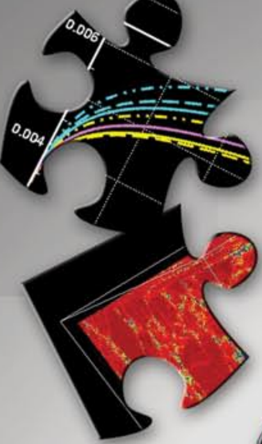
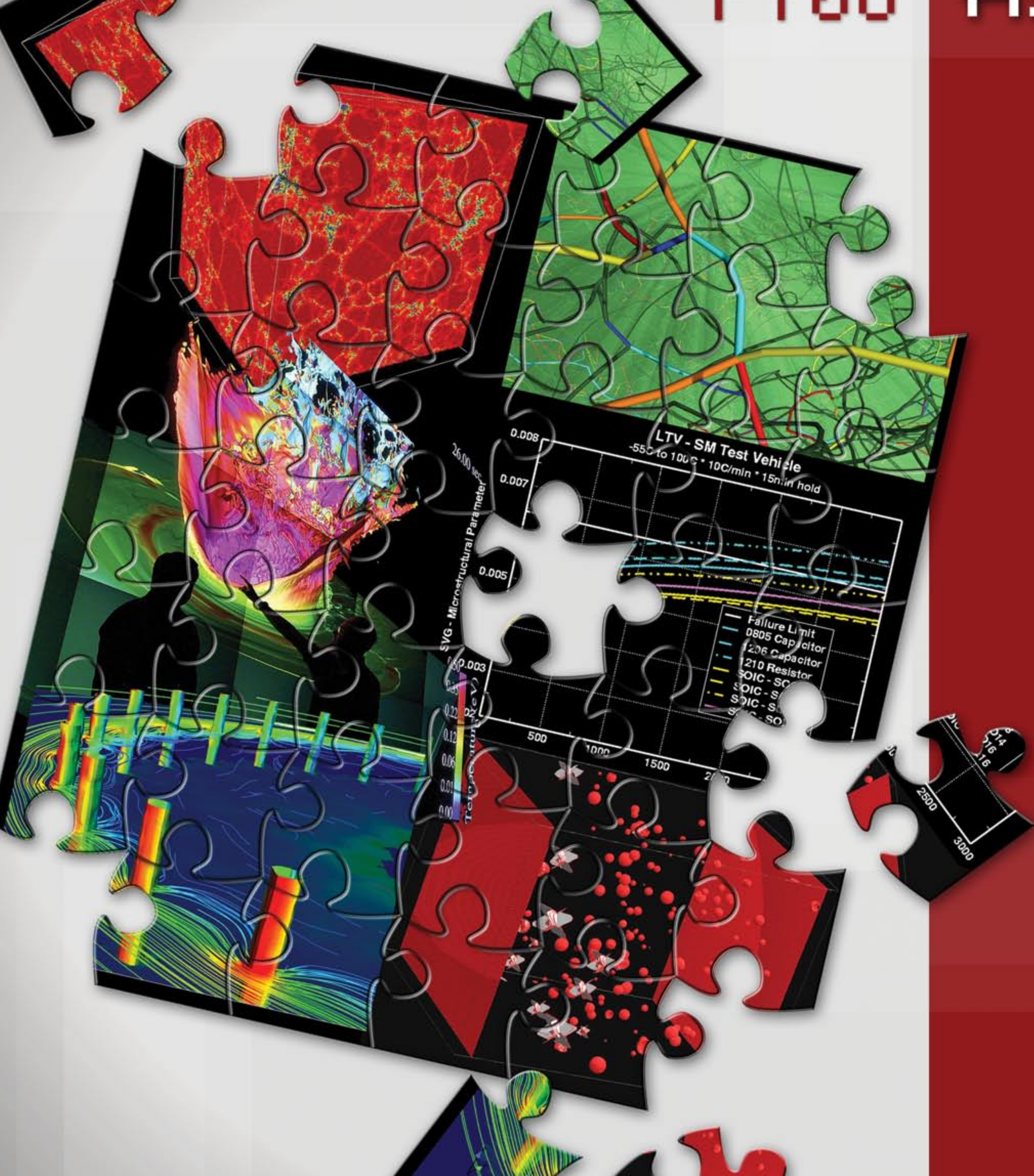
NA-ASC-106R-05-Vol. 1-Rev. 0

PROGRAM PLAN FY06

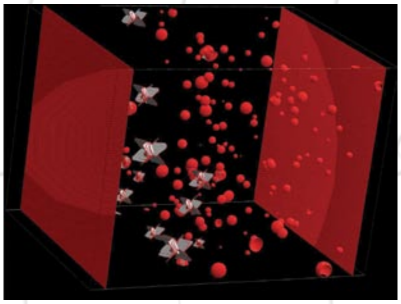




ASC™

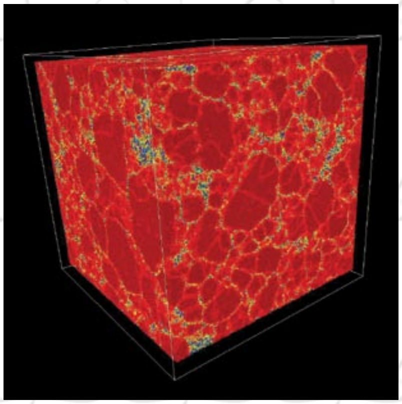
NNSA
National Nuclear Security Administration

ON THE COVER



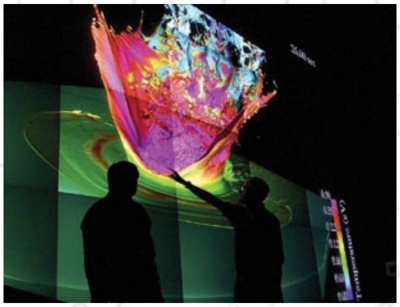
Plastic deformation induced as a shock wave passed through a 2.1 billion atom copper crystal containing a number of preexisting voids. Only those atoms in defect sites are shown, red at voids, free surfaces, or dislocation cores; and grey at stacking faults.

(Los Alamos National Laboratory)



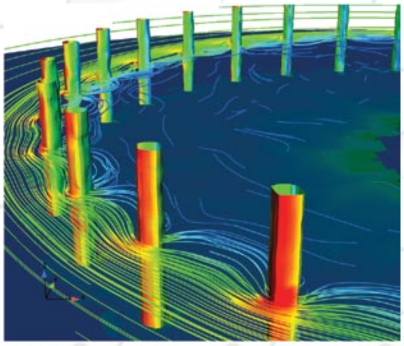
A snapshot of isothermal compression of molten Ta at 5000 K to a final pressure of 250 Gpa; this has resulted in solidification to a polycrystalline phase, (Solid atoms are shown in red, grain boundary atoms in yellow, and liquid in blue.)

(Lawrence Livermore National Laboratory)



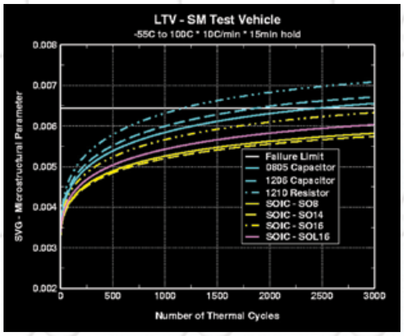
A photograph of Los Alamos scientists exploring data on the large powerwall in the SCC theatre. This 24-panel display measures 22 by 12 feet and displays 31 million pixels.

(Los Alamos National Laboratory)



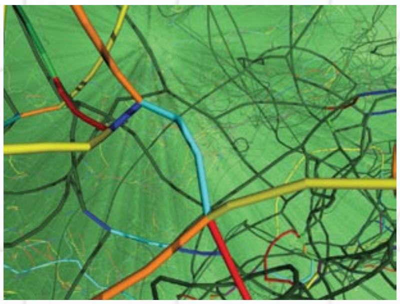
Computerized rendition of magnetic field lines in a z-pinch wire array.

(Sandia National Laboratories)



Viscoplastic continuum damage model reliability simulations of themomechanical fatigue of solder joints in the LTV-SM circuit boardtest vehicle. These simulations show that solder joints fail long before others, providing design guidance.

(Sandia National Laboratories)



An image of a dislocation network simulation using the ParaDiS code.

(Lawrence Livermore National Laboratory)

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For more information, contact Reeta Garber at ragarbe@sandia.gov

Advanced Simulation and Computing

PROGRAM PLAN FY06

October 2005

ASC Focal Point
Dimitri Kusnezov, Director
DOE/NNSA-NA 114
202-586-1800

Program Plan Focal Point for NA.114
Reeta Garber
Sandia National Laboratories
505-844-3900

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II. Executive Summary

The Stockpile Stewardship Program (SSP) is a single, highly integrated technical program for maintaining the safety and reliability of the U.S. nuclear stockpile. The SSP uses past nuclear test data along with current and future nonnuclear test data, computational modeling and simulation, and experimental facilities to advance understanding of nuclear weapons. It includes stockpile surveillance, experimental research, development and engineering programs, and an appropriately scaled production capability to support stockpile requirements. This integrated national program will require the continued use of current facilities and programs along with new experimental facilities and computational enhancements to support these programs.

The Advanced Simulation and Computing Program (ASC)[1] is a cornerstone of the SSP, providing simulation capabilities and computational resources to support the annual stockpile assessment and certification, to study advanced nuclear-weapons design and manufacturing processes, to analyze accident scenarios and weapons aging, and to provide the tools to enable Stockpile Life Extension Programs (SLEPs) and the resolution of Significant Finding Investigations (SFIs). This requires a balanced resource, including technical staff, hardware, simulation software, and computer science solutions.

In its first decade, the ASC strategy focused on developing and demonstrating simulation capabilities of unprecedented scale in three spatial dimensions. Now in its second decade, ASC is focused on increasing its predictive capabilities in a three-dimensional simulation environment while maintaining the support to stockpile stewardship. The program continues to improve its unique tools for solving progressively more difficult stockpile problems (focused on sufficient resolution, dimensionality, and scientific details); to quantify critical margins and uncertainties (QMU); and to resolve increasingly difficult analyses needed for the SSP. Moreover, ASC has restructured its business model from one that was very successful in delivering an initial capability to one that is integrated and focused on requirements-driven products that address long-standing technical questions related to enhanced predictive capability in the simulation tools.

This Program Plan describes the ASC strategy and the deliverables required to accomplish the FY 2006–2010 multifaceted objectives; defines program goals; introduces the new national work breakdown structure; and details the new sub-programs, their strategies, and their associated performance indicators. The plan also includes ASC's Level 1 milestones and the top ten risks. To ensure synchronization with the SSP's needs, the Program Plan will be reviewed and updated annually.

[1] In FY02 the Advanced Simulation and Computing (ASC) Program evolved from the Accelerated Strategic Computing Initiative (ASCI).

III. Introduction

The Advanced Simulation and Computing (ASC) Program supports the National Nuclear Security Administration's (NNSA's) long-term strategic goal of Nuclear Weapons Stewardship: *"ensure that our nuclear weapons continue to serve their essential deterrence role by maintaining and enhancing the safety, security, and reliability of the U.S. nuclear weapons stockpile."*[2]

In 1996, ASCI — the Accelerated Strategic Computing Initiative and predecessor to ASC — was established as an essential element of the Stockpile Stewardship Program (SSP) to provide nuclear weapons simulation and modeling capabilities.

Before the moratorium on nuclear testing began in October 1992, the nuclear weapons stockpile was maintained through (1) underground nuclear testing and surveillance activities and (2) "modernization" (i.e., development of new weapons systems). A consequence of the nuclear test ban is that the safety, performance, and reliability of U.S. nuclear weapons must be ensured by other means for systems that are expected to remain in the stockpile far beyond the lifetimes originally envisioned when these weapons were designed. The NNSA was established in 2000 to carry out the national security responsibilities of the Department of Energy, including maintenance of a safe, secure, and reliable stockpile of nuclear weapons and associated materials capabilities and technologies. In 2002, ASCI matured from an initiative to a program and was renamed the Advanced Simulation and Computing (ASC) Program.

NNSA will carry out its responsibilities through the 21st century in accordance with the current Administration's vision and the Nuclear Posture Review (NPR) guidance. NNSA Administrator Ambassador Brooks has summarized[3] the NNSA objectives for SSP as follows:

> *We will continue to lead the way to a safer world through the deep reductions in nuclear forces codified by the Moscow Treaty, through Nunn-Lugar and other cooperative threat reduction efforts, and through other actions. At the same time, although conventional forces will assume a larger share of the deterrent role, we will maintain an effective, reliable, and capable—though smaller—nuclear force as a hedge against a future that is uncertain and in a world in which substantial nuclear arsenals remain. Our ongoing efforts to reduce the current stockpile to the minimum consistent with national security requirements, to address options for transformation of this smaller stockpile, and to create a responsive nuclear weapons infrastructure are key elements of the Administration's national security strategy*… .

A truly responsive infrastructure will allow us to address and resolve any stockpile problems uncovered in our surveillance program; to adapt weapons (achieve a capability to modify or repackage existing warheads within 18 months of a decision to enter engineering development); to be able to design, develop, and initially produce a new warhead within three to four years of a decision to do so;[4] to restore production capacity to produce new warheads in sufficient quantities to meet any defense needs that arise without disrupting ongoing refurbishments; to ensure that services such as warhead transportation, tritium support, and other ongoing support efforts are capable of being carried out on a time scale consistent with the Department of Defense's ability to deploy weapons; and to improve test readiness (an 18-month test readiness posture) in order to be able to diagnose a problem and design a test that could confirm the problem or certify the solution (without assuming any resumption of nuclear testing).

Additionally, the NPR guidance has directed that NNSA maintain a research and development and manufacturing base to ensure the long-term effectiveness of the nation's stockpile and begin a modest effort to examine concepts that could be deployed to further enhance the deterrent capabilities of the stockpile in response to the national security challenges of the 21st century.

The ASC Program plays a vital role in the NNSA infrastructure and its ability to respond to the NPR guidance. The program focuses on development of modern simulation tools that can provide insights into stockpile problems, provide tools with which designers and analysts can certify nuclear weapons, and

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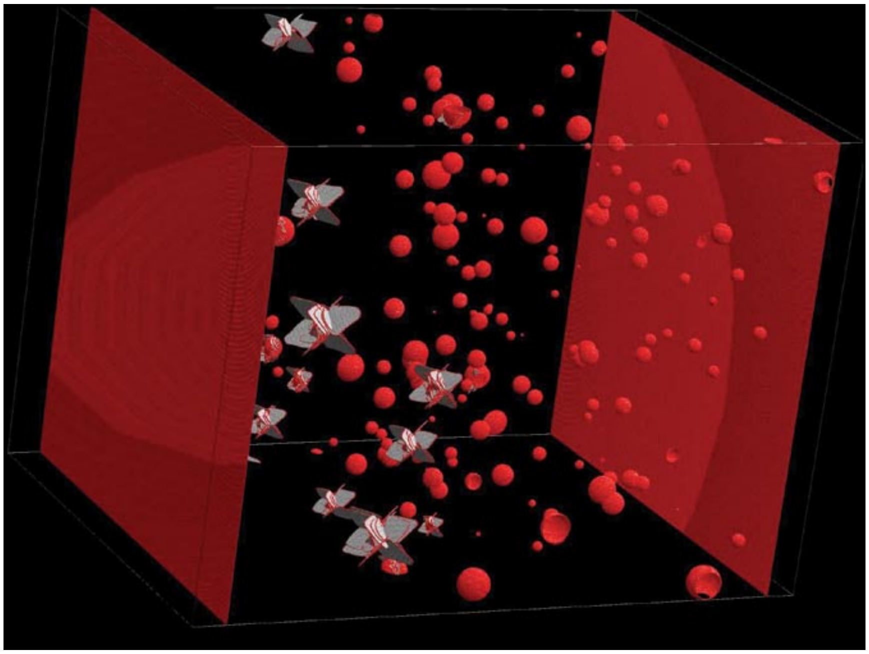
[2] NNSA Strategic Plan, page 8.

[3] Speech presented to the Heritage Foundation Conference: *U.S. Strategic Command: Beyond the War on Terrorism*, May 12, 2004.



1. Plastic deformation induced as a shock wave passed through a 2.1 billion atom copper crystal containing a number of preexisting voids. Only those atoms in defect sites are shown, red at voids, free surfaces, or dislocation cores; and grey at stacking faults.

(Courtesy: Los Alamos National Laboratory.)

guide any necessary modifications in nuclear warheads and the underpinning manufacturing processes. Additionally, ASC is enhancing the predictive capability necessary to evaluate weapons effects, design experiments, and ensure test readiness.

ASC continues to improve its unique tools to progressively solve more difficult stockpile problems, with a focus on providing the resolution, dimensionality, and scientific details required to quantify critical margins and uncertainties and to resolve the increasingly difficult issues arising in stockpile stewardship programs. The Directed Stockpile Work (DSW) provides requirements for simulation, including planned Stockpile Lifetime Extension Programs (SLEPs), stockpile support activities that may be ongoing or require short-term urgent response, and requirements for future capabilities to meet longer-term stockpile needs. Thus, ASC's advancing leading-edge technology in high-performance computing and predictive simulation meets these short- and long-term needs, including the annual assessments and certifications and Significant Finding Investigations (SFIs). The following section lists past, present, and planned ASC contributions to meet these needs.

ASC Contributions to the SSP

- In FY 1996, ASCI Red was delivered. Red, the world's first teraOPS supercomputer, has since been upgraded to more than 3 teraOPS.
- In FY 1998, ASCI Blue Pacific and ASCI Blue Mountain were delivered. These platforms were the first 3-teraOPS systems in the world.
- In FY 2000, ASCI successfully demonstrated the first-ever three dimensional (3-D) simulation of a nuclear weapon primary explosion and the visualization capability to analyze the results; ASCI successfully demonstrated the first-ever 3-D hostile-environment simulation; and ASCI accepted delivery of ASCI White, a 12.3-teraOPS supercomputer.
- In FY 2001, ASCI successfully demonstrated simulation of a 3-D nuclear weapon secondary explosion; ASCI delivered a fully functional problem solving environment for ASCI White; ASCI demonstrated high-bandwidth distance computing among the three national laboratories; and ASCI demonstrated the initial validation methodology for early primary behavior. Lastly, ASCI completed the 3-D analysis for a stockpile-to-target sequence (STS) for normal environments.

[4]While there are no plans to develop new weapons, gaining the capability is an important prerequisite to deep reductions in the nuclear stockpile.

- In FY 2002, ASCI demonstrated 3-D system simulation of a full-system (primary and secondary) thermonuclear weapon explosion, and ASCI completed the 3-D analysis for an STS abnormal-environment crash-and-burn accident involving a nuclear weapon.
- In FY 2003, ASCI delivered a nuclear safety simulation of a complex, abnormal, explosive initiation scenario; ASCI demonstrated the capability of computing electrical responses of a weapons system in a hostile (nuclear) environment;[5] and ASCI delivered an operational 20-teraOPS platform on the ASCI Q machine.
- In FY 2004, ASC provided simulation codes with focused model validation to support the annual certification of the stockpile and to assess manufacturing options. ASC supported the life-extension refurbishments of the W76 and W80, in addition to the W88 pit certification. In addition, ASC provided the simulation capabilities to design various nonnuclear experiments and diagnostics.
- In FY 2005, ASC identified and documented SSP requirements to move beyond a 100-teraOPS computing platform to a petaOPS-class system; ASC delivered a metallurgical structural model for aging to support pit-lifetime estimations, including spiked-plutonium alloy.
- By FY 2006, ASC will deliver the capability to perform nuclear performance simulations and engineering simulations related to the W76/W80 LEPs to assess performance over relevant operational ranges, with assessments of uncertainty levels for selected sets of simulations. The deliverables of this milestone will be demonstrated through 2-D and 3-D physics and engineering simulations. The engineering simulations will analyze system behavior in abnormal thermal environments and mechanical response of systems to hostile blasts. Additionally, confidence measures and methods for uncertainty quantification will be developed to support weapons certification Level 1 milestones.
- By FY 2007, ASC will support the completion of the W76-1 and W88 warhead certification, using quantified design margins and uncertainties.
- By FY 2008, ASC will deliver the codes for experiment and diagnostic design to support the CD-4 approval on the National Ignition Facility (NIF). In addition, a high-capability platform will be sited.
- By FY 2009, a modern baseline of all enduring stockpile systems, using FY 07 and FY 08 ASC code releases, will be completed.
- In FY 2010 and beyond, ASC will continue to deliver codes for experiment and diagnostic design to support the indirect-drive ignition experiments on the NIF.

[5]Level 1 milestone (NA-3.1), "Stockpile-to-Target sequence hostile environment simulation for cable SGEMP and electrical response to x-rays."

IV. Mission

Provide leading edge, high-end simulation capabilities needed to meet weapons assessment and certification requirements

To meet the above mission and enhance the ability of the SSP to respond to stockpile needs in FY 2005– 2010, ASC will:

- Continue supporting the immediate stockpile needs, including the annual assessments and certifications, LEPs, SFIs, and manufacturing operations.
- Advance the development of ASC codes to provide the increased predictive capability necessary to understand aging phenomena that push our current science-based tools outside tested regimes.
- Stimulate the U.S. computer-manufacturing industry to create the powerful high-end computing capability required by the SSP.
- Expand computational infrastructure and operating environment to enable better accessibility and usability of ASC capabilities.
- Enhance integration with the Science Campaigns to develop and incorporate improved, validated physics and materials models into the ASC codes.

V. Vision

Predict, with confidence, the behavior of nuclear weapons, through comprehensive, science-based simulations

ASC will further enhance both the science and technology necessary to accomplish the above vision by integrating with Science Campaigns and DSW to develop better science models; incorporating enhanced physics models into the simulation codes; delivering robust codes with enhanced computational techniques; applying verification and validation methodologies early in the modern code-development process; and providing leading-edge technology in the platforms and operating environments necessary for executing complex science-based simulations.

VI. Goals

Deliver increasingly accurate simulation and modeling tools, supported by necessary computing resources, to sustain the stockpile

Development and implementation of comprehensive methods and tools for certification, including simulations, are top Defense Programs (DP) priorities that will meet the SSP vision of an integrated nuclear security enterprise that consists of:

> *...research and development (R&D), tests and production facilities that operates a responsive, efficient, secure, and safe, nuclear weapons complex and that is recognized as preeminent in personnel, technical leadership, planning, and program management.*[6]

To ensure its ability to respond to stockpile needs and deliver accurate simulation and modeling tools, ASC's strategic goals for the next ten years are focused on:[7]

- Improving the confidence in prediction through simulations;
- Integrating the ASC Program with certification methodologies;
- Developing the ability to quantify confidence bounds on the uncertainty in our results;
- Increasing predictive capability through tighter integration of simulation and experimental activities;
- Providing the necessary computing capability to code users, in collaboration with industrial partners, academia, and government agencies.

VII. Strategy

In its first ten years, the ASC Program followed a strategy that emphasized the development and use of high-fidelity, 3-D codes to address stockpile issues, and the creation and deployment of the required computational capabilities and supporting infrastructure. The success of ASC was demonstrated through a series of pioneering proof-of-principle milestone calculations. For the next decade, ASC has adopted a new strategy that emphasizes a continual reduction in the phenomenology in the weapons simulation codes and a deeper understanding, in quantitative terms, of their predictive capabilities and uncertainties in order to enable risk-informed decisions about the performance, safety, and reliability of the stockpile.

The ASC Program and the other Science Campaigns will be integrated with structured certification methodologies, including as an inherent element the ability to assess and quantify the confidence in the use of ASC tools for making predictions and informed stockpile-related decisions. Developing the tools to address new concepts and options is another goal that leads to this new strategy, guiding the transition from a successful initiative toward a more powerful and demonstrably predictive capability.

The ASC strategy has, and will continue to have, both short- and long-term components. These elements are not separable, but complementary and interdependent. The goal of the short-term component is to meet the continuing and time-constrained needs of stockpile stewardship, in particular, SFIs and stockpile life-extension activities. Addressing these needs as the properties of the materials and devices in the stockpile change will force a transition to the modern codes with their increased dimensionality and enhanced modeling capabilities. The fidelity of these codes will continue to be improved so that they become increasingly able to address any potential stockpile problems that might be uncovered in the surveillance process.

The long-term component of the strategy is to ensure movement toward reduced phenomenology that will enhance confidence in the simulation results. It has been understood since the inception of computing in the

[6]Source: DP Program Planning and Resource Call Guidance

[7]Source: ASC Strategy, NA-ASC-100R-04-Vol.1-Rev.0, August 2004

weapons program that codes cannot be built and then accepted "on faith." To ensure that they are grounded in physical reality and provide a foundation for scientifically based decisions, the representation of weapons behavior must be supported by an increased focus on both verification and validation. As new models are incorporated into the codes, they can be rigorously tested against appropriate experiments to validate that they conform to physical reality. This strategy emphasizes a strengthened program of validation and peer review to quantify and then expand the parameter space currently spanned by older codes.

The products of ASC serve as the integrators for all aspects of the nuclear weapons enterprise, from assisting the plants in their manufacturing mission through the full stockpile life cycle. The ASC tools also provide capabilities for studies and assessments of crude terrorist devices in Homeland Security applications or advanced weapon concepts that could respond to any new strategic threat. The strategy described here will allow ASC to support the objectives articulated by Ambassador Brooks (quoted in Introduction above).

VIII. ASC Level 1 Milestones

Level 1 milestones specific to ASC (Table 1) are designed to track ASC's progress toward accomplishing its strategic goals, meeting its performance measures, and providing the predictive capabilities and computing power necessary to meet SSP needs. This table also identifies interfaces with other DP components in order to accomplish ASC Level 1 milestones. Appendix A lists all Defense Program, NA-10, Level 1 milestones, including those of ASC, which must be accomplished to meet the SSP mission.

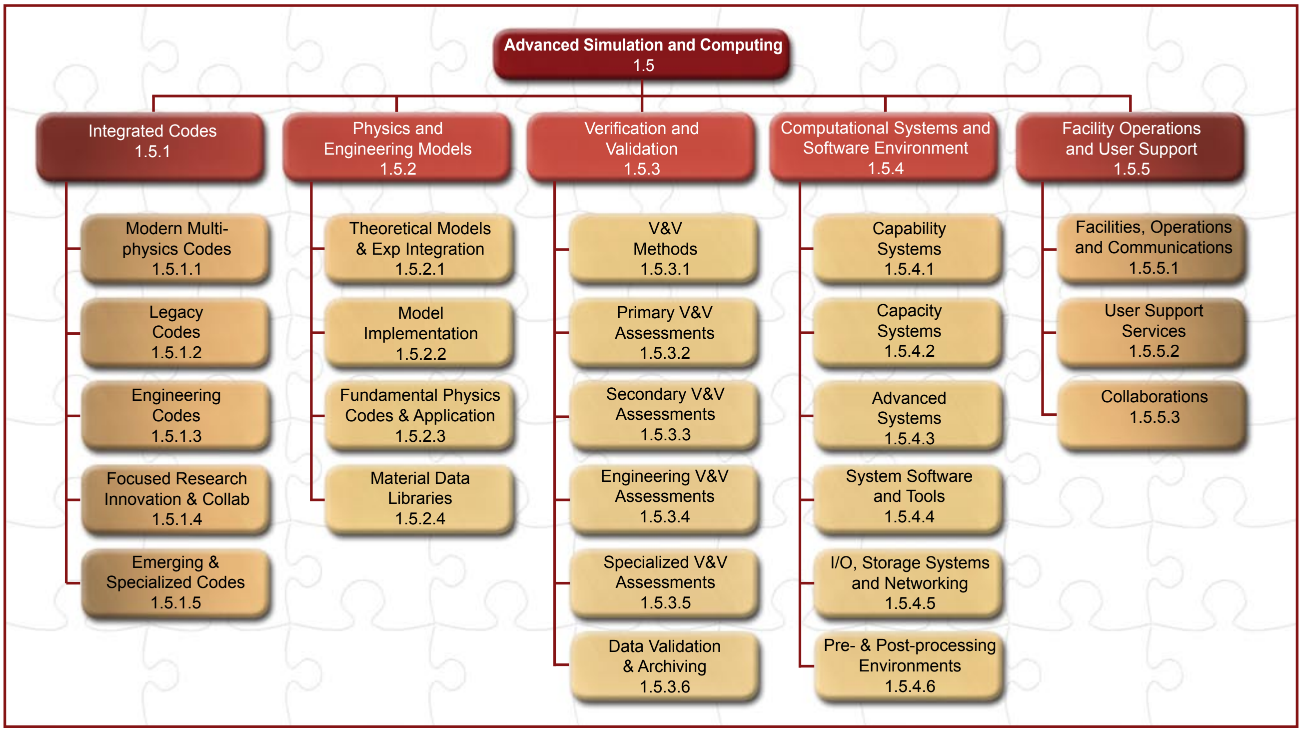
Table 1. ASC Level 1 Milestones and Interfaces with DP Components for FY 2006–2010

ASC Milestone # and Title	Responsibility	End Date	Input Entities	Capability to be Delivered from DP Entity
349. Deliver advanced ASC physics and engineering simulation capabilities to support the W76 and the W80 LEP/certification.	HQ LLNL LANL SNL	FY06 Q4	DSW, C1, C2, C4	Stockpile requirements, certification, methodology, data for validation.
350. Develop a 100 teraOPS platform environment supporting tri-lab DSW and Campaign simulation experiments.	HQ LLNL	FY07 Q1	DSW, Science Campaigns	Simulation requirements
359. Complete modern baseline of all enduring stockpile systems with ASC codes.	HQ, LLNL, LANL, SNL	FY09 Q4	DSW	System descriptions for simulation input; stockpile issues to be addressed, test data for validation.

IX. Program Structure

ASC's program structure is based on the new national Work Breakdown Structure (nWBS), described in the ASC Business Model (NA-ASC-104R-05-Vol.1-Rev.5). The ASC Program is at Level 2 within the Defense Programs (NA-10). Its five sub-programs, shown in the chart below, are at Level 3.

- Integrated Codes—1.5.1,
- Physics and Engineering Models—1.5.2,
- Verification and Validation—1.5.3,
- Computational Systems and Software Environment—1.5.4,
- Facility Operations and User Support—1.5.5.



Below is a brief description of these sub-programs, their respective strategies, and performance indicators.

To meet the overall ASC strategy, the joint strategy for the first three sub-programs (Integrated Codes, Physics and Engineering Models, and Verification & Validation) is to focus on improved models in the modern codes, delivery of validated tools, and response to SSP issues (e.g., SFIs, LEPs, annual assessments). Key drivers are to improve the confidence in prediction through simulations; to calculate, measure, and understand the uncertainty in the predictions; and to ensure rapid delivery of simulation capabilities to stockpile stewardship. The adequacy of this strategy will be assessed according to the following performance indicators (see Appendix B):

- Peer-reviewed progress in completing milestones, according to annual targets, in the development and implementation of improved models and methods into integrated weapons codes and deployment and support of integrated weapons codes for end users. (Long-term output.)
- Cumulative percentage of the 31 weapons system components, primary/secondary/engineering systems, analyzed using ASC codes as parts of annual assessments and certifications. (Long-term output.)

The fourth sub-program, Computational Systems and Software Environment, ensures the creation of a computing environment needed for all ASC-deployed platforms: capability, capacity, and advanced systems.[8] Not only is this sub-program responsible for related research and technology development, but it is also responsible for planning, procurement, and quality control activities. The adequacy of this sub-program's strategy will be assessed according to the following performance indicators (see Appendix B):

- Peer-reviewed progress, according to annual targets, in the development and implementation of the improved models and methods into integrated weapons codes and deployment to their users. (Long-term output.)
- The maximum individual platform computing capability delivered, measured in teraOPS. (Long-term output.)
- Total capacity of ASC production platforms attained, measured in teraOPS taking into consideration procurements and retirements of systems. (Long-term output.)
- Average cost per teraOPS of delivering, operating, and managing all SSP production systems in a given fiscal year. (Efficiency measure.)

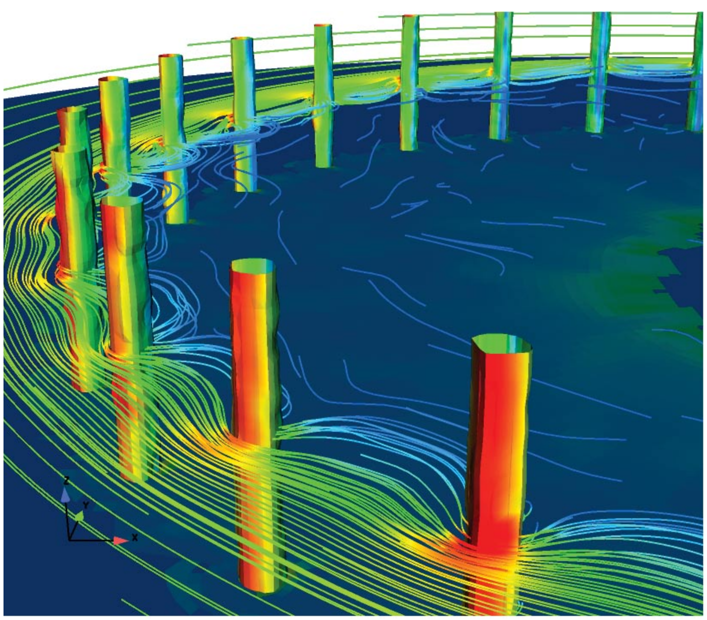
The fifth sub-program, Facility Operations and User Support, provides operational support for production computing and storage; user support services; and collaborative research opportunities with educational institutions, as well as programmatic support across the ASC Program. The adequacy of this sub-program's strategy will be assessed according to the following performance indicators (see Appendix B):

- Peer-reviewed progress, according to annual targets, in the development and implementation of the improved models and methods into integrated weapons codes and deployment to their users. (Long-term output.)
- Average cost per teraOPS of delivering, operating, and managing all SSP production systems in a given fiscal year. (Efficiency measure.)

A description of each sub-program and associated strategies is given below.

Integrated Codes (IC)

This sub-program constitutes lab code projects that develop and improve the weapons simulation tools, the physics, the engineering, and the specialized codes. These code projects are at varying levels of maturity, from recasted legacy codes that are able to run on advanced architectures to more sophisticated and accurate models and numerics being developed for representation in the next generation codes. This sub-program addresses the improvement of simulations of weapons systems that would predict with reduced uncertainties the behavior of devices in the stockpile and that would begin the analysis and design for a Reliable Replacement Warhead (RRW). In general, the sub-program's products are large-scale integrated simulation codes needed for: (1) SSP maintenance, (2) the LEP, (3) addressing and closing of Significant Findings, and (4) the support of dismantlement processes and future modifications. Specifically, products include legacy code mainte-



2. Computerized rendition of magnetic field lines in a z-pinch wire array.

(Courtesy: Sandia National Laboratories.)

[8]The ASC Program is in transition for current platforms. Future platforms will follow the Capital Acquisition Management process identified in the NA-10 *Program Management Manual.*

nance; continued research into the applications and operations of engineering codes and manufacturing process codes; investigations and developments of future nonnuclear replacement components, algorithms, and computational methods as well as development of software architectures; advancement of key basic research initiatives; and explorations into emerging code technologies and methodologies. Also included in this sub-program are university grants and collaborations such as the ASC Alliances and Computational Science Graduate Fellowships, which encourage lab-university collaboration. This sub-program's functional and performance requirements are established by designers, analysts, code developers, and the requirements of the Quantification of Margins and Uncertainties (QMU). Closely connected to this sub-program is the Physics and Engineering Models sub-program because of its focus on the development of new models that would be implemented into the modern codes. Similarly, there is also the connection to the V&V program for assessing the degree of reliability and level of uncertainty associated with the outputs from the codes.

Associated strategies for IC include:

- Developing coupled multi-physics models for device simulation, based on fundamental understanding and realistic, scientifically based representation of device behavior, with a reduced reliance on calibration to underground test data.
- Developing integrated physics models with more accurate numerical methods for treating complex geometries in 2-D and 3-D computer codes.
- Developing capabilities to simulate effects of replacement components as well as to analyze various Stockpile-to-Target Sequences (STSs) and modifications to ensure nuclear surety scenarios.
- Accelerating code performance through more powerful numerical algorithms and improved approximations.
- Enhancing interactions with academic colleagues in computer science, computational mathematics, and engineering.
- Investigating basic research results relevant to the ASC Program in computer science, scientific computing, and computational mathematics at the laboratories.
- Providing continued support to the Computational Science Graduate Fellowship programs, funded jointly by the DOE Office of Science, designed to engage doctoral candidates in basic and applied science or engineering disciplines with applications in high-performance computing.

Physics and Engineering Models (PEM)

This sub-program develops microscopic and macroscopic models of physics and material properties, as well as improved numerical approximations to the simulation of transport for particles and x-rays and other critical phenomena. This sub-program is responsible for the development, the initial validation, and the incorporation of new models into the IC; therefore, it is essential that both sub-programs be interdependent. There is also extensive integration with the SSP experimental programs, mostly funded and managed by the Science Campaigns such as the Dynamic Materials Properties and the Engineering Campaigns. Functional requirements for this sub-program are established by designers and analysts.

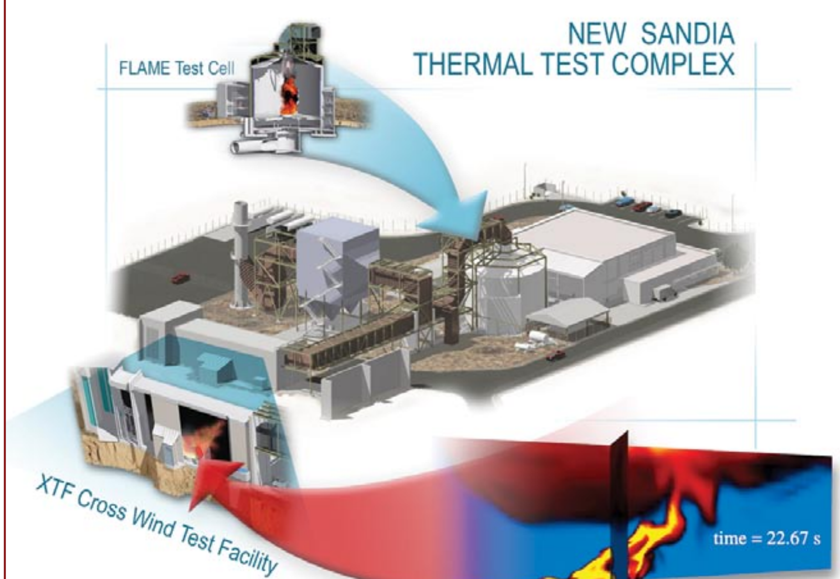
3. An image of a dislocation network simulation using the ParaDiS code. (Courtesy: Lawrence Livermore National Laboratory.)

Associated strategies for PEM include:

- Developing equation-of-state (EOS) and constitutive models for materials within nuclear devices, improved understanding of phase diagrams and the dynamic response of materials.
- Developing physics-based models representing the altered properties of plutonium as it ages, partly as a result of self-irradiation.
- Developing fundamental chemistry models of high explosives, including thermal, mechanical, and constitutive properties of unreacted explosives and explosive products, decomposition kinetics, detonation performance, and response in abnormal environments.
- Improving representation of corrosion, polymer degradation, and thermal-mechanical fatigue of weapons electronics.
- Developing more representative models of melting and decomposition of foams and polymers in safety-critical components.
- Building better models of microelectronic and photonic materials under hostile environments in support of the STS requirements.
- Developing physics-based models for the prediction of shock-induced turbulent mix and associated material interpenetration along material interfaces.
- Developing physics-based models and databases for nuclear reaction kinetics in relevant materials.

Verification and Validation (V&V)

Based on the functional and operational requirements established by designers, analysts, and code developers for greater fidelity of codes and models, this sub-program establishes a technically rigorous foundation for the credibility of code results. It interfaces with the IC sub-program to obtain regular, official code releases from the code projects. Verification activities assess code precision in implementing numerical approximations and assess the accuracy of these numerical approximations. Validation activities aid in the understanding and assessment of a model's accuracy by comparing model predictions with experimental data. Quantification methodologies provide measures of the uncertainties associated with the simulations. Sound software quality engineering practices are used to ensure robust, efficient, and well-documented software releases of the ASC codes. This sub-program collaborates with the Science and Engineering Campaigns and DSW to obtain experimental data for validation purposes. Final V&V assessment reports contain the standard deliverables of this sub-program.



4. An illustration of a helium plume simulation, part of an ASC V&V project at Sandia. (Courtesy: Sandia National Laboratories.)

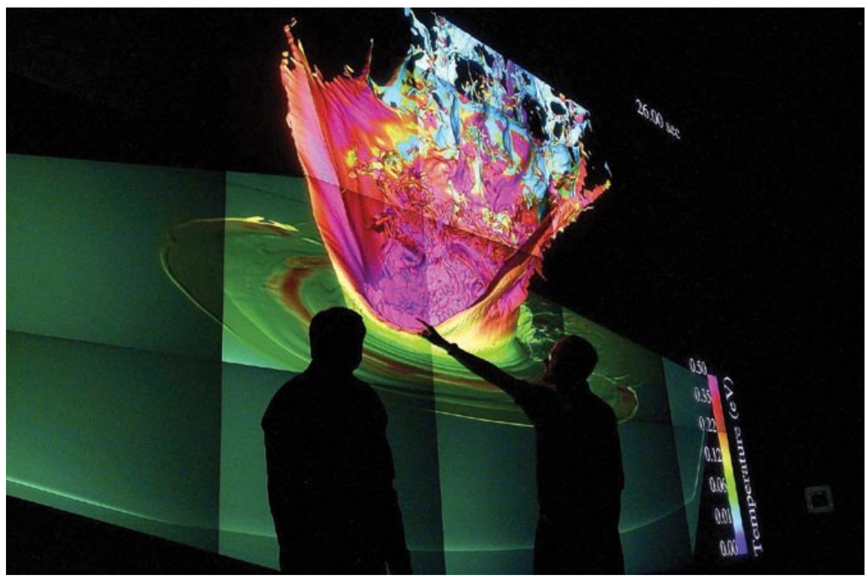
Associated strategies for V&V include:

- Defining and documenting methodologies for quantification of results, providing the basis by which computational uncertainties are assessed and evaluated.
- Increasing efforts to develop common verification and validation methodologies (convergence analyses, error quantification, etc.) and test suites, cutting across organizations and even external to a given laboratory to examine the adequacy and correctness of the ASC models and codes.

- Identifying requirements and performing comparison calculations against experimental validation data obtained through the experimental Science and Engineering Campaigns.
- Developing and maintaining repositories of V&V outputs, including data, test results, and analyses, to be accessible to the Stockpile community.
- Developing software quality standards stemming from customer or regulatory requirements and improved software engineering tools and practices for application to ASC simulations.

Computational Systems and Software Environment (CSSE)

This sub-program provides ASC users a stable, seamless computing environment for all ASC-deployed platforms, including capability, capacity, and advanced systems. It is responsible for delivering and deploying the ASC computational systems and user environments via technology development and integration at the Defense Program laboratories, in addition to partnerships with industry and academia. The scope of the sub-program includes strategic planning, research, development, procurement, maintenance, testing, integration and deployment, and quality and reliability activities for all ASC computational systems and software environment. Functional and operational computational requirements for this sub-program are established by the weapons designers, analysts, and code developers. This sub-program identifies computer science and system development opportunities in emerging technologies based on maket surveys, vendor discussions, and interagency and academic collaborations.



5. A photograph of Los Alamos scientists exploring data on the large powerwall in the SCC theater. This 24 panel display measures 22 by 12 feet and displays 31 million pixels. (Courtesy: Los Alamos National Laboratory.)

Associated strategies for CSSE include:

- Creating a common, usable, and robust application-development and execution environment for ASC computing platforms and ASC-scale applications, enabling code developers to meet the computational needs of weapons scientists and engineers.
- Producing an end-to-end, high-performance input/output, networking-and-storage archive infrastructure encompassing ASC platforms and operating systems, large-scale simulations, and data-exploration capabilities to enable efficient ASC-scale computational analysis.
- Providing a reliable, available, and secure environment for distance computing through system monitoring and analysis, modeling and simulation, and technology infusion.
- Developing and deploying high-performance tools and technologies to support visual and interactive

exploration of massive, complex data; effective data management, extraction, delivery, and archiving; and efficient remote or collaborative scientific data exploitation.

- Developing and deploying scalable data manipulation and rendering systems that leverage inexpensive, high-performance commodity graphics hardware.
- Deploying and providing system management of the ASC computers and their necessary networks and archival storage systems.
- Collaborating with vendors to stimulate and advance research and development efforts on advanced architectures that explore alternative computer designs for ASC applications, promising dramatic improvements in performance, scalability, reliability, packaging, and cost.
- Developing and implementing tools for efficient design through analysis (D-through-A), including problem setup and high-fidelity visualization results of simulations.

Facility Operations and User Support (FOUS)

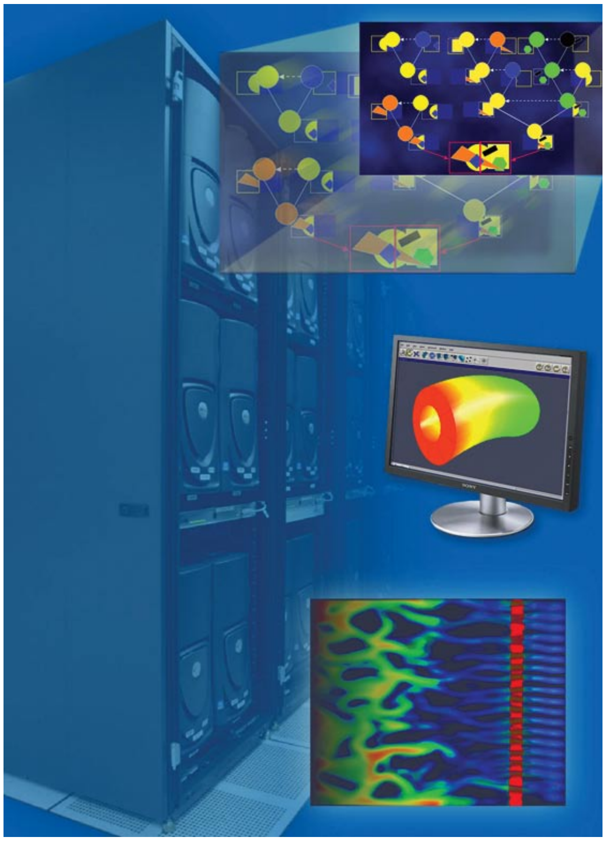
This sub-program provides both necessary physical facility and operational support for reliable production computing and storage environments as well as a suite of user services for effective use of ASC tri-lab computing resources. The scope of the facility operations includes: planning, integration and deployment; continuing product support; software license and maintenance fees; procurement of operational equipment and media; quality and reliability activities; and collaborations. Facility Operations also covers physical space, power and other utility infrastructure, and LAN/WAN networking for local and remote access, as well as requisite system administration, cyber-security and operations services for ongoing support and addressing system problems. Industrial and academic collaborations are an important part of this sub-program.

The scope of the User Support function includes planning, development, integration and deployment, continuing product support, and quality and reliability activities collaborations. Projects and technologies include computer center hotline and help-desk services, account management, Web-based system documentation, system status information tools, user training, trouble-ticketing systems, and application analyst support.

The designers, analysts, and code developers of the Nuclear Weapons Complex provide functional and operational computational requirements.

Associated strategies for FOUS include:

- Providing continuous and reliable operation and support of production computing systems and all required infrastructure to support these systems on a 24 hours a day, 7 days a week basis. The emphasis is on providing efficient production quality support of stable systems.
- Ensuring that the physical plant has sufficient resources (such as space, power, cooling) to support future computing systems.
- Providing the authentication and authorization services used by applications for the purposes of remote access and data movement across ASC sites.



6. An illustration of ParaView technology. Sandia has enhanced ParaView with substantial capabilities such as a highly scalable tool that delivers multiplicative graphics power of visualization cluster machines. (Courtesy: Sandia National Laboratories.)

- Developing and maintaining a wide-area infrastructure (links and services) that enables distant users to operate on remote computing resources as if they were local (to the extent possible).
- Enabling remote access to ASC applications, data, and computing resources to support computational needs at the plants.
- Operating highly reliable, available, and secure laboratory ASC computers and support integration of new systems.
- Providing analysis and software environment development and support for laboratory ASC computers.
- Providing user services and help desks for laboratory ASC computers.

X. Integration

Continual collaboration among ASC, Campaigns, and DSW is a major strength of the SSP. Joint efforts in software development, code verification and validation, and tool-suite application are good examples of this collaboration.

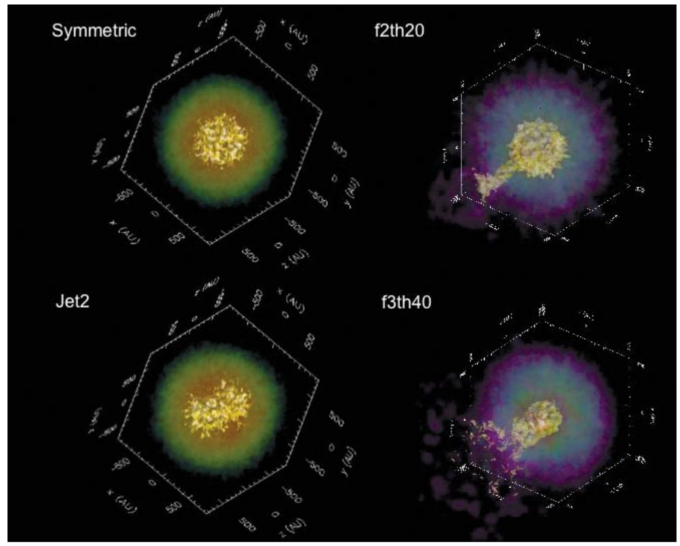
- *Software Development* – ASC code project requirements and priorities are negotiated with designers, via specific tasks and schedules, to meet DSW needs and thereby accommodate weapons systems' modifications as part of the SLEPs.
- *Code Verification and Validation* – The verification and validation of ASC codes is conducted by ASC in partnership with DSW as part of the formal stockpile stewardship V&V process. Experiments to address specific weapons issues are used to validate codes. Codes are also verified against idealized scenarios with known solutions. This process is part of an evolutionary delivery life cycle for the ASC codes, whereby increasingly predictive codes are delivered to DSW users and formally assessed by V&V teams on a regular basis.
- *Tool-Suite Application* – Weapons designers use the ASC simulation and modeling tool suite to assess unresolved surveillance SFIs by using 3-D simulations and new numerical techniques in the ASC simulation codes. These capabilities are vital to SLEP activities because they provide simulation and modeling tools needed to certify the performance, safety, and reliability of aging or refurbished nuclear weapons. There are many examples of these activities:
  - LANL, LLNL, and SNL are using the ASC tools and technologies to address physics and engineering issues associated with the W88, W76, W78, B61, and W80.
  - SNL was able to reduce the number of development tests in a stockpile-engineering product because of the high confidence in validated ASC simulations. This reduction in development tests allowed acceleration of the development schedule and an improved allocation of existing resources.
  - ASC simulations and tools are being used to refine and optimize casting and manufacturing processes for systems such as the W88 and B61. As a result of collaborative efforts with manufacturing experts and a strong V&V process, increased confidence in casting simulations has resulted in improved mold designs and manufacturing processes.

Integration with Directed Stockpile Work

Coordination between ASC and DSW is a significant aspect of redesign studies, during which modifications are made to a system, and models must be incorporated into the codes that account for changing parameters or system specifications. Simulations are also needed to model previous manufacturing processes for weapons components and to define new, cost-effective, safe, and environmentally compliant manufacturing processes that will allow consistent nuclear weapons safety, security, and reliability in the future.

Integration with Defense Programs' (DP) Science and Engineering Campaigns

The development of predictive capabilities relies on a strong experimental program to support the assessment of stockpile issues and to provide physics and materials data needed to validate new scientific models and theories incorporated into the simulation codes. Science and Engineering Campaigns provide crucial experimental data needed to support SSP activities. In the previous era of test-based confidence, experimental programs provided direct answers about the safety, security, and reliability of the stockpile. In the current era, the focus has shifted to a simulation-based confidence, which requires a close connection between ASC and the Science Campaigns. Using facilities such as the National Ignition Facility at Lawrence Livermore, the Dual Axis Radiographic Hydrodynamic Testing (DARHT) Facility at Los Alamos, and the Microsystems and Engineering Sciences Applications (MESA) Facility at Sandia, the Science Campaigns produce significant quantities of high-quality physics data. Working together with the Science Campaigns, ASC simulation tools are employed in the design of experiments. These experimental programs provide ASC with the data necessary to validate (evaluate and improve) the physics models required to better characterize weapons performance and aging.



7. Computerized explosion simulation showing nickel isosurfaces. (Courtesy: Los Alamos National Laboratory.)

Integration with the Department of Energy (DOE) Office of Science and Other Government Agencies

Certain technical problems that arise in terascale computing are universal to scientific simulation and apply equally well to applications within the NNSA, DOE's Office of Science, and other government agencies such as the National Security Agency (NSA), Department of Defense (DoD), and Defense Advanced Research Projects Agency (DARPA). This includes I/O and archival management of large scientific data sets, the analysis and visualization of petabyte data sets, the operating systems for high-performance computing, and mathematical algorithms and software for solving complex problems.

While there are significant differences in the detailed nature of the scientific problems addressed, there is still much to be gained by exploiting the natural synergy between the high-performance computing goals and objectives of ASC and those of other such governmental programs. Accordingly, ASC is collaborating with these other agencies to identify areas of common interest and to establish appropriate coordination of efforts.

XI. Risk Management

Risk management is a process for identifying and analyzing risks, executing mitigation and contingency planning to minimize potential consequences of identified risks, and monitoring and communicating up-to-date information about risk issues. Risk management is about identifying opportunities and avoiding losses. A "risk" is defined as (1) a future event, action, or condition that might prevent the successful execution of strategies or achievement of technical or business objectives and (2) the risk-exposure level, defined by the likelihood or probability that an event, action, or condition will occur, and the consequences if that event, action, or condition does occur. Table 2 summarizes ASC's top ten risks, which are managed and tracked.

Table 2. ASC Top 10 Risks

No.	Risk Description	Risk Assessment			Mitigation Approach
		Consequence	*Likelihood*	*Risk Exposure*	
1	Compute resources are insufficient to meet capacity and capability needs of designers, analysts, DSW, or other Campaigns.	High	High	**HIGH**	Integrate program planning with DSW and other Campaigns to ensure that requirements for computing are understood and appropriately set; maintain emphasis on platform strategy as a central element of the program; pursue plans for additional and cost-effective capacity platforms.
2	Designers, analysts, DSW, or other Campaign programs lack confidence in ASC codes or models for application to certification/qualification.	Very High	Low	**MEDIUM**	Maintain program emphasis on V&V; integrate program planning with DSW and other Campaigns to ensure requirements needed for certification/ qualification are properly set and met; maintain strong PEM program.
3	Inability to respond effectively with modeling & simulation (M&S) capability and expertise in support of stockpile requirements—near or long term, planned or unplanned (SLEP, SFIs, etc.).	Very High	Low	**MEDIUM**	Integrate program planning, particularly technical investment priority, with DSW and other Campaign programs to ensure that capability and expertise are developed in most appropriate areas; retain ability to apply legacy tools, codes, models.
4	Base of personnel with requisite skills, knowledge, and abilities erodes.	High	Low	**MEDIUM**	Maintain emphasis on "best and brightest" personnel base, with Institutes, research foundations, and university programs, as central feeder elements of the program.
5	Advanced material model development more difficult, takes longer than expected.	Moderate	High	**MEDIUM**	Increase support to physics research; pursue plans for additional computing capability for physics model development; maintain strong PEM program.
6	Data not available for input to new physics models or for model validation.	High	Moderate	**MEDIUM**	Work with Science and Engineering Campaigns to obtain needed data; propose relevant experiments.
7	Infrastructure resources are insufficient to meet designer, analyst, DSW, or other Campaign program needs.	High	Low	**MEDIUM**	Integrate program planning with DSW and other Campaigns to ensure that requirements for computing are understood and appropriately set; maintain emphasis on system view of infrastructure and CSSE strategy as central elements of the program.
8	External regulatory requirements delay program deliverables by diverting resources to extensive compliance-related activities.	Moderate	Low	**MEDIUM**	Work with external regulatory bodies to ensure that they understand NNSA's mission, ASC's mission, and the processes to set and align requirements and deliverables consistent with applicable regulations.
9	Inadequate ASC computational environment impedes development and use of advanced applications on ASC platforms.	Moderate	Very Low	**LOW**	Integrate planning between program elements to anticipate application requirements and prioritize CSSE development and implementation.
10	Fundamental flaws discovered in numerical algorithms used in advanced applications require major changes to application development.	Moderate	Very Low	**LOW**	Anticipate or resolve algorithm issues through technical interactions on algorithm research through the institutes, ASC Centers, and academia and focus on test problem comparisons as part of software development process.

XII. Program Funding

ASC funding is allocated to cover people, hardware, and contract costs incurred by the ASC divisions.

The budget is reported and analyzed monthly by ASC's laboratory resource analysts and by laboratory management. Funding and costs are tracked and reported at the program element level using DP's Budget and Reporting (B&R) classification codes and Financial Information System. These tracking systems are extended in greater detail down to the level of individual projects.

XIII. Revision

This is a revision of the FY05 ASC Program Plan (NA-ASC-101R-04-Vol.1-Rev.0), which was completely rewritten in accordance with the 2003 guidance established by DP's Implementer Team.

Program changes (that affect cost, schedule, and scope) discussed in this year's program plan are managed in accordance with clarified roles of Federal and laboratory managers.[9] In general, federal managers prioritize the elements of the national program, allocate the resources at the Level 3 sub-program level and resource-load at the Level 4 products; and monitor and evaluate the scope and execution of the program. Laboratory managers develop and execute technical projects. They are responsible for maintaining the Level 3 sub-program budgets, as allocated by HQ; and manage the scope, schedule, and budget of their individual projects, as described in *ASC Implementation Plan*.

[9] "Role of the Federal and Laboratory Program Managers," ASC Business Model, NA-ASC-104R-05-Vol. 1-Rev.5

Appendices

Appendices

Appendix A

NA-10 Level 1 Milestones

Table A-1 lists NA-10 Level 1 milestones for FY 2004–2013. ASC Level 1 milestones are highlighted in this table. The second part of this appendix lists all ASC Level 1 milestones prior to FY 2004.

Table A-1. NA-10 Level 1 Milestones

No.	Affinity Grouping	Milestone	Responsibility	Date Qx FYxx (M/YY)	Sub-program	Associated DP Priority
M1 M2 M3 M4 M5 M6	DSW Production	Meet the delivery requirements established by the P&PD with particular emphasis on meeting established joint DoD and NNSA commitments in accordance with the Directive Schedule.	Plants, SNL LANL, LLNL	Q4 FY04 (9/04) Q4 FY05 (9/05) Q4 FY06 (9/06) Q4 FY07 (9/07) Q4 FY08 (9/08) Q4 FY09 (9/09)	DSW	1, 2, 9
M7 M8 M9 M10 M11 M12	Construction & Infrastructure	Annually, prepare and execute an integrated, comprehensive RTBF/Facility and Infrastructure Recapitalization Program (FIRP) plan consistent with the Nuclear Weapons Complex Enterprise Strategy to ensure a flexible, responsive, robust infrastructure.	All Labs & Plants	Q4 FY04 (9/04) Q4 FY05 (9/05) Q4 FY06 (9/06) Q4 FY07 (9/07) Q4 FY08 (9/08) Q4 FY09 (9/09)	RTBF	10, 9
M13 M14 M15 M16 M17 M18	Certification	Annually, assess the safety, security, and reliability of the stockpile and provide the required assessments of certification and reports to the Secretary for submission to the President.	LANL, LLNL, SNL	Q2 FY04 (1/04) Q2 FY05 (1/05) Q2 FY06 (1/06) Q2 FY07 (1/07) Q2 FY08 (1/08) Q2 FY09 (1/09)	DSW	2
M19	Science & Engineering	Develop a resource-loaded plan for conducting DyNex experiments, including acquisition or manufacture of necessary materials, to support a decision by NA-10 whether to proceed.	LANL	Q2 FY04 (3/04)	Primary Certification	6
M20	LEPs	Complete the life-extension refurbishment of the W87.	LLNL, Plants	Q3 FY04 (4/04)	DSW	5
M21	Science & Engineering	DARHT dual axis multi-pulse radiographic capability available to the National Hydrotest Program.	LANL, LLNL	Q4 FY04 (9/04)	Advanced Radiography	3
M22	ICF	Complete the first stewardship experiment on NIF.	LLNL, LANL, SNL	Q4 FY04 (9/04)	ICF	3
M23	National Priorities	Define and begin implementation of a framework for developing advanced warhead concepts, including completion of 6.2/2a RNEP, to support the Nuclear Posture Review and the emerging needs of the DoD.	LANL, LLNL, SNL	Q4 FY05 (9/05)	DSW	4

No.	Affinity Grouping	Milestone	Responsibility	Date Qx FYxx (M/YY)	Sub-program	Associated DP Priority
M24	National Priorities	Complete transition to and maintain the capability to conduct underground nuclear testing within 18 months of the President's decision to conduct testing.	NV-BN LANL, SNL, LLNL	Q4 FY05 (9/05)	Primary Certification	8
M25	Science & Engineering	Complete and execute a full year of hydro tests as documented in the National Hydrotest Plan.	LANL, LLNL	Q1 FY06 (12/05)	Primary Certification	3
M26	ASC	Document the requirements to move beyond a 100TF ASC computing platform to a petaflop platform.	LANL, LLNL, SNL	Q1 FY05 (12/04) COMPLETED	ASC	3
M27	Science & Engineering	Provide pit lifetime estimates based on plutonium-spiked alloy.	LLNL, SNL	Q4 FY06 (9/06)	Enhanced Surveillance	5
M28	LEPs	Complete certification of a B61 warhead with quantified design margins and uncertainties.	LANL, SNL	Q4 FY06 (9/06)	DSW	5
M29	LEPs	Complete the life extension refurbishment of the first production unit for the B61 in accordance with the approved project baseline.	LANL, SNL, Plants	Q3 FY06 (6/06)	DSW	5
M30	Pits	Provide design, research and development, and documentation to support system requirements, and alternatives for CD-1 approval on the Modern Pit Facility.	HQ	Q2 FY07 (2/07)	Pit Certification & Manufacturing	6
M31	LEPs	Complete certification of a W80-3 warhead with quantified design margins and uncertainties.	LLNL, SNL	Q3 FY07 (3/07)	DSW	5
M32	LEPs	Complete the life-extension refurbishment of the first production unit for the W80-3 in accordance with the approved project baseline.	LLNL, SNL, Plants	Q3 FY07 (4/07)	DSW	5
M33	ASC	Deliver advanced ASC physics and engineering simulation capabilities to support the W76 and the W80 LEP/ certification[10]	LANL, LLNL, SNL	Q4 FY06 (6/06)	ASC	3
M34	ASC	Develop a 100 teraOPS platform environment supporting to the tri-lab DSW & Campaign simulation requirements.	LLNL	Q1 FY07 (12/06)	ASC	3
M35	ICF	Complete the first ZR stewardship experiment.	SNL	Q3 FY07 (6/07)	ICF	3
M36	LEPs	Complete certification of a W76-1 warhead with quantified design margins and uncertainties.	LANL, SNL	Q4 FY07 (9/07)	DSW	5

[10]The milestone's wording was revised on 6/05.

No.	Affinity Grouping	Milestone	Responsibility	Date Qx FYxx (M/YY)	Sub-program	Associated DP Priority
M37	LEPs	Complete the life-extension refurbishment of the first production unit for the W76-1 in accordance with the approved project baseline.	LANL, SNL, Plants	Q4 FY07 (9/07)	DSW	5
M38	Pits	Certification of a W88 warhead with a LANL- manufactured pit using quantification of margins and uncertainties.	LANL	Q4 FY07 (9/07)	Pit Certification & Manufacturing	6
M39	Pits	Begin type 126 pit manufacturing capability at ten pits per year.	LANL	Q4 FY07 (9/07)	Pit Certification & Manufacturing	6
M40	Construction & Infrastructure	Complete the key requirements for CD4 approval of MESA.	SNL	Q2 FY10 (4/10)	Engineering Campaigns	7,1,3
M41	ICF	CD4 approval to begin NIF operations.	LLNL	Q4 FY08 (9/08)	ICF	7
M42	Construction & Infrastructure	Complete the key requirements for CD4 approval on the Tritium Extraction Facility.	SRS	Q4 FY08 (9/08)	Tritium Readiness	7,1
M43	National Priorities	Irradiated Tritium Producing Burnable Absorber Bar (TPBAR) delivered to the Tritium Extraction Facility.	SRS	Q4 FY08 (9/08)	Tritium Readiness	7,1
M44	ASC	Complete modern baseline of all enduring stockpile systems with ASC codes.	LANL, LLNL, SNL	Q4 FY09 (9/09)	ASC	3
M45	ICF	Commence indirect-drive ignition experiments on the NIF.	LANL, LLNL, SNL	Q1 FY13 (12/12)	ICF	3

ASC's Previous Level 1 Milestones

Previous ASC milestones (prior to FY 2004) are identified with an ID label, the quarter in which they were to be completed, and a title. The ID label identifies the milestone, as seen in this example: "NA-0.1" is the first (".1") milestone to be completed in the area of Nuclear Applications ("NA") in the year 2000 ("0").

Nuclear Applications

NA-0.1 FY00 Q1	Three-dimensional primary-burn prototype simulation
NA-0.2 FY00 Q4	Three-dimensional prototype radiation-flow simulation
NA-1.1 FY01 Q1	Three-dimensional secondary-burn prototype simulation
NA-2.1 FY02 Q1	Three-dimensional prototype full-system coupled simulation
NA-3.1 FY03 Q1	Enhanced primary physics initial capability
NA-3.2 FY03 Q1	Focused secondary physics capability at LLNL

Nuclear Safety

NS-2.1 FY02 Q4	Three-dimensional safety simulation of a complex abnormal explosive-initiation scenario
NS-3.1 FY03 Q2	Nuclear safety simulation of a complex abnormal explosive-initiation scenario

Nonnuclear Applications

NN-0.1 FY00 Q2	Three-dimensional prototype hostile-environment simulation
NN-0.2 FY00 Q4	Architecture for coupled mechanics running at all NWC sites
NN-1.1 FY01 Q4	Mechanics for normal environments
NN-2.1 FY02 Q4	STS abnormal environment prototype simulation for crashes and burns events
NN-3.1 FY03 Q4	STS hostile environment simulation for cable SGEMP and electrical response to x-rays

Verification and Validation

VV-1.1 FY01 Q1	Establish and deploy a common set of acceptable software engineering practices applicable to all advanced application-development activities
VV-1.2 FY01 Q2	Demonstrate initial validation methodology on the then-current state of application modeling of early-time primary behavior
VV-2.1 FY02 Q4	Demonstrate initial validation methodology of the then-current state of ASCI code modeling for normal and abnormal STS environments behavior

Physics and Materials Modeling (Predecessor Materials & Physics Modeling)

PM-2.1 FY02 Q2	Microstructure-level shock response of PZT 95/5
PM-2.2 FY02 Q4	Delivery of initial macro-scale reactive flow model for high-explosive detonation derived from grain scale dynamics
PM-3.1 FY03 Q4	Meso-scale model for corrosion of electrical components
	Simulation and Computer Science
SC-3.1 FY03 Q4	User environment for the Q platform at LANL

Data and Visualization Sciences (DVS) (Predecessor: VIEWS)

VU-0.1 FY00 Q1	Prototype system that allows weapons analysts to see and understand results from three-dimensional prototype primary-burn simulations

PSE

PS-1.1 FY01 Q1	Initial software development environment extended to the 10-teraOPS system

DisCom

DC-1.1 FY01 Q2	Distance-computing environment available for use on the 10-teraOPS ASCI system

Physical Infrastructure and Platforms

PP-0.1 FY00 Q3	10-teraOPS system (White), final delivery and checkout
PP-2.1 FY02 Q3	20-teraOPS system (Q), final delivery and checkout

Appendix B

Performance Measures

Table B-1. ASC Performance Measures for FY 2004–2010

Goal: Provides leading edge, high-end simulation capabilities to meet weapons assessment and certification requirements, including weapon codes, weapon science, platforms, and computer facilities.

INDICATOR	ANNUAL TARGETS							ENDPOINT TARGET DATE
	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	
Peer-reviewed progress in completing milestones (according to target dates) in the development and implementation of improved models and methods into integrated weapon codes and deployment to their users. (Long-term Output.) Panel Criteria: (1) Delivery & implementation of validated models into code projects and (2) Documented verification of approximations.	High-Fidelity Primary Code	Initial baseline Primary Code	Initial validated simulation code for W76 and W80	W80 code baseline	Conduct modern baseline of all enduring stockpile systems	Complete modern baseline of all enduring stockpile systems	Quantify margins & uncertain-ties of modern baseline simulations	By 2015, accom-plish full transition from legacy design codes to modern ASC codes with documented quan-tification of margins and uncertainties of simulation solutions.
Cumulative percentage of the 31 weapon system components, primary/sec-ondary/engineering system, analyzed using ASC codes, as part of annual assess-ments & certifications. (Long-term Output.)	32%	38%	51%	67%	87%	96%	100%	By 2010, analyze 100% of 31 weapon system components using ASC codes, as part of annual assessments & cer-tifications (interim target).
The maximum individual platform computing capabil-ity delivered, measured in trillions of operations per second (teraOPS). (Long-term Output.)	40	100	100	150	150	350	350	BY 2009, deliver a maximum individual platform computing capability of 350 teraOPS.
Total capacity of ASC pro-duction platforms attained, measured in teraOPS, taking into consideration procurements & retirements of systems. (Long-term Output.)	75	172	160	310	420	930	930	By 2009, attain a total production platform capacity of 930 teraOPS.
Average cost per teraOPS of delivering, operating, & managing all Stockpile Stewardship Program (SSP) production systems in a given fiscal year. (Efficiency Measure.)	$8.15M	$5.7M	$3.99M	$2.79M	$1.96M	$1.37M	$0.96M	By 2010, attain an average cost of $0.96 M per teraOPS of deliver-ing, operating, & managing all SSP production systems.

Appendix C

ASC Risk Management Process

Risk management is a process for identifying and analyzing risks, encouraging mitigation and contingency planning to minimize potential consequences of identified risks, and monitoring and communicating up-to-date information about risk issues. Risk management is about identifying opportunities and avoiding losses.

A "risk" is defined as (1) a future event, action, or condition that might prevent the successful execution of strategies or achievement of technical or business objectives and (2) the risk-exposure level, defined by the likelihood or probability that an event, action, or condition will occur and the consequences if that event, action, or condition does occur.

ASC risk management consists of three major components: Assessment, Handling/Mitigation, and Tracking.

Risk Assessment

Risk assessment involves identification, analysis, and mitigation/contingency planning. The objective of risk assessment is to prioritize risks so that management may focus efforts on mitigating top risk items (Table C-1 and Table C-2). There are five different ASC risk types: Programmatic, Technical, Cost, Schedule, and Performance.

Risk Handling/Mitigation

Risk handling/mitigation is proactively undertaken to lessen consequence or likelihood and/or to develop contingency actions if risk issues develop (Table C-3). There are four different risk-handling methods: Avoidance, Control, Assumption, and Risk Transfer.

Risk Tracking

Risk tracking involves tracking the progress and status of mitigation actions and of risks. Risk status and evaluations can be found in Tri-Lab quarterly progress reports, as well as in DP status reports.

Table C-1 on the next page evaluates consequences against cost, performance, and schedule.

- *Cost Risks* – Not enough money at the highest level to do the job required in the time allocated.
- *Performance Risks* – One or more performance requirements may not be met because of technical concerns, or issues of competence, experience, organizational culture, and management team skills.
- *Schedule Risks* – Not enough time exists at the highest level to do the required job with the resources allocated.

Table C-1. Consequence Criteria

Consequence	Criteria
Very Low	**Cost:** Negligible impact on cost. Impact is contained within the strategic unit and results in neither undercosting nor overcosting of spend plan. **Performance:** Negligible impact on function or performance. Requirements are clearly met. **Schedule:** Negligible impact on schedule. Impact is managed within the strategic unit. Results in no impact to critical path and no impact to other strategic units. Milestones are clearly met.
Low	**Cost:** Minor impact on cost. Impact is contained within the strategic unit and results in less than 5% undercosting or less than 5% overcosting of spend plan. **Performance:** Minor impact on function or performance. Requirements are clearly met. **Schedule:** Minor impact on schedule. Impact may be managed within the strategic unit. Results in no impact to critical path and no impact to other strategic units. Milestones are clearly met.
Moderate	**Cost:** Recognizable impact on cost. Impact is not contained within the strategic unit and may result in less than 5% undercosting or greater than 5% overcosting of spend plan. **Performance:** Recognizable impact on function or performance. Requirements may not all be met. **Schedule:** Recognizable impact on schedule. Impact may not be managed within the strategic unit. May result in impact to critical path or may impact other strategic units. Milestones may not be met.
High	**Cost:** Significant impact on cost. Impact is not contained within the strategic unit and may result in less than 10% undercosting or greater than 10% overcosting of spend plan. **Performance:** Significant impact on function or performance. Requirements will not all be met. **Schedule:** Significant impact on schedule. Impact will not be managed within the strategic unit. Will result in impact to critical path or will impact other strategic units. Milestones will not be met.
Very High	**Cost:** Major impact on cost. Impact will not be contained within the strategic unit and will result in less than 10% undercosting or greater than 10% overcosting of spend plan. **Performance:** Major impact on function or performance. Requirements cannot be met. **Schedule:** Major impact on schedule. Impact cannot be managed within the strategic unit. Will result in failure in critical path or will significantly impact other strategic units. Milestones cannot be met.

Table C-2 on the next page evaluates likelihood against programmatic or technical risks.

- *Programmatic Risks* – Refer to tasks that flow from, or have an impact on, program governance, and those risks that impact program performance.
- *Technical Risks* – Refer to performance risks associated with end items.

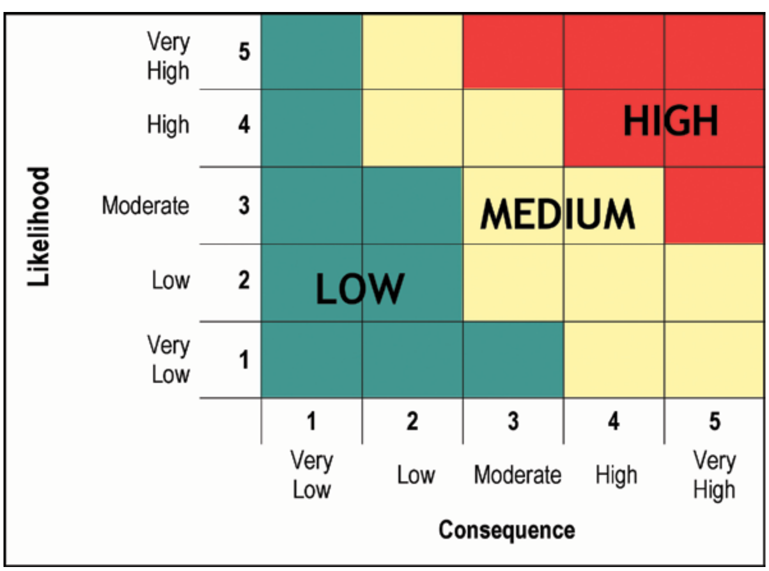
Table C-3 on the next page evaluates risk exposure, based on consequence and likelihood. Different risk-handling methods that relate to this exposure include:

- *Avoidance* – Uses an alternate approach, with no risks, if feasible. This approach can be applied to high and medium risks.
- *Control* – Develops a risk mitigation approach/action and tracks the progress of that risk. This approach is mostly applied to high and medium risks.
- *Assumption* – Accepts the risk and proceeds. This approach is usually applied to low-risk items.
- *Risk Transfer* – Passes the risk to another program element. This approach can be applied to external risks outside the control of the ASC Program.

Table C-2. Likelihood Criteria

Likelihood	Criteria
Very Low	**Programmatic:** No external, environment, safety, and health (ES&H), security, or regulatory issues. Qualified personnel, resources, and facilities are available. **Technical:** Nonchallenging requirements. Simple design or existing design. Few and simple components. Existing technology. Well-developed process.
Low	**Programmatic:** Minor potential for external, ES&H, security, or regulatory issues. Minor redirection of qualified personnel, resources, or facilities modification is necessary. **Technical:** Low requirements challenge. Minor design challenge or minor modification to existing design. Moderate number or complex components. Existing technology with minor modification. Existing process with minor modification.
Moderate	**Programmatic:** Moderate potential for external, ES&H, security, or regulatory issues. Moderate redirection of qualified personnel, resources, or facilities modification is necessary. **Technical:** Moderate requirements challenge with some technical issues. Moderate design challenge or significant modification to existing design. Large number or very complex components. Existing technology with significant modification. Existing process with significant modification.
High	**Programmatic:** Significant potential for external, ES&H, security, or regulatory issues. Significant redirection of qualified personnel, resources, or facilities modification is necessary. **Technical:** Significant requirements challenge with major technical issues. Significant design challenge or major modification to existing design. Large number and very complex components. New technology. New process.
Very High	**Programmatic:** Major potential for external, ES&H, security, or regulatory issues. Major redirection of qualified personnel, resources, or facilities modification is necessary. **Technical:** Major requirements challenge with possibly unsolvable technical issues. Major design challenge or no existing design to modify. Extreme number and extremely complex components. Possibly no technology available. Possibly no process available.

Table C-3. Risk Exposure Level Matrix



The risk-exposure values and the resulting matrix categorize risks as high, medium, or low. When risk exposure is high, a mitigating or contingency plan is required. When risk exposure is medium, a mitigating or contingency plan is recommended. When risk exposure is low, developing a mitigating or contingency plan is optional. Table C-2 details the risk-exposure levels found in Table C-3, describing the risk, its associated risk assessment, and the approach to mitigation.

Appendix D

ASC Management Structure

To ensure successful execution of the ASC strategy, an organizational structure, program-management process, and performance-measurement mechanisms have been instituted within the ASC tri-lab framework.

Organization

ASC's organizational structure is designed to foster a focused, collaborative effort to achieve program objectives. The following elements make up this structure:

- **Executive Committee.** This body consists of a high-level representative from each NNSA laboratory and a senior member in the Advanced Simulation and Computing Office at NNSA Headquarters (HQ). The Executive Committee sets overall policy for ASC, develops programmatic budgets, and oversees the program execution.
- **Sub-Program Management Teams.** These teams are responsible for planning and execution of the implementation plans for each of the ASC sub-programs: Integrated Codes; Physics and Engineering Models; Verification & Validation; Computational Systems and Software Environment; and Facility Operations and User Support. These management teams have a primary and alternate representative from each laboratory, and the corresponding sub-program manager from NNSA-HQ. These teams work through the executive committee. Tasking from NNSA-HQ for these teams originates from the ASC Federal Program Manager and is communicated through the executive committee.
- **ASC's NNSA-HQ Team.** This team consists of NNSA federal employees and contractors, in concert with laboratory and plant representatives. The ASC HQ team is responsible for ensuring that ASC supports the SSP. The team facilitates ASC interactions with other government agencies, the computer industry, and universities. In addition, the team sets programmatic requirements for the laboratories and reviews management and operating contractor performance.

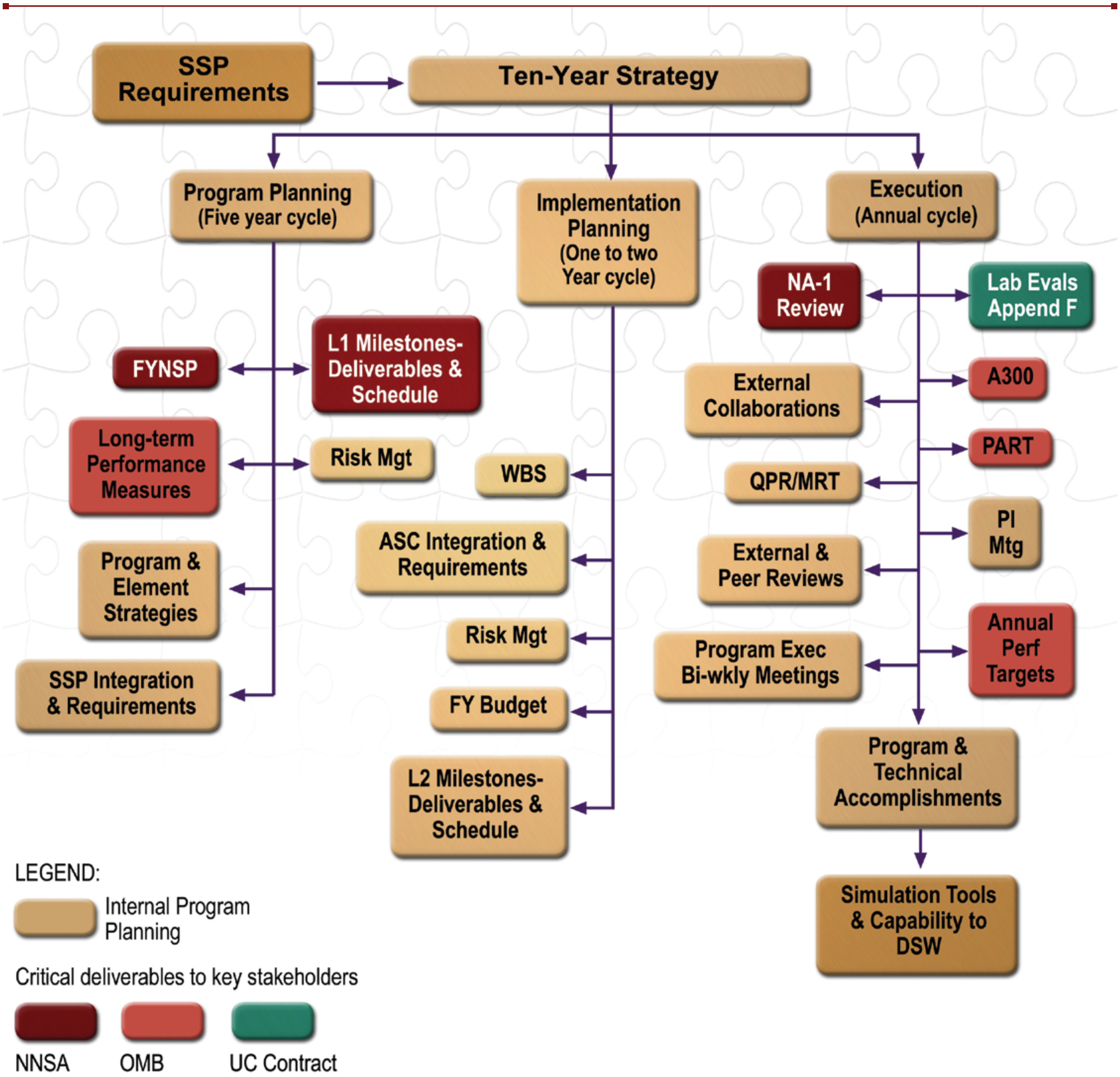
Program Management Planning and Execution Process

ASC program management uses a planning process made up of elements described below (Figure D-1). All planning activities follow the product-focused national work breakdown structure reflected in the Business Model.

- **ASC Program Plan (PP)** – Provides the overall direction and policy for ASC. This functions as a strategic plan, and it identifies key issues and work areas for ASC in the next six years. This document is reviewed annually to ensure that ASC supports SSP needs.
- **ASC Implementation Plan (IP)** – This document is prepared annually and describes the work planned in two-year intervals at each laboratory to support the overall ASC objectives.
- **Program Milestones –** ASC milestones are a subset of NNSA National Level 1 and Level 2 milestones. Level 1 milestones are national priorities or have high visibility at NA-10 or higher levels. They usually require multisite and/or multiprogram coordination, and provide integration across ASC, DSW, and the Campaigns. Level 1 milestones may be specific to ASC or meet other SSP objectives with significant ASC support. Level 2 milestones are designed to execute the ASC strategy, demonstrate the completion of advanced ASC capabilities, and often support ASC Level 1 milestones, DSW deliverables, and/or major Campaign milestones. ASC set requirements for Certification of Completion that constitutes a body of evidence that certifies completion of Level 2 milestones. Level 3 (and below) milestones demonstrate the completion of important capabilities within a program element and measure technical progress at the subprogram level; these milestones are laboratory specific and are managed by the laboratories. Progress on Level 1 and Level 2 milestones is recorded in the NNSA Milestones Reporting Tool (MRT) and is reported quarterly to the Defense Program Director (NA-10) via the Quarterly Program Reviews (QPR) meetings and annually to the NNSA administrator (NA-1) via the annual technical review meetings.

- **Program Collaboration Meetings** – The following meetings facilitate collaboration among the three national laboratories, industry, and universities:
  - *Principal Investigator Meetings.* These annual meetings provide a forum for ASC principal investigators to meet and discuss progress in their respective research areas. These meetings allow principal investigators at each laboratory to present and discuss their work with their peers at the other laboratories. In addition, the meetings include participants from outside the weapons laboratories in order to provide broader ASC peer review. The meetings also serve as an annual technical review for the DOE-HQ team.
  - *Executive Committee Meetings.* The ASC Executive Committee meets twice a month, via teleconference. These meetings ensure that relevant issues are identified, discussed, and resolved in a timely manner. The teleconferences are supplemented with quarterly face-to-face meetings.
  - *Sub-Program Meetings.* ASC program element teams conduct individual meetings to discuss progress, issues, and actions. The frequency of these meetings depends on the discretion of the ASC HQ program manager and his/her counterparts at the laboratories. These meetings identify issues that need to be elevated to the Executive Committee.
- **Reviews**
  - *External Reviews.* External reviews are conducted regularly by the laboratories to provide independent, critical insight to the laboratories on the technical progress of the ASC Program. The review panels consist of experts from academia, industry, and the national laboratories. Results of the reviews are provided to the laboratories and ASC HQ observers. These reviews augment other high-level reviews by laboratory, University of California, and Lockheed Martin review committees.
  - *Internal Program Reviews.* Program reviews are organized at various levels to provide adequate assessment and evaluation of the ASC program elements. Each laboratory and each program element determines the scope and nature of the review as well as the form of reporting the results of such reviews that best suits its needs.
- **Performance Measurement**
  - This includes performance indicators and annual performance targets, established to annually measure the successful execution of the program (see Appendix B). Laboratory managers are responsible for measuring and managing the performance of the projects within their purview. Each laboratory reports quarterly performance to NNSA in the form of accomplishments and progress toward Level 1 and 2 milestones.

Figure D-1. ASC Program Planning and Evaluation Activities



Appendix E

Glossary

Advanced Applications
Element of DAM program area that provides physics and geometric fidelity for weapons simulations.

Advanced Architectures
An ASC program element that is focused on development of more effective architectures for high-end simulation and computing.

ASC
Advanced Simulation and Computing Program. This program evolved from merging of the Accelerated Strategic Computing Initiative and the Stockpile Computing Program. The use of the acronym "ASCI" has been discontinued.

ASC Red Storm
A 40-teraOPS system, located at SNL, delivered in FY 2004.

ASCI
Accelerated Strategic Computing Initiative

ASCI Blue Mountain
A Silicon Graphics, Inc. (SGI) system located at LANL. In 1998, ASCI Blue Mountain was installed as a 3.072-teraOPS computer system.

ASCI Blue Pacific
An IBM system located at LLNL. In 1998, ASCI Blue Pacific was installed as a 3.89-teraOPS computer system.

ASCI Red
An Intel system located at SNL. ASC Red was the first teraOPS platform in the world when it was installed in 1998 (1.872 teraOPS). Processor and memory upgrades in 1999 converted ASCI Red to a 3.15-teraOPS platform.

ASCI Q
A Compaq, now Hewlett-Packard (HP), system located at LANL. ASCI Q is a 20-teraOPS computer system, delivered in FY 2003.

ASCI White
An IBM system located at LLNL. In 2000, ASCI White was installed as a 12.3-teraOPS supercomputer system.

B&R
DP budget and reporting classification codes.

Campaigns
An organization of SSP activities focused on scientific and engineering aspects that address critical capabilities, tools, computations, and experiments needed to achieve weapons stockpile certification, manufacturing, and refurbishment now and in the future, in the absence of nuclear testing.

capability/capacity systems
Terminology used to distinguish between systems that can run the most demanding single problems versus systems that manage aggregate throughput for many simultaneous smaller problems.

DARHT
The Dual Axis Radiographic Hydrodynamic Test Facility at LANL will examine implosions from two different axes.

DoD
U.S. Department of Defense

DOE
U.S. Department of Energy

DP
Defense Programs, one of the three major programmatic elements in NNSA.

DSW
Directed Stockpile Work, those SSP activities that directly support the day-to-day work associated with the refurbishment and certification of specific weapons in the nuclear stockpile.

EOS
Equation-of-state

ES&H
Environment, safety, and health

FY
Fiscal Year. The U.S. Government's fiscal year runs from October 1 through September 30.

IC
Integrated Codes

I/O
Input/output

LANL
Los Alamos National Laboratory, a prime contractor for NNSA, located in Los Alamos, New Mexico, and operated by the University of California.

LCD
Liquid crystal display monitor

LEP
Life Extension Program

LLNL
Lawrence Livermore National Laboratory, a prime contractor for NNSA, located in Livermore, California, and operated by the University of California.

NPR
Nuclear Posture Review

M&S
Modeling and simulation capability

MESA
Microsystems and Engineering Sciences Application Facility, scheduled for construction at SNL/NM, will provide the design environment for nonnuclear components of a nuclear weapon.

NIF
National Ignition Facility

NNSA
National Nuclear Security Administration, a semi-autonomous agency within DOE

nWBS
national work breakdown structure

petabyte
1015 bytes; 1,024 terabytes

petaflops
See PetaOPS

PetaOPS
1000 trillion floating-point operations per second. PetaOPS is a measure of the performance of a computer.

PP
Program Plan

PZT
Lead zirconate titanate

QMU
Qualification of margins and uncertainties

R&D
Research and development

science-based
The effort to increase understanding of the basic phenomena associated with nuclear weapons, to provide better predictive understanding of the safety and reliability of weapons, and to ensure a strong scientific and technical basis for future U.S. nuclear weapons policy objectives.

SFI
Significant Finding Investigation. An SFI results from the discovery of some apparent anomaly with the enduring stockpile. DSW Surveillance generally initiates an SFI. For complex SFIs, resolution comes from the Assessment & Certification element of DSW, often in partnership with ASC capabilities.

SLEP
Stockpile Life Extension Program. SLEP is the DP element responsible for planning and execution of component and weapons refurbishments.

SNL
Sandia National Laboratories, a prime contractor for NNSA with locations primarily in Albuquerque, New Mexico, and Livermore, California. Operated by Lockheed Martin Corporation.

SSP
Stockpile Stewardship Program, DP's response to ensuring the safety, performance, and reliability of the U.S. nuclear stockpile.

STS
Stockpile-to-target sequence, a complete description of the electrical, mechanical, and thermal environment in which a weapon must operate, from storage through delivery to a target.

terabyte
Trillions of bytes, abbreviated TB, often used to designate the memory or disk capacity of ASC supercomputers. A byte is eight bits (binary digit, 0 or 1) and holds one ASCII character (ASCII—the American Standard Code for Information Interchange). For comparison, the book collection of the Library of Congress has been estimated to contain about 20 terabytes of information.

teraflops
See teraOPS.

teraOPS
Trillion floating-point operations per second. TeraOPS is a measure of the performance of a computer.

test-based
The traditional approach used for the development of nuclear weapons, based on full-scale nuclear tests.

tri-lab
Refers to the three NNSA laboratories: LLNL, LANL, and SNL.

V&V
Verification and Validation. Verification is the process of confirming that a computer code correctly implements the algorithms that were intended. Validation is the process of confirming that the predictions of a code adequately represent measured physical phenomena.

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.