NIF Project Office Submission to DOE
Level 1& 2 Baseline Change Control Boards

TAB 1

TAB 2

TAB 3

TAB 4

TABS

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August 31, 2000

Baseline Change Proposal

Construction Project Data Sheet

Summary' **of Project Risk**

Project Execution Plan

Cost and Schedule Crosswalk

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BCP No. 00-015

Title:

Change Priority
.Routine 0 Priority

NIF Project Data Sheet Update for Rebaseline Cost and Schedule

BCCB Level
.Level 0 0 Levell 0 Leve12

0 Leve13 0 Leve14

Change Description and Justification:

0 SCODe

S~bmitted by: **Edward** Moses ~'cL Phone: 3-9624

Directed
0 Yes
.No

Change?

.Schedule

.Cost

BCP 00-015 modifies the NIF Project Data Sheet to reflect the rebaseline of the National Ignition Facility (NIP). The rebaseline process resulted in an increase of $1050M for a revised Total Project Cost (TPC) $2248M and delay of project completion from October 2004 to September 2008. There were no scope changes; the NIF Functional Requirements and Primary Criteria remain as approved ii1 BCP 97-004.
The new NIF baseline cost and schedule conform to the annual budgJet profile contained in the Secretary of Energy's Budget Amendment to Congress dated June 27, 2000 which provides for additional funding (over the President's budget requests) of: $95 million in fiscal year 2001; no more than $150 million in fiscal year 2002 and fiscal year 2003; $140 million in fiscal year 2004; $130 million in fiscal year 2005; and required funding thereafter to meet the 2008 completion date.

NIF Baseline Discussion
In June 1999, the NIP was found to have significant cost and schedul~ problems. These problems are attributable to two main causes:
1) The original contingency factor of 12% on Total Project Cost I(TPC) and 15% on Total Estimated Cost (TEC) was too low;
2) The complexity of the beampath infrastructure design and ~e necessity to assemble and install the laser system in a clean environment were not fully apprecia~d, and as a result, the cost and schedule associated with this scope were seriously underestimated in Ithe original baseline.
As a result of this Defense Programs directed the NIP Project to devqlop a new baseline cost and schedule plan. The resulting plan, once approved by DOE, will be delivered t<j> Congress by the Secretary of Energy as required by Conference Report (106-336).
To ensure that the Project plan is comprehensive and executable, DqE arranged for outside scientific and technical reviews of the NIP's remaining technical challenges as they relate to the project's cost and schedule
risk.
Prom October 1999 through August 2000, the NIP Project has gone *ough numerous reviews including: the Secretary of Energy Advisory Board (SEAB) Task Force on the NIP, which held six comprehensive reviews of the NIP over a six month period; the NIP Program Review Committee; the University of California's Presidents Council, the NIP Rebaseline Validation Review (Lehman review).
As a result of recommendations from these reviews a new senior management team has been established at NNSA/Office of Defense Programs (DP) and at LLNL to provide clearer management oversight and lines of authority; contingency has been increased; a formal risk analysis peliformed; industrial firms have been
engaged. r

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These reviews have provided the Department of Energy wifu a high level of confidence that there are "no technical or managerial obstacles that would prevent the completipn of the NIP laser system".

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The proposed NIP baseline is based on bottom-up cost and schedule estimates consistent with the Department's funding profile, which was established to ensure a balanced Stewardship program.
A start-up and commissioning strategy has been developed that all9ws for an activation sequence and concurrent access for Stockpile Stewardship experiments during thel four-year commissioning period of NIP.
The baseline: ~

National Ignition Facil~ty

Baseline Change Proposal

Final

08/28/00

1) Raises the contingency to 26.7% on the go-forward TEC; a level commensurate with DOE guidelines and includes an assessment of risk for each element. ~ contingency is based on a "bottom-up" analysis which include inputs from formal risk analysis, cost estimating uncertainty analysis, allowance for post award change orders, industry standard allocations for conventional construction and project management assessments;
2) Incorporates the results of a comprehensive systems engineering analysis which increased the cost estimates of beampath infrastructure construction and laser special equipment, with lesser increase to optical components, control systems and target systems.
3) Changes the method of accomplishing key implementation activities by transferring that responsibility to experienced industrial firms consistent with the Secretary's directive. An Integration and Management Installation (llvII) contract has been submitted to DOE for approval;
4) Initiates a beam line deployment strategy that allows Stockpile Stewardship experiments to be conducted on NIF at the earliest possible point in the schedule during the commissioning phase.

These actions have resulted in the path forward for the project that increases the total cost of the project by approximately $lbillion and extends the NIP completion date from October 2004 to September 2008.

The proposed baseline cost and schedule have been assessed by independent DOE review teams, (DOE Baseline Validation Review [Lehman Review] and an Independent Cost Review). The preliminary DOE Baseline Validation Review report states, "There are no show stoppers. This project is ready to move on". The recommendation by these teams support the Secretary's certification of the new NIP baseline.

Summary of Baseline Changes

1997 Baseline Estimate Current Estimate

Total Project Cost $1198M $2248M First Light (8 beams) Sep-O1 Jun-O4 12 Bundles (96 beams) Oct-Q3* Jun-O7

Full Facility (192 beams) Oct-O4 Sep-o8*

"Original CD4 called for 96 beam operations with 192 beams installed in October 03. Current CD4 is defined as all 192 beams operational, and is scheduled for September 08.

Summary of Baseline Cost Changes

122.1"1 Baseline Estimate: Base Cost

Contingency

Total

lng~

Base Cost Contingency Total

Proposed TPC:

$1066M

$132M $1198M

$798M* $252M**

$1050M

$2248M

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"The complexity of the beampath infrastructure design and the necessity tq assemble and install the laser system in a clean environment were not fully appreciated, and as a result, the cost and schedule associated- with this scope were seriously underestimated in the original baseline. The total identified increase in the !PC for the associated rebaselin~ (including the impact of stretching project completion to FYOS) is *$79BM.* .

."The original contin~ency factor of 12~Qn !PC and 15% on TEC was too low

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Final

08/28/00

llie_cord **of BCCB Decisions**

Leve14 BCCB Decision
0 Approved
'0 Disapproved
0 Returned for specific data 0 Endorsed and forwarded

Comments / limitations

Approval/endorsement signature

COmments *Ilimi* ta tiol1S

Date

Level 3 BCCB Decision
0 Approved
0 Disapproved
0 Returned for specific data .Endorsed and forwarded

-Ap nt signature Date ~ ~

1. **BCP number: 00-015**

2. Revised NIP Project Datasheet Update for Rebaseline Cost and Schedule

4. **Technical baseline change inputs**

Submitted by: Edward I. Moses Phone#: 3-9624 Fax #: 3-5957

Other technical baseline documents:

0 Primary Criteria 0 System Design Requirements 0 Functional Requirements 0 Interface Control Document

5. **Cost**

Budget analysis

Current TEC: $2,O94.9M
OPC: $153.2M
_____TPC: $2,248.1M

Previously budgeted amount

Project to date 9/30/99 Lien Balance 9/30/99

Note

TEC: *$1044.8M** OPC: $153.2M TPC: $1,198.0M

TPc: TPc:

$661.3M $126.6M

Change to funding profile included: .Yes DNo

*Previously budgeted an'lOunt ~$1045.7M. This was reduced by$0.924M for the FY 2000 rescission enacted by P.L. 106-113.

6. Schedule input: Milestones affected. .Level 0 milestone
.Levell milestone
.Level 2 milestone
.Level 3 milestone

7.ES&H impacts **.None**
0 PSAR/FSAR
0 PEIS
0 QA Program
0 Other documents

Titles

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8. Other impacts (e..g" security, stakeholders) O"! .
While there will be a comple°tion delay from October 2004 to September 2008, the beam line'deployment

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completion of the NIP project.

"~c

Final

96-D-111, National Ignition Facility (NIF), Lawrence Livermore National Laboratory, Livermore, California

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(Changes from FY 2001 Congressional Budget Request are denoted with a vertical line [I] in the left margin.)

Significant Changes

.This revised Construction Project Data Sheet reflects the rebaselining action performed to meet the Secretary of Energy's commitment to provide the new NIP schedule and cost estimate to Congress by September 2000. In this replanning, there are no scope changes; the NIP Functional Requirements/Primary Criteria remain as approved in the Baseline Change Proposal (BCP) 97-004. The changes to the schedule and cost estimate are mainly due to two factors: (1) The original contingency factors of 12% on Total Project cost (TPC) and 15% on Total Estimated Cost (TEC) were too low; (2) the complexity of the beampath infrastructure design and the necessity to assemble and install the laser system in clean environment were not fully appreciated and, as a result, the cost and schedule associated with this scope were seriously underestimated in the original baseline.

.The new NIF baseline

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1. Raises the TEC contingency on the go-forward costs by $252M or 26.7%; a level commensurate with DOE guidelines and includes an assessment of risk for each element. This contingency is based on a "bottom-up" analysis that includes inputs from formal risk analysis, cost estimating uncertainty analysis, allowance for post-award change orders, industry standard allocations for conventional construction, and project management assessments;

.2. Incorporates the results of a comprehensive systems engineering analysis, which increased the cost estimates of beampath infrastructure construction and laser special equipment;
.3. Changes the method of accomplishing key implementation activities by transferring that responsibility to experienced industrial firms consistent with the Secretary's directive. An Integration and Management Installation (IMI) contract has

been submitted to DOE for approval;
.4. Initiates a mission fIrst strategy deployment strategy that maximizes the utility of the NIP for Stockpile Stewardship activities as early as possible during commissioning.
.These actions have resulted in the path forward for the project that increases the total cost of the project from its original TPC estimate of $1.198B to the rebaselined estimate of $2.248B or by approximately $1 billion and extends the NIP completion date from October 2004 to September 2008.

The funding amounts contained in this datasheet confoml to the annual budget profile contained in the letter from the Secretary of Energy to Congress dated June 1,2000. These amounts have been reviewed for project impact and execution during a recently completed rebaselining exercise. The rebaseline cost and schedule estimates have been validated by an independent DOE review team.

.This datasheet changes the presentation of the costs for the National Ignition Facility to include not only the line item construction costs (TEC) and traditional Other Project Costs, but also the other related Operations and Maintenance costs that support NIP. These costs were funded from FY 1995 through FY 2000 within Lawrence Livermore National Laboratory's Inertial Confinement Fusion program. In the FY 2001 Budget Request, the funding is in Readiness in Technical Base and Facilities, and is specifically identified as NIP Operations and NIP Program Facilities and Infrastructure Buildup Activities. The activities supported with this funding are, and always have been, an integral part of the research and development program necessary to accomplish the advances in technology required to complete NIP, the largest and most complex optical unit ever to be designed and constructed. It includes the development of laser and optics technology, as well as the assembly, installation and activation of the Line Replaceable Units (the modules of the laser system) for all beams of NIP. The change from the amoumt assumed at the time of submission of the FY 2001 budget is due to the fact that there will now be research, development and support work associated with NIP through completion of the project in FY 2008. However, this does not represent an overall increase in funding during these years, since there would have been comparable costs for operating NIP from FY 2004 through FY2008.

1. Construction Schedule History

I A-E Work
Initiated

Fiscal Quarter

A-E Work Completed

Physical
Construction
Start

Physical
Construction
Comolete

Total
Estimated
Cost
($000)

Total
Project
Cost ($000)

Other Related
Costs ($000)

Total
Project-
Related
Costs ($000)

FY 1996 Budget Request
(Preliminary Estimate) ... FY 1998 Budget Request
(TitleIBaseline) FY 2000 Budget Request. FY 2001 Budget Request *(Current Baseline Estimate)* FY 2001 Amended Budget Request.

101996

101996
10 1996

101996

1Q 1996

101998

101998 20 1998

20 1998

20 1998

30 **1997**

30 1997 30 1997

30 **1997**

30 1997

30 *2002*

302003 302003

302003

402008

842,600 1,073,600

1,045,700 1,198,900 1,045,700 1,198,900

N/A

N/A N/A

N/A

N/A N/A

1,045,700 1,198,900 833,100 2,032,000 2,094,897 2,248,097 1,200,0008 3,448,097

2. Financial Schedule

(TEC **Funding)**

(dollars in thousands)
Fiscal Year Appropriations Obli ations Costs 1996 37,400 37,400 33,990 1997 131,900 131,900 74,294 1998 197,800 197,800 165,389 1999 284,200 284,200 251,476 2000 247,158b 247,158 240,600 2001 209,100 209,100 308,370 2002 245,000 245,000 254,960 2003 187,200 187,200 196,580 2004 150,000 150,000 136,250 2005 130,000 130,000 128,590 2006 130,000 130,000 130,240 2007 130,000 130,000 145,370 2008

15,139 15,139 28,788

a The Other Related Costs show an increase of $366.9 million. A similar amount would have been spent under the original estimate for operation of the completed facility. Therefore, for fiscal years 2004 to 2008, there is no expected increase in total funding for NIF Other Related Costs. (See Significant Changes for more detail.)

b Original appropriation was $248,100,000. This was reduced by $942,000 for the FY 2000 rescission enacted by P.L. 106-113.

3. Project Description, Justification and Scope

The Project provides for the design, procurement, construction, assembly, and acceptance testing of the National Ignition Facility. The NIP is an experimental inertial confinement fusion facility intended to achieve controlled thermonuclear fusion in the laboratory by imploding a small capsule containing a mixture of the hydrogen isotopes, deuterium and tritium. The NIP is being constructed at the Lawrence Livermore National Laboratory (LLNL), Livermore, California as determined by the Record of Decision made on December 19, 1996, as a part of the Stockpile Stewardship and Management Programmatic Environmental Impact Statement (SSM PElS).

The mission of the National Inertial Confinement Fusion (ICF) program is to execute high energy density physics experiments for the Stockpile Stewardship program, an important part of which is the demonstration of controlled thermonuclear fusion in the laboratory. Technical capabilities provided by the ICF program also contribute to other DOE missions including nuclear weapons effects testing and the development of inertial fusion power. As a key element of the Stockpile Stewardship Program, the NIP is designed to achieve propagating fusion burn and modest (1-10) energy gain within 2-3 years of full operation and to conduct high energy density experiments, both through fusion ignitions and through direct application of the high laser power. This mission was identified in the NIP Justification of Mission Need, which was endorsed by the Secretary of Energy. Identification of target ignition as the next important step in ICF development for both defense and non-defense applications is consistent with the earlier (1990) recommendation of DOE's Fusion Policy Advisory Committee, and the National Academy of Sciences Inertial Fusion Review Group. In 1995, the DOE's Inertial Confinement Fusion Advisory Committee affirmed the program's readiness for an ignition experiment. A review by the JASONs in 1996 affirmed the value of the NIP for stockpile stewardship.

The NIP project supports the DOE mandate to maintain nuclear weapons science expertise required for stewardship of the stockpile. After the United States announcement of a moratorium on underground nuclear tests in 1992, the Department established the Stockpile Stewardship program to ensure the preservation of the core intellectual and technical competencies in nuclear weapons. The NIP is one of the most vital facilities in that program. The NIP will provide the capability to conduct laboratory experiments to address the high energy density and fusion aspects that are important to both primaries and secondaries in stockpile weapons.

At present, the Nation's computational capabilities and scientific knowledge are inadequate to ascertain all of the performance and safety impacts from changes in the nuclear warhead physics packages due to aging, remanufacturing, or engineering and design alterations. Such changes are inevitable if the warheads in the stockpile are retained well into this century, as expected. In the past, the impacts of such changes were evaluated through nuclear weapon tests. Without underground tests, we will require better, more accurate computational capabilities to assure the reliability and safety of the nuclear weapons stockpile for the indefinite future.

To achieve the required level of confidence in our predictive capability, it is essential that we have access to near-weapons conditions in laboratory experiments. The importance of nuclear weapons to our national security requires such confidence. For detonation of weapon primaries, that access is provided

in part by hydrodynamic testing. For secondaries and for some aspects of primary performance, the NIP will be a principal laboratory experimental physics facility. !

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The most significant potential commercial application of ICF in the long term is the generation of electric power. Consistent with the recommendations of the Fusion Policy Advisory Committee, the NIP will provide a unique capability to address critical elements of the inertial fusion energy program by exploring moderate gain (1 -10) target designs, establishing requirements for driver energy and target illumination for high gain targets, and developing materials and technologies useful for civilian inertial fusion power reactors. !

The ignition of an inertial fusion capsule in the laboratory will produce extremely high temperatures and densities in matter. Thus, the NIP will also become a unique and valuable laboratory for experiments relevant to a number of areas of basic science and technology (e.g., stellar phenonena).

The NIF is an experimental fusion facility consisting of a laser and target area, and associated assembly and refurbishment capability. The laser will be capable of providing an output pulse with an energy of 1.8 megajoules (MJ) and an output pulse power of 500 terawatts (TW) at a wavelength of 0.35 micrometers *(JIm)* and with specified symmetry, beam balance and pulse shape. The NIF design is an experimental facility housing a multibeam line, neodymium (Nd) glass laser capable of generating and delivering the pulses to a target chamber. In the target chamber, a positioner will center a target containing fusion fuel, a deuterium-tritium mixture, for each experiment.
The NIF experimental facility, titled the Laser and Target Area Building, will provide an optically stable and clean environment. This Target Area Building will be smelded for radiation confinement around the
target chamber and will be designed as a radiological, low-hazard facility capable of withstanding the natural phenomena specified for the LLNL site. The baseline facility is for one target chamber, but the design shall not preclude future upgrade for additional target chambers.

The NIF project consists of conventional and special facilities.
.Site and Conventional Facilities include the land improvements (e.g., grading, roads) and utilities (electricity, heating gas, water), as well as the laser building, which has an approximately 20,300 square meters footprint and 38,000 square meters in total area. It is a reinforced concrete and structural steel building that provides the vibration-free, shielded, and clean space for the installation of the laser, target area, and integrated control system. The laser building consists of two laser bays, each 31 meters (m) by 135 m long, and a central target area--a heavily shielded (1.8 m thick concrete) cylinder 32 m in diameter and 32 m high. The laser building includes security systems, radioactive confinement and shielding, control rooms, supporting utilities, fire protection, monitoring, and decontamination and waste handling areas. Optics assembly and refurbishment capability is provided for at LLNL by incorporation of an optics assembly area attached to the laser building and minor modifications of other existing site facilities.

Special facilities include the Laser System, Target Area, Integrated Computer Control System, and Optics.

The laser system is designed to generate and deliver high power optical pulses to the target chamber. The system consists of 192 laser beams configured to illuminate the target surface with

a specified symmetry, unifonnity, and temporal pulse shape. The laser pulse originates in the pulse generation system. This precisely fonnatted low energy pulse is amplified in the main amplifier. To minimize intensity fluctuation, each beam is passed through a pinhole in a spatial filter on each of the four passes through the amplifier and through a transport spatial filter. The beam transport directs each high power laser beam to an array of ports distributed around the target chamber where the frequency of the laser light is tripled to 0.35 ~m, spatially modulated and focused on the target. Systems are provided for automatic control of alignment and the measurement of the power and energy of the beam. Structural support and auxiliary systems provide the stable platfonn and utilities required.
The target area includes a 10 m diameter, low activation (i.e., activated from radiation) aluminum vacuum chamber located in the Target Area of the laser building. Within this chamber, the target will be precisely located. The chamber and building structure provide confinement of radioactivity (e.g., x-rays, neutrons, tritium, and activation products). Diagnostics will be arranged around the chamber to demonstrate subsystem perfonnance for project acceptance tests. Structural, utility and other support systems necessary for safe operation and maintenance will also be provided in the Target Area. The target chamber, the target diagnostics, and staging areas will be capable of conducting experiments with cryogenic targets. The Experimental Plan indicates that cryogenic target experiments for ignition will be needed 2-3 years after completion of the project. Therefore, the targets and this cryogenic capability will be supplied by the experiments. The NIF project will make mechanical and electrical provisions necessary to position and align the cryogenic targets within the chamber. The baseline is for indirectly driven targets. An option for future modifications to pennit directly driven targets is included in the design.

..The integrated computer control system includes the computer systems (note: no individual computer will cost over $100,000) required to control the laser and target systems. The system will provide the hardware and software necessary to support initial NIP acceptance and operations checkout. Also included is an integrated timing system for experimental control of laser and diagnostic operations, safety interlocks, and personnel access control.

..Thousands of optical components will be required for the 192 beamlet NIP. These components include laser glass, lenses, mirrors, polarizers, deuterated potassium dihydrogen phosphate crystals, potassium dihydrogen phosphate crystals, pulse generation optics, debris shields and windows, and the required optics coatings. Optics includes quality control equipment to receive, inspect, characterize, and refurbish the optical elements.

Project Milestones:

Major milestones and critical decision points have changed as follow:

Milestones

Approval of Mission Need (CD1)

Title !Initiated

NEPA Record of Decision

Approval to Initiate Construction (CD3)

Current
Date

Jan 1993

Jan 1996

Dec 1996

Mar 1997

Previous
Date

Jan 1993

Jan 1996

Sep1996 Mar 1997

Start Special Equipment Installation	Nov 1998	Nov 1998
1[st] light	Jun 2004	NA
12 bundle	Jun 2007	Oct 2003
24 bundles	Sep 2008	NA
Project Complete (CD4)*	Sep 2008	Oct 2003

*CD4 was previously defined as 12 bundles commissioned and 12 bundles installed. CD4 is now defined as all 24 bundles commissioned.

Project milestones for FY 2000 and FY 2001 include: .FY 2000

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Complete Optics Facilitization

Complete Optics Assembly Building
Place Integration Management and Installation Contract

lQ 3Q

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Certification of new cost and schedule baseline

FY 2001

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Supplemental Environmental Impact Statement -Record of Decision Inert gas/vacuum Management Pre-Start Review - Phase 3
A ward production contracts for amplifier slabs

End conventional construction

3Q
4Q

Weapons Activities/Construction! 96-D-III-National Ignition Facility

Rev 2b

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4. Details of Cost Estimate

D e s i g n P h a s e
Preliminary and Final Design costs (Design Drawings and Specifications) Design Management Costs (1.8%ofTEC) ' '."1""..""""." Project Management Costs (1.8%ofTEC) ".".""""""i.""""""..'
Total Design Costs (13.2%ofTEC) Construction Phase
I
Improvements to Land. Buildings. Special Equipment. Utilities. Inspection, Design and Project Liaison, Testing, Checkout and Acceptance. Construction Management (0.9% ofTEC) , Project Management (2.6%ofTEC) , Total Construction Costs (74.8%ofTEC) , Contingencies
Design Phase (2.2% of TEC; 3.9% of remaining TEC BA) Construction Phase (9.9% of TEC; 20.9% of remaining TEC BA) Total Contingencies (12.0% of TEC; 26.7% of remaining TEC BA) Total, Line Item Costs (TEC)

dollars in thousands

199,556 37,721 38,717 275,994

1,800
173,400
1,199,825 *500*
118,700 18,000
54,683 1,566,908

45,330 206,665

101,143
21,900 22,000
145,043

1,800 170,724 520,802 500 73,250 22,800 31,500 821,376

1,000
78,281

251,995 79,281 2,094,897 1,045,700

The cost estimate assumes a project organization and cost distribution consistent with the management requirements appropriate for a DOE Major System as outlined in the NIF Project Execution Plan.
Actual cost distribution will be in conformance with accounting guidelines in place at the time of project execution.

Weapons Activities/Construction/
96-D-III-National Ignition Facility

Rev 2b

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5. Method of Performance

The NIF Project Office (consisting ofLLNL, Los Alamos National Laboratory (LANL), Sandia National Laboratory (SNL), and University of Rochester Laboratory for Laser Energetics (UR/LLE) and supported by competitively selected contracts with ArchitectlEngineering firms, an integration management and installation contractor, equipment and material vendors, and construction firms) will prepare the design, procure equipment and materials, and perform conventional construction, safety, system analysis, and acceptance tests. DOE/NNSA will maintain oversight and coordination through the Defense Programs Office of the NIP Project. All activities are integrated through the guiding principles and five core functions of the DOE Order on Integrated Safety Management Systems (ISMS) (DOE P450.4). DOE conducted the site selection and the NEPA determination in the SSMPEIS. LLNL was selected as the construction site in the ROD made on December 19, 1996.

5.1 NIF Execution

5.1.1 Conceptual and Advanced Conceptual Design

The conceptual design was completed in May 1994 by the staff of the participating laboratories. Keller and Gannon contractors provided designs of the conventional facilities and equipment.

Design requirements were developed through the Work Smart Standards (WSS) Process approved by the Director of the Oakland Operations Office. New requirements have been defined since the original WSS was placed in Contract 48 in 1997. A gap analysis will be performed, and if changes are required a revision will be prepared.

The Conceptual Design Report was subjected to an Independent Cost Estimate (ICE) review by Foster Wheeler USA under contract to the DOE. The advanced conceptual design phase further developed the design, and is the phase in which all the criteria documents that govern Title I Design were reviewed and updated.

5.1.2 **Title** I Design

In fiscal year 1996, Title I Design began with the contract award for the Architect/Engineers (Parsons and AC Martin) and a Construction Management firm (Sverdrup) for the design and the constructiblity reviews of the (1) NW Laser and Target Area Building and (2) Optics Assembly Building. Title I Design included developing advanced design details to finalize the building and the equipment arrangements and the service and utility requirements, reviewing project cost estimates and integrated schedule, preparing procurement plans, conducting design reviews, completing the PSAR and NEP A documentation, and planning for and conducting the constructibility reviews.

Title I Design was completed in November 1996 and was followed by an ICE review.

5.1.3 Title II Design

The participants in Title II (final design) include LLNL, LANL, SNL, Parsons, AC Martin, and Jacobs/Sverdrup (constructibility reviews). The Title II Design provides construction subcontract packages and equipment procurement packages, construction cost estimate and schedule, Acceptance Test Procedures, and the acceptability criteria for tested components (e.g., pumps, power conditioning, special equipment), and environmental permits for construction (e.g., *Storm Water Pollution Prevention Plan).*

5.1.4 **Title** III Design

The Title m engineering participants include LLNL, Parsons, AC Martin, and Jacobs/Sverdrup. Title m engineering represents the engineering necessary to support the construction and equipment installation, including inspection and field engineering. The main activities are to perform the engineering necessary to resolve issues that may arise during construction (e.g., fit problems, interferences). Title ill engineering will result in the final as-built drawings that represent the NIP configuration.

5.1.5 Construction and Equipment Procurement, Installation, and Acceptance

Based on the March 7, 1997, Critical Decision 3, construction began with site preparation and excavation of the Laser Target Area Building (LT AB) fonning the initial critical-path activities. The NIF Construction Safety program was approved and sets forth the safety requirements at the construction site for all LLNL and non-LLNL (including contractor) personnel. There was sufficient Title n Design completed to support bid of the major construction and equipment procurements. The conventional facilities are designed as construction subcontract bid packages and competitively bid as firm fixed price procurements. The initial critical-path construction activities include both the Laser and Target Area Building and the Optics Assembly Building (where large optics assembly and staging will take place). fu addition, the site support infrastructure needed to support construction of conventional facility, beampath infrastructure installation, and line replaceable equipment and optics staging are being put in place. At the same time, procurements on the critical path (e.g., target chamber) began following the established *NIF Acquisition Plan.*

The next major critical path activity is the assembly and installation of the Beampath Infrastructure Systems. These are the structural and utility systems required to support the line replaceable units. The management and installation of the Beampath Infrastructure System is being contracted to an Integration Management and Installation Contractor. This was done to fully involve industry in the construction of NIP as directed in the Secretary of Energy's 6-Point Plan and recommended by the Secretary of Energy Advisory Board interim report in January 2000. During the period of Beampath Infrastructure System installation, line replaceable unit and optics procurements continue.

The line replaceable unit equipment will be delivered, staged, and installed as phased beneficial occupancy of the Laser and Target Area Building is achieved. This is a complex period in which priority conflicts may occur because construction, equipment installation, and acceptance testing will be occurring. The Product Line Managers, Area Integration Managers, and Integration Management and Installation Contractor will manage and integrate the activities to avoid potential interferences affecting the schedule. The construction, equipment installation, and acceptance testing will be supported by Title III inspection and field engineering, which will include resolving construction and installation issues and preparing the final as-built drawings.

5.1.6 Operational Testing and Commissioning

After installation, the facility and equipment will be commissioned prior to the phased turnover to the operations organization. The transfer points employ the Management Pre-Start Review process in which an independent team evaluates the readiness (e.g., training and qualification of operators, Commissioning Test Procedures results, and as-built drawings) and recommends turnover by the NIP Project Manager. The NIP Project Manager approves the transfer of responsibility for ISMS Work Authorization.

The integrated system activation will begin with the commissioning of the first bundle. Management Pre-Start Reviews (MPRs) will be used by the Project Manager to control each system turnover. In specific cases, such as first light, first experiment, and ignition readiness, the DOEINNSA Field Office will oversee and concur in the MPR. A sequence of MPRs are scheduled to ensure a disciplined and controlled turnover of NIP systems from construction to activation. MPRs will be conducted by LLNL prior to the start of first experiments and NIP 192-beam operation, and the results will be validated by the Defense Programs Office of the NIP Readiness Assessment. The first experiment and 192-beam Readiness Assessment requires that the FSAR be completed and approved (including the documented operating/maintenance procedures, operating staff training, and as-built design documentation). The 192-beam Readiness Assessment results are a key input for Critical Decision 4 (Project closeout) by the Acquisition Executive.

5.1.7 Project Completion

The complete set of NIP criteria is contained in the *NIF Functional Requirements and Primary Criteria.* These are the criteria that NIP is required to meet when fully operational. However, early test operation of NIP by the Program through a series of turnovers controlled by Management Pre- Start Reviews will be achieved by a phased transition to Program operations for user tests before Project completion. This enables the Program to begin experimental operations in support of Stockpile Stewardship and other programmatic missions at the earliest possible date, as NIP performance capability is building up toward the eventual goals set out in the *NIF Functional Requirements and Primary Criteria* and *Project Completion Criteria.*

6. Schedule of Project Funding

Project Cost
Facility Costs
Design. Construction. Total,LineitemTEC Other Project Costs
R&D necessary to complete construction a
Conceptual design costs b NEPA documentation costs C Other project-related costs d Total, Other Project Costs. Total Project Cost (TPC)

Other Related Operations and Maintenance *Costs* - **NIF** Demonstration Program e **TOTAL** Project and Related Costs.

Budget Authority (BA) requirements f TEC(capitalfunding) , OPC(O&Mfunding) NIF Demonstration Program (O&M funding) Total,BArequirements

dollars in thousands

143,043 75,000 50,000 30,000 23,281 321,324
130,630 176,476 190,600 278,370 997,497 1,773,573 273,673 251,476 240,600 308,370 1,020,778 2,094,897

85,126 12,300 3,754 18,815

13,909 0
601
1,638

2,252 0
370 660

3,238 0
600 480

0
0
1,275
8,182

104,525 12,300 *6,600* 29,775

119,995 **16,148** 3,282 4,318 9,457 153,200 393,668 267,624 243,882 312,688 1,030,235 2,248,097

276,400 55,648 70,723 76,799 720,430 1,200,000 670,068 323,272 314,605 389,487 1,750,665 3,448,097

367,100 284,200 247,158 209,100 987,339 2,094,897 132,300 6,800 5,900 5,900 2,300 153,200 276,400 65,900 77,200 60,800 719,700 1,200,000
775,800 356,900 330,258 275,800 1,709,339 3,448,097

a Costs include optics vendor facilitization and optics quality assurance.

b Includes original conceptual design report completed in FY 1994 and the conceptual design activities for the optical assembly and refurbishment capability and site infrastructure.

C Includes preparation of the NIF portion of the Stockpile Stewardship and Management Programmatic Environmental Impact Statement, NIF Supplemental Environmental Impact Statement and environmental monitoring and permits.

d Includes engineering studies (including advanced conceptual design) of project options; assurances, safety analysis, and integration; start-up planning, management, training and staffing; procedure preparation; startup; and Operational Readiness Review.

e Funding previously requested and appropriated in the Inertial Confinement Fusion Program and, beginning in FY 2001, under Readiness in Technical Base and Facilities, NIF Operations.

f Long-lead procurements and contracts require BA in advance of costs.

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7. Related Annual Funding Requirements

Annual facility operating costs a Annual facility maintenance/repair costs b Programmatic operating expenses directly related to the facility C
Capital equipment not related to construction but related to the programmatic effort in
the facility '..." "..".' '.' '."'..".' ' GPP or other construction related to the programmatic effort in the facility. Utility costs d
..."",."""..""."...""",.".,.",.,."..""",...
e
Other costs. Total related annual funding (estimate based on operating life of FY 2009
through FY2038) ,...",.".,."., "."."..",.

(dollars in thousands)
Current Previous Estimate Estimate
38,767 21 ,200 55,787 33,200 41,865 61,100

204 204 6,637 1,577

200 200 9,000 6,300

14S,042f 131,2009

a Includes all NIF support personnel not in maintenance/repair, some of which were included previously in Programmatic expenses (245 personnel).
b Includes refurbishment of laser & target systems, building maintenance, and component procurement (137 personnel).

C Includes the **LLNL** portion of the nationallCF Program that is directly related to the use of **NIF** but not facility scientific support, which is now included in facility operating costs.
d Estimate of electricity usage.

e Estimate of industrial gases (argon, synthetic air).

In FY2001 dollars.

9 **In FY** 2000 dollars.

8. Design and Construction of Federal Facilities

All DOE facilities are designed and constructed in accordance with applicable Public Laws, Executive Orders, OMB Circulars, Federal Property Management Regulations, and DOE Orders. The total estimated cost *of* the project includes the cost *of* measures necessary to assure compliance with Executive Order 12088, "Federal Compliance with Pollution Control Standards"; Section 19 *of* the Occupational Safety and Health Act *of* 1970, the provisions *of* Executive Order 12196, and the related Safety and Health provisions for Federal Employees (CPR Title 29, Chapter XVll, Part 1960); and the Architectural Barriers Act, Public Law 90-480, and implementing instructions in 41 CPR 101-19.6.

The project will be located in an area not subject to flooding determined in accordance with Executive Order 11988.

DOE has reviewed the GSA inventory of Federal Scientific laboratories and found insufficient space available, as reported by the GSA inventory.

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Summary of Project Risk

As part of the rebaseline activity, the NIP project conducted a detailed, bottom-up estimate of cost and schedule to guidance defined in the NIP Rebaseline Plan. Throughout the rebaseline effort, the Project has been actively working to reduce project risk. As a result, the Balanced Program baseline plan was formulated to encompass the resources required to achieve project success, to utilize industrial capability as much as possible to accomplish the execution of the project, to include specific high-leverage risk mitigation activities, and to provide appropriate cost and schedule contingencies.

The Balanced Program Baseline proposal here represents a project plan that fits within the specified funding profile, preserves the original Primary Criteria, and remains responsive to Stockpile Stewardship campaign requirements (although behind the requested schedule of capabilities).

A summary of activities conducted to reduce overall project risk in the areas of Technical, Acquisition, Cost and Schedule, and a delineation of contingency follows.

Technical Risk Summary

For more than a year now, NJF personnel have been involved in a disciplined and rigorous process for identifying, analyzing, prioritizing and mitigating technical risks. The team was supported in this effort by a subcommittee of the NIP Program Review Committee, the Technology Review Group. This process has included attention to risks that may exist for failure of a component or subsystem to fully meet its performance objectives as well as an active search for elements of scope that may have been overlooked in previous plans. As a result of this effort, a large number of previously unrecognized scope elements have been added to the rebaseline plan and the program now includes a very active set of risk mitigation efforts.

Risk items were chosen for mitigation based on comparisons among the various risks in terms of their cost or schedule impact, their cost to mitigate, the probability that the risk would be realized, the expected effectiveness of the mitigation activity, and the value of the mitigation versus its cost. The value of mitigating an item is given by the magnitude of its risk times the fraction of the risk that is actually mitigated. The cost to mitigate is ultimately the resources (budget) that must be invested to effect the mitigation. This comparison, along with other factors, such as available resources and the confidence in a mitigation strategy, allowed us to complete the prioritization. Those risks that fall in the areas of Health and Safety or Technical Disruption were given highest priority.

ACQuisition Risk Summary

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The acquisition risk discussion addresses risks associated with the conventional facility, the Beampath Infrastructure System (BIS), the Line Replaceable Units (LRUs) and optics. With the conventional facilities for NIP nearing completion, acquisition risk in this area is now quite small. Our attention this past year has been focused on reducing risks for the Beampath Infrastructure and for the Line Replaceable Units. Substantial effort has been directed toward understanding the breakdown of wQrk necessary for completing the installation and commissioning of BIS and we have given high priority to hiring an experienced Integration Management and Installation Contractor who can manage this work from completion of the design through full BIS commissioning.

Our effort for reducing the acquisition risk for the LRUs has included formation of a Production/Procurement group capable of coordinating LRU procurement needs across the project. This group has identified a strategy of procurement that includes identification and development of a number of qualified vendors, called manufacturing integrators, who can provide LRUs to NIP at a relatively high level of subsystem integration; this process is now moving forward. Under the currently planned schedule, the procurements are stretched out over a longer period of time than in a project optimized schedule; a risk associated with attracting and maintaining the vendor base over this period is introduced. We have identified this risk and have tried to accommodate it by allocating our highest level of contingency for LRU procurements.

For many years the LLNL ICF program has understood the risks associated with procurement of the large optics that are an integral part of any ICF laser system. As a result, we have developed long-standing relationships with a number of optics vendors. We have supported facilitation at their sites for the space and equipment necessary for meeting our needs, and we have carefully adjusted the planned delivery rates of their optics such that their workload can remain at a relatively even and profitable level. Under the proposed schedule, the procurement rate of the optics has been maintained as much as possible in order to preserve this important relationship with industry.

Cost and Schedule Risk Summary

A detailed cost and schedule basis has been developed for the new baseline. The cost projections are a bottom-up estimate that has been assembled for both Project activities and supporting Program activities. More than 25,000 cost items have been detailed for all of the go-forward work and procurements necessary to successfully complete the project from FYOI to FY08. These estimates have a high degree of confidence with more than 80% of the estimates based on either detailed drawings/specifications or actual contract values. An equivalent degree of detail has been implemented into a task-based schedule that contains over 24,000 activities and 35,000 logical linkages. The extent of this logical network provides confidence that milestone objectives can be completed on schedule and is a powerful tool that can be used to resolve schedule issues as they arise. The cost and schedule systems are linked to ensure that resources are available as required to accomplish the schedule. In addition to developing these detailed plans, specific risk mitigation efforts and contingency allocations have been made to further increase project confidence.

Contin2encv

A contingency pool for the go-forward project has been ~eveloped as part of this baseline activity. The contingency pool was developed in a bottom-up manner by reviewing the remaining tasks associated with completion of the project, assigning percentage contingency factors to those tasks in proportion to the perceived risk of those activities. Together with the baseline estimates, these bottom-up contingency assignments were then checked against total baseline guidance. The result is a contingency of $252M for TPC and $148M for NIF Demonstration Program (formerly RTBF). Contingency for the NIP Project and other activities related to NIP is $400M or 25% of the to-go cost.

Schedule contingency is included in the NIP Integrated Master Project Schedule. The project will deliver laser light to the target chamber for the first time in FY04 and will complete the commissioning of all 192-laser beams in FY08. Milestones for these important dates and the commissioning of other laser groupings have been established. Internal to the NIP project, target dates, which are earlier than the project milestones, have also been established. Positive schedule float depending on the specific milestone ranges from 60 to 120 working days.

UCRL-ID-126525 Rev. 2b

National Ignition Facility Project Execution Plan

August 2000

National Ignition !a.cility P!oject Execution P~n

National Ignition Facility

Project Execution

Revision 2b

~ *L* T' Edward Mose$, .

NIP Laboratory ~Ject Manager

.James AndeIson,
, Defense Programs O:f:£ice **olthe** NIF Project

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elyn R. C1-eedon.
NNSA Deputy Admirdstrator for Defense Programs

National Ignition Facility ~Qject E;x;ec~on Plan -Rev 2b

Table of Contents

Appendices

1. Justification of Mission Need

The *National Ignition Facility (NIF) Justification of Mis.c;:ion Need,l* which was approved "by the Secretary of Energy in January 1993, defines the mission of the National Inertial Confinement Fusion (ICF) Program and discusses the specific mission of the NIF :Project. The NIP experimental capability will allow nuclear-weapons scientists to assess :stockpile problems, verify computational tools, test for nuclear-weapons effects, and increase their understanding of weapons physics. The three weapons laboratory ,directors and the National Nuclear Security Aqministration (NNSA) Deputy ,Administrator for Defense Programs have reviewed the role of the NIP in Stockpile Stewardship in a joint letter: Along with the Accelerated Strategic Computing Initiative numerical simulations and other aboveground experimental facilities, the NIP will provide critical data that will allow the United States to maintain its technical Icapabilities in nuclear weapons in the absence of underground testing. As a secondary ~Dbjective, the NIP will advance our understanding of ICFand help to assess its potential jas an energy source. Achieving fusion ignition in the NIF will advance both defense and energx objectives. In affirming the Project's Critical Decision 2,* "Approval of New ~3tart",3 the Secretary of Energy verified the mission need and emphasized that the NIF]has the potential to contribute significantly to the DOE missions.

:2.. **Project Description**

JDescription and participants-The NIP Project is a NNSA Major System. The Project]Jrovides the design, facility construction, equipment procurement, and acceptance 1:esting of the NIF. The Project, located at Lawrence Livermore National Laboratory ~:LLNL), involves LLNL, Los Alamos National Laboratory (LANL), Sandia National Laboratories (SNL), and the University of Rochester Labo

ratOry for Laser Energetics j:UR/LLE).

4:ost and timeline- The current cost and schedule basis is described in the NIF Project Data Sheet in Appendix D, which shows a Total Estimatecl Cost of $2,094.9 million and a Total Project Cost of $2,248.1 million, with completion in fiscal year 2008.

15elected site-The *Record of Decision*[4] *(ROD)* for the *Stoc~ile Stewardship and j\.1anagement Programmatic Environmental Impact Statement* (SSMPEIS), issued in December 1996 by the Secretary of Energy, specified LLNL as the selected site.

'Although Key Decisions 0, 1', and 1 have already occurred, the Key Decision process is being phased out and a Critical Decision process is being implemented. The correlations between Key Decisions and Critical Decisions are: ~Cey Decision 0 = Critical Decision 1 (Approval of Mission Need); Key Decision 1 = Critical Decision 2 (Approval of 1'.Jew Start); Key Decision 2 (Start Final Design) is no longer used and has no Critical Decision equivalent; Key Decision 3 (Start Construction = Critical Design 3); and Key Decision 4 = Critical Decision 4 (project Completion).

2.1 Primary Criteria

The *National Ignition Facility Functional Requirements and Primary Criteria*[6] represents the top-level system requirements that must be achieved to support the *National Ignition Facility justification of Mission Need,*[1] and to ensure that the construction and operation meet applicable federal, state, and local requirements to ensure protection of workers, the public, and the environment. These criteria also address the Project assurance requirements (e.g., Security, quality assurance) last updated in 1997. The primary criteria, approved by the NIP Project and the NNSA Office of the NIP Project, are the basis for the NIP Technical Baseline. All proposed changes to the approved primary criteria are subject to review and approval by the Levell Baseline Change Control Board (BCCB), chaired by the NNSA Deputy Administrator for Defense Programs. The performance requirements and the principal primary criteria for NIF systems are listed in the following sections. I

2.1.1 Performance Requirements

The primary NIP performance requirements, defined in the *National Ignition Facility Functional Requirements and Primary Criteria,*[6] can be summarized as follows: .

.Each beam will have the specified energy and power encircled in a 600-pm laser spot size at the target plane with spatial and tempor~l beam conditioning to control intensity fluctuations.

.The facility will be designed to use two-sided target irradiation geometry, with two cones of beams per side, and eightfold rotation symmetry. The beams will be pointed on target to within 50 ~ rms.

.The laser temporal pulse may have a maximum peak-to-foot contrast ratio of 50:1.

.The laser will deliver 500 TW /1.8 MJ at 30) to the laser entrance holes of the target hohlraum.

.The facility will support classified and unclassified experiments.

.The maximum annual fusion yield will be 1200 MJ /y with a maximum credible DT fusion yield limit of 45 MJ/shot (1.6 x 1019 neutrons).

.The design life for permanent structures is at least 30 years with regular maintenance.

2.1.2 Assurance Criteria

The assurance criteria, contained in the *NIF Functional Requirements and Primary Criteria,6* were developed by a joint LLNL/Department of Energy (DOE) team using a Work Smart Standards (WSS)-like process.7 Through a directive signed by the Manager of the Oakland Operations Office these criteria were placed in Appendix G of the Contract 48 between the DOE and the University *qf* California. 8 These criteria (established for the duration of the Project) would be replaced after Critical Decision 4, Project Closeout, by the LLNL-approved institu..tional set of WSS to govern NIF operation. There is a period of a decade between the development of the original NIF 'WSS and the beginning of operations and therefore a joint NNSA/LLNL team is :reviewing potential gaps between the original WSS and the LLNL institutional WSS to

determine if any Environmental Safety and Health (ES&H) criteria require earlier transition. Changes to the original WSS will require the ppropriate BCCB approval.

NIF must meet the following summarized assurance riteria:

- .Hazards category: low hazard, radiological.
- .Public dose will remain below 100 mrem/y from 11 exposure modes and 10 mrem/y from emissions of radionuclides in ambient air.
- .The NIP will meet the requirements for an impro ed risk level of fire protection sufficient to meet DOE objectives.
- .Waste management shall minimize the generatio of waste at the source per applicable DOE orders.
- .NIP safeguards and security will physically prote t and control classified data and equipment.

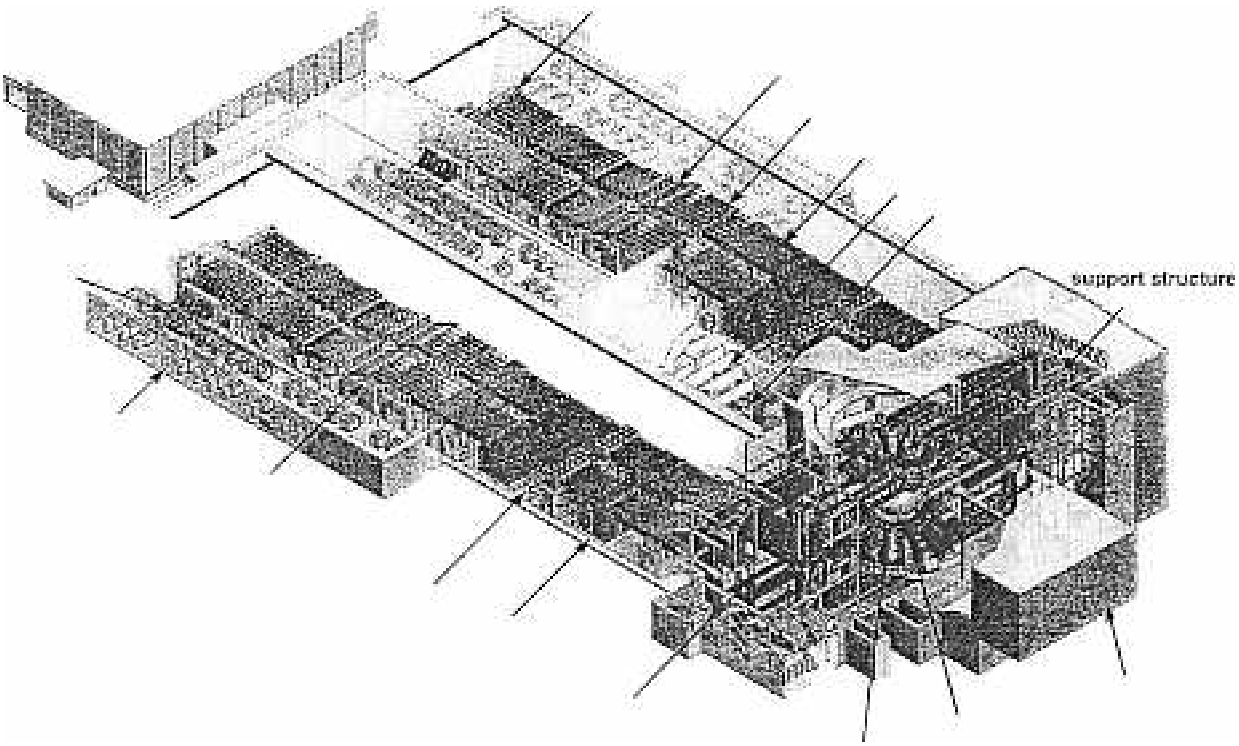
2.2 NIF Summary Design Description

The laser will be capable of providing an output pulse with the required energy of 1.8 MJ and an output pulse power of 500 TW at a wavelength of 0.35 ~ with specified symmetry, beam balance, and pulse shape. Figure 2-1 shows the NIF experimental facility, which will house the multibeam, neodymium-doped glass laser capable of generating and delivering the pulses to a target chamber. In the 10-m-diameter shielded target chamber, the light from the NIP beams will be tightly focused to enable weapons physics, weapons effects, ICF, and basic science experiments.

/

Optics assembly
building

Cavity mirror
mount assembly



Power conditioning!
transmission /,,"'1'
lines' !c

Amplifier
power conditioning modules

"

Periscope
polarizer mount
assembly

Pockels cell assembly

I Amplifier
Spatial filters
Control room
Master oscillator room

Beam control
& laser diagnostic
sY$tems

Pre-amplifier
modules

Transport turning
mirrors

Switchyard

Target chamtler

Diagnostics
building

40-o0-0996-2100A

Final optics
system

Figure 2-1. NIF Laser and Target Area Building.

User-supplied diagnostics will be used to make the accurate measurements of the high temperature and pressure states of matter. The recorded data will be used by researchers involved in national security, energy, and basic science research.

The NIF consists of six primary systems described in e following paragraphs: . 1. Conventional Facility .

2. Laser System.
3. Target Experimental Systems.
4. Integrated Computer Control Systems.
5. Assembly, Installation, and Refurbishment Equip ent.
6. Utility Systems.

/ Beam transport layout

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/

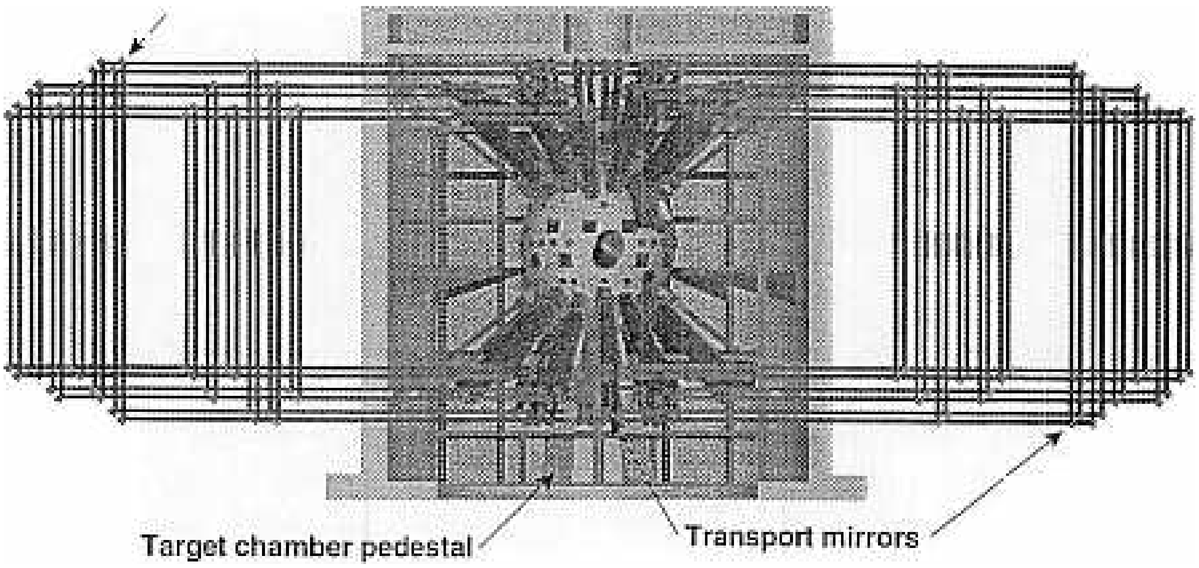

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Figure 2-2. NIF Target Chamber.

Conventional Facilities-Facilities consist of the site, La

t r and Target Area Building,

Optics Assembly Building, and Support Facilities.
Laser and Target Area Building-The Laser and Target Area Building (shown in Figure 2-1) provides the environmentally controlled facility to house the NIF experimental systems. It is a reinforced-concrete and structural steel building with a footprint of approximately 20,300 m2. The building includes two laser bays, each approximately 31 m wide by 135 In long joined at a central target area, which is a shielded (1.8-m-thick concrete) cylinder approximately 32 m in diameter and about 32 In high. The target chamber (shown in Figure 2-2) is structurally supported in this cylinder. The Laser and Target Area Building, a heavily shielded structure, includes security systems, radioactive confinement and shielding, control rooms, supporting utilities, fire protection, monitoring, and decontamination and waste handling. Site improvements include grading, utilities, and landscaping.
Optics Assembly Building-This building has a footprint of 2600 m2 and provides about 1400 m2 of clean room area for

optics assembly, mechanical cleaning, and optics and mechanical transfer. The Optics Assembly B.uilding is connected to the Laser and Target Area Building via a "clean corridor" tq. allow transfers while maintaining cleanliness and alignment of the large optics. .'.

Support Facilities-The support facilities are upgrades to existing LLNL support facilities (e.g., B391 that housed the Nova Laser) to provide target receipt and inspection, small optics, electrical, and mechanical support.

Laser System-The NIF laser system consists of 192 laser beams configured to illuminate the target surface with a specified symmetry, uniformity, and temporal pulse shape. The laser pulses originate in the Injection Laser System. This precisely formatted, low-energy pulse is amplified using a series of preamplifiers and amplifiers. To minimize spatial intensity fluctuations, each beam will pass through a pinhole in a spatial filter on each of the four passes through the amplifier and through a transport spatial filter. I

The beam transport system directs each high-power laset beam to an array of ports distributed around the target chamber, where the frequency of the laser light is tripled
in frequency to 0.35 J.lIn, spatially modulated (by phase plates), and focused on the target. Control systems will automatically control beam alignment and measurement of beam power and energy. The beampath infrastructure systems are composed of the structural support, laser beampath exoskeleton, and auxiliary systems that provide the stable platform and utilities required for beam transport and control.

Target Experimental Systems-The target area includes the 10-m-diameter, spherical vacuum chamber manufactured from low-activation aluminum alloy. It is located in the heavily shielded target area of the Laser and Target Area Building. A target positioner precisely locates the targets in the target chamber. The target chamber and the surrounding building structure provide the primary and secondary confinement of radioactivity
(e.g., x-rays, neutrons, tritium, and activation products). User-supplied diagnostics arranged around the target chamber will be used to obtain the comprehensive test data. Structural, utility, and other systems will provide required maintenance support. The Environmental Protection System controls the tritium inventory .

Integrated Computer Control Systems-The integrated controls system mo~tors and controls the laser and target systems. This computer-based control system includes the hardware and software necessary to support NIP operations, including the supervisory control system, ancillary system controls, integrated timing system for experimental control of laser and diagnostic operations, data acquisition, safety interlocks, and area access control. The laser physics simulation and analysis systems are part of the integrated control system.

Assembly, Installation, and Refurbishment Equipment-The assembly, installation,
and refurbishment equipment includes all equipment required for: line-replaceable unit transport and handling, optics assembly, preamplifier module maintenance equipment, auxiliary equipment, small optic processing, and metrology equipment. The assembly, installation, and refurbishment equipment is located in the Preamplifier Module Maintenance Area, the Optical Assembly Building, and the support facilities.

Laser and Target System Utilities-The laser and target system utilities provide the water systems for demineralized, low conductivity, domestic, tempered, chilled, hot, and firewater (but not the fire protection system): The facility has multiple vacuum systems and gas systems that supply argon, synthetic air, and compressed air.lnsid~. the facilities, the electrical distribution and cabling systems are part of the overall ubhty
system. ..: I

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2.3 **NIF Work Breakdown Structure I**

The NIP Project Work Breakdown Structure (NWBS) is the administrative organizing element for the NIF Project and supporting program elements. **It** consists of Plant and Capital Equipment (PACE) funded Total Estimated Cost and Operations and Maintenance (O&M) funded Other Project Cost and NIP Demonstration Program funded activities. Appendix B includes the NIP Project Summary NWBS. In the rebaselining of the schedule and cost estimate that occur

1 ed in Fiscal Year *2000,* the

NWBS was revised and updated. '", ,cc

~~. Management Roles and Responsibilities

The Secretary of Energy has delegated to the Deputy Secretary the role of J\cquisition Executive for the NIP Project. The Deputy Secretary approves all critical decisions. The NNSA Administrator and the Deputy Administrator for Defense Programs have full responsibility for all NIF Project decisions not specifically retained by the Acquisition Executive. The Deputy Administrator for Defense Programs will oversee the strategy and role of the NIP in the Stockpile Stewardship Program.

Overall DOE/NNSA managem~nt responsibilities were first stated in the approved *lJroject Charter9* signed in March 1993. Since then, the Defense Programs Office of the 1~ Project 10 was established to interpret, explain, and defend the role of the NIP Project cmd provide executive-level Project control for Defense Programs. More recently, part of the NNSA' s Office of Research and Inertial Fusion has ~een combined with the Office of the NIP under a single Director at NNSA Defense Programs headquarters with a Deputy Director /Field Manager at the Livermore site. I

3.1 Deputy Administrator, NNSA Defense Programs

The NNSA Deputy Administrator for Defense Programs, is responsible for the NNSA roles for formulating policy and overall direction, budget authorization, and for interfacing with the National ICF Program and the Stockpile Stewardship Program. The Deputy Administrator reports directly to the NNSA Administrator and will:

.Chair the NIF Levell BCCB to coordinate the NNSA decisions on all proposed baseline changes that are within the Levell approval thresholds or decision points (as identified in Tables 4-1 and F-l).

.Provide authority for the disposition of Levell Ba line Change Proposals (BCPs).

.Interface with the Level 0 BCCB.

.Establish and implement the Project policy throug the *Project Charter,9 justification of Mission Need;* and this *Project Execution Plan.*

.Review and coordinate the approval of NNSA-con

fOlled baselines, and initiate critical decision and other required reviews.

.Maintain a close interface with Stockpile Stewards 'p user groups and with Energy and Science Program users.

3i.2 Director, NNSA Office of the NIF Project I

The Defense Programs Director, Office of the NIP Project, is responsible for the I'JNSA roles for formulating policy and overall direction, budget authorization, and interfacing with the National ICF Program and ~e Stockpile Stewardship Program. The JDirector reports directly to the NNSA Deputy. Administrator for Defense Programs and
'will: ". I

Chair the NIP Level 2 BCCB to coordinate t11eNN~A decisions on all proposed baseline changes that are within the Level 2 approral thresholds or decision
points (as identified in Tables 4-1 and F-l). I

.Establish and implement the Project policy through the *Project Charter,9 Justification of Mission Need;* and this *Project Execution Plan.*
.Be responsible for NNSA Program Management for all research and development programs supporting the NIP Project.
.Establish the Project review process and ensure t

jat independent reviews are conducted.

.Secure resources, issue Project Work Authorizati ns, and overall formal Project and technical guidance and direction.
Review the status of technical, cost, and schedule performance of the Project.
.Review and coordinate the approval of NNSA-co trolled baselines and initiate critical decision and other required reviews.
.Maintain a close interface with Stockpile Steward hip user groups and with Energy and Science Program users.

3.3 Defense Programs, Depu,ty Director, Office of the NIF Project/Field Manager

The Defense Programs Deputy Director, Office of the NIF Project/Field Manager, is responsible for the formal day-to-day onsite Project interface and monitoring. The Deputy Director /Field Manager reports functionally to the Director of the Office of the NIF Project and administratively to the DOE Oakland Op~rations Office *(OAK)* and will:

Provide NNSA on-site Project management, including monitoring all aspects of the Project phases relative to the technical, cost, and schedule baselines and ensuring the adequacy of the Project management system.
Be responsible for NNSA on-site management of all research and development programs supporting the NIF Project.
Provide the DOE/NNSA oversight over all NIF-related ES&H requirements including Integrated Safety Management (ISM) system implementation.
Act as the backup Chairperson to the Director of tjhe Office of the NIF Project for the NIF Level 2 BCCB. I

I

Coordinate with DOE and NNSA Field matrix organizations, as required, to obtain support for Project management

activities.
Function as the formal communications channel b~tween the NIF Project Office and DOE/NNSA headquarters; apprising the Director, Office of the NIF Project, of any Project-related issues.
Develop, monitor, and evaluate performance against the contract measures
for the NIF.
Participate and provide guidance in the NIF ProjeCt Office Level 3 BCCB when necessary. .I

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3.4 Irector, awrence LIvermore Nahona La ora,tory

The Laboratory Director is responsible for administr~tion of NIF Programs and for oversight of the NIF Project. I

The Director reports functionally to the NNSA Deputy Administrator for Defense Programs and administratively to the Regents of the University of California and will:

Provide administrative leadership for the NIF ensuring resolution of institutional infrastructure, organization interfaces and priorities within the Laboratory Interface with the Senior NNSA management on
]IFoverSight and status Appoint the Associate Director for NIP Programs (ine manager) responsible for the NIP Project and the supporting ICF Program.
In addition to laboratory internal oversight, appo. ts a NIP Program Review Committee to perform independent reviews of pr .ect strategy, status, and
issues.
Ensure review results and recommendations are r ported to the V.C. Regents, and the NNSA.
Interface with the Stockpile Stewardship manage ent community.

2~.5 Associate Director for NIF Programs I

The Associate Director for NIP Programs is responsible for both the NIP Project and the ICF Program. Provides senior institutional management of the LLNL NIP Programs. 'The Associate Director for NIP Programs reports functionally to the Defense Programs ~Jffice of the NIP Project and administratively to the LLNL Laboratory Director and
'will: I

.Provide executive-level representation of the NIF Project/LLNL ICF Program to NNSA offices, other agency and government leaders, and the private sector.
.Interface with the NIF Program Review Committee (PRC), composed of individuals selected for their expertise and experience relevant to each of the Project phases, to obtain independent and critical review of and advice on all Project aspects.
t .Provide senior institutional management and coor ination of the NIP Project and the ICF Programs
.Provide liaison with the University of California (UC) Office of the President and the LLNL Laboratory Director to ensure strong oversight of the NIF Project.
.In~erface with the Stockpile Stewardship user co$unity and energy and
SCIence users. J

~~.6 NIF Project Manager I

The NIF Project Manager is responsible for implementing the Project and directing .the participants. The NIF Project Manager reports to the

tssociate Director for NIF :Programs and will:

.Chair the Level 3 BCCB to coordinate Project deciJons on all proposed baseline changes that are within the Level 3 approval thresholds or decision points (as identified in Tables 4-1 and F-1). .I

.Execute the Project and direct the parti<;ipating laboratories and industrial contractors such as architect engineers, c9nstruction managers/ general contractors, equipment vendors, and other industrial firms.

.Be responsible for all research and development programs required to successfully complete the NIF Project. I

.Monitor progress and effect necessary corrective actions, where required, to resolve problems and conflicts that affect Project implementation.

.Interface with the NNSA Director, Office of the NIF Project, and the Deputy Director /NIF Field Manager.

.Establish and maintain baselines (technical, cost, and schedule) in accordance with this *Project Execution Plan*, and report their stbtus to the NNSA in a timely and accurate manner. I

.Ensure industry involvement in the implementatibn of the NIF by providing for the contracting, management, and technical direction (as the Contracting Officer's Technical Representative) of the Architect/Engineers, Engineering Support Contractors, the Integration Management and Installation Contractor, and other contractors/vendors. I

.Implement, utilizing the principles of the ISM system, applicable ES&H requirements; quality assurance; and security in th

l e design, construction, and activation of NIF.

3.7 Institutional Deputy Project Managers I .

The Institutional Deputy Project Managers are resporlsible for supporting the NIF Project Manager in the Project implementation while rep

r esenting their institutions. The Institutional Deputy Project Managers will:

.Represent their institutions on the Project and at t eir institution in terms of resource allocation, priority, and conflict resolution.

.Plan, direct, and control assigned Project responsibilities.

.Provide input to cost, schedule, and technical reporting for their assigned areas of responsibility.

.Execute their assurance responsibilities, incorpor ting ISM principles for ES&H, quality assurance, and security.

Figure 3-1 depicts the NIF functional Project line m agement structure for the primary participants.

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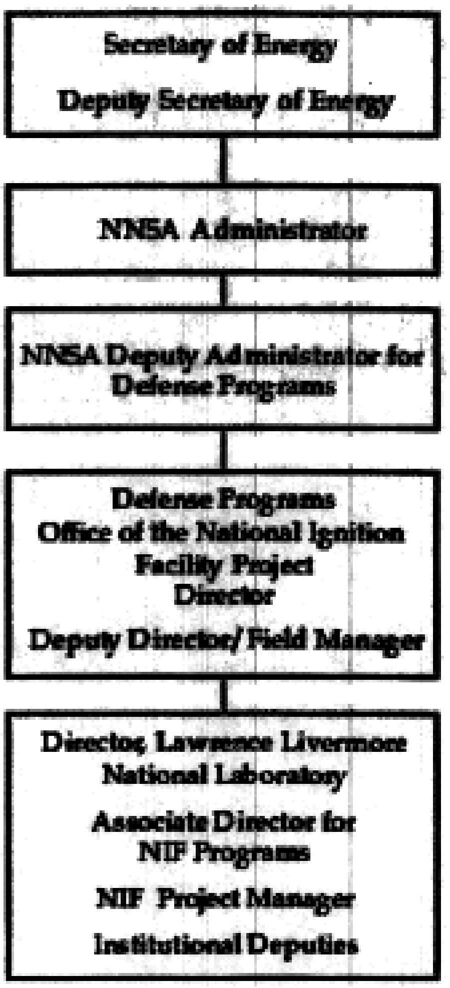

Figure 3-1. NIF functional Project management structure.

~l. **Project Execution** ;\;;1

This chapter describes the management processes that !Will be used to implement the r~IF Project. The NIF Project work logic diagram, which r presents the progression of Project activities, is shown in Appendix C.

!c~,,"'ic'.'

4.1 Baseline Establishment I

The technical, cost, and schedule baselines for the NIF lare formally established in this Project Execution Plan and provide the basis from which all proposed future changes are measured. The baseline schedule and cost estimates for the path forward have been approved by the Level 0 BCCB after an independent validation review. This revision of the Project Execution Plan reflects the latest Project cost and schedule baseline approved by the Acquisition Executive. This document will be revised to reflect any future changes once they are approved through the established BCCB process. A summary of the current baseline data is contained in the NIF Project Data ~;heet (see Appendix D), NIP Project Baseline costs (Appendix E) and Integrated Project ~;chedule (see Appendix F). I;)),::.,;

~L1.1 Technical Baseline

The approved NIF technical baseline is currently documented in the *Justification of j\1ission Need Statement; NIF Functional Requirements and Primary Criteria* (Appendix J),6 f;ystem design requirements, subsystem design requirements, and interface control documents. I

The complete hierarchy of criteria and their relationship is shown in Figure 4-1. As detail design is accomplished, more system design requirements, interface control documents, and design media in the form of top-level drawings, calculations, and f;pecifications will be formulated. In addition, key approved environmental and safety documents (e.g., the *SSMPEISs* and *Preliminary Safety AnalMsis Report (PSAR)11* augment the baseline, as will the *Final Safety Analysis Report (FSAR)* and *Draft Supplemental jSnvironmentalimpact Statement* (DEIS)13 when the latter ~o documents are completed and approved. I

!1.1.2 Cost Baseline I

The initial NIF cost baseline was based on the *NIF Conceptual Design Report14* cost estimate, with associated profiles of budget authorization and outlay. This baseline was 111pdated and revalidated with an Independent Cost Estimate Review at the completion of Title I Design, and approved by the Acquisition Executive (Level 0 BCCB) in March :1997. In September 2000, the Level 0 BCCB approved a total rebaseline of the NIF cost j~nd schedule baselines (note: technical baseline unaffected). The updated Project Data ~3heet contains the funding profile and is the basis for the approved baseline cost plan {see Appendix E). "'..' j

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JFigure 4-1. Relational hierarchy of criteria.

4.1.3 Schedule Baseline i

Appendix F contains the **NIF** Summary Integrated Project Schedule, Major Milestones, and Critical Decisions (see Figure F-l). i

I

4.2 Baseline Change and Contingency Control I

Establishment and maintenance of baselines are impoJant aspects of Project control. Changes to baselines will be carefully controlled to avoid loss of validity and distortion in performance reporting. The purposes of the Project cha rge control system are to assure that:

.The cost, schedule, and technical impacts of proposbd changes are developed and considered by all appropriate parties. I

.The evaluations, produced by the appropriate parties, are considered in the approval or rejection of the proposed changes.

.Appropriate parties are informed of proposed changes and their disposition. .Baseline documentation is controlled and updated rs appropriate to reflect approved changes.

.Action on all change requests is deliberate and without undue delay, but carried out without interfering disproportionately -vVith Project progress.

4,.2.1 Baseline Change Control and Configuration Control

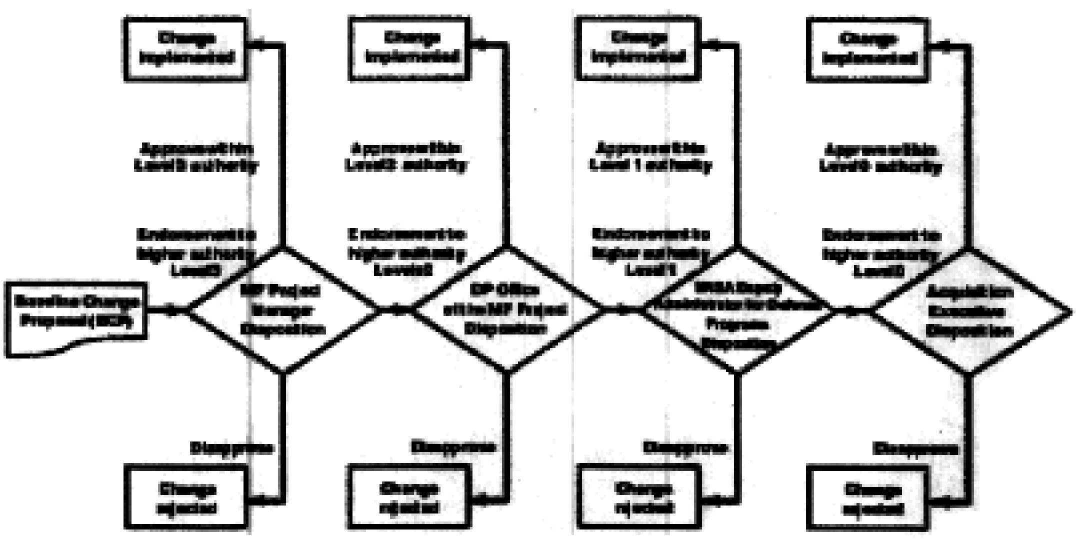
Technical, cost, and schedule baselines established upon approval of this *Project l~xecution Plan* are subject to the Baseline Change Control Board (BCCB) review process. BCCBs will be established at four levels (0, 1, 2, and 3) to approve, disapprove, or E~ndorse (i.e., recommend approval to a higher-level BCCB) all proposed baseline c:hanges. The Energy Systems Acquisition Advisory Board (ESAAB) provides advice, assistance, and recommendations on critical decision points to the OOE Acquisition I~xecutive. The ESAAB will be the Board to consider changes to the baseline, presented in the form of Baseline Change Proposals (BCPs), within the Acquisition Executive I.-evel 0 Authority. I

I

The change board hierarchy is shown in Figure 4-2, an~ change thresholds are listed in Table 4-1. Each lower-level board that approves a baseline change will provide the next higher-level board with a copy of the approved baseline change package and will endorse all proposed changes to be considered by the next higher-level board. This process ensures proper oversight of all proposed changes, which can originate at any level in the Project.

Membership of the Levell, Level 2, and Level 3 BCCBs will be at the discretion of 1:he respective board chairpersons. Authority and responsibilities of each board are to be defined in its decision-making charter. The Leve.l1, Level 2, and Level 3 BCCB Chairpersons shall have full decision-making,.authority; the boards are advisory rather l:han voting boards. The Chairperson of each board, at his or her discretion, may provide disposition of a requested change without .conducting a board meeting. The 'Vice Chairperson of the Level 2 BCCB will be notified of and may participate in all lL.evel 3 BCCB meetings.

Figure 4-2. Baseline Change Control Board (BCCB) hierarchy.



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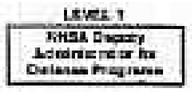

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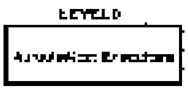

National Ignition ~Zity Project Execution Plan -Rev 2b

Table 4-1. Baseline Change Control Thresholds.

Acquisition Executive (Level 0)

Technical (Scope) Baseline Threshold

.Any change to scope that
affects
Justification of Mission Need.1

Schedule
(Milestone) Baseline Threshold

.Changes to LevelO milestones in excess of six months.

Cost (Dollar) Baseline Threshold

.Any change in Total
Project Cost
(TPC).

NNSA Deputy Administrator for Defense Programs (Levell)

.Changes to scope that affect operations functions but not the Justification of Mission Need.!
.Any deviation from the
primary criteria and selected functional
.6
requIrements.

.Changes to Level 0 milestones of less than six

months.
.Changes to
Levell
milestones in excess of six
months.

.Any change in Total Estimated Cost (TEC) that does not affect the TPC.
.Changes greater than $25M that do not affect the TEC/TPC.
.Changes requiring modification of the Project Data Sheet Funding
Profile.

DP Director,
Office of the NIF (Level 2)

.Any deviation in functional requiremeJ\ts other than
selected functional
requirements.6

.Changes t~
Levell milestones of
less than six months.
.Changes to Level 2 milestones in excess of six
months. I

NIF Project Manager
(Level 3)

.Any change in System Design Requirements that affect system performance.

.Changes to Level 2 milestones of less than six months.
.Changes to Level 3 milestones in excess of six months.

I. Changes less
I
I than $25M and
! greater than
I $10M that do not affect TEC/TPC.
.Changes
requiring
contingency
allocation of
more than $10M.

.Changes less than $10M that do not affect the
TEC/TPC.
.Changes requiring
contingency
allocation up to
$10M.

For directed changes, the NNSA-HQ (Levell or Level 2) directive will be the authorization for implementing the change. Directed changes do not require change board approval unless they impact the technical, cost, or schedule baseline. If the NIF

:Project Office determines an impact to the baselines, the impact will be submitted as a "BCP for review by the appropriate BCCB.

If changes (either approved or directed) exceed congressionally mandated thresholds, congressional notification is required prior to authorization to proceed. All -congressional notifications will be coordinated through the DOE Chief Financial Officer prior to submission.

The NIF Project Office will control Project documents through the process of issuing, reviewing, and approving changes. These are the chief change- control processes for Project documents and are central to the NIF configuration control system, which will ensure that the Project documents are current with the actual as-installed NIF systems. The configuration control system is described in the *NIF Configuration Management Plants* and the implementing Project procedures.

4.2.2 Contingency Control

Project contingency is the planned funds identified in the Plant-and-Capital- Equipment-funded NIF Total Estimated Cost and Other-Project-Cost-funded activities to cover unforeseeable but "in-scope" situations. Contingency was first established in the conceptual design process and documented in the *NIF Conceptual Design Report!4* It was updated after the completion of Title I Design and again as part of the FY 2000 rebaselining. The established Project contingency can only be adjusted through the BCCB process.

For the NIF Project, allocations of contingency will be controlled through BCCB actions. For these changes, a master contingency log will be kept by the Level 3 BCCB to record each allocation. Contingency will be monitored and controlled on a total Project basis. The Project manager will establish lower-level BCCBs, as appropriate, and will delegate certain levels of authority. Allocations of less than or equal to $500,000 can be made without a BCCB meeting. Notification of these allocations will go to the next higher level change board.

Each year's PACE funded TEC and O&M funded Other Project Cost appropriations will include a portion of the total Project contingency.

4.3 NNSA Budget Authorization Process

NIF funding requests are made as part of the NNSA annual budget request process, for inclusion in the Defense Programs' Corporate Review Budget, the Office of Management and Budget, and the Congressional budget submissions. An independent validation of the NIF annual budget request may be perf()rmed for each fiscal year for which funds are requested.

The NIP Project Manager must establish annual budg~t guidance for the Project participants based on the negotiated scope of..work to be accomplished by each. This will yield the distributions recommended to the Office of the NIF Project. Funding distribution will be coordinated by the Office of the NIF Project. -

After Congressional authorization/ appropriation of NIF funds, the NNSA will distribute the NIF funds to the appropriate Operations Offices via the approved financial plan process. The Work Authorization System/Prime Contract Modification

Process will be used by NNSA for the general authorization of funds for work at the participating laboratories.

4.4 Procurement and Contracting

The *NIF Project Acquisition Plan16* identifies NIF procurements and contracts and describes the estimated cost and schedule. A detailed annual commitment plan is developed by the NIF Project Office prior to the start of e,ach fiscal year, or as otherwise required. '

Procurement solicitation and award actions for the Project will be accomplished by a dedicated procurement team at LLNL that will be responsible for the NIF acquisitions. However, all the participating laboratories will be able to make procurements as needed in accordance with their prime contracts or cooperative agreements.

4.5 Reviews

4.5.1 NNSA Status and Independent Reviews

The NIF Project conducts periodic (e.g., monthly, quarterly) status reviews for Defense Programs as requested. These reviews are integral to the Project technical, schedule, and cost tracking and reporting processes. Independent Reviews may be conducted to address various aspects of the Project. Reviewers may include the Secretary of Energy Advisory Board (SEAB) task force, reviews commissioned by the Office of the NIF Project (e.g., safety reviews, cost validation reviews, independent cost reviews, the NIP Program Review Committee, the UC and other properly empowered bodies.

4.5.1.1 NIF Program Review Committee (PRC)

The NIF PRC is to advise the LLNL Laboratory Director on all aspects of the NIP Project during the remainder of its design, construction, and operations phases. The PRC written reports go directly to Defense Programs, Director, Office of the NIF Project and the UC President's Office. The Defense Programs Office of the NIF Project must concur on the Project's proposed responses to PRC report findings. The NIF PRC will have four sub-committees to review:

.Policies, Procedures, and Governances.

.Project Performance.

.Technology.

.Target Physics.

4.6 Performance Control and Reporting Systems"

Pro

J"ect control and reportingrequirements .are outlined in the *Life-Cycle Asset*

17. 18

Management Order and *Construchon Program Management Plan.* These documents provide guidance for a graded approach to Project.management to minimize overall Project cost and schedule risk. The Project control system is closely integrated with the baseline change control and work authorization processes and will provide the required status and variance analysis for the specified reporting period. Analysis will, as a

minimum, be provided for cumulative cost and commitment or schedule variances that exceed 10% or $100,000, whichever is greater. The NIP Project uses this integrated Project ~:ontrol system to provide effective planning and reporting, as well as day-to-day :management capabilities. This system will:

.Identify and organize all of the work scope required to complete the Project. .Provide the means to break the work scope into tasks, with a time-phased budget and resource plan.

.Report to the Office of the NIF Project at Level 2 oflthe NIF Work Breakdown Structure (NWBS).

.Measure and report actual costs and commitments against the approved task plans and established baselines.

.Report on cumulative Project Earned Value, including computed cost and schedule variances, for the overall Project, at NWBS Level 2 and for selected Level 3 elements.

.Generate and maintain the cost and schedule baseline estimates for the Project. .Forecast future funding requirements.

.Provide the basis for Project budget submissions and validations.

.Monitor and control procurement and contracting activities and commitments. .The Project shall maintain the ability to provide, information at NWBS Level 3 and below if requested.

4.6.1 Control Systems

Each month, based on the current month and cumulative data, the responsible Cost Account Manager will prepare a status report. If variance thresholds are exceeded, the status report will include a variance analysis. The variance analysis report will identify the nature of the variance, the cause of the variance, the expe~ted impact on the Project, a recovery plan, and a current estimate-at-completion (EAC). The NIF Project Office summarizes the variance reports and maintains an EAC (annual and total Project) for each Level 2 and selected Level 3 NWBS elements.

The schedule, which contains a critical path network, is maintained as a Project planning and measurement tool. The individual tasks in the network support the effort and budgets in the Cost Account Plans. At the end of every month, the responsible manager will provide a schedule update, including changes to planned activity durations, changes to planned start and completion dates, changes to actual start and completion dates, additions and deletions of activities, changes to logic, and changes to budget.

In the event of major changes in the Project scope, schedule, and/ or funding profile, the Project may be rebaselined. Rebaselining consists of modifying plans for all or part of the NWBS to re-establish a valid performaryce measurement baseline. Rebaselining is managed to ensure that cost and schedule control is maintained during the rebaseline process. For example, a DOE-approved *Transition ~eriod Implementation Plan19* was used to define and track Project progress during the rebaselining process completed at the

.Estimate at Completion (EAC): Estimate to complete the Project or an individual WBS element; includes all costs incurred to date and the estimated costs for the remaining work required.

end of FY 2000. All changes to the baseline are subject to BCCB review and are documented.

4.6.2 Reporting

The NIF Project Office will be responsible for collecting, maintaining, and integrating sufficient information to satisfy all of the Project management reporting requirements.

Each Project participant shall maintain complete financial data at the NWBS levels appropriate for its assigned work. Monthly and cumulative planned versus actual costs and commitments, with annual estimates to complete, will be reported to the NIP Project Office each reporting period. At the same time, each participant shall also report monthly technical and schedule progress. The NIF Project Office will prepare and distribute monthly and quarterly reports to Defense Programs, Director, Office of the NIF Project, based on the integration of monthly information using an Earned Value System approach. Variance reports will be provided on NWBS Level 2 and selected NWBS Level 3 elements for cumulative cost and schedule variances that exceed 10% or $100,000 which ever is greater. In addition, annual and EAC projections will be reported on Level 2 and selected level 3 elements.

Monthly reports (prepared for October, November, January, February, April, May, July, and August) shall be transmitted from the NIF Project Manager to the NNSA Office of the NIF Project by the 25th working day after the end of the month.

Quarterly reports (prepared for October-December, January-March, April-June, and July-September) shall be transmitted by the 25th working day after the end of the last month of the quarter from the NIF Project Manager to the NNSA Office of the NIF Project. The Office of the NIF Project shall transmit the NIF Quarterly R~J2.Qrts to the NNSA Deputy Administrator for Defense Programs and other headquarters staff with the Director's assessment within five working days of receipt.

4.7 Assurances

The predominant assurance objective is that the NIP will be constructed and operated in a safe, secure, and environmentally-sound manner and will ensure the reliable performance of the test program. To achieve these top-level objectives, the Project established formal programs for quality assurance; security; and ES&H protection. A NIP Policy (NIP Project Control Procedure 1.11, *Integrated* Safe~ *Management* (ISM))2O was prepared to describe how ISM (DOE

Order P450.4) 1 is implemented in the NIP Project. Several master plans have been prepared: a Quality Assurance *Program* Plan;22 a security plan; and an ES&H *Management* Plan.23 Key outputs of the assurance program include the Quality Assurance procedures, security procedures, Quality Assurance files, Acceptance Test Procedures, Operational Test Procedures, Preliminary *Hazards* Analysis,2 PSAR;l *Construction* Safety *program,25* FSAR;2
DEIS,13 and environmental permits. co,'

4.7.1 Qu,,-lity Assurance A ,

Project Quality Assurance has been planned and managed consistent with the *NIF Quality Assurance Program Plan,22* prepared in accordance with DOE Order 5700.6C, *Quality Assurance:6* Each phase of the Project may require significantly different quality

assurance requirements; therefore, the *Quality Assurance Program Plan22* and implementation procedures have been revised twice and will be revised as appropriate. Also, new requirements have been defined since the original WSS were placed in Contract 48 in 1997.7 A gap analysis will be performed (e.g. 10 CFR 830.120) and, if c:hanges are required, a revision will be prepared. Any changes require the appropriate I~CCB approval.

The *Quality Assurance Program Plan22* identifies the quality assurance requirements and measures for controlling work on the Project. The Plan:

.Provides the base requirements (e.g., preparation and control of criteria, control of procured items, nonconforming item disposition) in a phased manner to meet the Project's technical requirements.

.Initiates core quality assurance elements in a risk-based graded approach to mitigate or eliminate the risk of component or system failure.

.Provides the quality assurance basis to integrate individual activities or interface with related activities (e.g., target fabrication).

.Defines how DOE ISM system requirements (contained in DOE P450.4)21 are implemented in the Project.

.Provides a single Project document showing how all applicable NNSA and DOE quality assurance requirements will be met.

The *Quality Assurance Program Plan22* utilizes a graded approach in which levels of risk are assessed and then an appropriate level of quality assurance and control requirements established. Risk management for the Project began with the *NIF Risk ..Management Plan:7* Risk Management evaluation and mitigation has been assigned to
the Systems Engineering organization in the Project. They have established the Risk :Management Working Group and will provide an updated *RisklV1anagement Plan27* as part of the *System Engineering Management Plan* currently under preparation.

~~.7.2 Environmental Safety and Health Planning

The *ES&H Management Plan*[23] describes how the NIP Project ensures the health and safety of workers and protects the public and the environment. It describes the policy, responsibilities, and documented evaluations and regulatorx approvals that have been obtained~rior to the beginning of construction (e.g., *PSAR, Construction Safety Program*, National Environmental Policy Act (NEPA) determination, and environmental permits) and then prior to operation (e.g., *FSAR;2* readiness assessments, environmental permits). The plan describes each area (radiation protection, safety, environmental impact; e.g., waste generation, effluents, etc.) in a specific section.

The *NIF ES&H Management Plan*[23] was approved by the NIP Project Manager and the Deputy Director of the Office of the NIP Project and is being implemented.

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The NIP Project Control Procedure 1.11, *I~tegrtlted Safet,y Management*, documents how the project implements an ISM system (DOE P450.4)[21] that integrates ES&H activities. .

4.7.2.1 NEP A Determination and Site Selection

The NIP is included as a section of the Stockpile Stewardship and Management Programmatic Environmental Impact Statement (SSM PEIS).[5] The Notice of Intent for

the SSM PElS[28] states that the National Environmental Protection Act (NEP A) document is sufficiently detailed to address site selection, constructions and operation of the NIP. The Record of Decision (ROD)[4] resulting from the SSMPElS was issued in December 1996. As settlement to the litigation from 38 Non-Government Agencies led by the Natural Resources Defense Council, a DSElS[13] has been prepared and reviewed 'with Public meetings in December 1999. The final DEIS is being prepared, and is scheduled to lead to a *ROD* by the end of FY 2000.

With the SSM PEISs completed, a Mitigation Action Plan[29] and a Pollution :Prevention/Waste Minimization Plan[3O] have been ;prepared to mitigate the environmental impacts presented in the SSM PElS and the *ROD.*[4] Also, the environmental monitoring program has prepared a baseline for the selected site, and the environmental permits for construction and operation are being obtained from the appropriate federal, state, and local agencies.

The following sequence outlines the activities requireq to allow Title n Design and site construction to proceed on schedule: '

.The Notice of Intent of the SSM PElS[28] was publish~d in the Federal Register in June 1995.

.Input and feedback on the issues to be considered in the SSM PEISS were obtained from public meetings, and the DOE has prepared an implementation plan that forms the basis for the preparation of the draft SSM PEIS.s

.The NIP NEP A documentation was prepared as a separate volume of the SSM

PEIS.s

.The NIP Environmental Volume describes all of the environmental impacts of constructing and operating the NIP at the preferred and alternative sites. It also discusses the consequences of the "no action" alternative.

.The draft SSMPEISswas reviewed *bl* the public and the comments were incorporated into a final SSM PElS, which was issued for public review.

.Following completion of the final SSM PEISs, the DOE published the ROD4 with LLNL as the chosen site. For the NIP, this ROD4 includes the programmatic decisions on purpose, need, and site selection. A positive decision on the Project- specific analysis of the environmental impacts of NIF construction and

operations allows for site preparation and building excavation to begin (after Critical Decision 3).

.DOE issued Critical Decision 3 (Appendix I of this document) on March 7, 1997. .The Mitigation Action Plan29 was issued and is used annually. The

environmental permits required for construction are being obtained and the site characterization baseline will be frozen for the environmental monitoring program. Prior to operation, environmental permits required for operation will be obtained from the Environmental Protection .Agency and state and regional authorities. " .

, .

.As a result of litigation settlement, a DSEIS13.has been prepared. The Notice of

Intent31 was published, and the DSEIS13 reference was reviewed with the Public in meetings at Livermore, California, and Washington, DC, in December 1999.

41.7.2.2 Safety Documents

The tP;rimary safety documents are the NIF Integrated Safety Management (ISM) Policy: ES&H Management Plan,23 Functional Requirements and Primary Criteria (Sections 3-10),6 Preliminary Hazards Analysis:4 Preliminary Safety Analysis Review (PSAR),l1 Construction Safety program,2S and the Final Safety Analysis Review (FSAR):2 In addition, Facility Safety Procedures, Integration Work Sheets, and appropriate Operational Safety Procedures will be prepared prior to operation. The NIF has been added to the site Emergency Plan.32 These documents fully implement the ISM (:DOE P450A).21 The PSARll was completed in May 1996, approved by LLNL in ~;eptember 1996, and received DOE OAK concurrence in October 1996.

The PSAR;l started based on the conceptual design and completed during Title I Design, confirmed the facility hazard category to be low hazard, radiological, which 'was first established by the *Preliminary Hazards Analysis.24* The *FSAR12* will be based on Title n Design and will be one of the key documents required for first-bundle operations and the Readiness Assessment.

4.7.2.3 Construction Safety Program

The Construction Safety program,25 which defines safety and environmental requirements and controls at the construction site, was first issued in January 1997 and has been updated twice. It describes how the ISM guiding principles and core functions :are applied to manage, monitor, and improve construction safety at the site. It is :provided for compliance to each constroction contractor in the bid package. Each contractor provides a site-specific safety plan, consistent with the *Construction Safety .program:* approved by the NIF Project prior to starting work. The *Construction Safety .Program* is implemented by the Integration Management and Installation Contractor .with oversight by the NIF

Project Office. Safety performance is formally audited quarterly by Defense Programs Office of the NIF.

5. Method of Accomplishment

The NIF Project Office (consisting of LLNL, LANL, SNL, and UR/LLE and supported by competitively-selected contracts with Architect Engineering firms, an integration management and installation contractor, equipment and material vendors, and construction firms) prepares the design, procures equipment and materials, and :performs conventional construction, safety, system analysis, and acceptance tests. DOE/NNSA will maintain oversight and coordination through the Defense Programs 'Office of the NIF Project. All activities are integrated through the guiding principles and five core functions of the DOE ISM system (DOE P450.4)

!;.1 **NIF Execution**

5.1.1 Conceptual and Advanced Conceptual Design

The conceptual design was completed in May 1994 by the staff of the participating laboratories. Keller and Gannon contractors provided designs of the conventional facilities and equipment.

Design requirements were developed through a *Work Smart Standards-Like Process*[7] approved by the Manager of the Oakland Operations Office. New requirements have been defined since the original WSS were placed in Contract 48 in 1997. A gap analysis will be performed and, if changes are required a revision will be prepared.

The *Conceptual Design Report*[14] was subjected to an Independent Cost Estimate Review by Foster Wheeler USA under contract to the DOE. The advanced conceptual design phase further developed the design, and is the phase in which all the criteria documents that govern Title I Design were reviewed and updated.

5.1.2 Title I Design

In fiscal year 1996, Title I Design began with the contract award for the Architect/Engineers (Parsons and AC Martin) and a Construction Management firm (Sverdrup) for the design and the constructiblity reviews of the (1) NIF Laser and Target Area Building and (2) Optics Assembly Building. Title I Design included developing advanced design details to finalize the building and the equipment arrangements and the service and utility requirements, reviewing Project cost estimates and integrated schedule, preparing procurement plans, conducting design reviews, completing the *PSAR*[11] and NEP A documentation, and planning for and conducting the constructibility reviews.

Title I Design was completed in November 1996 and was followed by an Independent Cost Estimate Review.

5.1.3 Title II Design " r

The participants in Title II (final design) mclude LLNL, LANL, SNL, RM Parsons, AC Martin, and Jacobs/Sverdrup (constructibility reviews). The Title n Design provides construction subcontract packages and equipment procurement packages, construction cost estimate and schedule, Acceptance Test Procedures and the acceptability criteria for tested components (e.g., pumps, power conditioning, special

equipment), and environmental permits and plans for construction (e.g., *Storm Water .Pollution Prevention Plan).*[33]

5.1.4 Title III Engineering

The Title III Engineering participants include LLNL, Parsons, AC Martin, and .Jacobs/Sverdrup. Title III Engineering represents the engineering necessary to support the construction and equipment installation, including inspection and field engineering. The main activities are to perform the engineering necessary to resolve issues that may arise during construction (e.g., fit problems, interferences, etc.). Title ill Engineering will result in the final as-built drawings that represent the NIF configuration.

5.1.5 Construction and Equipment Procurement, Installation, and Acceptance

Based on the March 7, 1997, Critical Decision 3, construction began with site preparation and excavation of the"LTAB forming the initial critical-path activities. The NIP Construction Safety Program (Section 4.7.2.3) was approved and sets forth the safety requirements at the construction site for all LLNL and non-LLNL (including contractor) personnel. There was sufficient Title n Design completed to support bid of the major construction and equipment procurements. The conventional facilities are designed as construction subcontract bid packages and competitively bid as firm fixed price procurements. The initial critical-path construction activities include both the Laser and Target Area Building and the Optics Assembly Building (where large optics assembly and staging will take place). In addition, the site support infrastructure needed to support construction of conventional facility, beampath infrastructure installation, and line replaceable equipment and optics staging are being put in place.

At the same time, procurements on the critical path (e.g., target chamber) began following the established *NIF Project Acquisition Plan.*[16] This plan is being updated to reflect the current acquisition strategy.

The next major critical path activity is the assembly and installation of the Beampath Infrastructure Systems. These are the structural and utility systems required to support the line replaceable units. The management and installation of the Beampath Infrastructure System is being contracted to an Integration Management and Installation Contractor. This was done to fully involve industry in the construction of NIF as directed in the Secretary of Energy's 6-Point Plan and recommended by the Secretary of Energy Advisory Board interim report in January 2000.34 During the period of Beampath Infrastructure System installation, line replaceable unit and optics procurements continue.

The line replaceable unit equipment will be delivered, staged, and installed as phased beneficial occupancy of the Laser and Target Area Building is achieved. This is a complex period in which priority conflicts may occur because construction, equipment installation, and acceptance testing will be occurring. The Associate Project Managers, Area Integration Managers, and Integration Man~gement and Installation Contractor will manage and integrate the activities to avoid potential interferences affecting the schedule. The construction, equipment installa~ion. and acceptance testing will be supported by Title ill inspection and field engineering, which will include resolving construction and installation issues and preparing the final as-built drawings.

5.1.6 Operational Testing and Commissioning

After installation, the facility and equipment will be commissioned prior to the phased turnover to the operations organization. The transfer points employ the Management Pre-Start Review (MPR) process in which an independent team evaluates the readiness (e.g., training and qualification of operators, Commissioning Test Procedures results, as-built drawings, etc.) and recommends turn over by the NIF Project Manager. The NIF Project Manager approves the transfer of responsibility for ISMS Work Authorization.

The integrated system activation will begin with the commissioning of the first bundle. MPRs will be used by the Project Manager to control each system turnover. In specific cases, such as light propagation Phase 4 light to target bay, the DOE NNSA Field Office will concur in the MFR. A sequence of MPRs are scheduled (see Table F-1) to ensure a disciplined and controlled turnover of NIF systems from construction to activation. MPRs will be conducted by LLNL prior to the start of first experiments and NIF 192-beam operation, and the results will be validated by the Defense Programs Office of the NIF Readiness Assessment. The first experiment and 192-beam Readiness Assessment requires that the *FSAR12* be completed and approved (including the documented operating/maintenance procedures, operating staff training, and as-built design documentation). The 192 beam Readiness Assessment results are a key input for Critical Decision 4 (Project closeout) by the Acquisition Executive.

5.1.7 **Project Completion**

The complete set of NIP criteria is contained in the *NIF Functional Requirements and Primary Criteria.6* These are the criteria that NIP is required to meet when fully operational. However, early test operation of NIP by the Program through a series of turnovers controlled by MPRs will be achieved by a phased transition to Program operations for user tests before Project completion. This enables the Program to begin experimental operations in support of Stockpile Stewardship and other programmatic missions at the earliest possible date, as NIP performance capability is building up toward the eventual goals set out in the *NIF Functional Requirements and Primary Criteria.6* The Project Completion Criteria are documented in Appendix K.

5.2 Security

The operation of the NIF generates classified data requiring safeguarding; the Project itself represents a large investment of government funds in assets that must be protected. The Functional Requirements and the System Design Requirements identify security-system design requirements. A NIF First Experiments Security Plan will be prepared and submitted for OAK/NNSA Safeguards and Security Division Director approval prior to the first-bundle experimental operations. The plan will describe the NNSA requirements and compliance of the NIF design (e.g., access control, vaults, secure transfer lines, etc.) and administrative proc,edures that implement them. It will also describe the site security organization arid interface to the NIF Project security team. Issues related to transparency of experimentation by the user community and international collaboration will be addressed in the final NIF Security Plan to be approved by the OAK/NNSA Safeguards and Security Division Director before Critical Decision 4.

6. Effective Date and Amendments

This *NIF Project Execution Plan* will be implemented immediately upon approval. This approved plan is a controlled document and provides the Project baseline. All Project baseline revisions are subject to the BCCB system requirements as discussed in C:hapter 4. Updated technical, schedule, and cost plans resulting from BCCB decisions, as well as appendix changes of this document, may be appended to this plan without concurrence of the original approvers.

The initial *Project Execution Plan* required approval by the Secretary in his roll as Acquisition Executive. Subsequent revisions to the body of the document will require approval of the Deputy Administrator for Defense Programs.

'7. **References**

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Appendix A

Acronyms and Albbreviations

31

National Ignition Facility Project Execution Plan -Rev 2b

BCCB

DOE

DSEIS

I~AC

]~SAAB

I~S&H

FSAR

ICF

ISM

I~ANL

I.,LNL

N.A

-roJ *r*

fll1.L.l

fllJ.L.2

fllI.LA

1'.J.L.5

r'.JEPA

NNSA

l'lWBS

Acronyms and Abbreviations

Baseline Change Control Board

Baseline Change Proposal
Department of Energy
Draft Supplemental Environmental Impact Statement

Estima te-a t-com p letion
Energy System Acquisition Advisory Board Environmental Safety and Health
Final Safety Analysis Report
Inertial Confinement Fusion

Integrated Safety Management
Los Alamos National Laboratory

Lawrence Livermore National Laboratory

Assembly, Installation, Refurbishment Equipment Integrated Computers and Controls
Conventional Facilities

Main Laser System Multiplexed Diagnostics
Laser Transport & 3w Systems

Laser System Beam Control and Diagnostics

Laser System Integration
Laser System Optical Integration

Management
Target Experimental Systems Utilities

National Environmental Policy ~~t

National Ignition Facility ~: National Nuclear Security Administration NIP Project Work Breakdown Structure

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National Ignition Facility Project Execution Plan -Rev 2b

ID&M

IOAK

:PACE

:PRC

.*PSAR*

.ROD

:RTBF

:SEAB

:SNL

,*SSMPEIS*

UR/LLE

Operations and Maintenance

Department of Energy Oakland Operations Office

Plant and Capital Equipment

Program Review Committee
Preliminary Safety Analysis Report Record of Decision
Readiness in Technical Base Facilities

Secretary of Energy Advisory Board

Supplemental Environmental Impact Statement

Sandia National Laboratories

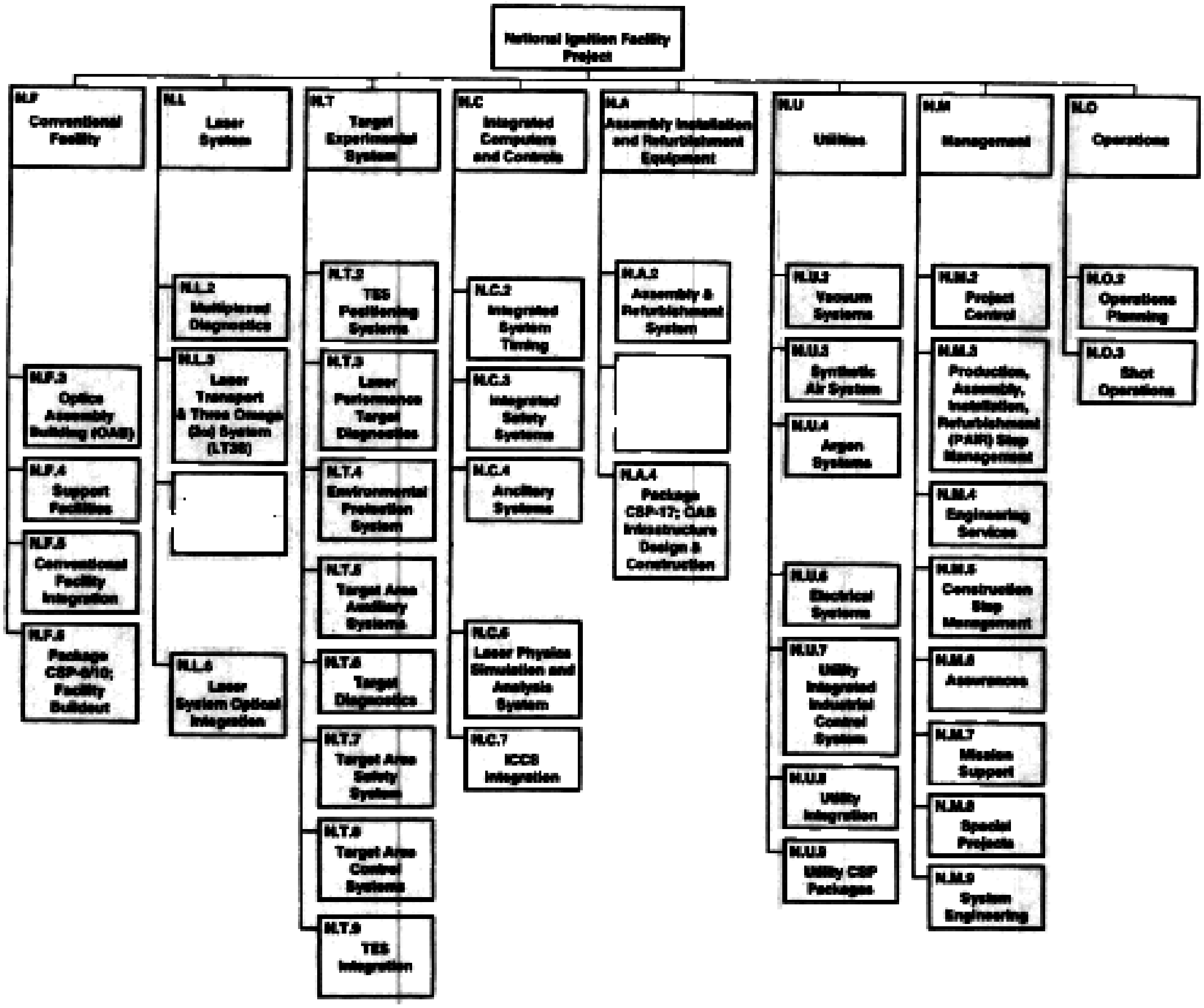
Stockpile Stewardship and Management Programmatic Environmental Impact Statement

University of California
University of Rochester Laboratory for Laser Energetics

Appendix B

NIF Work Breakdown Structure

NIF Work Breakdown Structure



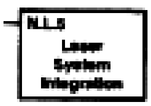
-IN.F.'
____Site
"mprovements

N.F.2
Laser & Target Area Buildings (LTAB)

-IN.L.1
Main Laser
System (MLS)

--I N.C.1
Supervisory
Control

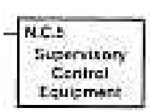
N.L4
Laser System I Beam Control & Diagnostics



-fN:A. 1 Transport &
Handling

-IN.U.1
Water
Systems

IN.A.3
I A!lsembly.
i Inslallation. & I Rel\orbishment
Integration



-IN.M.1 -
__Project
Manage",,'n!

-/ N.O.'
_Operations Managemant

'~O-OO-O700-5539pbOl

:Figure B-1. NIF Work Breakdown Structure.

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National Ignition Facility Project Execution Plan -Rev 2b

Appendix C

NIF Project Work Logic Diagram

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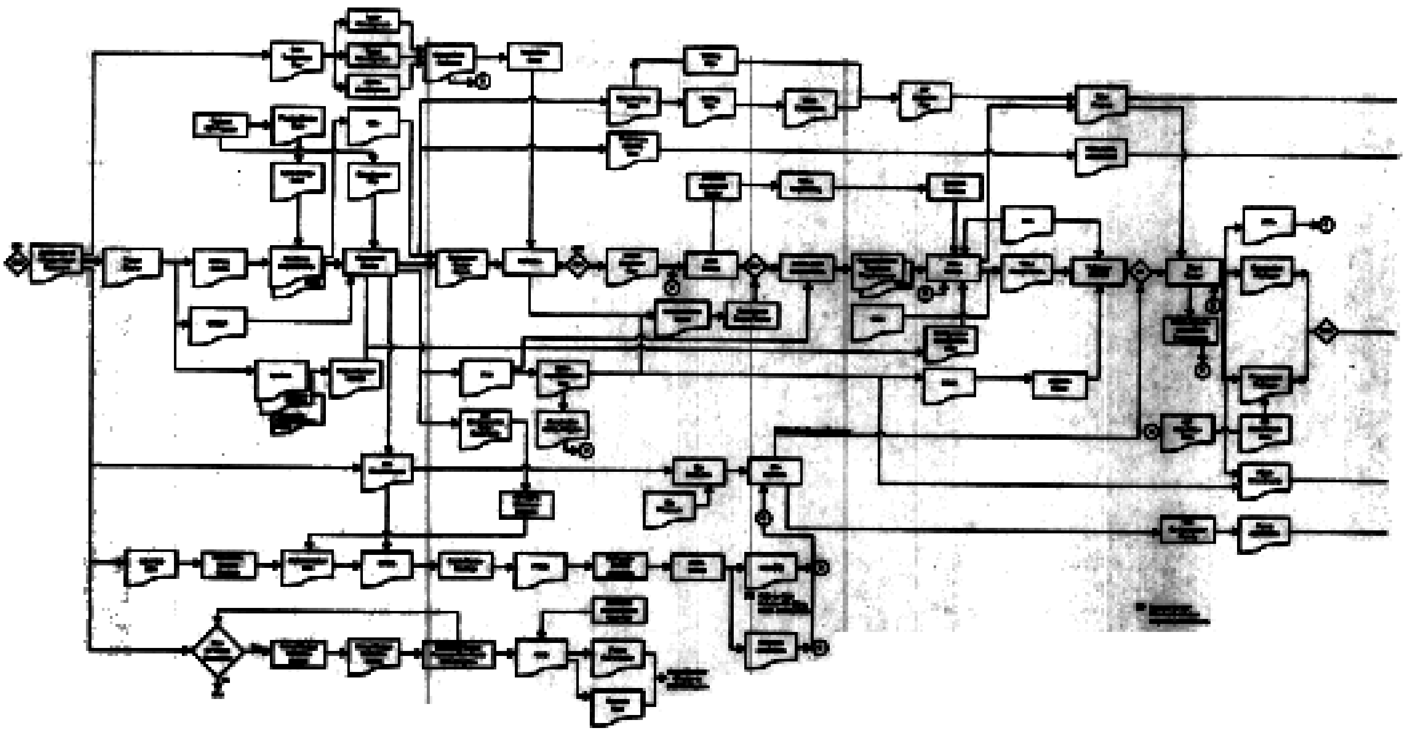

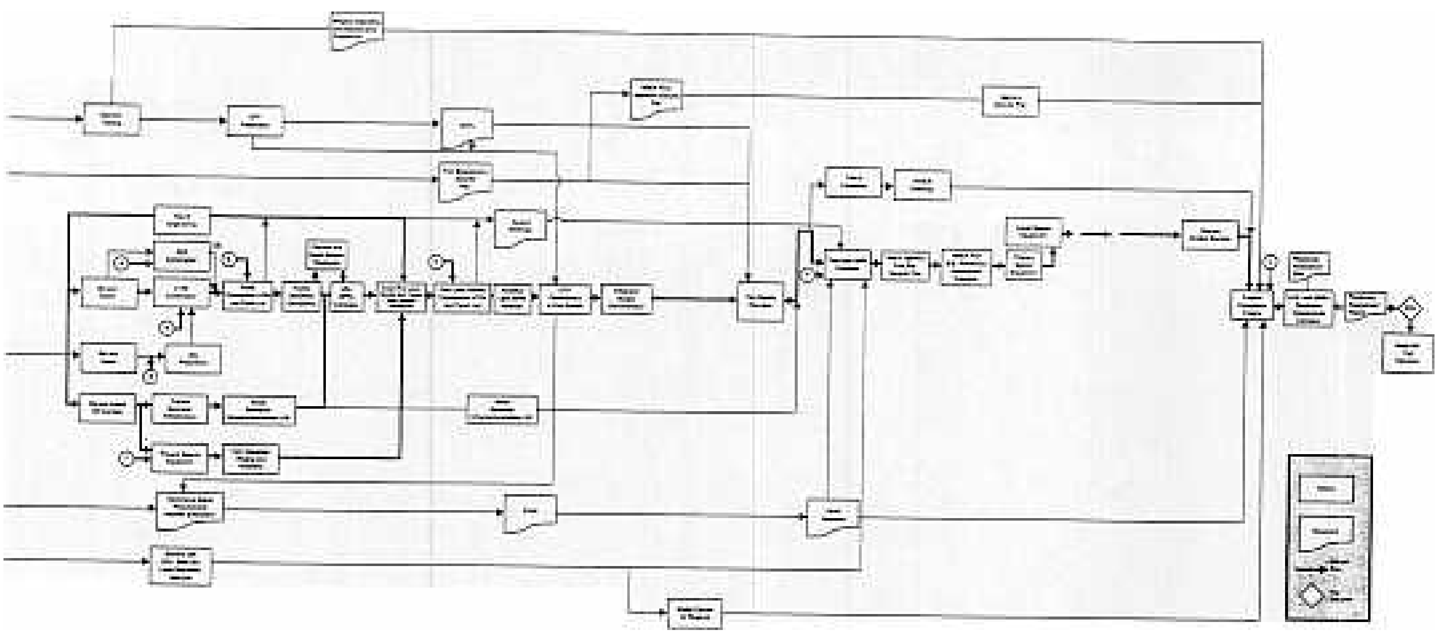

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National Ignition Facility Project Execution Plan Rev 2b

Appendix D

NIF Project Data Sheet

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96-D-111, National Ignition Facility (NIF), Lawrence Livermore National Laboratory, Livermore, California

(Changes from FY 200] Congressional Budget Request are denoted with a vertical line [I] in the left margin.)

Significant Changes

- This revised Construction Project Data Sheet reflects the rebaselining action perfonned to meet the Secretary of Energy's commitment to provide the new NIF schedule and cost estimate to Congress by September 2000. In this replanning, there are no scope changes; the NIF Functional Requirements/Primary Criteria remain as approved in the Baseline Change Proposal (BCP) 97-004. The changes to the schedule and cost estimate are mainly due to two factors: (1) The original contingency factors of 12% on Total Project cost (TPC) and 15% on Total Estimated Cost (TEC) were too low; (2) the complexity of the beampath infrastructure design and the necessity to assemble and install the laser system in clean environment were not fully appreciated and, as a result, the cost and schedule associated with this scope were seriously underestimated in the original baseline.

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The new NIP baseline:

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1. Raises the TEC contingency on the go-forward costs by $252M or 26.7%; a level commensurate with DOE guidelines and includes an assessment of risk for each element. This contingency is based on a "bottom-up" analysis that includes inputs from formal risk analysis, cost estimating uncertainty analysis, allowance for post-award change orders, industry standard allocations for conventional construction, and project management assessments;

.2. Incorporates the results of a comprehensive systems engineering analysis, which increased the cost estimates of beampath infrastructure construction and laser special equipment;
.3. Changes the method of accomplishing key implementation activities by transferring that responsibility to experienced industrial firms consistent with the Secretary's directive. An Integration and Management Installation (IMI) contract has been submitted to DOE for approval;
.4. Initiates a mission first strategy deployment strategy that maximizes the utility of the NIF for Stockpile Stewardship activities as early as possible during commissioning. .
.These actions have resulted in the path forward for the project that increases the total cost of the project from its original TPC estimate of $1.198B to the rebaselined estimate of $2.248B or by approximately $1 billion and extends the NIF completion date from October 2004 to September :2008.

The funding amounts contained in this datasheet conform to the annual budget profile contained in the letter from the Secretary of Energy to Congress dated June 1, 2000. These amounts have been reviewed for project impact and execution during a recently completed rebaselining exercise. The rebaseline cost and schedule estimates have been validated by an independent DOE review team.

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This datasheet changes the presentation of the costs for the National Ignition Facility to include not only the line item construction costs (TEC) and traditional Other Project Costs, but also the other related Operations and Maintenance costs that support NTF. These costs were funded from FY 1995 through FY 2000 within Lawrence Livermore National Laboratory's Inertial Confinement Fusion program. In the FY 2001 Budget Request, the funding is in Readiness in Technical Base and Facilities, and is specifically identified as NTF Operations and NIF Program Facilities and Infrastructure Buildup Activities. The activities supported with this funding are, and always have been, an integral part of the research and development program necessary to accomplish the advances in technology required to complete NIF, the largest and most complex optical unit ever to be designed and constructed. It includes the development of laser and optics technology, as well as the assembly, installation and activation of the Line Replaceable Units (the modules of the laser system) for all beams of NIF. The change from the amount assumed at the time of submission of the FY 2001 budget is due to the fact that there will now be research, development and support work associated with NTF through completion of the project in FY 2008. However, this does not represent an overall increase in funding during these years, since there would have been comparable costs for operating NTF from FY 2004 through FY2008.

1. Construction Schedule History

iA-E **Work I Initiated**

Fiscal Quarter

A-E Work
I Com~leted

Physical Construction
I Start

Physical
Construction
I Com~l~

Total
Estimated
Cost

($000)

Total
Project
Cost
($000)

Other Related
Costs ($000)

Total
Project-
Related
Costs ($000)

FY 1996 Budget Request
(Preliminary Estimate) ... FY '1998 Budget Request
(Title/Baseline) FY :~OOO Budget Request.
FY :~001 Budget Request
(Current Baseline Estimate) FY 2001 Amended Budget
Request.

101996

101996 101996

101996

101996

101998

101998 20 1998

20 1998

20 1998

301997

30 1997 30 1997

30 1997

30 1997

302002

302003 302003

302003

402008

842,600 1,073,600

1,045,700 1,198,900 1,045,700 1,198,900

1,045,700 1,198,900

2,094,897 2,248,097

N/A

N/A N/A

833,100 2,032,000 1,200,000a 3,448,097

N/A

N/A N/A

2. Financial Schedule

(TEC Funding)

(dollars in thousands)

C Fiscal Year Appropriations Obligations Costs 1996 37,400 37,400 33,990 1997 131,900 131,900 74,294 1998 197,800 197,800 165,389 1999 284,200 284,200 251,476 2000 247,158b 247,158 240,600 2001 209,100 209,100 308,370 2002 245,000 245,000 254,960 2003 187,200 187,200 196,580 2004 150,000 150,000 136,250 2005 130,000 130,000 128,590 2006 130,000 130,000 130,240 2007 130,000 130,000 145,370 2008 15,139 15,139 28,788

a The Other Related Costs show an increase of $366.9 million. A similar amount would have been spent under the original estimate for operation of the completed facility. Therefore, for fiscal years 2004 to 2008, there is no expected increase in total funding for NIF Other Related Costs. (See Significant Changes for more detail.)

b Original appropriation was $248,100,000. This was reduced by $942,000 for the FY 2000 rescission enacted by P.L.106-113.

3. Project Description, Justification and Scope

The Project provides for the design, procurement, construction, assembly, and acceptance testing of the National Ignition Facility. The NIF is an experimental inertial confinement fusion facility intended to achieve controlled thermonuclear fusion in the laboratory by imploding a small capsule containing a mixture of the hydrogen isotopes, deuterium and tritium. The NIF is being constructed at the Lawrence Livermore National Laboratory (LLNL), Livermore, California as determined by the Record of Decision made on December 19, 1996, as a part of the Stockpile Stewardship and Management Programmatic Environmental hnpact Statement (SSM PElS).

The mission of the National Inertial Confinement Fusion (ICF) program is to execute high energy density physics experiments for the Stockpile Stewardship program, an important part of which is the demonstration of controlled thermonuclear fusion in the laboratory. Technical capabilities provided by the ICF program also contribute to other DOE missions including nuclear weapons effects testing and the development of inertial fusion power. As a key element of the Stockpile Stewardship Program, the NIF is designed to achieve propagating fusion bum and modest (1-10) energy gain within 2-3 years of full operation and to conduct high energy density experiments, both through fusion ignitions and through direct application of the high laser power. This mission was identified in the NIF Justification of Mission Need, which was endorsed by the Secretary of Energy. Identification of target ignition as the next important step in ICF development for both defense and non-defense applications is consistent with the earlier (1990) recommendation of DOE's Fusion Policy Advisory Committee, and the National Academy of Sciences Inertial Fusion Review Group. In 1995, the DOE's Inertial Confinement Fusion Advisory Committee affirmed the program's readiness for an ignition experiment. A review by the JASONs in 1996 affirmed the value of the NIF for stockpile stewardship.

The NIF project supports the DOE mandate to maintain nuclear weapons science expertise required for stewardship of the stockpile. After the United States announcement of a moratorium on underground nuclear tests in 1992, the Department established the Stockpile Stewardship program to ensure the preservation of the core intellectual and technical competencies in nuclear weapons. The NIF is one of the most vital facilities in that program. The NIF will provide the capability to conduct laboratory experiments to address the high energy density and fusion aspects that are important to both primaries and secondaries in stockpile weapons.

At present, the Nation's computational capabilities and scientific knowledge are inadequate to ascertain all of the performance and safety impacts from changes in the nuclear warhead physics packages due to aging, remanufacturing, or engineering and design alterations. Such changes are inevitable if the warheads in the stockpile are retained well into this century, as expected. In the past, the impacts of such changes were evaluated through nuclear weapon tests. Without underground tests, we will require better, more accurate computational capabilities to assure the reliability and safety of the nuclear weapons stockpile for the indefinite future.

To achieve the required level of confidence in our predictive capability, it is essential that we have access to near-weapons conditions in laboratory experiments. The importance of nuclear weapons to our national security requires such confidence. For detonation of weapon primaries, that access is provided in part by hydrodynamic testing. For secondaries and for some aspects of primary performance, the NIF will be a principal laboratory experimental physics facility.

The most significant potential commercial application of ICF in the long term is the generation of electric power. Consistent with the recommendations of the Fusion Policy Advisory Committee, the NIF will provide a unique capability to address critical elements of the inertial fusion energy program by exploring moderate gain (1 -10) target designs, establishing requirements for driver energy and target illumination for high gain targets, and developing materials and technologies useful for civilian inertial fusion power reactors.

The ignition of an inertial fusion capsule in the laboratory will produce extremely high temperatures and densities in matter. Thus, the NIP will also become a unique and valuable laboratory for experiments relevant to a number of areas of basic science and technology (e.g., stellar phenonena).

The NIF is an experimental fusion facility consisting of a laser and target area, and associated assembly and refurbishment capability. The laser will be capable of providing an output pulse with an energy of 1.8 megajoules (MJ) and an output pulse power of 500 terawatts (TW) at a wavelength of 0.35 micrometers (flm) and with specified symmetry, beam balance and pulse shape. The NIF design is an experimental facility housing a multibeam line, neodymium (Nd) glass laser capable of generating and delivering the pulses to a target chamber. In the target chamber, a positioner will center a target containing fusion fuel, a deuterium-tritium mixture, for each experiment.

The NIF experimental facility, titled the Laser and Target Area Building, will provide an optically stable and clean environment. This Target Area Building will be shielded for radiation confinement around the target chamber and will be designed as a radiological, low-hazard facility capable of withstanding the natural phenomena specified for the LLNL site. The baseline facility is for one target chamber, bl,lt the design shall not preclude future upgrade for additional target chambers.

The NIF project consists of conventional and special facilities.

.Site and Conventional Facilities include the land improvements (e.g., grading, roads) and utilities (electricity, heating gas, water), as well as the laser building, which has an approximately 20,300 square meters footprint and 38,000 square meters in total area. It is a reinforced concrete and structural steel building that provides the vibration-free, shielded, and clean space for the installation of the laser, target area, and integrated control system. The laser building consists of two laser bays, each 31 meters (m) by 135 m long, and a central target area--a heavily shielded (1.8 m thick concrete) cylinder 32 m in diameter and 32 m high. The laser building includes security systems, radioactive confinement and shielding, control rooms, supporting utilities, fire protection, monitoring, and decontamination and waste handling areas. Optics assembly and refurbishment capability is provided for at LLNL by incorporation of an optics assembly area attached to the laser building and minor modifications of other existing site facilities.

Special facilities include the Laser System, Target Area, Integrated Computer Control System, and Optics.

The laser system is designed to generate and deliver high power optical pulses to the target chamber. The system consists of 1921aser beams configured to illuminate the target surface with

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a specified symmetry, unifomrity, and temporal pulse shape. The laser pulse originates in the pulse generation system. This precisely formatted low energy pulse is amplified in the main amplifier. To minimize intensity fluctuation, each beam is passed through a pinhole in a spatial filter on each of the four passes through the amplifier and through a transport spatial filter. The beam transport directs each high power laser beam to an array of ports distributed around the target chamber where the frequency of the laser light is tripled to 0.35 I.1m, spatially modulated and focused on the target. Systems are provided for automatic control of alignment and the measurement of the power and energy of the beam. Structural support and auxiliary systems provide the stable platform and utilities required.

The target area includes a 10 m diameter, low activation (i.e., activated from radiation) aluminum vacuum chamber located in the Target Area of the laser building. Within this chamber, the target will be precisely located. The chamber and building structure provide confinement of radioactivity (e.g., x-rays, neutrons, tritium, and activation products). Diagnostics will be arranged around the chamber to demonstrate subsystem performance for project acceptance tests. Structural, utility and other support systems necessary for safe operation and maintenance will also be provided in the Target Area. The targe~ chamber, the target diagnostics, and staging areas will be capable of conducting experiments with cryogenic targets. The Experimental Plan indicates that cryogenic target experiments for ignition will be needed 2-3 years after completion of the project. Therefore, the targets and this cryogenic capability will be supplied by the experiments. The NIF project will make mechanical and electrical provisions necessary to position and align the cryogenic targets within the chamber. The baseline is for indirectly driven targets. An option for future modifications to permit directly driven targets is included in the design. -

The integrated computer control system includes the computer systems (note: no individual computer will cost over $100,000) required to control the laser and target systems. The system will provide the hardware and software necessary to support initial NIF acceptance and operations checkout. Also included is an integrated timing system for experimental control of laser and diagnostic operations, safety interlocks, and personnel access control.

Thousands of optical components will be required for the 192 bearnlet NIF. These components include laser glass, lenses, mirrors, polarizers, deuterated potassium dihydrogen phosphate crystals, potassium dihydrogen phosphate crystals, pulse generation optics, debris shields and windows, and the required optics coatings. Optics includes quality control equipment to receive, inspect, characterize, and refurbish the optical elements.

Project Milestones:

Major milestones and critical decision points have changed as follow:

Milestones	Current Date	Previous Date
Approval of Mission Need (CD1)	Jan 1993	Jan 1993
Titl13 I Initiated	Jan 1996	Jan 1996
NEPA Record of Decision	Dec 1996	Sep 1996
Approval to Initiate Construction (CD3)	Mar 1997	Mar 1997

6

Start Special Equipment Installation

151 light

12 bundle

24 bundles

Project Complete (CD4)'

Nov1998

Jun 2004

Jun 2007

Sep 2008 Sep 2008

Nov 1998

NA

Oct 2003

NA

Oct 2003

*CD4 was previously defined as 12 bundles cornrnissioned and 12 bundles installed. CD4 is now defined as all 24 bundles cornrnissioned.

Project milestones for FY 2000 **and** FY 2001 **include: .FY** 2000

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Complete Optics Facilitization

lQ

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Complete Optics Assembly Building
Place Integration Management and Installation Contract

Certification of new cost and schedule baseline

3Q
4Q
4Q

FY 2001

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Supplemental Environmental Impact Statement -Record of Decision

Inert gas/vacuum Management Pre-Start Review -Phase 3

A ward production contracts for amplifier slabs

End conventional construction

lQ 2Q 3Q
4Q

Weapons Activities/Construction! 96-D-III-National Ignition Facility

Rev 2b

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4. Details of Cost Estimate

Design Phase
Preliminary and Final Design costs (Design Drawings and Specifications)
Design Management Costs (1.8%ofTEC) Project Management Costs (1.8% of TEC) Total Design Costs (13.2%ofTEC) Construction Phase
Improvements to Land. Buildings. Special Equipment. Utilities. Inspection, Design and Project Liaison, Testing, Checkout and Acceptance
Construction Management (0.9% of TEC) Project Management (2.6% ofTEC) Total Construction Costs (74.80;00fTEC) '.'.'.' ",.., ,..,.,..
Contingencies
Design Phase (2.2% of TEC; 3.9% of remaining **TEC** BA) Construction Phase (9.90;0 of TEC; 20.90;0 of remaining **TEC** BA) Total Contingencies (12.0% ofTEC; 26.7% of remaining **TEC** BA) Total, Line Item Costs (TEC)

(dollars in thousands

199,556 101,143 37,721 21,900 38,717 22,000 275,994 145,043

1,800 173,400 1,199,825 500 118,700 18,000 54,683 1,566,908

1,800 170,724 520,802 500 73,250 22,800 31,500 821,376

45,330 1,000 *206,665* 78,281

251,995 79,281 2,094,897 1,045,700

The cost estimate assumes a project organization and cost distribution consistent with the management requirements appropriate for a DOE Major System as outlined in the NIP Project Execution Plan.
Actual cost distribution will be in conformance with accounting guidelines in place at the time of project execution.

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5. Method of Performance

The NIP Project Office (consisting ofLLNL, Los Alamos National Laboratory (LANL), Sandia National Laboratory (SNL), and University of Rochester Laboratory for Laser Energetics (UR/LLE) and supported by competitively selected contracts with Architect/Engineering firms, an integration management and installation contractor, equipment and material vendors, and construction firms) will prepare the design, procure equipment and materials, and perform conventional construction, safety, system analysis, and acceptance tests. DOE/NNSA will maintain oversight and coordination through the Defense Programs Office of the NIP Project. All activities are integrated through the guiding principles and five core functions of the DOE Order on Integrated Safety Management Systems (ISMS) (DOE P450.4). DOE conducted the site selection and the NEPA determination in the SSMPEIS. LLNL was selected as the construction site in the ROD made on December 19, 1996.

5.1 NIF Execution

5.1.1 Conceptual and Advanced Conceptual Design

The conceptual design was completed in May 1994 by the staff of the participating laboratories. Keller and Gannon contractors provided designs of the conventional facilities and equipment.

Design requirements were developed through the Work Smart Standards (WSS) Process approved by the Director of the Oakland Operations Office. New requirements have been defined since the original WSS was placed in Contract 48 in 1997. A gap analysis will be perfonned, and if changes are required a revision will be prepared.

The Conceptual Design Report was subjected to an Independent Cost Estimate (ICE) review by Foster Wheeler USA under contract to the DOE. The advanced conceptual design phase further developed the design, and is the phase in which all the criteria documents that govern Title I Design were reviewed and updated.

5.1.2 **Title** I Design

In fiscal year 1996, Title I Design began with the contract award for the Architect/Engineers (Parsons and AC Martin) and a Construction Management finn (Sverdrup) for the design and the constructiblity reviews of the (1) NIF Laser and Target Area Building and (2) Optics Assembly Building. Title I Design included developing advanced design details to finalize the building and the equipment arrangements and the service and utility requirements, reviewing project cost estimates and integrated schedule, preparing procurement plans, conducting design reviews, completing the PSAR and NEP A documentation, and planning for and conducting the constructibility reviews.

Title I Design was completed in November 1996 and was followed by an ICE review.

5.1.3 **Title II Design**

The participants in Title n (final design) include LLNL, LANL, SNL, Parsons, AC Martin, and Jacobs/Sverdrup (constructibility reviews). The Title II Design provides construction subcontract packages and equipment procurement packages, construction cost estimate and schedule, Acceptance Test Procedures, and the acceptability criteria for tested components (e.g., pumps, power conditioning, special equipment), and environmental permits for construction (e.g., *Storm Water Pollution Prevention Plan).*

5.1..4 Title III Design

The Title ill engineering participants include LLNL, Parsons, AC Martin, and Jacobs/Sverdrup. Title ill engineering represents the engineering necessary to support the construction and equipment installation, including inspection and field engineering. The main activities are to perform the engineering necessary to resolve issues that may arise during construction (e.g., fit problems, interferences). Title ill engineering will result in the final as-built drawings that represent the NIF configuration.

5.1.5 Construction and Equipment Procurement, Installation, and Acceptance

Based on the March 7, 1997, Critical Decision 3, construction began with site preparation and excavation of the Laser Target Area Building (LT AB) fornling the initial critical-path activities. The NIP Construction Safety program was approved and sets forth the safety requirements at the construction site for all LLNL and non-LLNL (including contractor) personnel. There was sufficient Title "II Design completed to support bid of the major construction and equipment procurements. The conventional facilities are designed as construction subcontract bid packages and competitively bid as firm fixed price procurements. The initial critical-path construction activities include both the Laser and Target Area Building and the Optics Assembly Building (where large optics assembly and staging will take place). In addition, the site support infrastructure needed to support construction of conventional facility, beampath infrastructure installation, and line replaceable equipment and optics staging are being put in place. At the same time, procurements on the critical path (e.g., target chamber) began following the established *NIF Acquisition Plan.*

The next major critical path activity is the assembly and installation of the Beampath Infrastructure Systems. These are the structural and utility systems required to support the line replaceable units. The management and installation of the Beampath Infrastructure System is being contracted to an Integration Management and Installation Contractor. This was done to fully involve industry in the construction ofNIF as directed in the Secretary of Energy's 6-Point Plan and recommended by the Secretary of Energy Advisory Board interim report in January 2000. During the period of Beampath Infrastructure System installation, line replaceable unit and optics procurements continue.

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The line replaceable unit equipment will be delivered, staged, and installed as phased beneficial occupancy of the Laser and Target Area Building is achieved. This is a complex period in which priority conflicts may occur because construction, equipment installation, and acceptance testing will be occurring. The Product Line Managers, Area Integration Managers, and Integration Management and Installation Contractor will manage and integrate the activities to avoid potential interferences affecting the schedule. The construction, equipment installation, and acceptance testing will be supported by Title ill inspection and field engineering, which will include resolving construction and installation issues and preparing the final as-built drawings.

5.1.6 Operational Testing and Commissioning

After installation, the facility and equipment will be commissioned prior to the phased turnover to the operations organization. The transfer points employ the Management Pre-Start Review process in which an independent team evaluates the readiness (e.g., training and qualification of operators, Commissioning Test Procedures results, and as-built drawings) and recommends turnover by the NIF Project Manager. The NIF Project Manager approves the transfer of responsibility for ISMS Work Authorization.

The integrated system activation will begin with the commissioning of the first bundle. Management Pre-Start Reviews (MPRs) will be used by the Project Manager to control each system turnover. In specific cases, such as first light, first experiment, and ignition readiness, the DOE/NNSA Field Office will oversee and concur in the MPR. A sequence of MPRs are scheduled to ensure a disciplined and controlled turnover of NIF systems from construction to activation. MPRs will be conducted by LLNL prior to the start of first experiments and NIF 192-beam operation, and the results will be validated by the Defense Programs Office of the NIF Readiness Assessment. The first experiment and 192-bearn Readiness Assessment requires that the FSAR be completed and approved (including the documented operating/maintenance procedures, operating staff training, and as-built design documentation). The 192-beam Readiness Assessment results are a key input for Critical Decision 4 (Project closeout) by the Acquisition Executive.

5.1.7 Project Completion

The complete set of NIF criteria is contained in the *NIF Functional Requirements and Primary Criteria.* These are the criteria that NIF is required to meet when fully operational. However, early test operation of NIF by the Program through a series of turnovers controlled by Management Pre- Start Reviews will be achieved by a phased transition to Program operations for user tests before Project completion. This enables the Program to begin experimental operations in support of Stockpile Stewardship and other programmatic missions at the earliest possible date, as NIF performance capability is building up toward the eventual goals set out in the *NIF Functional Requirements and Primary Criteria* and *Project Completion Criteria.*

6. Schedule of Project Funding

Project Cost
Fac:ility Costs
Design. Construction. Total,LineitemTEC '.".'.".''". Other Project Costs
R&D necessary to complete construction Conceptual design costs bP.c
NE A documentation costs. Other project-related costs d Total, Other Project Costs. Total Project Cost (TPC)

a

Oth,er Related Operations and Maintenance Costs - NIF Demonstration Program e TOTAL Project and Related Costs.

Budget Authority (BA) requirements T TEC(capitalfunding) .".'..'.'.' '.
OPC(O&Mfunding) NIF Demonstration Program (O&M funding)
Total,BArequirements ,.,.".'"' ,

(dollars in thousands)

143,043	75,000	50,000	30,000	23,281	321,324
130,630	176,476	190,600	278,370	997,497	1,773,573
273,673	251,476	240,600	308,370	1,020,778	2,094,897

85,126 12,300 3,754 18,815

13,909
0 **601**
1,638

2,252
0 370 660

3,238 0
600
480

0
0
1,275
8,182

104,525
12,300
6,600 29,775

119,995 **16,148** 3,282 4,318 9,457 153,200
,.-. .--,---
393,668 267,624 243,882 312,688 1,030,235 2,248,097

276,400 55,648 70,723 76,799 720,430 1,200,000 ,-- -,---,---
670,068 323,272 314,605 389,487 1,750,665 3,448,097

367,100 *284,200* 247,158 ***209,100*** 987,339 2,094,897 *132,300* 6,800 5,900 5,900 2,300 *153,200* *276,400* *65,900* *77,200* *60,800* *719,700* 1,200,000
., --,---,---
775,800 *356,900* 330,258 *275,800* 1,709,339 3,448,097

11 Costs include optics vendor facilitization and optics quality assurance.

b Includes original conceptual design report completed in FY 1994 and the conceptual design activities for the optical assembly and refurbishment capability and site infrastructure.

(; Includes preparation of the NIF portion of the Stockpile Stewardship and Management Programmatic Environmental Impact Statement, NIF Supplemental Environmental Impact Statement and environmental monitoring and permits.

d Includes engineering studies (including advanced conceptual design) of project options; assurances, safety analysis, and integration; start-up planning, management, training and staffing; procedure preparation; startup; and Operational Readiness Review.

e Funding previously requested and appropriated in the Inertial Confinement Fusion Program and, beginning in FY 2001, under Readiness in Technical Base and Facilities, NIF Operations.

Long-lead procurements and contracts require BA in advance of costs.

Weapons Activities/Construction! 96-D..III-National Ignition Facility

Rev 2.b

12

7. Related Annual Funding Requirements

Annual facility operating costs a Annual facility maintenance/repair costs b , Programmatic operating expenses directly related to the facility C Capital equipment not related to construction but related to the programmatic effort in the!facility GF'P or other construction related to the programmatic effort in the facility. Utility costs d '
e
Other costs. Total related annual funding (estimate based on operating life of FY 2009 throughFY2038)

(dollars in thousands) Current Previous
Estimate Estimate 38.767 21,200 55,787 33,200 41,865 61,100

204 204 6,637 1,577

200 200 9,000 6,300

145,042 f 131,200 9

a Includes all **NIF** support personnel not in maintenance/repair, some of which were included previously in Pro~Jrammatic expenses (245 personnel).

b Includes refurbishment of laser & target systems, building maintenance, and component procurement (137 personnel).

C Includes the **LLNL** portion of the nationallCF Program that is directly related to the use of **NIF** but not facility scientific support. which is now included in facility operating costs.

d Estimate of electricity usage.

e Estimate of industrial gases (argon. synthetic air).

f In FY2001 dollars.

9 **In FY** 2000 dollars.

8. Design and Construction of Federal Facilities

All *DOE* facilities are designed and constructed in accordance with applicable Public Laws, Executive Orders, OMB Circulars, Federal Property Management Regulations, and *DOE* Orders. The total estimated cost of the project includes the cost of measures necessary to assure compliance with Executive Order *12088*, "Federal Compliance with Pollution Control Standards"; Section 19 *of* the Occupational Safety and Health Act of 1970, the provisions of Executive Order 12196, and the related Safety and Health provisions for Federal Employees (CPR Title 29, Chapter XVll, Part 1960); and the Architectural Barriers Act, Public Law *90-480*, and implementing instructions in 41 CPR *101-19.6.*

The project will be located in an area not subject to flooding determined in accordance with Executive Order 11988.

DOE has reviewed the GSA inventory of Federal Scientific laboratories and found insufficient space available, as reported by the GSA inventory.

NIF

Appendix

E

Project

Baseline

54

Costs

Nationa~!gnitio~acility Project Executio~Plan Rev 2b

Table E-1. NIF Annual Financial Schedule (Escalated $M)

FY93 I FY94 i FY9S1 FY96 I FY97 I FY98 I FY99! FYOO I FYO11 FYO21 FYO31 FYO4 Fyosi F'YO6 I FYO7 IFYoel Total I

Total Estimated Cost

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34.0	74.3	165.4	251.5	240.6	308.4	254.9	196.6	136.2	128.6	130.2	145.4	28.8	2094.9

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'Table E-2. NIF Annual Cost Plan at NWBS Level 2 and selected Level 3 (Escalated $M)
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Total Estimated Cost

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Appendix F

NIF Project Integrated Schedule, Major Milestones arld Critical Decisions, and NIF Project Documents

NIF Project Integrated Schedule,]\1ajor Milestones and Critical Decisions, and NIF Project Documents

This appendix contains the NIF Summary Integrated Project Schedule (Figure F-l), Major Project Milestones and Critical Decision Points (Table F-l), and NIF Project Documents (Table F-2).

CD1
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FY93: FY94 j-FY:gs-; FY96 : FY97: FY9B: FY99 : FYOO! FYO1 : FYO2: FYO3 : FYO4 [FYO5 : FY06-

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Impletl!

C01 Approve mission needed C:02 Approve new start
K:01' Oellums process- NIF study complete

CD3 Approve construction start CD4 Approve operation start
DM1 Optics facilitization complete DM2 End conventional construction

Figure F-l. NIF Summary Integrated Projec~,~chedule.

Table F-l. NIF Project Major Milestones and Critical Decision Points.

Activity
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Milestone Description
CDI-Approval of Mission Need

3010 IcDR Complete

20

CO2-Approval of New Start

1010 !Notice of Intent Issued

3020 jArchitect/Engineer Contracted

30

IKDI'Dellums Process Complete

3030 mile I Initiated

3040 /Construction Manager Contracted

2010 IPSAR DOE Concurrence

3050 /PSAR Approved

1020 /Approval to Initiate Title n Design

1030 !-Approval to Initiate Long Lead

40

NEPA Record of Decision

50

CD3-Approval to hritiate Title n Construction

2020

Issue Pollution Prevention/Waste Min

3060 !Start Special Equipment Installation

1040 jOptics Facilitization Complete (OM-I)

DOE Acquisition
Executive

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x

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x

NNSA Deputy
Admimstrator for Defense Projects

NNSA
Office of the
NIF Project

Levell I Level 2

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x

x

x

NIF
Project Manager
Level 3

x

x

x

x

x

x

Planned
Dates
Jan-93

Actual
Dates
Jan-93

May-94 I May-94

Oct-94

Jun-95

Oct-94

Jun-95

Dec-95 ! Dec-95

Dec-95 I Dec-95

Jan-96

Jan-96

May-96 I May-96

Aug-96 I Aug-96

Sep-96 I Sep-96

Nov-96 I Nov-%

Nov-96 I Nov-96

Dec-96 I Dec-96

Mar-97 I Mar-97

Aug-98 I Aug-98

Nov-98 I Nov-98

Dec-99

Dec-99

IDOE Acquisition
Executive!

I Activity 1m

I Milestone Description

Level 0

60

iRebaseline Plan Approved

x

2040 IIMI Contract Approved

3210

OAB MPR Phase I-Pennit Equipment Installation

2030 ~EIS Record of Decision

3240

Inert GasNacuum MPR Phase 3-Pemlit SF Vacuum

1050

End Conventional Construction (DM-2)

2050 rrarget Chamber Positioned

2060

~oint MPR-OAB Phase 2-Pennit LRU IAssembly

3320

LRU Installation MPR P2-Permit LB2 LRU Instl

3205

rPDL MPR-Pennit Production Optics
IProcessing

3310

1..RU Installation MPR PI-Pennit PAM/PABTS Instl

3280

PCS MPR-Pennit 1B2 FIashlamp Test Main Amp PI
I

3330

~u Installation MPR P3.Pennit SY2 LRU Instl

3110

n.s MPR Phase I-Permit P AMMA Opemtions

307U fsAR Approved

3340

LRU Installation MPR P4-Pennit TB ~U Instl

3410

Light Propagation MPR P1-Pennit Light in LB2- TB

NNSA Deputy
Administrator for Defense Projects

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NNSA
Office of thE ;NIF Project

NIF
Project Manager

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May-OO I May-OO I

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Mar-Ol

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Mar-O2

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Dec-O3

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National Ignition Facility Project Execution Plan Rev 2b

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DOE Acquisition
Executive I

NNSA Deputy
Administrator for Defense Projects

NNSA
Office of the NIF Project

!Activity
m Milestone Descri Level 0 Levell Level 2

2070 iFSAR NNSA Concu=nce

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3120

ILS MPR Phase 2-Permit MOR ::>perations

3130

n..s MPR Phase 3-Pennit PASS Laser Align

3140

~ MPR Phase 4-Pennit n.s Integration Testing

3420

light Propagation MPR P2-Pennit light in LB2

3430

ught Propagation MPR P3-Pernrit ught in PDS

2080

croint MPR-Light Propagation Phase 4- pennit Light to Target Bay

x

3220 !Inert GasNacuum MPR Phase I-Pennit trc Vacuum

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linen GasNacuum MPR Phase 2-Pemrit
bas Filling

3520 frst Light to Target Chamber Center

3500

First Experiments Readiness

3510

IOkj I w to Precision Diagnostics-
LB2/SY2

3590 II st Bundle Commissioned

2090 INNS~ Approval First Experiments !Readmess Assessment

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3350 iLRU Installation MPR P5-Pennit LBI iLR U Ins tl

3290

PCS MPR-Permit LBI Aashlarnp Test
Main Amp P2

]060

Beampath Infrastructure
'Commissioning Complete

x

NIF
Project
I Manager
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! Planned Dates

Jan-04

Jan-04

Jan-04

Jan-Q4

Feb-04

Feb-04

Feb-04

Mar-Q4

May-04

Jun-04

Nov-04

Dec-04

Dec-04

Jan-OS

Jan-O6

Feb-Q6

Mar-06

I Actual Dates

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DOE Acquisition
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Administrator for Defense Projects

I NNSA
Office of the NIF Projectl

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3600 16 Bundles Commissioned

3360

[.RU Installation MPR P6-Pennit SYI LRU Instl

3450

Light Propagation MPR PS-Perrnit Light in LBI

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light Propagation MPR P6-Pemrit Ught in SYI

3610 ~ Bundles Commissioned

2110 /4-Fold Symmetry Capability

3620 112 Bundles Commissioned

2120

8-Fold Symmeb"y in One Cone ICapability

3630 115 Bundles Commissioned

2130

8-Fold Symmetry in Two Cones Capability

3640 lIs Bundles Commissioned

3680 ~ecurity Review (UNL)

2150 ~ecurity Review (NNSA)

3670

~eadiness Assessment-Full NIF Operations (U.NL)

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Readiness Assessment-Full NIF Operation (Office of the NIF)

3660 124 Bundles Commissioned

70

CD4-ApprovaI to Begin Operations

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Jun-06

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Dec-06

Dec-O6

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Mar-O8

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Jul-08

Sep-O8

Sep-O8.

*** = CD4 is now defined as all 24 Bundles Commissioned**

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National Ignition Facility Project Execution Plan Rev 2b

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Responsibilities

Document

I Justification of Mission Need

.-!:roject Data Sheet
Project Charter
-.!'roject Execution Plan
,.-!:rirnary Criteria
F:unctional Requirements
System Design Requirements Interface Control Documents
Preliminary Hazards Analysis Quality Assurance Plan
I Conceptual Design Report
-Environmental Permits ttt
l'JEPA (SSMPEIS/ROD)
F'relirn. Safety Analysis Report
ES&H Plan
Security Plan
Quality Assurance Audit
C:onstruction Completion Report
Project Control Manual
Final Safety Analysis Report Operational Test Procedures
LLNL Readiness Assessment Report
NNSA Readiness Assessment Report

Annual Budget Validation Report
Unusual Occurrence Report Configuration Management Plan
Monthly Status Report
Quarterly Status Report Project Acquisition Plan
Joint MPRs ttttt
Readiness Assessments tttttt

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Table F-2. NIF Proiect Documents.

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..National Nuclear Security Administration ...Environmental Safety and Health
Office of Engineering and Construction Management ,t Office of the NIF Project
:t J:'JIF ~ojec\Office

†† National Environmental Policy Act preparer
††† Approval by Environmental Protection Agency, Regional Air Quality Districts
†††† Results will be included in the Readiness Assessment
††††† Light Propagation Phase & Tritium Systems and Cryogenic Target, High-Yield Ignition Readiness.
†††††† First experiments, full 192-beam operation

:Frequency *Key:* a = annual, n = ''as-needed,'' 0 = "one-lime," m = monthly, q = quarterly
Responsibility *Key:* P = preparation, R = review. C = concurrence, A = approval, I = infomlation only, In = input

CAB Phase ll- Permit LRU Assembly

Appendix G

Key Decision 1 (Critical Decision 2) Approval Letter, October 1994

The Secretery of Energy
Washington, DC 20585

MEMO~"DUM 1-'OR THE SECRETARY

THROUGH:

FROM:

SUB.JECT:

Charles E. Curtis
Under Secret8r)"

Victor H. Reis

ACTION:

Approve Key Decision One tor
the NationaJ. Ignition Focility

Since the May 24, 1994, Energy SYStE!m5 Advisory Board meeting on the National Ignition Facility, the Department has conducted a ",ide ranging review of issues and concerns associated wit.h prcceeding to the next stege of devE!lopment of the .fecility. The issues examined in this context incJ.ude concerns about the i.D1:>act of the fficility on U.S. nonprolifer!Ltion goals; contribut.ions of the project to stockpile stewardship efforts end ot.her scierJce, technology and energy objectives of the Department; end envirorunental, sefety, health end b\ldgetary considerations. Many of these issues, most notebly t:he concern that construc:tion of the facility may hinder U.S. no~)roliferetion objectives, have elso been articulated by veriou6 incl.ividuals, non-government.al organizet"ions, and members of ConfJrE~ss.

The Department concurs that the iss\le5 identified above must be carefully examined and thoroughly .d~~bated prior to a decisictn t.o proceed with construction of t.he fac:ility. To t.h~t end. t.hE! Department has endorsed ~n ongoing ~)rocess of analysis end dialogue as proposed by the Chairman of t.he House ArU1ed Services Committee. Congressman Ron Dellums, t.o 68tisfy concerns about outst8nding issues. Specifically, ~;he DellUn\S process will consist of the fo11owing elements:

(1) if e positive Key Deci6iOtl One iauthorizing preliJl:linery desi-gn) is taken, the Deptlrtment egrees to establ~.6h ~ new milestone -- a Key Dec:ision 8One Prime- -.pr1.or to making Key Decision "TWo (cluthorizing detailed desj.gn) . The princip~l focus of K~' .Decision One Prime would be to resolve the question oj: whether or not the National Ignition Facility will ~id or hinder our non- pro]iferation efforts:

(2)

(3)

en assessment that the mi!;sion and purpose of the facility remain tim~ly end relevent;
comprehensive stakeholder participation on issues of concern. especially nonproliferation: and

(4)

coordination with other agencies of the U.S. government necessary for carrying out t:he steps agreed to above.

The Department took the first step in implementation of this process through a workshop on the Nat~.onal Ignition Facility C'n September 8. 1994. with represent.8tivE~s of Federal agencies. national laboratories. contractors. non-governmental organi~ations and advisory groups.

Based upon careful consideration of information and viewpoints received to date. and subject to the c:onditions and requireme.nts of the Dellums process. we conclude t1'lat it is appropriate to approve Key Decision One at this time. Approval of Key Decision one will support the initiation of thE~ National Environmental Policy Act process. as well as the est~abliGl'unent of a budget line item for fiscal year 1996 to support pre111t1.inary desig-n work such as engineering studies, prel~nary d%~awings. preliminary cost estimates an4 project scheduling.

The following ~&sess~nts support the conclusion to approve Key Decision one at this time:

t1issions
The National Ig'ni tion Facility haE. the! potential to contribute significantly in the following miSS10t1l areas:

(1)

-(21

Nuclear wea'Cons chvsics: I:n the ~sence of underground testing'. the National Ig-nition Fecility would be a critical tool for t.he Department' s Science:-Based Stockpile Stewardship prOgram. I:t would play en inportant role in ~intaining the co~inued safety and reliability of the stockp5:le by creating exper1mente.l condi t1ons that. approach certain aspects of nuclear weapo~~ PhYsics. In particular. this experimental capability would allow nuclear weapons scientists to assess stockpile p:~bl~, verify cOn';)utctional tools. anCS incre~5e: their understanding of weapons PhySiC5.

Inertial fusion enemy_: 'I'he Nati.onal Ignition FDcility would represent the scientific ~llmina.tion of more r.han 30 years of research in inerti~l co~lfinement fusion. This type of fusion concept focuses laser clr particle beams on ~pherical targets ceusing them tCI ift;11ode. creating high te%tIPere.tures and pressures necess;ary for these tergets to burn. With the Nationel Ignitiot1t Fe.cility. scientists ple.n to e.chieve ignition (self-heetino of the fuel) end fuel burn (more fusion energy produced tha~l laser energy deposited) in the labot:atory for the first time!. Such an Dchievement. could be an itnportant step towarcl the development of fusion energy. The recent. declas~ifica.t.ion of work. in the inertial confinement fusion program would enable international

(3)

cooperation on experiment.s at the National Ignition Facility.

~ci~!J~e, ~ec~~loav. erLd ot.h~r_applications: The Na't.ional Ignition F.cili ty would be a -magnet -facility, attr,~cti~g world-cle.ss scientiets e.nd engineers to work on problems of me.jor importence to 8ociety~ The ability to prob~
experimental conditions similar to those at the center of the sun and the sters would accelerate progress in be.sic sciences such as stellar physics and cosmology. In eddition, as the world's largest precision optical instrument. the project would spur industrial capabilities, technologi~s, end commercial epplications.

r:;ost and Schedule

~*e* facility would take approximately seven years to de5il~ and build (fiscal years 1996 through 2002). with the total prloje~t cost estimated at $900 ndllion over the eeven year period (in fiscal yee.r 1995 dollarsJ. 'rtte annual operating cost is ;expect.ed to be about $60 mllicn. 'rhe total e>q>er1mentAl operatinl~ lifetime of the facility is projected to be lS years. and cost $900 million. Decorm\issioning and decontamination costs ,~re estimated at $35 million. '!'his results in a life-cycle CI~st estimate of about Sl.8 billion.

NonprolifereticQll I -

Concerns have been expressed About the potential for the l~ational Ignition Facility to undermine t7. s. nonproliferation goal:s. 1.n particular, some have argued that 't'esearch at the facili~~ would allow the U. S. to continue to design and develop advance~d new nuclear weapons concepts, thereby c:ircumventing the prohi:bitions of e CORi'rehensive 'rest Ban Treaty. Othen ere conC:erned that access to the technologies or res~~cb data of the National Ignition Facility by non-nuclear WE~apon states could lead to hori%ontal prolifere.tion. On the other hand, because of its contribution to the maintenance of a 8~fe and reliable nuclear stockpile, the Ne.tional Ignition F~.cility might further u.s. nonproliferetion goals by speeding acceptance of ~ Comprehensive Test Ban ~ nuclear ~ecpons stctes.

The Department believes that. c polJ.cy of international collaboration and transp~rency for future e)q)erimentetion at the facility could help dispel fears a}~ut a secret advanced u.s. weapons program, and thus csBuage ~mny of the nonprolifer'ation concerns. The Depart.ment will furt~her explore this apprClach of openness for the fccility, and wilJ, resolve the broader r'ange of nonproliferation issues within the Key Decision One Pri~! process.

$afetv and Environmental Analvsis

The: DepaTtmC!nt. has co"\plet.ed ~ preliminary haZoards analysis cm r.he National Ignition Facility followed by safety, envi ronment-a 1 , radiat:ion protection. quality aS5urcnc4~, cnd decontamination and deco1m\issioning assessments. The facil:lty has been classified. by the Department to be a l~ hazard, nonl1uclear facility. The project will be reviewed in accordance with Lhe Na~ional Environmental Policy Act to evaluate the safety and environmental impacts from siting, construction and ()peration of ~he tacilir.y.

Sitina

"%'he National Environmental policy Act 2:"equires that eny preference related to the siting of e j:acility be stated by the Department. Given the resident technic:al expertise and existing infrastructure at Lawrence Livennore N~itional Laboratory, we believe that Livernore is preferable at:.this time to other candidate sites. Accordingly, we ~ould reconu-nend that you ennounce the Departmen~l preference for Livermore if Key Decision One is approved.

Rational Environmental Policy Act PrOCt~

Approval of Key Decision One obligates the Department to initi~ce the process of environmental review recJUired under the National Environmental Policy Act. ~e Departm4~t intends to initiate a programmatic environmental impact 6tatt~nt on Stockpile Stewardship and Management as a replac4~t to the now outda~ed programmatic EIS for reconfiguration. Since the NationAl Ignition Facility. would be an itaportant:. element of the stockpile stewardship program, we believe that the enyironmental itI'IPact, work on the proposed National Ignition Facility should occur within the larger framework of the pr~1rammatic environmental ~~act sr.atement for stockpile steward~~hip.

Reconvnendation

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Approvc Key Decision One, which w:i.ll: (l)initiate the National Environmental Policy Act process for the facilicty; find (2) establish a line item in tJhe fiscal year 1996 budget to support preliminary planning, .engineering, schedule find cost studies.

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Endorse the OpE~ And deliberative process for further inQUiry proposed by Congressman Dellums for proceeding to 8 Key Decision One Pri~ prior to Key Decision Two.

Announce that Lewrence Livermore National Laboratory is the Department's !Jreferred site for the Netional Igniti ~n Facility.

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National Ignition Facility Project Execution Plan Rev 2b

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1\pprove a Nal.ional Environm~mta.l Poli<..'Y ACL process that would include an examination of the National Ign3t.ion Facil~ty cs part of e progrl~atic environmental impact !'o"1..atement on stockpil,e stewl:rdship and management..

APPROVED:

(1

DISAPPROVED:

DATE:

October 20, 1994

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Appendix H

Approval of Baseline Change Action, March 1997

Department of Energy

Washington, DC 205B5
De~ 20, 1996

MEMORANDUM FOR mE SECRETARY

THROUGH:

THROUGH:

FROM:

SUBJECT:

ISSUE:

BACKGROUND:

CHARLES B. CURTIS !
DEPUTY SECRET MY) '\ ..1

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Z DONALD W. PEARMAN, ,JR.,! " *.\".,./'L)* ." -""' *I*

ASSOCIATE DEPtJrY SEC~ Y FOR FIElD MANA MENT

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Victor H. Rcis *I-kf7L~*
Assistant -Sea-etarY for 'Def~1SC Programs

6C110N: ACQUISmON 1:.XECUTIVE APPROVAL OF BASE1..n..rE CHANGE PROPOSAL FOR THE NA 110NAL IGNmON FACnJ1Y

Acquisition Executive apprO'lral is requested to adjust the cost and scltcdule baseline for the National Ignition Facility stn.tegic system. If you approve the ..~cbed baseline change proposal, total project c~st would be ina'eascd by SI25.:I.mi1lion from SI,O73.6 rnItlion to $1,198.9 million, the total estimated cost of construction would be increased by $203.1 miUion fi:om $842.6 milnon to Sl,O45.7 million, and the completion date woUld be extended by twelve months.
The National Ignition Fa~' (NIF) is a key element of Defense Programs' sci~ased St04=kpile Stewardship and MAnagement Program. 11ds stntegic syst«:m provides for design. construction and acceptance of. high-energy, high-power solid-state laser and tar.get system for Iaboruory-sCI.le \1I'eapons physics experiments, inertial confinement fusion ignition aJOO resean:h. and applications ofbigh energy density physics. Pretb:ninary design is oomptete and final design has started. The Record ofI:lecision for the Stockpile Stewardship and Mans.gement ProgrammAtic I!nv1ronmental Impact Statement WI$: issued on December 19, 199E, and the L&wrenoe Uvermore National L&bomory. Uvermore, CA 111as been selected as the construction site. The proposed cost and schedule baseline changes have been recommended for ..pprovaJ to the Assistant Secretary ofDefcnse Programs by the NIF Levetl DOE Headquarter;, Baseline Q1a~;e Control Board. These changes extend the baseline completion date by 12 months (or 2001.) from th«~ end ofFYO2 to the end ofFYO3, with an increase in the total project oost ofS12S.3 million (or 11.7%) £rOI11 Sl,073.6 ml1lion'0 $1,198.9 million. The total estimated cost of

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DISCUSSION:

construction increased by :S203.1 million from $842.6 to 5:1,045.7 million. However, other project costs decreased by $77.8 million, thus limiting the increase in the total project cost to $125.3 rnil.lion.

The proposed baseline cost and schedule increases are a rc:sult of: (1) the changes to the projeCt :scope (described below) incorporated in the preliminary design (Title 1 :~; (2) the expected annual funding availability in the five year period FY 1998-2002; and, (3) selection oi:'the Lawrence Livermore Natic,nall..2.boratory as the NIF construction site.

The scope changes are:

Facility user design requirements from the weapons program. weapons effects testing, and inertial fusion program needed to meet their programmatic missions.

Site-specific infrastructure requirements for the Livern1lore construction site which were footnoted in the FY96 anod FY97 Project Data Sheets.

Title 1 design changes 1to meet operational and mainteDMCC goals.

The changes to the total project cost associated with these scope changes is S 74.3 M

The. remainder of the incfe:lSe. $S I M, is attributable to the~ extension of the baseline completion dal~e by twelve months to Oct 200:1. This was necessary to confonn the project's annuaI funding requirerlrlents to expected DP funding avaiblbUity during the five year perioci.

The NIP is B. significant step beyond the state of the art in inertial confinement science, technology and facility size. The Pro.ject has been well managed and progres!;ed on schedu1e: Title I design has been completed and LLNL has 1>een selected as the site. The b21Seline scope changes are to accommod!tte requests by the user comrnurlity. These scope changes and DOnna! maturation of the project drive 'the cost increase. The cost increasle is not unreasonable and reBedS a weII- established science base at1.d conceptual design. An Indep~ent Cost Estima.te (ICE) conducted by the Office ofField Managenaent has validated the scope. The c:ost increase which resulted frorn the extension of the baseline s~~hedule has Dot been examined l~y the ICE.

SENSITIVITIES:

POLICY IMPACT:

RECOMMENDATION:

This action establishc~s a new baseline cost and schedule for a highly visible Departlrnent science and technology initiative, especially under the revised OMB Circular A-II, part 3.

Action is consistent \vith current Department policy.

That you approve the recommended Baseline Change Proposal to:

-Increase the Ibaseline total estimated cost of construction by $203.1 minion from S842.6 minion to SI,O45.7 minion.

-Increase the baseline total project cost by S 125.3 million from Sl,O73.~i million to SI,198.9 million.

-Extend the blLSe(ine project completion date by twelve months from October 2002 to October 2003.

Attachment

APPROVE:

~4.Lt3Q...(

DISAPPROVE:

DATE:

Concun-ences:

March 7. 1997

General CounseVShebek for l~ordhaus *1/13/97* Policy/Chupka 1/12/97
Economic lmpactlMoody *1/8197*
Human Resourcestl'amura for Dumam *1/6197* ChiefF'mancial OfficerlSmed\.ey *1/13197*
Environment, Safety and Health/Brush for O'Toole 1/14/97 Environmental Management//~m (undated)
National Securlty/Baker 1/1~' /97
Congressional/Alcock for Fol:nster 12/27/96

Appendix I

Critical Decision 3 Approval Memorandum, March 1997

Department of EnI~rgy
Washington, DC 20585

February 6, 1997

MEMORANDUM FOR nIP. ACTING SECRETARY

nrn.OUGH:

Charles B. Curtis DeputySccretary

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W~ ***t. t. t. t***
1997-003291

I.iA[/ I (1997.

FROM:

SUBJECT:

ISSUE:

BACKGROUND:

Victor H. Reis ***l"I(,f~***
Assistant Sccretazy for Defensc Programs

ACllON: Memo~dum to (tIe Energy Systems Acquisition Adviso~, Board Acquisition Executive r,cquesting approval ofCriticaI Decision 3 (CD-J), Start ofConstnld:ion for the National Ignition Facility (NIF).

The Department's project management system process and OMB Circular A-I09, require that the Sea"etary, 1$ the Acquisition ExeoJti..'e, approve CD-3, before the NIF can proceed to its next phase, the start of C()nstrucUOD- It is critical that CD-) is approvcd beforc MardI to prevent costly slippage in scho.1ule.

The National Ignition Facility is a key dement of Defense Programs' scien~a.sed Stockpile Stewardship and Management Prognm. This Strategic System pro..;des for design, construction and acceptance of !. high-<:l1ergy, high-power solid-state laser and target system for laboratory-scale weapons physics experiments, inertial confinement fusion ignition and research, IIld applications ofbigh energy density physics.

All p~uisite Critical Decision mUestones, previously called Key Decisions (KDs). have been &J:'proved. These include KD-O (now CD.. I), Approval of Mission Need (Rcf'~ I), approved by SecretaIy Watkins on January *IS*, 1993; KD-l (now CD-2), Approval of New Start (Reference 2), approved by Sea'etary O'Leary on October 2.0, 1994; and, KD-1' (prime) (Re:r~ 3), an added decision milestone, approved by Secretary O'Leary on December 20, 1995. Approval of KD-l' was based on the find"mg that the technical protifcra.tion con=-ns at the NIF WC'e manageable 1J:1d. thereforc, could be made a~tablc, and the NlF could contribute positively to U.S. amIS control and nonproliferation policy goals. The Sea'etary delegated authority to approve the Project Execution Plan to the Assistant Secretary on June 14, 1996 (Reference 4). The MIssion Need was reconfinned at each successive milestone.

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National Ignition Facility Project Execution Plan Rev 2b

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The Record of Decision for thc Stockpile Stewardship and Management Programmatic Environmenta! Impact Statement (Reference *S)* was issued by Secretary O'Leary on December t 9, t 996. Lawrence Livennore National Laboratory Ms been selected as the construction site. The Preliminary Safety Anal~ Report (Reference 6) catcgoriz.es the N1F as a low hazard. radiological faciUty. DOE..OAK approved this repon on October 3, 1996. in the Safety Evaluation Rcpon on the Lawrence Uvcrmore National Laboratory. I

The NIF project has completed preIimin&ry design (Title I) which added project scope changes to the conceptual design COrtlpleted in May, 1994. These changes included: (I) facility user requirements from the weapons physics, the radiation effed.s teSting, and the inertial fusion programs; (2) site-specific infrastructure requirementS (previously only footnoted in the Project Data Sheet pending site selection); and. (3) design requirements to meet operational and rnJjntenance goals. An independent design review committee conducted a Idet&i1ed technical assessment of the preliminary design a.nd in their Summary Report of December 9, 1996, (Reference 7), recommended proceeding with detailed engineering design (1itle n). major long-lead pro~ent and site prcparation. The NIF preliminary design formc:d the basis for DOE Field Management's Independent Cost Estimate (R.eference 8) which was within 1 percent of the project'. estimate. This constitUtes excellent agreement and validates the NIF cost baseline for proceeding with fmal design. Final design and planning for thc: stan of construction are proceeding in accordance with approved fiscal year 1997 plans.

Congressional funding for the NIF project in fiscal years 1996 md 1997 ;>rovided the Department's full requests.

The 199~7 appropriation included funding for site preparation Md ezrly construCtion planning.
The Department's fisc&1 year 1998 budget submission. including the NIF Project Data ShecL requests fun appropriation for the remaining funds ncccssary to complete construction of the NIF. 11t1e Project Data Sheet incorporates-the scopedlangCS dL~JSsed above and associated cost and schedule changes. These changes: (1) cxtcnd the bueUne completion date by one year from the end of fiscal year 2.002. Ito the end of fiscal ycar 2003; (2) incrase the Total Project Cost frolU SI,073.6 million to SI.198.9 million. an increase ofSI2S.3 ln111ion; and. (3) U'C aJnststent in timing with overall program needs and capabffity md with anticipated obligational8,uthority targets for Defense Programs for fiscal ye.ar 1998 and beyond. These scope, cost and schodule basc:Une d1I.nges were approved through the Level 1 NIF Baseline Change Control Board and subsequently concurred with by the Energy Systems Acquisition Advisory Board members. IS a Level 0 aCtion (R4;fcrcnce 9). on
January 16. 1997. Final approval by the Acquisition 'Executive has been requested.

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National IgI'lition Facility Project Execution Plan Rev 2b

SENS[TIVI11ES:

POUCY IMPACT:

As *of2J19/97:* On February 14, 1997. a laW$Uit was filed Mming DOE I.nd the National Academy ofScicnccs (NAS) as dcfendmts. The suit seeks among other things, to enjoin DOE from rc!ying on a Na.tional Academy ofScicnccs Inertia] Confinement Fusion tecltnicaI review panel in making its decision to stitt C4)nstruction (CD-3) because, it alleges. DOE is in violation of the Feclcral Advisory Cortunittcc Act (FACA). While the NAS final report is expected in early}l.{arcfl. DP has rea.clIcd its teclmicaI conclusions without the NAS panel repot:t. The Office of General Counsel concun with DP and has no legaI objection
to DP's intention to proceed with CD.3.

ACtion is consistent with current Department policy.

RECOMMENDA nON: Approve Critical Decision 3, Stan ~r ConstI'\Jction for the ND=.

APPROVE: {J ~ r.::j<~':4 --

DISAPPROVE:

DATE:

fte.rch 7.1.997

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The Energy Systems Acquisition Advisory Board s~ JField Management, has ~ concurrences from an m~ ofthc Board.

PolicyfChupka Undated
Economic impad.fMoody *214/97*
Human ResourcestraImJra for Durham mJ/97
ChicfFmanciaI OfficcrlSmedle')' *2fJ.l/97*
Emirorunent. Safar and HtalthfBrusb for O'Toole *2fJ.4/97* En-.'ironmental ManagementlAlm Undated
National SecurityfBak~ 211.1/97
CongressionaJ/Fonist~ Undated
Gcnet'al CounselfJohnston 2119/97 *1*

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for Field Mulagement

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National Ig;rzition Facility Project Execution Plan Rev 2b

Appendix J

NIF Functional Requirements and Primary Criteria

Department of Energy
Oakland Operations OffIce
1301 Clay StreEtt
Oakland, California 94612-5208

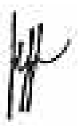
APR 2 9 1997

Dr. Jeffrey A. Paisner
NIF Project Manager
Lawrence Livermore National Laboratory P.o. Box 808, L-488
Livermore, Ca. 94550

"'A'f \]1 I ,~~,

Subject: Close-out of the Baseline Change Proposal 97-004

Dear Dr. Paisner:



Baseline Change Proposal (BCP) 97-04, incorporating minor changes to the "NIF Functional Requjrewents and Primary Criteria, " has been approved by the level 1 Baseline Change"Control Board. As you recall, appoval ofBCP 9'1', 04 was delayed, pending completion of the ~rork Smart Standards (WSS) Process Document. The WSS Process DOCUDlent was submitted to the Level 1 BCP, and approved on March 20,1997, closing-out BCP 97-04.

Following approval of the BOP 97-04, the Ftmctional Requirements and Primary Criteria (FRPC) were .was submitted to Dr. James Turner for approval. His approval was received on April4,1997. In order to make the FRPC the official requirements for design aIid construction of the NIF, I have requested that the FRPC be included into tb,e University *of* California Contract (DE-AC03-76SFOO048). On April]l8,1997 a letter was sent to Mr. Ronald Nelson from the DOE Contracting Officer requesting that the FRPC be applied to the contract for design and construction of the NIF. The FRPC, once incorporated into the contract, define the requirements and standards *to* be used for design and construction of the NrF, and will replace DOE environment, safety and health orders specified in Appendix G, Section I for the NIF only.

Enclosed is a copy of the approved FRPC and the WSS Process Document. Please distnoute copies of the final FRPC tcl the following organizations:

1. DOE Headquarters, DP-18 (3 copies)
2. NIF DOE Field Office, ICFD (15 copies) 3. Levell BCCB Secretary, (1 copy)

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Dr. Paisner

Page 2

Thank you for your efforts in closing out BCJP 97-04. If you have any questions, please call me at (510) 423-0593.

/

s 4~~. Samuelson
~;ttDioE Field Manger

Enclosures:

cc: Jon Yatabe, Level 3 BCCB

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DOE F 1325.8

National Ig11itiqn Facility Project Execution Plan Rev 2b

(13-84)
United States Government Department of Energy

memorandum

DATE:
REPLY TO ATTN OF:

SUBJECT:

APR 0 3 1997

Oakland Operations Office (ICFD) I
Functional ~quirements and Primary Crlt;eria for the NIF

TO:

James M. Turner, Ph.D, Manager

Attached are the Functional Requiremen1!;s and Primary Criteria (FRPC) for the National Ignition Facility (1.uF) and the Work Smart Standards (WSS) Process Document. The]~C establishes the scientific and engineering requirements that must be met during design and construction of NIF. '£he WSS ProceSl3 Document, dOcuments the process used to develop the FRPC.

The requirements identified in the FRPC for construction of NIF replace the set of standards that currently exist in the DOE/UC contract. When construction is complete the NIF will opera.te under the set of requirements established as a part.of the: WSS process that is currently under way at LLNL.

A Contracting Officer's Directive will be is~;ued by LCMD that incorporates the FRPC into contract 48. TJilese requirements will be in effect for the entire construction period.

In the absence of an established OAK policy for approval of standards and requirements under the Work Smart Sitandards process, I believe it is appropriate for you to approve this set oj: standards, prior to our issuing the C.O. Directive. Please indicate your decision by signing below.

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Should you have any questions, or if you desire a briefing prior to making your decision, please contact me. I

NIF DOE Field Manager

Action:

APprovej~~~~-

D a ~ :~~~::~~~r.z -

Disapprove D'ate

cc: C. Taylor

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NIFOOO1006-0C

National Ignition Facility Functional Requirements

and Primary Criteria

:Revision 1.6

March 1997

NIF

The National Ignition Facility

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Functional Requixments and Primary Criteria Revision 1.6

NIF-OOO1006-0C

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NIF Functional Requirements land Primary Criteria
Rev. 1.6 !
Approval Sheet

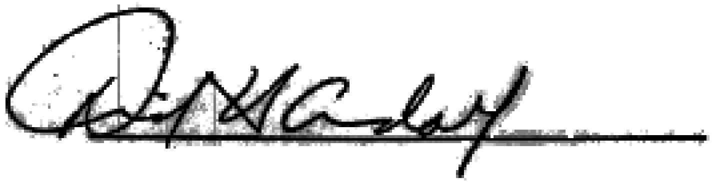
NIP Project Manager

Qffi~ *fJ r* ~~~.., ~
~~f Aaai;ner
Lawrence Livermore National Laboratory

NIP DOE Field Manager

Sa'muelson
Oakland Operations Office

Director, Office of the NationalIgnition Facility



David H. Crandall
Defense Programs

"

Functional Requirements and Primary Criteria Revision 1.6

NIF-OOO1006-0C

Table of Contents

1.0 Introduction

1.1 Objectives

This document establishes the scientific and engineering requirements that must be achieved by the National Ignition Facility (NIF). The process used for developing these requirements is described in "Process for the Development of the NIP Primary Criteria and Functional Requirements," NIF-OOO1566, March 1997. Mission goals, as defined in the Justification of Mission Need, are translated into laser power,laser beam characteristics, and other performance specifications. Top-level operability, safety, and environmental requirements are defined and discussed. Finally, key requirements that must be met to satisfy Department of Energy (DOE) Orders, state, and federal regulations, national consensus standards and preferred procedures are highlighted to help ensure that they are incorporated by the design teams.

1.2 Application

The Functional Requirements and Primary Criteria serves as a technical baseline for the Project. Any modifications must be processed through the change control mechanism specified in the NIF Project Execution Plan and implementing procedures and formally approved. Each individual requirement or criterion has been placed in one of two hierarchy levels for control purposes. Those items which are Levell, Primary C:riteria, are marked with either a single or double asterisk and are controlled by DOE Headquarters. Nonasterisked items are classified as Level 2, Functional Requirements, and are controlled by the NIP DOE Field Manager. The control of double-asterisk requirements may be, delegated to the NIP DOE Field Manager at some point in the hlture as part of the ongoing decentralization process.

1.3 Terms

The terms "should" and "shall" have important implications beyond what might be implied by common usage. "Shallll denotes a requirement that is mandatory and must. be met. *IIShouldll* denotes a nonmandatory recommendation or goal.

1.4 Site-Specific Requirements

These requirements are applicable to the LLNL site, selected by the DOE in the Record of Decision for the Programmatic Environmental Impact Statement for Stockpile Stewardship and Management. ..

2.0 Mission-Related Requirements

The laser system shall be designed to meet the following requirements simultaneously, although all performance requirements need not be demonstrated simultaneously on a single event.

2.1 Laser

2.1.1 Laser Pulse Energy*

The laser shall be capable of routinely producing a temporally-shaped pulse of energy at least 1.8 million joules (MJ) incident on the entrance hole of the target hohlraum.

2.1.2 Laser Pulse Peak Power*

The laser shall be capable of producing a pulse with peak power of at least 500 trillion watts (TW).

2.1.3 Laser Pulse Wavelength*

The wavelength of the laser pulse delivered to the target shall be 0.35 microns (_m). The design should not preclude delivering 0.53 _m and 1.05 _m wavelength light to the target with reasonable modifications.

2.1.4 Beamlet Power Balance*

The rms deviation in the power delivered by the laser beams from the specified power shall be less than 8% of the specified power averaged over any 2 nanosecond (ns) time interval. -

2.1.5 Beamlet Positioning Accuracy*

The rms deviation in the position of the centroids of all beams from their specified aiming points shall not exceed 50 micrometers (_m) at the target plane or its equivalent. .

2.1.6 Laser Pulse Duration

The laser shall be capable of producing a pulse with overall duration of up to 20 ns. 2.1.7 Laser Pulse Dynamic Range

The laser shall be capable of delivering pulses to the fusion target with a dynamic range of at least 50:1, where the dynamic range is defined as the ratio of intensity at the peak of the pulse to the intensity in the initial "foot" pprtion of the pulse.

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2.1.8 Capsule Irradiation Symmetry

Variations in the x-ray energy deposited on the fusion capsule, located in the target hohlraum, should be ~2% rms. Current target design and performance calculations indicate that this level of irradiation uniformity can be achieved by two-sided laser illumination of the hohlraum. Multiple laser beams on each side enter the hohlraum along two concentric cones with cone half-angles of approximately 27 degrees and 53 degrees, and with two-thirds of the beams on the outer cone and the remaining one- third on the inner cone. Each cone sh~ll consist of 8 or more beams. The capability shall be provided for the pulse shape delivered by beams on the inner cone to be different from the shape delivered by those on the outer cone.

2.1.9 Prepulse Power

The laser intensity delivered to the target during the 20-ns interval prior to arrival of the main laser pulse shall not exceed 108W /cm2.

2.1.10 Laser Pulse Spot Size

Each beam shall deliver its design energy and power encircled in a 600 _m diameter spot at the target plane or its equivalent. In the appropriate configuration, each beam should deliver 50% of its design energy and power encircled in a 100 _m diameter spot at the target plane or its equivalent.

2.1.11 Beam Smoothness

The NIP shall have spatial and temporal beam conditioning to control intensity fluctuations in the target plane.

2.1.12 Direct-Drive Requirements*

Future upgrade to meet the following requirements, specific to direct-drive experiments, shall not be precluded in the baseline NIF design.

2.1.12.1 Direct-Drive Irradiation Symmetry. Direct-drive ICF targets shall be irradiated by three pairs of concentric cones, with midplane symmetry. The cone half- angles .and number of beams on each cone shall be:

Direct-drive cone	Cone half-angle (approximate)	Fraction of total beams
Inner	same as indirect drive	1/6
Outer	same as indirect drive	1/3
Waist	75 degrees	1/2

2.1.13 Beam Focusing and Pointing

The NIF should have flexibility in beam focusing and pointing t~J address the needs of radiation effects testing and other users. r

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2.2 Experimental Area

The National Ignition Facility shall be operated in a maru1er consistent v.ith its role as a . national resource. Whenever possible, the design shall accommodate the reQuirements' of users with diverse needs. The baseline facility design shall not preclude f~ture addition of target chambers for additional weapons physics and/ or radiation ~ffects testing. The baseline design and operation should be capable of performing raa'ation effects testing of important national assets, up to system level components, to mc: intain and certify their reliability. The following requirements are intended to satisfy thE. most basic of these needs.

2.2.1 ICF Target Compatibility*

The target chamber and target area support systems shall be capable of target operations with both cryogenic and noncryogenic targets containing fusion fuel. Provisions shall be made to accommodate and support experimenter-supplied cryo;,tats for cryogenic targets.

2.2.2 Annual Number of Shots with Fusion Yield for Chamber Design*

The NIP shall be capable of performing yield shots with total DT fusion yield of 1200 MJ / year. The NIP shall be capable of performing up to 50 shots per year with a routine DT fusion yield of 20 MJ. The NIP design shall provide for life-cycle-cost-effective future addition of components that are needed only for high yield operations and are therefore not needed in the first three to five years of operations, such as shield doors and decontamination equipment.

2.2.3 Maximum Credible DT Fusion Yield*

The target chamber shall be designed based on routine DT fusion yield of 20 MJ, with the capability to withstand a DT fusion yield produced by a single shot of up to 45 MJ (a 45 MJ yield corresponds to 1.6 _1019 neutrons).

2.2.4 Classification Level of Experiments*

The facility shall be designed to allow both classified (at the SRD level) and unclassified experiments. Its design should permit changing classification levels with minimal impact on operations and cost. .

2.2.5 Target Positioner

The target positioner shall be capable of placing and holding targets vvithin 3 crn of target chamber center, with accuracy, repeatability, and stability consistent with the relative laser /target alignment specified in Section 2.1.5 and operations specified in Section 2.2.1.

2.2.6 Time Between Shots with No Fusion Yield

To address the needs of indirect-drive, direct-drive, and other users, the laser ap.d experimental area shall be capable of conduc~ing no fusion yield experiments with a time between shots of 8 hours, with a goal of 4hou~s.

2.2.7 Target Chamber Vacuum Capability
The target chamber shall be capable of achieving a vacuum level of <1

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2.2.8 Diagnostic Instrument Capabilities to Verify Laser Performance
The facility shall have the following measurement capabilities that are required to verify the Primary Criteria and Functional Requirements:

.Laser pulse energy and power.
.Laser pulse duration and dynamic range.
.Laser beam power balance.
.Simultaneity of arrival of pulses from individual beamlines at target chamber center with 10 ps accuracy.
.Laser beam pointing accuracy with 10-20 micron spatial resolution.
.Laser prepulse intensity.
.Laser pulse spot size.
.Laser pulse smoothness.
.Laser beam thermal recovery time.

2.2.9 Diagnostic Instrument Capabilities for Ignition and Applications Experiments The target chamber and area shall be capable of accommodating diagnostic instruments for the following measurements nece~sary for fusion ignition and applications experiments:

.Symmetry of x-ray emission from imploded cores with 5- to 10-micron spatial resolution.
.Motion of the x-ray emitting volumes in hohlraums with 20 micron spatial resolution.
.Laser light backscattered into the focusing lens.
.Radiation flux out of hohlraums within the photon energy range 0.15-2.5 keY with 100-ps time resolution and 20% accuracy.
.Strength of radiation driven shocks with 5- to 10-micron resolution and time resolution of 10 ps.
.Fusion yield over a range from 1011 to 1019 neutrons.
.Symmetry of neutron emission from imploded cores with 20-micron spatial resolution.
.Temperature of the compressed fusion fuel with 20% accuracy for ion temperatures of 2 keY or greater.
.Number and energy distribution of fast electrons in hohlraums in the band from 5 keY to 300 keY.
.Radiation flux out of hohlraums within the photon energy range 2.5-100 ke V with 20% accuracy.

2.2.10 Removal and Replacement of Diagnost:i.~ Instruments*

Rapid removal and replacement of diagnostic..instruments consistent with the shot frequency specified in Section 2.2.6 shall be accomplished by diagnostic inserters and manipulators for close-in target diagnostics.

2.2.11 Personnel Access Inside the Target Chamber*

Personnel access to the inside of the target chamber shall be consistent with requirements for periodic cleaning necessary to maintain radiological, low-hazard, non- nuclear operations and for inspection and maintenance consistent with operational requirements.

2.2.12 Distributed Laser Plasma Radiation Source Compatibility*

The NIP should provide the basic capability to allow laser irradiation of distributed target arrays with future upgrade. The target chamber should allow flexibility in beam dump placement.

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3.0 Safety Requirements**

The NIP shall be designed, constructed, and operated as a radiological low-hazard facility. Compliance with this classification shall be verified through a Preliminary Hazard Analysis assessment of bounding accidents involving those radionuclides and/or chemicals presenting the most significant hazards (see DOE Order 5481.1B, Safety Analysis Review System). Administrative controls shall be established prior to the first use of tritium-bearing targets to ensure that inventory limits for a low-hazard radiological facility are not exceeded.

3.1 *Radiation Protection **

Collective and individual ionizing radiation doses to the public from all exposure pathways from the NIP shall meet the requirements of DOE Order 5400.5, Radiation Protection of the Public and the Environment, and 40 CFR 61, National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities. These requirements state that exposure of members of the public from emissions of radionuclides in the ambient air from normal N1F operations shall remain below 10 *mrem/y.* The facility shall also meet the requirements of DOE Order 5400.5 to not cause the public dose from all exposure modes and all sources of radiation at the site boundary to exceed 100 *mrem/y.*

The NIP personnel radiation protection program shall follow DOE Order N441.2 Radiation Protection for Occupational Workers and 10 CFR 835, Occupational Radiation Protection. The ALARA (as low as reasonably achievable) principle shall be utilized in both design and operation of the facility to eliminate unnecessary radiation dose to workers in the Laser and Target Area Building, collocated employees, and visitors from both routine and off-normal operations. Radiation protection shall include: shielding; control of workplace ventilation; monitoring of personnel for external and internal radiation dose; establishment of a routine contamination monitoring program including air monitoring; and the proper containment of radiation and radioactive materials.

The radiation shielding design limit the maximum doses to an individual worker to one- tenth (shielding design goal) of the occupational external dose limits specified in 10 CFR 835. Concrete shielding shall comply with ACI 301, which provides adequate strength for DBE loads. .

The requirements for radiological safety in .~9 CFR 835, Occupational Radiation Protection, should be evaluated by the designers an~ incorporated when they are determined to be cost effective, even though the Projected inventory of tritium in NIP (-0.05 g or 500 Ci) is well below the threshold for a nuclear facility. The target chamber and tritium processing systems shall form the primary confinement barrier. Leakage past these barriers shall be ALARA. The experimental-area ventilation system shall be

designed to operate at negative pressures during and immediately after shots of greater than one megajoule and provide secondary tritium confinement.

The final exhaust release point from this system should be elevated for dispersion. Exhaust air shall be continuously monitored for radioactivity. The target area shall also' be monitored to ensure that radiological conditions are safe for personnel entry.

3.2 ***Life Safety*****

The NIF shall fully comply with the requirements for life safety contained all National Fire Protection Association (NFP A) Codes. Particular focus shall be directed towards features related to the means of egress, such as protection of vertical openings, travel distances, capacities, and emergency lighting.

3.3 ***Laser Safety****

The laser safety shall comply with AJ.\JSI 2136.1. Exposure to hazardous levels .of laser light shall be prevented by the use of physical barriers, personnel training, interlocks, and personnel entry controls. Protective equipment, such as laser goggles, shall be used when necessary for operational purposes. Interlock systems shall be dedicated and designed to be fail-safe and shall activate laser shutters or shut off power to laser systems if access doors are opened and hazardous exposures are possible.

3.4 ***Industrial Hygiene and Occupational Safety****

Industrial hygiene and occupational safety shall comply with 29 CFR 1910 Occupational Safety and Health Act (OSHA) -Operation. Construction safety shall comply with the requirements of 29 CFR 1926, OSHA- Construction.

Facility subsystems (e.g., capacitor banks, vacuum systems, tritium recovery, nitrogen supply *I* and personnel safety interlock systems) shall be designed to default to a safe state upon loss of power.

3.5 ***Fire Protection****

The NIP shall meet the design and fire protection requirements, all NFP A Codes and the Uniform Building Code (UBC). The structural members of the Experimental Building (including exterior walls, interior bearing walls, columns, floors, roofs, and supporting elements) shall, as a minimum, meet UBC fire-resistive standards. Appropriate fire barriers shall be provided to limit property damage, fire propagation, and loss of life by separating adjoining structures, isolating hazardous areas, and protecting egress paths. The NIF shall meet the requirements for an J'improved risk" level of fire protection sufficient to attain DO~, objectives. To achieve this level of protection, automatic fire sprinklers shall be installed throughout the complex. The sprinklers shall be coupled with adequate fire protection water supplies and automatic and manual means for detecting and reporting incipient fires. Fire hazard analyses will be completed as required by all NFP A Codes.

3.6 ***Robotic Systems Safety***

Robotic systems shall comply with the requirements of ANSI/RIA R15.06-1992; Industrial Robots and Robot System-Safety Requirements.

4.0 Environmental Protection

4.1 W ast\~ Management**

The NIF snaIl minimize the generation of wastes at the source per: DOE Policy P450.1, Enviroi1mental Safety and Health Policy for the Department of Energy Complex, General Envirol1ffiental Protection Program, and DOE Order 5820.2A, Radioactive Waste Management; and the Resource Conservation and Recovery Act (USC 6901 to 6992); and the Toxic Substances Control Act (USC 2601-2692). The NIP waste handling areas shall comply i'llith the standards of confinement and ventilation requirements specified by DOE Order 5820.2A, Radioactive Waste Management.

The NIF will generate hazardous waste, low-level radioactive waste (LLW), and mixed (LLW and hazardous) waste. These wastes shall be collected in approved containers, labeled, packaged, sorted, and shipped to an EP A/DOE-approved treatment or disposal site according to the Resource Conservation Recovery Act and the following regulations: hazardous waste per 40 CFR 260, 261 and 262; low-level waste per DOE Order 5820.2A; and mixed (LLW and hazardous) waste per DOE Order 5820.2A, and 40 CFR 260. The LLW packages shall meet the radioa<;:tive solid waste acceptance criteria
of the final approved disposal site Pollution prevention will be considered in the NIF design as required by DOE Order 430.1.

4.2 Effluents*

Liquid effluent discharges from NI? discharge points shall be monitored and controlled in compliance with 10 CFR 835, DOE Order 5400.5, Radiation Protection of the Public and the Environment; the Clean Water Act (33

U.S.C.1251 et seq.); and by conditions on 40 CFR 125 Criteria and Standards for National Pollutant Discharge Elimination System.

Air emissions shall meet the requiremer~ts of Section 3.1 (radiation shielding and confinement) for radionuclides and the requ.~ements of the Clean Air Act, (42 U.S.C. 7401) including National Emission Standards for Hazardous Air Pollutants (NESHAP), and state and local air quality management di~trict requirements.

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5.0 Safeguards and Security**

The NIP safeguards and security features shall meet the requirements of DOE Order 5632.1C, Protection of Safeguards and Security Interests, and DOE Order 470.1, - Safeguards and Security Program. These requirements include physical protection of classified data and equipment and items in use and in storage. For the facility security areas and access control, requirements shall be established based on the nature of experiments (i.e., classified or unclassified) being performed. The limited areas shall be the target area, target receiving and inspection, final target alignment, classified data acquisition, and office areas where classified computing is performed. Automated Data Processing (ADP) systems handling classified information shall meet the requirements of DOE Orders 5637.1, Classified Computer Security Program, and 5300AD, Telecommunications: Protected Distribution Systems. Elements of DOE Orders 470.1, Safeguards and Security Program, and 472.1, Personnel Security Activities, will also be incorporated into the security plan.

The NIF complex shall also meet the requirements for physical protection of DOE property and unclassified facilities, protection program operations, and personnel security, including issuance, control, and use of badges, passes, and credentials.

Because the continuous operation of the NIP is not required to prevent adverse impacts on national security or the health and safety of the public, it is not classified as a vital facility, per DOE Order 5632.1C.

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6.0 Building Systems

6.1 Design Life Requirements

The LTAB and the Optics Assembly Building (GAB) represent the only newly constructed facilities at LLNL. The NIF facilities shall be designed for at least 30 years design life for permanent structures. Systems or portions of systems for which that is impractical shall be designed for ease of replacement. Ease of replacement means that replacement is feasible at reasonable cost and can be accomplished in a timely manner consistent with plant availability requirements. "Replacement" here also includes removaL refurbishment, and reinstallation of original equipment.

The performance category for target area and laser structural systems shall be category 2 with a graded approach for other systems.

Where alternative designs and modes of construction are possible at essentially equivalent cost, the design and construction method that most readily allows for future reconfiguration and modification should be selected.

6.2 Vibration Requirements

Certain facilities or areas within facilities will house vibration-sensitive special equipment. The structural design of these areas shall provide means to effectively isolate this equipment to control vibration within specified displacement and rotation requirements. Specific constraints are specified in the System Design Requirements for NIF Facilities.

6.3 Cleanliness Requirements

The laser bays, experimental areas, and optical assembly rooms must be dust free to prevent laser damage to the optics. Specific constraints are specified in the System Design Requirements for NIP Facilities.

6.4 Temperature Control

Temperatures in the laser bays experimental areas must be controlled in order to maintain a stable laser alignment. Specific constraints are specified in the System Design Requirements. "..' .

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6.5 Electrical Power

Electric power shall be installed in accordance with NFP A 70, which includes details from the National Electrical Code; IEEE 493, Recommended Practices for Design of Reliable Industrial and Commercial Power Systems; and ANSI C2, the National Electrical Safety Code.

6.5.1 Voltage Quality

Voltage shall be maintained in compliance with ANSI C84.1, Electrical Power Systems and Equipment-Voltage Rating (60 HZ). Electrical supply systems shall operate within the limits specified for Range A of this specification. Voltage occurrences outside these limits should not exceed the Range B limits. These variances should be limited in extent, frequency, and duration. Computers shall be protected with low voltage dropouts requiring manual restart.

6.5.2 Standby Power

Standby power shall be available for health, life, property, and safeguards and security loads, including emergency egress lighting, fire alarms and sensors, security systems, and radiation monitors. Power for safety and security functions shall be installed and operated according to NFP A 101, the Life Safety Code; ANSI/NFP A 110-1993, the Standard for Emergency and Standby Power Systems; NFP A 72, National Fire Alarm Code; and other applicable NFP A and OSHA standards.

6.5.3 Uninterruptible Power

Uninterruptible power systems (UPS), are not required for the NIP facilities or special equipment.

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7.0 Operational Availability

User demands for shot time are expected to be high, therefore, the facility shall be designed for maximum reasonable availability and rapid recovery from unplanned shutdowns.

7.1 Reliability *I* Availability and Maintainability (RAM)*

The components, systems, and processes that limit overall facility availability shall be identified during the design process through analyses of turnaround times, mean times between failures, mean times to repair, preventive maintenance requirements, etc. Techniques such as in-site backups, on-hand spares, modular components, on-call maintenance forces, and more robust designs shall be used to increase availability if the following goals cannot otherwise be achieved: .

.The facility shall be available for three shift operations at least 253 days per year (73% availability). .

.The facility shall be available for at least 616 no-yield target shots per year. To address, the possible future needs of direct-drive and other users, the design should not preclude an increase in the availability to approximately 1200 total shots per year. .The Project shall provide the initial set of maintenance equipment, consisting of at least one unit of each piece of equipment that is required to maintain and operate NIF. Future addition of more units of , maintenance equipment shall not be precluded. Continuous high-availability NIF operation, as defined above, may require future additional units of maintenance equipment.

.The lasers shall perform within specification (e.g., laser energy, beam balance, pointing accuracy) on at least 80% of all shots.

The Project should also use this RAM process to determine how to achieve availability in the most cost-effective manner, to determine what spares in what quantities should be kept in inventory, to optimize turnaround procedures, tQ plan preventive maintenance and inspection programs, and to respond to unscheduled outages.

7.2 Recovery Time*

, Because of its importance to the DOE, the NIF .shall be designed to survive any abnormal event, including accid.ents and nattiral phenomena, expected to occur more frequently than once in 2000 years. The time re'!uit:ed to recover from such events is allowed to vary in accordance with the probability of occurrence. Maximum recovery times are specified below.

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Probability of Occurrence Per Year, P	Maximum Recovery Time
$P = 1$	24 hours
$1 > P \geq 10^{-2}$	1 week

3 months for laser, target, and associated building structures 6 months for support Systems

10-2 > p ~ 5 X 10-4

The probabilities of occurrence listed in DOE~STD-IO20-94 and DOE-STD-IO21-93 shall be utilized for natural phenomena.

Standby power shall be available to preserve process continuity in cases designated by the NIF Project and specified in the System Design Requirements. Neither uninterruptible power systems nor standby power is required for the computer
systems.

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8.0 Decontamination and Decommissioning

The NIP design shall meet the site-specific requirements. The NIP shall be designed for periodic cleaning of the interior of the test chamber to maintain tritium levels on interior surfaces as low as reasonably achievable. The NIP design shall include considerations that will allow for cost-effective future decommissioning of the structures and equipment.

A plan for NIF Decontamination and Decommissioning (D&D) shall be developed in accordance with DOE Order *5820.2A*, Radioactive Waste Management. A D&D assessment shall be made during conceptual design to ensure that features and measures are incorporated in NIP to simplify D&D. The NIF D&D plan will be prepared before the end of the Title n design.

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9.0 Quality Assurance**

The NIP Quality Assurance Program shall meet the requirements of DOE Order 5700.6C, Quality Assurance. As specified in this DOE Order, a graded approach using quality levels based on risk assessment shall be spelled out in the NIF Quality Assurance Program Plan and utilized throughout the Project. The Quality Assurance Program Plan shall cover all aspects of the NIP Project in a phased implementation, beginning with conceptual design.

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10.0 Orders, Codes, and Standards

10.1 DOE Orders*

The NIF shall be designed and constructed in full compliance with DOE Orders and federal regulations. Exceptions shall be limited to those cases where the Project has formally requested and been granted either an exemption or a finding of equivalency by Headquarters.

It is recognized that updates and additions to DOE Orders, federal regulations, and consensus industry standards are outside of the control of the Project team and are a frequent source of cost and schedule growth. These requirements are all frozen as of March 1, 1996.

10.2 Codes and Standards

Technical codes, standards, and guides promulgated by nationally recognized organizations should be utilized by the NIFProject whenever available and practical, per DOE Order 1300.2A. A partia1listing of nationally recognized organizations is included in the following sections. Additional references identified during the developmental phases shall be formally cited and controlled in system and subsystem design requirements documents and specifications through the Project Change Control Process.

10.3 Applicable Orders, Codes, and Standards

This section lists DOE Orders, codes, and standards in effect on March I, 1996, that are considered to be applicable to the NIF Project. The listing begins with DOE and other federal regulations (e.g., Resource Conservation and Recovery Act), and is followed by a partial listing of_national consensus standards organizations. The . applicable portions of these documents will apply.

10.3.1 DOE Orders

.1300.2A -Technical Standards Program
.5300.4D -Telecommunications: Protected Distribution System
.5400.1 -General Environmental Protection Program
.5400.5 -Radiation Protection of the Public and the Environment
.5480.19 -Conduct of Operations ."..' .
.5481.1B -Safety Analysis and Review Systerp (for non-nuclear facilities and hazards only) ...
.5632.1C -Protection of Safeguards and Security Interests .5633.3B -Control and Accountability of Nuclear Material

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.5637.1 -Classified Computer Security Program
.5700.6C -Quality Assurance
.5820.2A -Radioactive Waste Management
.151.1- Comprehensive Emergency Management System
.430.1 -Life Cycle Asset Management
.N441.2 -Radiological Protection for DOE Activities
.P450.1 -Environment, Safety and Health Policy for the Department of Energy Complex .
.470.1 -Safeguards and Security Program
.471.2 -Information'Security Program
.472.1 -Personnel Security Activities

10.3.2 Other Government Regulations
.10 CFR 835 -Occupational Radiation Protection
.10 CFR 20 -Standards for Protection Against Radiation
.29 CFR 1910 -Occupational Safety and Health Act (OSHA) -Operation
.29 CFR 1926 -Occupational Safety and Health Act (OSHA) -Construction .40 CFR 125 -Criteria and Standards for NPDES (National Pollutant Discharge Elimina non System)
.40 CFR 260,261,262 -Hazardous Waste Management System
.40 CFR 61 Subpart H -National Emission Standard for Emissions of Radionuclides other than Radon from Department of Energy Facilities
.FED-Sffi-209E -Airborne Particulate Cleanliness Classes in Cleanrooms apd Clean Zones
.33 USC 1251 et seq. -Clean Water Act
.42 USC 7401 -Clean Air Act
.42 USC 4321 et seq. -NEPA (National Environmental Policy Act)
.40 USC 6901-6992 -Resource Conservation and Recovery Act (RCRA)
.15 USC 2601-2692 -Toxic Substance Control Act

10.3.3 National Consensus Standards
The NIF Project shall comply with the following national consensus standards, as noted elsewhere in this document:
-ACI301 -1996, Specifications for Structural Concrete for Buildings
-ANSI C2 -1993, National Electric Code
-ANSI C84.1 -1989, Electrical Power ~ystems and Equipment-Voltage Rating (60 HZ) .*f*..
-ANSI 2136.1 -1993, Laser Safety .
-ANSI/RIA R15.06 -1992, Industrial Robots and Robot System-Safety Requirements
-DOE-Sill-1020-94, Natural Phenomena Hazards Design and Evaluation Criteria for DOE Facilities

-DOE-Sill-1021-93, Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, & Components.
-IEEE 4931990, IEEE Recommended Practice for the Design of Industrial and Commercial Power Systems
-All NFP A Codes
-NFPA 701996, National Electric Code
-NFPA 721993, National Fire Alarm Code
-NFP A 1011994, Code for safety to Life from Fire in Buildings and Structures -ANSI/NFPA 110-1993, Standard for Emergency and Standby Power Systems -Uniform Building Code (UBC) 1994
Orders, standards, and codes listed as mandatory in DOE Orders are not necessarily referenced in this list.

In addition to complying with these specific standards, the NIF Project shall utilize applicable and appropriate national consensus codes and standards in the design,' procurement, fabrication, installation, construction, inspection, and testing of structures, systems, and components, per DOE Order 1300.2A. Codes, standards, and guides of recognized technical and professional organizations, such as those in the following list, shall be applied as appropriate to NIF materials and workmanship:

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AA AASHTO ABMA ACI ACGIH AISC AISI AMCA ANSI APA
ARI ARMA ASCE ASHRAE

ASME ASTM AWS AWWA BHMA CISCA CGA CMAA CRSI EPRl FM

Aluminum Association
American Association of State Highway Officials
American Boiler Manufacturers Association
American Concrete InstitUte
American Council of Government Industrial Hygienists
American Institute of Steel Construction
American Iron and Steel Institute
Air Movement and Control Association

American National Standards Institute
American Plywood Association
Air Conditioning and Refrigeration Institute
Asphalt Roofing Manufacturers Association
American Society of Civil Engineers
American Society of Heating, Refrigerating & Air Conditioning Engineers
American Society of Mechanical Engineers
American Society for Testing and Materia~
American Welding Society
American Water Works Assotiation
Builders Hardware Manuficturers Association
Ceiling and Interior Systems .contractors Association
Compressed Gas Association'
Crane Manufacturers Association of America
Concrete Reinforcing Steel Institute
Electric Power Research Institute
Factory Mutual Engineering and Research20 20

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GA Gypsum Association
ICBO International Council of Building Officials (Uniform Building Code) ICEA In$ulated Cable Engineers Association
IEEE Institute of Electrical and Electronics Engineers
IES Illuminating Engineering Society of North America
ISA Instrument Society of America
NAPHCC National Association of Plumbing, Heating, & Cooling Contractors NCMA National Concrete Masonry Association
NEC National Electric Code (NFP A)

NEMA National Electrical Manufacturers Association
NIOSH National Institute for Occupational Safety and Health
NIST National Institute of Standards and Technology
NFP A National Fire Protection Standards
RFCI Resilient Floor Covering Institute
SDI Steel Deck Institute
SDI Steel Door Institute
SMACNA Sheet Metal & Air Conditioning Contractors National Association SSPC Steel Structures Painting Council
STI Steel Tank Institute
SWI Steel Windowfustitute
TCA Tile Council of America
TIMA Thermal Insulation Manufacturers Association
UL Underwriters Laboratories

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11.0 Revision Record

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96-004

96-005

96-006

97-001 97-002

97-004

Directea changes in DOE C5rders and Federal Regulations. Miscellaneous changes throughout document

Furi-ctionality Changes to the NIP Baseline.
Changes include the addition of: optic assembly capability ,beam smoothing, flashlamp cooling, 4x2 amplifiers, not-to-preclude direct drive, not-to- preclude radiation effects testing, and laser spot size.

Engineering Option Studies: increased shot rate and full implementation of direct drive.

Title I Update of FunctionaIRequirements/Primary Criteria. Changes to incorporate results of Title I design and design review *I* update of DOE Orders ~n~- an~args *I* and miscellane~~anges

Typographical changes and minor wording changes to reflect completion of ROD and final incorporation of Necessary and Sufficient Standards

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ECR #	BCP#	Description of/Reason for Change
n/a	n/a	CDR release

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NIF

Appendix

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Project

Completion

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Physical Status

NIF Project Completion Criteria

.Construction Completed (beneficial occupancy) -LTAB
-DAB
-Central Plant
-Site Utilities
.Required Equipment in Place and Acceptance Tested

.Assembly Installation and Refurbishment Equipment (including 3 transporters and OAB equipment)
.Beampath infrastructure system for 192 beamlines
.Line replaceable units for 192 beamlines assembled, installed, and the beamlines acceptance tested
.Target Area Building and Chamber, including
-Flexibility in Beam Dump placement (NWET)
-Equitorial ports available to allow direct drive irradiation symmetry
-Designed for a routine DT fusion yield of 20 MJ (50 shots/yr) with capability to withstand a maximum credible yield of 45MJ ability to perform yield shots with total DT fusion yield of 1200 MJ/yr.
.Target Positioner(s) and 4 Diagnostic Instrument Manipulators (DIM) .Diagnostics sufficient to demonstrate laser performance requirements .Classified Data Acquisition capability and Control Room
As required to support SRD
.Project provides sufficient spares for project construction

Laser Performance Requirements

	96 Beam Performance	Single Bundle Performance
Pulse Energy	500kJ	75kJ
Peak Power	200TW	21TW
Wavelength	.35 µm	.35 µm
Positioning Accuracy	100 µm rms at target plane	100 µm
Pulse Duration	20ns	20ns
Pulse Dynamic Range	>25:1	50:1
Pulse Spot Size	600 µm	600 µm
Pre-pulse power	$<10^8$ W/cm^2	$<4 \times 10^8$ W/cm^2
Cycle Time	8 hours max between full system shots	8 hours max between full system shots

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Documentation

.The NIF design shall provide for life-cycle cost effective future addition of components that are needed only for high yield operation and are therefore not needed in the first 3-5 years of operation such as shield doors and decontamination equipment.

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NWBS to WBS Cross-reference

Sorted by NWBS

The following table is a cross-reference between the NIF Work Breakdown Structure (NWBS) [NIF5005352-0A] and the Work Breakdown Structure (WBS) [NIF-5000220- aD]. The NWBS is based on a Functional System Description of the NIP.

The table contains three columns. These columns are the Functional System Description (FSD), NWBS, and WBS from left to right. Not all entries have an FSD code because not all elements of the NWBS are functional, but if an entry exists the FSD has the same name as the NWBS element. The elements in a row across the table represent elements that are common. For example, the flfst row across the table shows that NOOO National Ignition Facility, N National Ignition Facility, and 1.0 NIF Project are similar for cost, schedule, and technical issues. Information that was previously documented as WBS 1.0 can now be documented as N or NOOO.

The cross-reference reflected in this table is not a one-to-one relationship. The NWBS is defined at a lower level of detail than the WBS. Therefore, there are places in the table where there are blanks in the WBS column because the NWBS is defined at a lower level of detail. There are also places where a WBS element is used multiple times. This is because parts of the system defined in the WBS have been split into more than one NWBS element.

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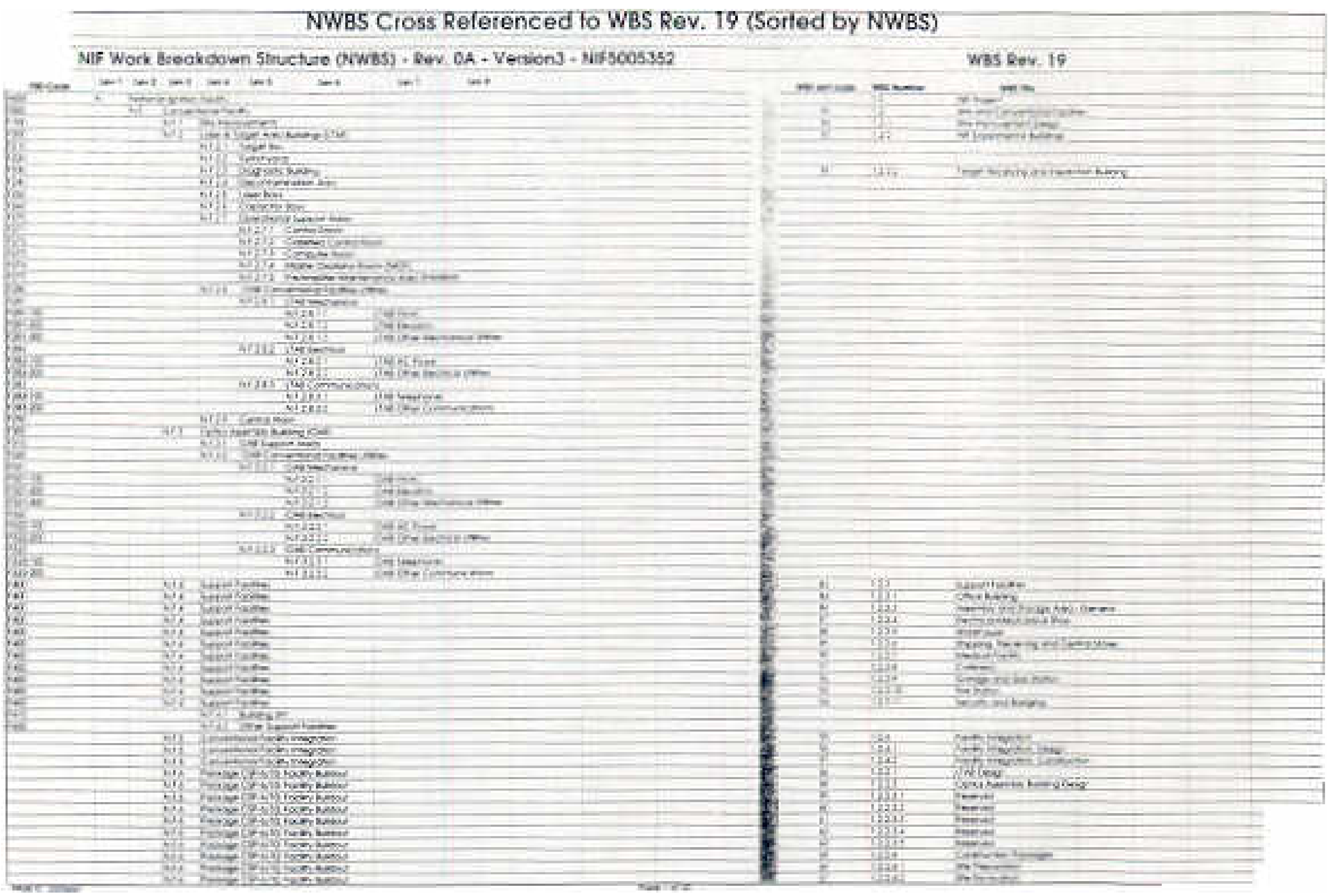
Crosswalks

NIF NWBS Cross-reference to WBS, Rev. 19 NIF Schedule Change Crosswalk


NWBS Cross Referenced to WBS Rev. 19 (Sorted by NWBS)

NIF Work Breakdown Structure (NWBS) - Rev. 0A - Version3 - NIF5005352

WBS Rev. 19

NWBS Cross Referenced to WBS Rev. 19 (Sorted by NWBS)

NIF Work Breakdown Structure (NWBS) - Rev. 0A - Version3 - NIF5005352

WBS Rev. 19

FRC Code	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8	WBS sort code	WBS Number	WBS Title
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

NWBS Cross Referenced to WBS Rev. 19 (Sorted by NWBS)

NIF Work Breakdown Structure (NWBS) - Rev. 0A - Version3 - NIF5005352

WBS Rev. 19

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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

NWBS Cross Referenced to WBS Rev. 19 (Sorted by NWBS)

NIF Work Breakdown Structure (NWBS) - Rev. 0A - Version3 - NIF5005352

WBS Rev. 19

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NWBS Cross Referenced to WBS Rev. 19 (Sorted by NWBS)

NIF Work Breakdown Structure (NWBS) - Rev. 0A - Version3 - NIF5005352

WBS Rev. 19

Revision 2b

NWBS Cross Referenced to WBS Rev. 19 (Sorted by NWBS)

NIF Work Breakdown Structure (NWBS) - Rev. 0A - Version3 - NIF5005352

WBS Rev. 19

Revision 20

NWBS Cross Referenced to WBS Rev. 19 (Sorted by NWBS)

NIF Work Breakdown Structure (NWBS) - Rev. 0A - Version3 - NIF5005352

WBS Rev. 19

NIG Code	Lev 1	Lev 2	Lev 3	Lev 4	Lev 5	Lev 6	Lev 7	Lev 8	WBS sort code	WBS Number	WBS title
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

NWBS Cross Referenced to WBS Rev. 19 (Sorted by NWBS)

NIF Work Breakdown Structure (NWBS) - Rev. 0A - Version3 - NIF5005352

WBS Rev. 19

NWBS Cross Referenced to WBS Rev. 19 (Sorted by NWBS)

NIF Work Breakdown Structure (NWBS) - Rev. 0A - Version3 - NIF5005352

WBS Rev. 19

NWBS Cross Referenced to WBS Rev. 19 (Sorted by NWBS)

NIF Work Breakdown Structure (NWBS) - Rev. 0A - Version3 - NIF5005352

WBS Rev. 19

PBS Code	Lev 1	Lev 2	Lev 3	Lev 4	Lev 5	Lev 6	Lev 7	Lev 8	WBS Sort Code	WBS Number	WBS Title
[illegible]											

NWBS Cross Referenced to WBS Rev. 19 (Sorted by NWBS)

NIF Work Breakdown Structure (NWBS) - Rev. 0A - Version3 - NIF5005352

WBS Rev. 19

FM Code	Lev 1	Lev 2	Lev 3	Lev 4	Lev 5	Lev 6	Lev 7	Lev 8	WBS acct code	WBS Number	WBS Title

NWBS Cross Referenced to WBS Rev. 19 (Sorted by NWBS)

NIF Work Breakdown Structure (NWBS) - Rev. 0A - Version3 - NIF5005352

WBS Rev. 19

NWBS Cross Referenced to WBS Rev. 19 (Sorted by NWBS)

NIF Work Breakdown Structure (NWBS) - Rev. 0A - Version3 - NIF5005352

WBS Rev. 19

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

NWBS Cross Referenced to WBS Rev. 19 (Sorted by NWBS)

NIF Work Breakdown Structure (NWBS) - Rev. DA - Version3 - NIF5005352

WBS Rev. 19

[illegible] Code	Lev 1	Lev 2	Lev 3	Lev 4	Lev 5	Lev 6	Lev 7	Lev 8	[illegible]	WBS Number	WBS Title
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

NWBS Cross Referenced to WBS Rev. 19 (Sorted by NWBS)

NIF Work Breakdown Structure (NWBS) - Rev. 0A - Version3 - NIF5005352

WBS Rev. 19

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NWBS Cross Referenced to WBS Rev. 19 (Sorted by NWBS)

NIF Work Breakdown Structure (NWBS) - Rev. 0A - Version3 - NIF5005352

WBS Rev. 19

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NWBS Cross Referenced to WBS Rev. 19 (Sorted by NWBS)

NIF Work Breakdown Structure (NWBS) - Rev. 0A - Version3 - NIF5005352

WBS Rev. 19

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Revision 2A

NWBS Cross Referenced to WBS Rev. 19 (Sorted by NWBS)

NIF Work Breakdown Structure (NWBS) - Rev. 0A - Version3 - NIF5005352 WBS Rev. 19

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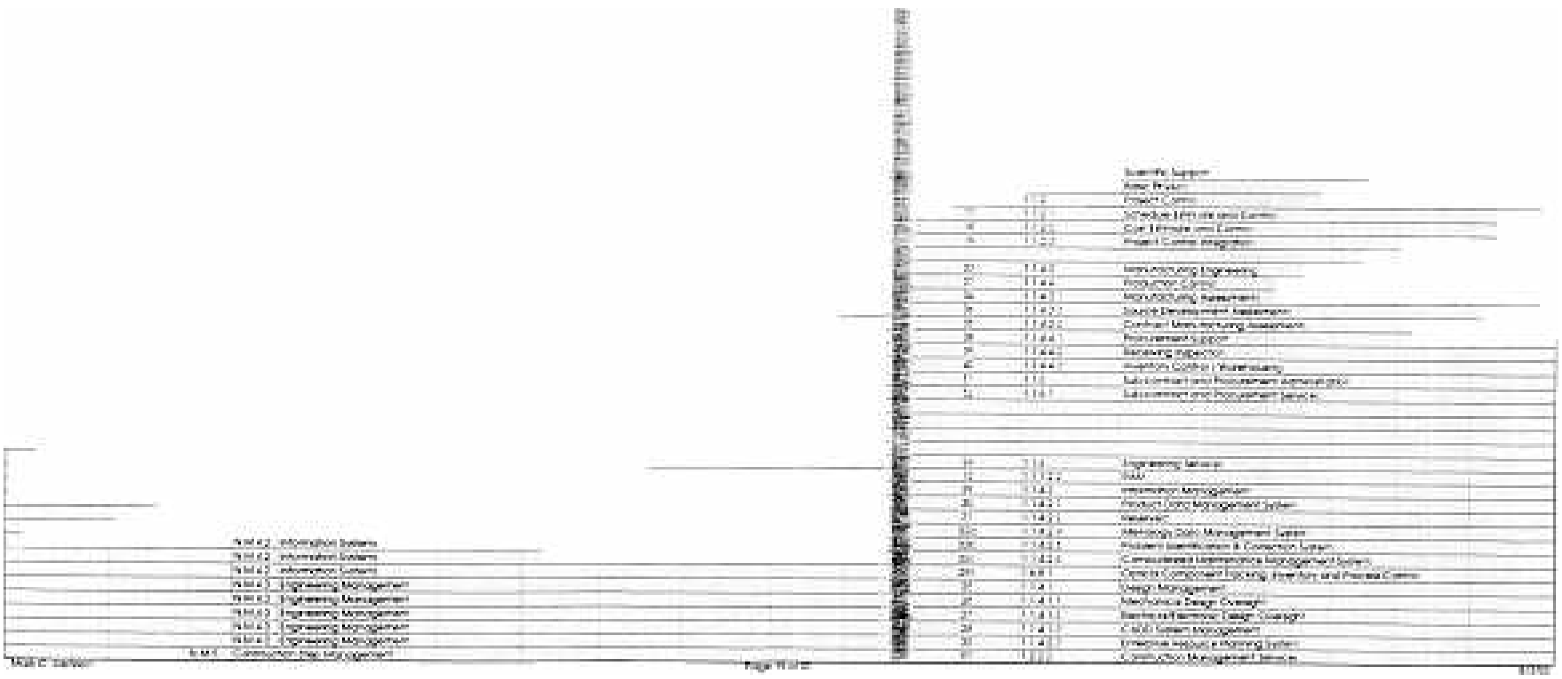

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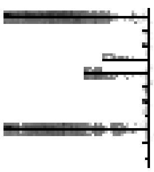

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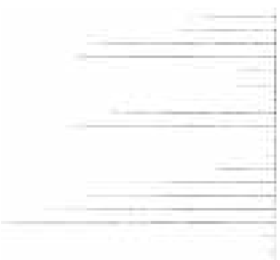

NWBS Cross Referenced to WBS Rev. 19 (Sorted by NWBS)

NIF Work Breakdown Structure (NWBS) - Rev. 0A - Version3 - NIF5005352

WBS Rev. 19

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NIF Schedule Change Crosswalk

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CD1-Approvsl of Mission Need
CDR Complete
CD2-Approvsl of New Start
Notice of Intent Issued
Architect/Engineer Contracted
KD1' Dellums Process Complete
Tille I Initiated
Construction Manager Contracted
PSAR DOE Concurrence
PSAR Approved
Approval to Initiate Title II Design
Approval to Initiate Long Lead Procurement
NEPA Record of Decision
CD3-Approval to Initiate Title II Construction
Issue Pollution Preventlon/Waste Mln Plan
Start Special Equipment Installation
Optics Facllitization Complete (DM-1)
Rebaseline Plan Approved
IMI Contract Approved
OAB MPR Phase 1-permlt Equipment Installation SEIS Record of Decision
LTAB Superstructure Complete'
Inert GasNacuum MPR Phase 3-Permlt SF Vacuum End Conventional Construction (DM-2)
Target Chamber Positioned
Joint MPR-OAB Phase 2-Permlt LRU Assembly LRU Installation MPR P2-Permlt LB2 LRU Insll OPDL MPR-Permlt Production Optics Processing LRU Installation MPR P1-Permlt PAM/PABTS Insll PCS MPR-Permlt LB2 Flashlamp Test Main Amp P1 LRU Installation MPR P3-Permit SY2 LRU Instl
ILS MPR Phase 1-Permlt PAMMA Operations
FSAR Approved
LRU Installation MPR P4-Permlt TB LRU Instl

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Light Propagation MPR P1-Permlt Light In LB2- TB
FSAR NNSA Concurrence
LTAB Construction Complete2
ILS MPR Phase 2-Permlt MOR Operations
ILS MPR Phase 3-Permlt PASS Laser Align
ILS MPR Phase 4-Permit ILS Integration Testing

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NIF Schedule Change Crosswalk

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Light Propagation MPR P2-Permit Light in LB2

Light Propagation MPR P3-Permlt Light In PDS

Joint MPR-Light Propagation Phase 4-Permit LIght to Target Bay

Inert GasNacuum MPR Phase 1-Permlt TC Vacuum
Inert GasNacuum MPR Phase 2-Permlt Gas Filling
First Light to Target Chamber Center
i First Experiments Readiness Assessment
I 10kj 1w to Precision Diagnostics-LB2ISY2
I 1st Bundle Commissioned
NNSA Approval First Experiments Readiness Assessment LRU Installstion MPR P5-Permlt LB1 LRU Inst!
PCS MPR-permlt LB1 Flashlamp Test Main Amp P2 Beampath Infrastructure Commissioning Complete
6 Bundles Commissioned
LRU Installation MPR P6-Permit SY1 LRU InsU
Light Propagation MPR P5-Permit Light in LB1
Light Propagation MPR P6-Permit Light in SY1
9 Bundles Commissioned
4-Foid Symmetry Capability
12 Bundles Commissioned
8-Fold Symmetry In One Cone Capability
15 Bundles Commissioned
8-Fold Symmetry In Two Cones Capability
18 Bundles Commissioned
Security Review (LLNL)
Security Review (NNSA)
Readiness Assessment-Full NIF Operations (LLNL)

Readiness Assessment-Full NIF Operation (Office of the NIF)

End 01 Construction"

24 Bundles Commissioned

I CD4-Approval to Begin Operations

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1 = Milestone replaced with MPR's of LB1, LB2, SY1 and SY2
2 = Milestone incorporated wIth End Conventional Construction
3 = Rfiplaced with Readiness Assessment -Full NIF Operation (OfficE~ of the NIF)
4 = CD4 was origInally defined as 12 Bundles Commissioned ancl12 bungles installed 5 = CD4 Is now defined as all 24 Bundles Commissioned .-
6 = Previously ORR/ORE Complete-Start Early Operations ~c, C"",",,"'

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IPage 2