performance.
- A simplified monthly project progress report will be developed and submitted to the FPD and Program Manager.
- For all other key project required documents—i.e., ES&H, QAP, HAR, Risk Management, etc. —the project will leverage the most recent library of project documents, if available.

6.2.4 Joint Projects with the National Nuclear Security Administration (NNSA)

To increase the efficiency and cost effectiveness of the proposal process, ASCR may decide to undertake joint procurements, reviews, and reporting with NNSA. In this case, facilities from DOE/SC and NNSA jointly develop the specifications of the new systems allowing vendors to prepare and submit one proposal for multiple systems.

Regarding project management during joint projects, ASCR facilities will follow same steps identified in Figure 1 while NNSA follow their project management processes.

6.3 Project Reporting

Order 413 requires that all projects after CD-0 with total project costs (TPC) ≥ $50M report performance in DOE's Project Assessment and Reporting System (PARS),[9] a Department-wide web-based software project tracking tool. Once a project has begun, monthly project status reports are required to be entered into PARS; for projects past CD-2 and TPC ≥ $50M, earned value management (EVM) reporting is required in PARS as well.

On October 17, 2017 the Department adopted a specific exemption, through an administrative change to DOE Order 413, for certain aspects of HEC projects:

> "Only the facility construction and facility improvement activities of High Performance Computing (HPC) projects will be subject to the Earned Value Management (EVM) requirements of this Order. 'Non-construction activities,' which are programmatic elements of HPC activities including research and development, leases, and software development, will be subjected to the following components:
>
> - EVM Compliance – Non-construction activities will be tracked with level of effort activities and milestone achievement and EVM compliance should be eliminated.
> - PARS II Reporting – Non-construction activities will be entered with narrative information only."

In interpreting this guidance, ASCR asserts the following principles:

- All ASCR Upgrade Projects (both HEC and HPN) will be subject to the same requirements.
- ASCR affirms the inherent project management value of tracking project performance through an integrated approach to monitoring cost, schedule, and scope.
- ASCR recognizes that tabulation and tracking of low-level WBS elements in a quantitative EVM compliance tool may provide limited project management value for its HEC and HPN Upgrade Projects.
- The non-research scope of HEC and HPN Upgrade Projects is predominantly systems integration and software development[10], and are "non-construction" with respect to the guidance above.

In light of these considerations, ASCR tailors its project reporting and controls requirements as follows:

For non-construction scope,

- ASCR Upgrade Projects are required to translate project milestones into a discrete effort earned value basis in order to tabulate and track cost and schedule performance indices. The IPT will decide what quantitative information, if any, to report in PARS.

[9] For more information on PARS visit http://energy.gov/node/290329

[10] In the case of an HEC Upgrade Project, the host laboratory contracts with a vendor to perform the systems integration; for ESnet, LBNL performs the integration directly.

- For project effort that does not have defined or measureable milestones, the project should track and report level of effort (labor) contributed to the project as a component of the Total Project Cost.
- It is ASCR's expectation that the project will apply the discrete effort earned value basis to as much of the project scope as reasonable.

7.0 GUIDANCE FOR TRANSITION TO OPERATIONS

DOE Order 413 states that the Transition to Operations should clearly define the basis for certifying achievement of initial operating capability and full operating capability.

7.1 High End Computing Facilities

During the Transition to Operations of ASCR HEC facilities, the hardware and software environment, including file systems and software libraries, may need to undergo further testing at scale to confirm that the HEC facility is ready for scientific studies. With the concurrence of ASCR, the HEC facilities may solicit proposals for early science runs and/or open the facility to friendly early science users to test the Upgraded system under the conditions similar to routine operations. Following the Transition to Operations, the HEC facility is opened to projects awarded in accordance with the ASCR Allocations Policy. The Upgrade Risk Management Plan should include the risks of the Transition to Operations.

The Transition to Operations criteria are stated in the Project Execution Plan (PEP) and may allow for a direct transition to operations after CD-4 project completion.

7.2 High Performance Network Facility

As for HEC facilities, acceptance testing is a critical step in certifying HPN readiness for operations. Acceptance tests include testing data movement on the network or parts of the network for extended periods of time without loss or errors above acceptable thresholds. For network links provided by third-party providers like telecom carriers, similar acceptance tests are performed before the facility starts paying for that service.

The Transition to Operations criteria are stated in the Project Execution Plan (PEP) and may allow for a gradual transition to operations after CD-4 project completion. After successful acceptance testing, the transition to operations phase consists of moving production data traffic to and from ESnet sites from the previous network to the upgraded network. Since network uptime is critical to all sites, transition to operations may occur over many weeks to allow for maintenance window coordination with the sites. During the transition phase, both networks will be carrying production traffic and need to be maintained by the ESnet operations staff at expected performance levels. The transition to operations is complete when all ESnet sites are using the upgraded network for their production connectivity.

Once the upgraded network is carrying production traffic from all the ESnet sites, the older infrastructure needs to be decommissioned. Decommissioning typically includes removing older network equipment distributed across multiple sites, terminated contracts no longer needed, and balancing traffic across the network footprint. Decommissioning may be considered as part of operations, rather than as part of the upgrade project.

ESnet facility upgrades may consist of multiple contracts that include a mix of contracted services and equipment that is integrated and implemented by ESnet engineers. Each of these contracts could have provisions for buying more equipment over time at a negotiated price schedule over a longer term (during the operations phase).

8.0 ROLES AND RESPONSIBILITIES

This section outlines responsibilities for ASCR and the Sites in regards to Upgrade Projects, Transition to Operations, and Management-in-Use/Operations.

Acquisition Executive (AE):

- Approves Missions Need Statements, Acquisition Strategies, PEPs, and CDs
- Approves appointments of Federal Project Directors.
- Chairs ASCR ESAABs.
- Requests SC PMSO (SC-28) conduct Independent Project Reviews (IPRs) and SC ESAABs.

ASCR Associate Director (AD):

- Approves annual budgets, monthly Financial Plans, and the degree of tailoring for Upgrades and maintenance activities.

ASCR Facilities Division Director:

- Prepares annual budgets.
- Approves OMB Exhibit 300s, if necessary, Upgrade Funding Profiles, monthly Dashboards, monthly Upgrade Watch List/Status reports for LCF projects, Performance Baselines (e.g., LTO contract scope, cost, and schedule), Baseline Change Proposals (as delineated in the PEPs), and updates to this Plan.
- Transmits final version of Exhibit 300s to DOE Office of Project Assessment (OPA) and to the SC Budget Office (SC-41).
- Requests Budget Reviews (aka "Deep Dives") and Operational Assessment Reviews (OARs).
- Issues annual Budget Review Guidance and annual OA Guidance.
- Conducts strategic planning exercises.
- Concurs on monthly Financial Plans.

ASCR Facilities Program Manager (PM):

- Provides high-level oversight of the facility Upgrades, Transitions to Operations, and Operations, such as Program Management of the ALCC and NERSC ERCAP allocations.
- Participates in Upgrade Reviews (e.g., IPRs), ASCR ESAABs, e.g., provides the CD-0 presentation, annual Budget Reviews, OAs, on Integrated Project/Program Teams (IPTs), operations and IPT conference calls, ESAAB Dry Runs, and Program Requirements and Best Practices Workshops.
- Conducts Site Visits and quarterly IPT Reviews, where applicable.
- Arranges for the peer reviews of ALCC proposals.
- Prepares annual OMB Exhibit 300s, monthly Financial Plans, monthly Dashboards, and monthly reports, annual OA summaries and provide to the Facilities Division Director.
- Approves Transition to Operations plans.

- Reviews and prepares ASCRs assessment of the Site Office's monthly project assessment in PARS. Also reviews other monthly project reports.
- Provides input to annual Budgets, OAR Guidance, Budget Review Guidance and Lab Appraisal, including development of notables for award fees.
- Comments on scientific accomplishments documents, Mission Need Statements, Acquisition Strategies, PEPs, CD documents, Performance Baselines (PBs), Baseline Change Proposals, Upgrade Funding Profiles, monthly operations reports, including metrics and usage, Alternative Analyses, Risk Management Plans, Key Performance Parameters, Program requirements and Best Practices Workshop reports, Design Review reports, IPR reports, ESAAB reports, NRE documents, CDRs, IPT Charters, Risk Registries, safety documents, Hazard Analyses, Vendor contracts, LTO documents, Acceptance Testing documents, project Closeout Reports. Annual Spend Plans, CIO quarterly reports, OA reports, Lab responses to OAs and Upgrade Completion (Acceptance) Criteria. Ensures completion of Mission Need Statement.
- Approve Early Science applications

SC PMSO (SC Office of Project Assessment, SC-28)

- Conducts SC ESAABs and Independent Project Reviews.

Federal Project Director (FPD)/ASCR Program Liaison (where applicable):

- Attains and maintains certification in concert with the requirements outlined in DOE Order 361.1B before they are delegated the authority to serve as FPD and/or within one year of appointment, achieve the appropriate level of certification.
- Serves as the single point of contact between Federal and contractor staff for all matters relating to an upgrade project and its performance.
- Establishes PBs, reflective of identified and assessed risks and uncertainties, to include Total Project Costs (TPCs), CD-4 dates, and minimum KPPs. The key project milestones and completion dates shall be stated no less specifically than month and year. The scope will be stated in quantity, size and other parameters that give shape and form to the project. The funding assumptions upon which the PB is predicated will be clearly documented and approved. Ensures completion of Acquisition Strategy.
- Chairs Integrated Project/Program Team, including periodic conference calls, and prepares and maintains the IPT Charter and operating guidance with IPT support and ensures that the IPT is properly staffed. Defines and oversees the roles and responsibilities of each IPT member. Provides broad project guidance. Delegates appropriate decision-making authority to the IPT members.
- Ensure the timely, reliable and accurate integration of contractor performance data into the Upgrade's scheduling, accounting, and performance measurement systems.
- Evaluates and verifies reported progress; make projections of progress and identify trends.
- Participates in Upgrade Reviews (e.g., IPRs), and presents to ASCR ESAABs (for everything except CD-0), annual Budget Reviews, OAs, ESAAB Dry Runs, NEPA reviews (where applicable), and Operational Readiness Reviews (to determine the facility or area can be occupied from both a regulatory and a work function standpoint).

- Establishes Beneficial Occupancy Dates for the facilities and/or equipment.
- Approves IPT charter and Baseline Change Proposals (as delineated in the PEPs).
- Ensure achievement of KPPs and Project Completion (Acceptance) Criteria and that mission requirements have been achieved. The FPD will verify and document the scope accomplished, TPC, KPPs met, and the completion date as it relates to the original CD-2 performance baseline and the latest approved baseline change.
- Prepares PEPs which includes the tailoring strategy, CDs documentation, the monthly PARS reports, upgrade performance measures, Project Closeout Report, monthly Upgrade Watch List input, if appropriate, and Lessons Learned reports which can be part of the Project Closeout Report.
- Provides input to, annual OMB Exhibits 300s, monthly Dashboards Comments on Missions Need Statements, Acquisition Strategies, Baseline Change Proposals, Upgrade Funding Profiles, Transition to Operations plans, monthly operations reports, Alternative Analyses, Risk Management Plans, Request for Proposals, Contracts, and scientific accomplishments documents.
- Provides oversight of subcontracts; e.g., LTOs.

Center Facility Director (or designees):

- Exercises full financial authority and accountability for the Upgrades, Transitions to Operations, and operations; e.g., manages all procurements and human resources and ensures that safety and security are fully integrated throughout the facility.
- Appointed as the Lab Contracting Officer's Technical Representative, as determined by the Lab Contracting Officer.
- Defines Upgrade cost, schedule, performance, and scope baselines.
- Oversees the Upgrade line management organization and ensure the line Upgrade teams have the necessary experience, expertise, and training in design engineering, safety and security analysis, construction, and testing.
- Ensures the development and implementation of key Upgrade documentation; that design, construction, environmental, sustainability, safety, security, health and quality efforts performed comply with the contract, public law, regulations and EOs and DOE Order 413.3B Appendix B 11-29-2010 B-7.
- Participates in annual Budget Reviews, OAs, Needs and Best Practices Workshops, Upgrade Reviews e.g., IPRs, IPTs, ESAAB Dry Runs, and NEPA reviews (where applicable)
- Prepares scientific accomplishments documents, Baseline Change Proposals, Transition to Operations plans, monthly operations reports, Alternative Analyses, Risk Management Plans, KPPs, or Acceptance Criteria in the vendor’s statement of work, Request For Proposals, draft Contracts, Hazard Analysis Reports, Construction Upgrade Safety and Health Plans, NEPA documentation, Security Vulnerability Assessments, and Integrated Safety Management Plans.
- Approves Baseline Change Proposals as delineated in the PEPs
- Provides input to, annual OMB Exhibit 300s, PEPs, CD documentation, PBs, Upgrade Funding Profiles, monthly Dashboards, monthly Upgrade Watch List,if appropriate, monthly PARS reports, Project Closeout Report, Lessons Learned reports.

- Documents High Performance and Sustainable Building provisions per EO 13423, Section 2(f), EO 13514, Section 2, and Sustainable Environmental Stewardship considerations per DOE O 450.1A, as amended, in Acquisition Strategies, and/or PEPs, as appropriate.

9.0 APPENDIX A: Risk Management at ASCR Facilities

HEC and Networking facilities implement a risk-based approach, utilizing best practices in industry, National Institute of Standards and Technology (NIST) guidelines, and experiences of the facilities. A project risk management plan and risk register is required by DOE Order 413.3B and guidance on project risk management is provided in DOE G 413.3-7. However operational risk management of HEC and networking facilities (i.e., steady state) will be different and guidance for such can be found in industry and other agency such as NIST. Closely aligned with HEC and network facility risk management is risk management of Information Technology Systems as outlined in the Information Technology Infrastructure Library (ITIL) best practices for risk assessment/management. Of course ASCR facilities are cutting-edge and hence introduce unique operational risks for each facility. Each facility manages and tracks their risks via routine reviews and reporting of the major risks (operational and project) identified in the Risk Register(s) for each facility. The facilities maintain project cost and schedule contingencies commensurate with their major risks. Leading indicators are identified and tracked for event or time-based risks. The Risk Register is a living document which changes as the upgrade is executed. The project Risk Management Plan describes how risks will be identified, rated and managed. The disposition of project risks is a key element of management reporting. Project risks are managed using a three phase process:

- Identification (scope, cost, and schedule risks).
- Assessment (both qualitative and quantitative); e.g., Severity = Probability X Impact.
- Mitigation and Management; e.g., early procurement of long-lead time equipment.

The Risk Register identifies all risks and the risks:

- Avoid: Eliminate uncertainty; e.g., change scope. Take prior action to eliminate the likelihood and/or impact of the risk.
- Transfer: Transfer responsibility or liability; e.g., to a vendor.
- Mitigate: Reduce the size of the risk exposure; e.g., order spares.
- Accept: Recognize risk, plan to monitor and control; e.g., funding and schedule contingencies.

Typical risks at a HEC Center include:

- HEC not performing according to specifications; e.g., can't provide sufficient processors hours to users.
- HEC unreliable; e.g., buggy.
- HEC does not provide sufficient uptime; e.g., crashes too often.
- HEC hard to use; e.g., users find it difficult to use their codes.
- HEC not available when planned.
- Cyber security not sufficient.
- Software problems that result in insufficient support of scientific applications.

Typical HPN risks include:

- High performance networking (HPN) technology and features are not available when expected
- HPN equipment not performing according to specifications
- HPN equipment has hardware and/or software bugs
- New/disruptive technology changes the planned HPN performance parameters
- HPN available capacity is less than mission needs-network capacity demands grows faster than anticipated
- Consolidation in the telecommunications industry reduces the ability to obtain dark fiber infrastructure
- HPN cyber security not sufficient

10.0 GLOSSARY

- **Capital assets** are land (including parklands), structures, equipment (including motor and aircraft fleets) and intellectual property (including software) which are used by the Federal Government and have an estimated useful life of two years or more. Capital assets exclude items acquired for resale in the ordinary course of operations or held for the purpose of physical consumption, such as operating materials and supplies. The cost of a capital asset is its full life-cycle cost, including all direct and indirect costs for planning, procurement (purchase price and all other costs incurred to bring it to a form and location suitable for its intended use), operations and maintenance (including service contracts), and disposal. Capital assets may or may not be capitalized (i.e., recorded on an entity's balance sheet) under Federal accounting standards.
- **CD-0** is Approve Mission Need. There is a need that cannot be met through other means. ASCR will identify a credible performance gap between its current capabilities and capacities and those required to achieve the goals articulated in its Strategic Plan. The Mission Need Statement (MNS) is the translation of this gap into functional requirements that cannot be met through other means. It should describe the general parameters of the solution and why it is critical to the overall accomplishment of DOE's mission, including the benefits to be realized. The cost range provided at CD-0 should be Rough-Order of Magnitude (ROM) and is used to determine the AE authority designation. It does not represent a definitive cost and schedule baseline, which will be established at CD-2. DOE Order 413.3B requires projects with TPC ≥ $10M to provide monthly status reporting in PARS after CD-0.
- **CD-1** is Approve Alternative Selection and Cost Range. The selected alternative and approach is the optimum solution. This process uses a systems engineering methodology that integrates requirements analysis, risk identification and analysis, acquisition strategies, and concept exploration in order to develop a cost-effective, preferred solution to meet a Mission Need. The recommended alternative should provide the essential functions and capabilities at an optimum life-cycle cost, consistent with required cost, scope, and schedule, performance, and risk considerations. It should be reflected in the site's long-range planning documents. The CD-1 documentation includes the Alternatives Analysis and Acquisition Strategy.
- **CD-2** is Approve Performance Baseline (PB). Definitive scope, schedule and cost baselines have been developed. The documentation must include any long-lead time Request(s) For Proposals and clearly specify the project's proposed PB, which includes the Total Project Cost (TPC), schedule, including milestone dates such as the projected CD-4 date , scope as defined by a minimum or threshold set Key Performance Parameters (KPPs) that must be achieved for successful project completion. The CD-2 documentation includes the Project Execution Plan (PEP).
- **CD-3** is Approve Start of Construction/Execution. The project is ready for implementation; e.g., the procurement contract is approved. The project is ready to conduct all construction, implementation, procurement, fabrication, acceptance and transition activities.

- **CD-4** is Approve Start of Operations or Project Completion. The project is ready for turnover or transition to operations, if applicable. CD-4 is the achievement of the project completion criteria defined in the KPPs in the Project Execution Plan (PEP) and the approval for Transition to Operations. The approval of CD-4 is predicated on the readiness to operate and/or maintain the system, facility, or capability. Transition and turnover does not necessarily terminate all project activity. In some cases, it marks a point known as Beneficial Occupancy Date (BOD) at which the operations organizations assume responsibility for starting operations and maintenance. The AE approves CD-4 upon notification from the project team via an Energy Systems Acquisition Advisory Board (ESAAB) that all project completion criteria defined in the PEP have been met. The document signed by the AE approving CD-4 must clearly specify the scope accomplished, the TPC, Key Performance Parameters met, and the completion date (month and year) as it relates to the original CD-2 performance baseline and latest approved baseline change. The date the AE signs the document represents the CD-4 completion date. The CD-4 documentation includes Acceptance Testing results and final risk analysis. A lessons-learned is a post-CD-4 document required within 90 days after CD-4 approval.
- **Key Performance Parameter (KPP)** defines the project's scope that if changed would have a major impact on the system or facility performance, schedule, cost and/or risk. The threshold KPPs are the minimum parameters against which the project's performance is measured when complete. At CD-2, the documented threshold KPPs comprises the official Performance Baseline.
- **Non-recurring engineering** (**NRE**) refers to the one-time cost to research, develop, design and test a new product. When budgeting for a project, NRE must be considered to analyze if a new product will be profitable. Even though a company will pay for NRE on a project only once, NRE costs can be prohibitively high and the product will need to sell well enough to produce a return on the initial investment. NRE is unlike production costs, which must be paid constantly to maintain production of a product. It is a form of fixed cost in economics terms.
- **Performance Baseline (PB):** as established in the PEP, defines the definitive cost, scope and schedule commitments to which the project must be executed and is based on an approved funding profile. The PB includes the entire project budget (total cost of the project that includes contingency) and represents the DOE commitments to Congress and the OMB. Although only Operating Funds are used for the ASCR upgrades, the approved PB is controlled, tracked and reported from the beginning to the end of a project to ensure consistency between the PEP and the OMB Exhibit 300s.
- **Performance Baseline Change:** represents an irregular event. The approval by the AE does not constitute approval of individual contract changes and modifications. If a contract change is necessary, the Contracting Officer has exclusive authority to issue changes and modify contracts, but only if the changes or modifications comply with regulatory and statutory requirements. It is critical that the FPD and the Contracting Officer ensure that changes to the contract are identified, issued, administered, and managed in a timely manner over the life of the project and contract. The document signed by the AE approving the BCP must clearly specify the project's revised PB,

which includes the TPC, CD-4 date (month and year), scope and minimum KPPs that must be achieved at CD-4. In addition, the AE must endorse any reduction in funding that adversely affects the project's approved funding profile. PB change approval thresholds and authorities should be defined in the PEP. These approval levels must be incorporated into the change control process for each project.

- **Performance Baseline Deviation:** occurs when the approved TPC, CD-4 completion date, or performance and scope parameters cannot be met. The FPD must promptly notify ASCR whenever project performance indicates the likelihood of a PB deviation. When a deviation occurs, the AE must make a specific determination whether to terminate the project or establish a new PB by requesting the FPD to submit a Baseline Change Proposal (BCP). Additionally, all PB deviation decisions must be reported to the ASCR Facilities Program Manager.
- **Project Execution Plan (PEP):** is the core document for the management of a project. The Federal Project Director (FPD) is responsible for the preparation of this document. It establishes the policies and procedures to be followed in order to manage and control project planning, initiation, definition, execution and transition/closeout, and uses the outcomes and outputs from all project planning processes, integrating them into a formally approved document. It includes an accurate reflection of how the project is to be accomplished, the minimum KPPs for CD-4, funding requirements, technical considerations, risk management, configuration management, and roles and responsibilities. A preliminary PEP is required to support CD-1. This document continues to be refined throughout the duration of an upgrade; e.g., the detailed scope of work and acceptance testing criteria are developed for CD-2. PEP revisions are documented through the configuration management process (a sample PEP is available in the guidance for DOE Order 413.3B).

11.0 LIST OF ACRONYMS

- AA: Alternatives Analysis
- AD: Associate Director
- AE: Acquisition Executive
- AEs: Acquisition Executives
- ALCC: ASCR Leadership Computing Challenge
- ALCF: Argonne Leadership Class Facility
- API: application programming interface
- AS: Acquisition Strategy
- ASC: Advanced Simulation and Computing
- ASCR: Advanced Scientific Computing Research
- BOD: Beneficial Occupancy Date
- CDs: Critical Decisions
- CPIC: Capital Planning and Investment Control
- DME: Development, Modernization, and Enhancement
- DOE: Department of Energy
- ERCAP: Energy Research Computing Allocations Process
- ESAAB: Energy Systems Acquisition Advisory Board
- ESP: Early Science Proposal
- EVMS: Earned Value Management System
- FPD: Federal Project Director
- GUI: Graphical User Interface
- HAR: Hazard Analysis Report
- HEC: High End Computing
- INCITE: Innovative and Novel Computational Impact on Theory and Experiment
- IPRs: independent project reviews
- IPT: the Integrated Project/Program Team
- IT: information technology
- ITIL: Information Technology Infrastructure Library
- KPP: Key Performance Parameter
- LCF: Leadership Class Facility
- LTO: Lease-To-Own
- MNS: Mission Need Statement
- NEPA: National Environmental Policy Act
- NERSC: National Energy Research Scientific Computing Center
- NIST: National Institute of Standards and Technology
- NNSA: National Nuclear Security Administration
- NRE: Non-recurring Engineering
- OA: Operational Assessment
- OARs: Operational Assessment Reviews
- OBES: Office of Basic Energy Sciences
- OLCF: Oak Ridge Leadership Class Facility
- O&M: Operations & Maintenance
- OMB: Office of Management and Budget

- OPA: Office of Project Assessment
- OSCARS: On-Demand Secure Circuits and Advance Reservation System
- PARS: Project Assessment and Reporting System
- PB: Performance Baseline
- PEP: Project Execution Plan
- PM: Program Manager
- RFP: Request for Proposal
- ROM: Rough-Order of Magnitude
- SC: Office of Science
- SCMS: SC Management System
- SOW: statement of work
- TPC: total project costs
- WBS: Work Breakdown Structure