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Department of Energy

Oakland Operations Office
1301 Clay Street
Oakland, California 94612.5208

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JAN 18 *2Gn1*

Tri Valley CAREs
Ms. Marylia Kelley 2582 Old First Street Livermore, CA 94550

Subject:

Freedom of Information Act Request -#2000-0K-98

Dear Ms. Kelley:

This office is in receipt of your December 13, 2000, Freedom of Information Act (FOIA) request. You requested the following documents that were prepared by the National Ignition Facility Project at Lawrence Livermore National Laboratory:

1. National Ignition Facility Baseline Change Proposal BCP 00- 015, approved August 2000.

2. All the attachments to item 1, including the Revised Draft Project Execution Plan.

3.
2.

Any revisions and updates to documents included in item 1 and

4. National Ignition Facility Baseline Change Proposal BCP 97- 004, approved March 7, 1997, and all attachments to that document.

5. All other level 0 and level 1 Baseline Change Proposals for the NIF Project, which were acted upon by Department of Energy

officials from 1996 to the present.

6. National Ignition Facility Functional Requirements and Primary Criteria (Rev. 1.6), released March J_997.

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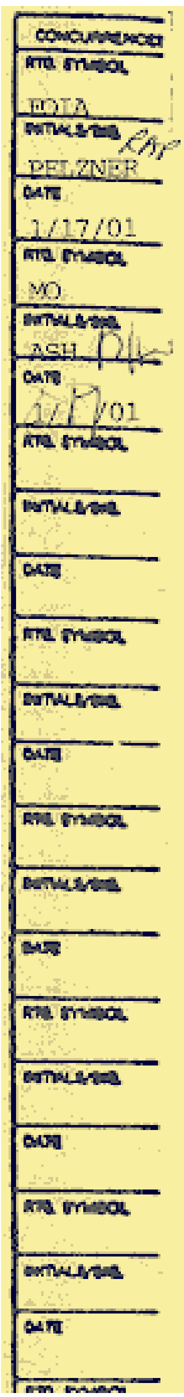
Any subsequent revisions to item 6.

In full compliance with your request, without deletions.

There is no charge for this service.

the documents are provided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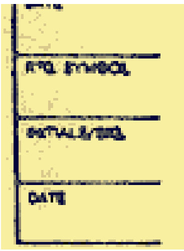

Ms. Kelley
Page 2

If you have any questions, please contact Ms. RoseAnn Pelzner, the FOIA Officer, at (510) 637-3195.

Enclosures

bcc w/o **encls:**

Sincerely,

Douglas A. Ash Chief of Staff
FOIA Authorizing Official

J. Belluarado, OPA S. Samuelson, DroMD

Department of Energy
Oakland Operations Office
1301 Clay Street
Oakland, California 94612-5208

APR 29 1997

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

Livermore, Ca. 94550

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

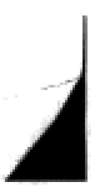
Dear Dr. Pai§~

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

Following approval of the BCP 97-04, the Functional Requirements and Primary Criteria (FRPC) were was submitted to Dr. James Turner" for approval. His approval was received on April 4,1997. In order to make the FRPC the official requirements for design and construction of the NIF. I have requested that the FRPC be included into the University of California Contract (DE-ACO3-76SFOOO48). On April 18,1997 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 constru~tion of the NIF. The FRPC, once incorporated into the contract, define the requirements and standards to be used for design and construction of the NIF, 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 distribute copies of the final FRPC to the following organizations:

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



Dr. Paisner

Page 2

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

/

s 41~. Samuelson
~~tDLOE Field Manger

Enclosures:

cc: **JonYatabe,** Level 3 **BCCB**

...
...

(12-84)
United States Government Department of Energy

memorandum

DATE:
REPLY TO ATTN OF:

SUBJECT:

TO:

APR 0 8 **1997**
Oakland Operations Office (ICFD)

Functional Requirements and Primary Criteria for the NIF

James M. Turner, Ph.D, Manager

Attached are the Functional Requirements and Primary Criteria (FRPC) for the National Ignition FacilitY (NIF) and the Work Smart Standards (WSS) Process Document. The FRPC establishes the scientific and engineering requirements that must be met d~g design and construction of NIF. The WSS Process 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 operate 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 issued by LCMD that incorporates the FRPC into contract 48. These 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 Standards process, I believe it is appropriate for you to approve this set of standards, prior to our issuing the C.O. Directive. Please indicate your decision by signing below.

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

Action:

NIF DOE Field Manager

APprovej~~~~--,

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Disapprove Date

cc: C. **Taylor**

Nlll-OOOI006-0C

National Ignition Facility Functional Requiretnents and Prim.ary Criteria

Revision 1.6

March 1997

NIF

The National Ignition Facility

Functional Requirments and Primary Criteria Revision 1.6

NIF-oOOIOO6-0C

NIF Functional Requirements and Primary Criteria
Rev. 1.6
Approval Sheet

NIF Project Manager

NIF DOE FieJd Manager

Director, Office of the National Ignition Facility

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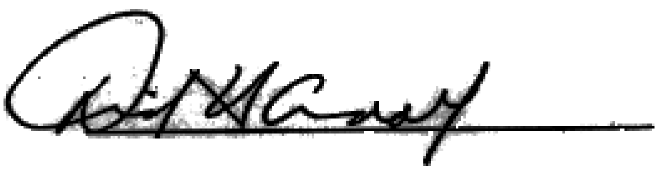
Lawrence Livermore National Laboratory

~cott L. Sa1i1uelson Oakland Operations Office



David H. Crandall Defense Programs

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Functional Requirments and Primary ~a Revision 1.6

NIF-oooIIOO6-0C

Tafule of Contents

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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 NIF Primary Criteria and Functional Requirements:' NIF-GOO1566, March 1997. Mission goals, as defined in the Justification of Mission Need, are translated into laser powe4laser beam characteristics, and other. performance specifications. Top-level operability, safety ,and enVfironmental 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 throu~ 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 hierarch}' levels for control purposes. Those items which are Levell, Primary Criteria, 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 NlF DOE Field Manager. The control of double-asterisk requirements may be delegated to the NIF DOE Field Manager at some point in the futU1'e 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. "Shall" denotes a requirement that is mandatory and must be met "Should" denotes a ~onmandatory 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 *I* 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 W avelength~

The wavelength of the laser pulse delivered to the target shaIIbe 0.35 microns *(JJm).* The design should not preclude delivering 0.53 Jim and 1.05 *JJm* 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 c~pable 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" portion of the pulse.

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2.1.8 Capsule Irradiation Symmetry

Variations in the x-ray energy deposited on tihe fusion capsul~, located in the target hohlraum, should be ~% rms. Current target design and perfornI1ance calculations indicate that this level of irradiation uniformity ~ be achieved "::iJy two-sided laser illumination of the hohlraum. Multiple laser beam1S on each side:t::enter the hohlraum along two concentric cones with cone half-angle$ of approximately 27 degrees and
53 degrees, and with two-thirds of the beams om -the outer cone an1d the remaining one- third on the inner cone. Each cone shall consist aIf 8 or more beaImS. The capability shall be provided for the pulse shape deijvered by bemms 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 dUIriing the 2G-ns..intreval prior to arrival of the main laser pulse shall not exceed lOS W *I* ~..

2.1.10 Laser Pulse Spot Size

Each beam shall deliver its desi~. energy ancd power encircled in a 6do J.Lm di~eter spot at the target plane or its equivalent. In the mppropriate co~ouration, each beam should deliver 50% of its d~jgn energy and poWler encircled in a?. 100 I.1n1 diameter spot at the target plane or its equivalent.

2.1.11 Beam. Smoothness

The NlF shall have spatial and temporal beaIm conditioning too 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 baselline NIP design.

2.1.12.1 Direct-Drive Irradiation Symmetry -Direct-drive ICF targets shall be irradiated by three pairs of concentric cones, wit:h midplane syrrmnetry. The cone half- angles and number of beams on each cone shall1be: .

Direct-drive cone Cone half-angle (apprmximate) F::raction o! ~~ta1 be~

Inner same as indirect drive 1/6 Outer same as indirect d:rive 1/3

Waist. 75 degrees ___1/2-

2.1.13 Beam Focusing and Pointing

The NIF should have flexibility in beam foCU15ing and pointinig to address the needs of radiation effects testing and other users.

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2.2 Experimental Area

The National Ignition Facility shall be operated in a manner consistent with 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 future addition of target chambers for additional weapons physics and/or radiation effects testing. The baseline design and operation should be capable of performing radiation effects testing of important national asse~, up to system level components, to maintain and certify their reliability. The following requirements are intended to satisfy the most basic of these needs.

2.2.1 ICF Target Compatibiliiy*

The target chamber and target area support systems shall be capable of target operations with both cryogenic and noncryogenic targets containing fusion fuel~ ~rovisions shall be made to accommodate and support experimenter-supplied cryostats 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. TheNIF 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 1.6x 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 s~all be capable of placing and holding targets within 3 cm 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 and experimental area shall be capable of conducting no fusion yield experiments with a
time between shots of 8 hours, with a goal of 4 hours.

2.2.7 Target Chamber Vacuum Capability

The target chamber shall be capable of achieving a vacuum level of <1 x 10-5 Torr.

2.2.8 Diagnostic Instrument Capabilities to Verify Lasen' Performance

The facility shall have the following measurement capmbilities that aJre 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 J:0-20 micron sy:>atial resoluticm.
.Laser prepulse intensity.
.Laser pulse spot size.
.Laser pulse smoothness.
.Laser beam thermal recovery time.

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2.2.9 Diagnostic Instrument Capabilities for Ignition amd Applicatioms Experiments The target chamber and area shall be capable of acconnmodating diagnostic
instruments for the following-measuremer1!ts necessary foU" fusion ignitiom and
applications experiments:

.Symmetry of x-ray emission from iInploded cores with 5- to 1Q-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 keV with 100-ps time resoluiion and 20% accuracy.
.Strength of radiation driven shocks with 5- to 1Q-Imicron resolution and time resolution of 10 ps.
.Fusion yield over a range from 1011 to 1019 neutroI:lS.
.Symmetry of neutron emission from imploded cores with 2Q-micron spatial resolution.
.Temperature of the compressed fus~n fuel with 20% accuracy fa!! ion temperatures of 2 keV or greater. .
.Number and eI}~rgy distribution of fast electrons iJ:l hohlraums in the band from 5 keV to 300 keV. .
.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 Diagnostic Instrunnents*

Rapid removal and replacement of diagnostic ins~lents consistentt: with the shot frequency specified in Section 2.2.6 shall be accomplished by diagnostic inserters and manipulators for close-in target diagnostics.

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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 NIF 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.

3.0 Safety Requirements**

The NIP shall be designed, constructed, and operated as a radioi..:ogicallow-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 :)rder 5481.1B, Safety Analysis Review System). Administrative controls shall be e5£Iablished pnor to the first use of tritium.obearing 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 mom all exposure pathways from the NUl shall meet the requirements of. DOE Order ~.5, Radiation Protection of the Public and the Environment, and 40 CFR 61; NatiCTRTa] Emission Standards for Emissions of Radionuclides Other Than Radon frOm D.epartment of Energy Facilities. These requi1:.ements state that exposure of membe!:!;S of the public from emissions of radionuclides in the ambient air from normal NUl Oper-dtiOns shall remain below 10 mrem/y. The facility shall also meet the requirements of COJE Order 5400.5 to not cause the public dose from all exposure modes and all sources *o:r::* radiation at the site boundary to exceed 100 mrem/y.

The NUl personnel radiation protection program shall follow DCJE Order N441.2 Radiation Protection for Occupational Workers and 10 CPR 835, OcqIpational Radiation Protection. The ALARA (as low as reasonably adUevable) principle.~ be utilized in both design and operation of the facility to eliminate unnecessary raaiiation dose to workers in the Laser and Target Area Building, collocated employees, and visitors from bOth routine and off-normal operations. Radiation protection shall iI::1c1ude: shielding; control of workplace ventilation; monitoring of personnel for extemaa 1 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 imrlividual worker to one- tenth (shielding design goal) of the occupational external dose- :..!:imits specified in 10 CPR 835. Concrete shielding shall comply with ACI 301, which pro'\'"71des adequate strength for DBE loads.

The requirements for radiological safety in 10 CFR 835, Occupaticonal Radiation Protection,_should be evaluated by the designers and incorporated -,when they are detennined 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-::Darrier. Leakage past these barriers shall be ALARA. The experimental-area ventilatiCDn system shall be designed to operate at negative pressures during and immediately a:t:fter shots of greater than one megajoule and provide secondary tritium confinement.

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The final exhaust release point from this system should be elevated for dis-~UI1. Exhaust air shall be continuously monitored for radioactivity. The target area sf-~ ..:also be monitored to ensure that radiological conditions are safe for personnel en~ -

3.2 Life Safety**

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

Laser Safety*

The laser safety shall comply with ANSI Z136.1. Exposure to hazardous levers 4"::iif laser light shall be prevented *by* the use of physical barriers, personnel training. . interlocks, and personnel entry controls. Protective equipment, such as laser go~iES:;, shall be used when necessary for operational purposes. Interlock systems shalll:e dedicated and designed to be fail-safe and shall activate laser shutlersor shut oE .?\Dwer .to laser systems if access doo~ are opened and hazardous exposures are possible..

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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 ~;11 comply with the requirements of 29 CPR 1926, OSHA- Constructioru

Facility subsystems (e~g., capacitor banks, vacuum systems, tritium recovery-
nitrogen supply, and personnel safety interlock systems) shall be designed to d~1lt to a safe state upon loss of power.

Fire Protection*

The NIF shall meet the design and fire protection requirements, all NFP A Cc~. and the Uniform Building Code (UBC). The structural members of the Experimental
Building (including exterior walls, interior bearing walls, columns, floors, roofs. .u:::ri supporting elements) snaIl, as a minimum, meet UBC fire-resistive standards. Appropriate fire barriers shall be provided to limit property damage, fire prop~~on, and loss of life by separating adjoining structures, isolating hazardous areas, anC protecting egress paths. The NIF shall meet the requirements for an "improved =::s: 0" level of fire protection sufficient to attain DOE objectives. To achieve this level oc protection, automatic fire sprinklers shall be installed throughout the complex.. ~ sprinklers shall be coupled with adequate fire protection water supplies and at I;... ,..~tic and manual means for detecting and reporting incipient fires. Fire hazard anal~ 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 Protectiion

4.1 Waste Management**

The NIP shall minimize the generation of wastes at the so~urce per: DOE Policy-
P450.1, Environmental Safety and Health Policy for the Depaartment of Energy C~lex, General Environmental Protection Program, and DOE Order::: 5820.2A, Radioactive:
Waste Management; and the Resource Conservation and Reecovery Act (USC 690"1 r.: 6992); and the Toxic Substances Control Act (USC 2601-26922). The NIF waste han-lffijng areas~hall comply with the standards of confinement and veEntilation requ~e:Ii:S:; specified by DOE Order 5820.2A, Radioactive Waste Manage2menl

The NIP will generate hazardous waste, low-level radioaE:t:tive waste (LLW);aIIri: .mixed" (LLW and hazardous) waste. These wastes shall be coiillected iri approved containers, labeled, packaged, sorted, and shipped to an EP M/DOE-approved tI~. I'lent or disposal site according to the Resource Conservation Reco:>very Act and the foilc~g regulations: hazardous waste per 40 CFR 260, 261 and 262; Icow-level waste per 'CCE: Order 5820.2A; and mixed (LLW and hazardous) waste per i:DOE Order 5820.2A. .ZI!r:d 40 CFR 260. The LLW packages sKall meet the radioactive solid" waste acceptance Ic' ; i i~ of the final approved disposal site. Pollution prevention will be= considered in the ~""IF design as req'\lired by DOE Order 430.1.

4.2 Effluents*

Liquid effluent discharges from NIF discharge points shaill be monitored anc. controlled in compliance with 10 CPR 835, DOE Order 5400.5, Radiation ProtectL~ ~af the Public and the Environment; the Clean Water Act (33 U.S.C. 1251 et seq.); anc .~. conditions on 40 CFR 125 Criteria and Standards for Nationa3l Pollutant Dischars:e:

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Elimination System.

Air emissions shall meet the requirements of Section 3.1 rradiation shielding ~t=: confinement) for radionuclides and the requirements of the '..=lean Air Act, (42 '1:--'":::--= 7401) including National Emission Standards for Hazardous, Air Pollutants (NE...C:E=-=:H», and state and local air quality management district require~nts.

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 mterests, 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 receivmg and inspection, final target alignment, classified data acquisition, and office areas where classified computing"is performed. Automated Data Processing (ADP) systems handling classified iI;1formation shall meet the requirements of DOE Orders 5637.1, Classified Computer Security Pro~, and 5300AD, Telecommunications: Protected Dishibution Systems. Elements of DOE Orders 470.1, Safequards and Security Pro~, and 472.1, Personnel Security Activities, will also be incorporated into the security plan.

The NIP complex shall also meet the requirements for physi<;al 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 Builiding (GAB) represent the only:newly constructed facilities at LLNL. The NIF faciIitties shall be designed for at least 30 years design life for permanent structures. SystemlS or portions oiI systems for wrnich that ic; impractical shall be designed for ease of repll:acement. Ease of replacement::means that replacement is feasible at reasonab1e cost arua can be accoIDll'lished in a tiIImely manner consistent with plant availability requiremeI1lits. "Replacement" here also iIB1cl~des . removal, refurbishment, and reinstallation aiforiginal equipment.

The performance category for target arem land laser strudural systems ~ 11 be category 2 with a graded approa~ for othersystems.

Where alternative designs 'and modes of construction are possible at esseentially equivalent cost, the design and construction method that mrost readily ~ for fuhIre reconfiguration and modification should be selected.

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Vibration Requirements

.Certain facilities or areas within facilities- will house vibJration-sensitive::,special equipment. The stru~al design of these areas shall provide means to effeectively isolate this equipment to control vibration within specified displacement a:::nd rotation requirements. Specific constraints are specified in the System Design Requz=rements for NIP Facilities.

Cleanliness Requirements

The laser bays, experimental areas, and optical assembly rooms must~ dust free to prevent laser damage to the optics. Specific constraints are specified in the- :3ystem Design Requirements for NIP Facilities.

6.4 Temperature eontrol

Temperatures in the laser bays experime:!:ltal areas must be controlled =1: order to maintain a stable laser alignment. Specific ccmstraints are specified in the S",7stem Design Requirements.

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 prot~ed 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 alarIi\s 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.

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 rapic:i recovery from unplanned shutdowns.

7.1 Reliability, 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,meaJ.1 times between failures; mean times to repair, preventive maintenance requirements, etc. Techniques such as in-site backups, on-hand spares, modular components, on-caIl 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 NIP. Future addition of more units of maintenance equipment shall not be precluded. Continuous high-availability NIP 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, to plan preventive maintenance and inspection programs, and to respond to unscheduled outages.

7.2 Recovery Tiine*

Because of its importance to the DOE, the NIP shall be designed to survive any abnonnal event, including accidents and natural phenomena, expected to occur more frequently than once in 2000 years. The time required to recover from such events is allowed to vary in accordance with the probability of occurrence. Maximum recovery times are specified below.

Probability of Occurrence Per Year, P	Maximum Recovery Time
P = 1	24 hours

1 week
3 months for laser, target, and
associated building structures
-6 months for support systems

1 > P ~ 10-2
10-2 > P 5 x **10-4**

The probabilities of occurrence listed in DOE-STD-IO2D-94 and DOE-STD-IO21-93 shall be utilized for natural phenomena.
Standby power shall be available to preserve process continuity hi 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 Decommissioming

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The NIF design shall meet the sine-specific require;ments. The NIF .shall be designerii for periodic cleaning of the interior rof the test chamber to maintain trillium levels on interior surfaces as low as reasonab~ty achievable. TheNIF' design shalll include considerations that will allow for comt-effective futUI:e decommissionimg of the
structures and equipment.

A plan for NIF Decontaminatiom:and DecommisSioning (D&D) shall be developed :in accordance with DOE Order 5820.2A, Radioactive Waste Managememt. A D&D assessment shall be made during comceptual design tm ensure that featb.1res and measures are incorporated inNIF tm:simplify D&D. 'm\e NIF D&D plmn will be prepared before the end-of the Title n design.

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 NIP Quality Assurance Program Plan and utilized throughout the project. The QA 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 NIP shall be designed and constructed in ~l compliance \\lit:h DOE Orders i:3aIld federal regulations. Exceptions shall be limjted to those cases where -the project has formally requested and been granted either an exemption or a findjng of equivalen~7 by
Headquarters.

It is recognized that updates and additions to DOE Orders, feder::al regulations, an1d
consensus industry standards are outside of the control of the project team and are ~ frequent source of cost and schedule growth. These requirements are all frozen as or
March 1, 1996.

10.2 Codes and Standards

Technical codes, standards, and guides promulgated by nationalLy recognized organizations should be uti~ by the NIP Project whenever available and practicai;., per DOE Order 1300.2A. A partial listing of nationally recognized OL":ganizations is included in the following sections. Additional references identified during the developmental phases shall be formally cited and controlled in system and subsyste=:In design requirements documents and specifications through the Project Change ContIIol
Process.

10.3 Applicable Orders, Codes, and Standards

This section lists DOE Orders, codes, and standards in effect on ~l1arch 1, 1996, tiuat are considered to be applicable to the NIP 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 organiz:Rtions. The applicable portions of these documents will apply-.

10.3.1 DOE Orders
.1300.2A -Technica1.Standards Program
.5300.4D -Telecommunications: Protected Distribution SysteI::l
.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 System (for non-nuclea=- 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) -Consh"uction ..40 CFR 125 -Criteria and Standards for NPDFS (National Pollutant Discharge Elimination System)

.40 CFR 260,261,262 -H~douS Waste Management System
.40 CFR 61 Subpart H .:. National Emission Standard for Emissions of Radionuclides other than Radon from Department of Energy Facilities
.FED-STD-209E -Airborne Particulate Oeanliness Oasses in Cleanrooms and Clean Zones
.33 USC 1251 et seq. -Clean Water Act .
.42 USC 7401 -Clean Air Act
.42 USC 4321 et seq. -NEP A (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:

-ACI 301 -1996, Specifications for Structural Concrete for Buildings
-ANSI C2 -1993, National Electric Code
-ANSI C84.1-1989, Electrical Power Systems and Equipment-Voltage Rating
(60 HZ) ".
-ANSI Z136.1 -1993, Laser Safety
-ANSI/RIA R15.06 -1992, Industrial Robots and Robot System-Safety Requirements
-OOE-Sill-1020-94, Natural Phenomena Hazards Design and Evaluation Criteria for DOE Facilities
-OOE-Sill-l021-93, Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, & Components.

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-IEEE 4931990, IEEE Recommended Practice for the Design *of* mdustrial and Commercial Power Systems
-All NFP A Codes
-NFP A 70 1996, 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 -Unifo~ Building Code (UBC) 1994

Orders, standards, and codes listed as mandatory in DOE Orders are no't necessarily referenced in this list.

In addition to complying with these specific standards, the NIP Project shall utilize applicable and appropriate national consensus codes and standards in the design, pr~ent, 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 app.1ied as appropriate to NIF materials and workmanship:

AA Aluminum Association
AASHTO American Association of State Highway Officials 'I ABMA American Bo..iler Manufacturers AssOciation
ACI American Concrete Institute
ACGlII American CoUlicil *of* Government! Industrial Hygienists
AISC American Institute of Steel Construction
AISI American Iron and Steel Institute

AMCA Air Movement and Control Association
ANSI American National Standards Institute
AP A American Plywood Association
ARI Air Conditioning and Refrigeration Institute
ARMA Asphalt Roofing Manufacturers Association
ASCE American Society of Civil Engineers
ASHRAE American Society of Heating, Refrigerating & Air Conditioning Engineers
ASME American Society of Mechanical Engineers
ASTM American Society for Testing and Materials
A WS. American Welding Society
A WW A American Water Works Association
BHJ\,.1A Builders Hardware Manufacturers Association
CISCA Ceiling and Interior Systems Contractors Association
CGA Compressed Gas .Association
CMAA Crane Manufacturers Association of America
CRSI Concrete Reinforcing Steel Institute
EPRI Electric Power Research Institute
FM Factory Mutual Engineering and Research20 20

GA Gypsum Association
ICBO International Council of Building Officials (Uniform Building Code) ICEA Insulated 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
RFO 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
S11 Steel Tank Institute
SWI Steel Window Institute
TCA Tile Council of America
'fllv1A Thermal Insulation ManufaCturers Association
UL Underwriters Laboratories

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Functional Requimtents and Primary Criteria Revision 1.6

NIF-OOOIOO6-0C: .

11.0 Revision Record

~ Descri~tion of/Reason for Change -

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1.4

1.4

1.5

1.6

1 3/94
j 4/1/96

n/a
n7a

4/1/96 In/a

.4/1/96 I **n/a**

12/18/
96

80,81

3/10/97

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96-004

96-005

96-006

97-001 97-002

97-004

I COR release

Directed changes in DOE Orders and Federal Regulations. Miscellaneous changes throughout document

Functionality 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 Functional Requirements/Primary Criteri;a. Changes to incorporate results of Title I design and design review, update of DOE Orders and standards, and miscellaneous chan~es

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

March 1997

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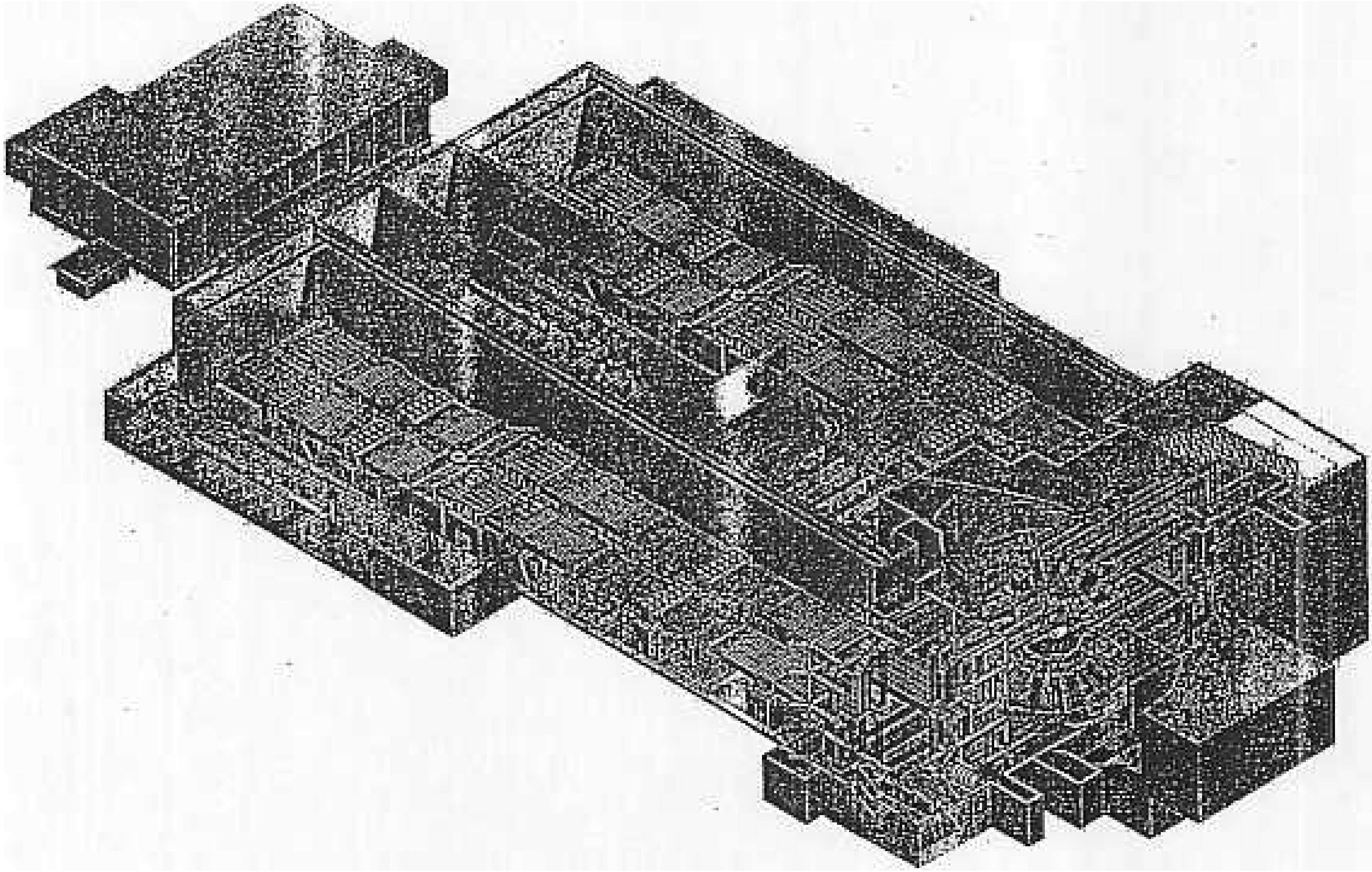
Process for the Development of the NIF Primary Criteria and Functional Requirements



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Process for the Development of the NIF Primary Criteria and Functional Requirements

Prepared by:

Reviewed by:

March, 1997

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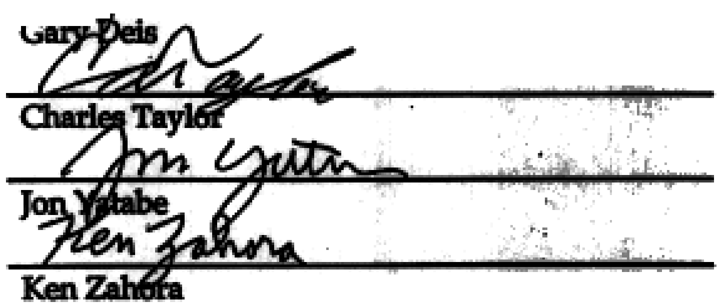

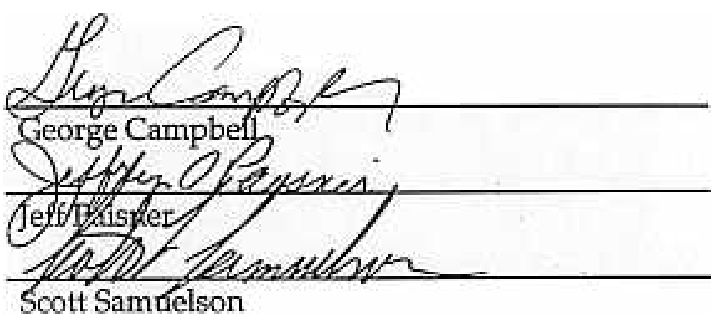

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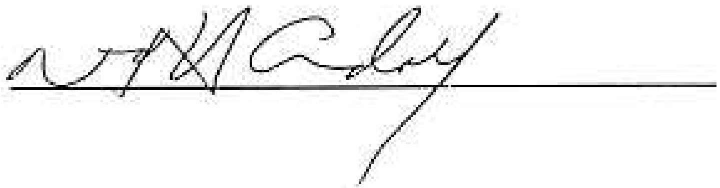

David.crandall

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Contents

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1. Introduction

1.1 Purpose and Scope

The purpose of this document is to document the formal process used to develop the OOE-controIled levels of the NIF Project design criteria (see Fi~ 1). These criteria represent the specific technical and applicable regulatory requirements that the DOE will use to define and control the scope of the NIF Project. These criteria form the foundation of the techniCal baseline, which in turn results in a cost and schedule baseline. All three baselines are contaihed in the *Project EXecution Plan* (DOE, 1996a). These top-level criteria form the basis for all lower-tier criteria that are used to control the design, manufacture, construction, installation, and acceptance-testing of NW systems, structures, and components. These criteria are applicable to all project activities, which are completed at Gritical Decision 4 when all of the systems aJ,"e acceptance tested and turned over to Operations for activation. The reqUirements for activation are the LLNL sitewide requirements existing at the point of -operation.

1.2 Organization of this Document

The NIP *Primary Criteria and Functional Requirements* (Appendix A) represent the OOE-controlled levels of the NIF design criteria. As such, they must be a "necessary and sufficient" set of design standards. This document descn"bes the process employed by the NIP Project, working together with the DOE and other stakeholders, to identify, review, and approve the necessary and sufficient sel Since thiS work responds directly to DOE Notice 450.3-T_Tse of Necessary and Sufficient Process-this document is organized directly according to DOE M450.3-1-00E Oosure Process for Necessary and Sufficient Sets of Standards. Section 1 provides introductory and background material, including the purpose and scope of the document, and pertinent general background regarding the NIF Project. Sections 2, 3, and 4 correspond to the three main chapters of DOE M450.3-1: related to initiating the process; identifying the necessary and sufficient set of .standards; and using the approved set. Section 3 is further subdivided to correspond to the six main process steps used to identify the necessary and sufficient set. '.

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DOE orders,
codes,
standards, etc.

Federal, state,
and local
regulations

Justification of mission need
(JMN)

NIF primary
criteria and
selected
functional
reQuirements

Other
functional
requirements

System design
requirements

NIF users and stakeholders requirements

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Level 1

DOE HQ Control

Level 2

Subsystem.
I ~ design Level 4 requirements

DOE Field Office Control

Level 3

Laboratory Project Office Control

4 0-00.04 94-1715 P bO4

Figure 1. Hierarchy of NIF design criteria.

1.3 NIF Project Background

The NIF is a key element of the DOE Defense Program's Stockpile Stewardship and Management Program. With the cessation of underground testing compliant with the Comprehensive Test Ban Treaty, the above-ground testing capability combined with.. advanced computational modeling capability are critical to the ensure the reliability of the enduring stockpile. The mission of the NIFis described in the Secretary of Energy's

justification of Mission Need (DOE, 1993). The NIP will be capable of achieving fusion ignition and modest (1-10) gain, allowing the evaluation of weapons effects under conditions of very high energy and density. The NIP will also provide radiation effects testing and support fusion energy research and science evaluations (e.g., stellar processes). The NIP consists of an experimental building, the Laser and Target Area Building, supported by an Optics Assembly Building. These buil~g~ provide a controlled environment for the laser systeI;n, which will consist of 192 individual laser beams that can fo~ 1.8 mega joules of laser energy on a small target filled with a mixture of deuterium and tritium centered in a test chamber. The target chamber and surrounding facility are appropriately shielded with concrete to provide protection from the neutron and x-ray radiation released during the performance of the yield shots, which are projected to range up to 20 megajoules.

In 1993, the DOE in the initiation of the NIF Project provided the *Justification of Mission Need* (DOE, 1993) to define NIF's role in Stockpile Stewardship and Management, along with its major requirements. LLNL expanded these requirements in terms of the specific requirements for the laser and target systems in Design Basis Documents (LINL, 1994a). 'nlese documents and the applicable DOE. Orders, Federal Regulations, and Natio~ Consensus Standards formed the basis for a Project Team appointed by the Project Manager, headed by the Project Scientist and Assurance" - Manager, to develop the *Functiqnal Requirements and Primary Criteria* (DOE, 1994a) to guide and control Conceptual Design (Campbell, 1993). These Criteria were approved " by the DOE Field Office (Functional Requirements) and the Director of Office of ICF and NIF (primary Criteria). Once the criteria were approved, ~e original signers approved all proposed changes (Note: this occurred prior to formation of Baseline Olange Control Boards.) The first revision controlled Conceptual Design. Based on the comments made in the succeeding Project review,"the Functional Requirements and Primary Criteria were ~evised. At each important review of the Project design, this update has occurred. As" each revision to these top-leveJ criteria was issued, all of the lower-tier criteria Vv.c..-e revised for consistency. This disciplined flowdown from top- level criteria down through all subtier criteria is described in later sections on the process.

1.4 NIF-A Low Hazard Radiological Facility

The environmental ~pacts of the NIP construction and operation were evaluated in the *Programmatic Environmental Impact Statement for Stockpile Stewardship and Management* (DOE, 1996b) and its *Record of Decision* (in DOE, .1996b). The safety aspects have been evaluated in the *Preliminary Hazards Analysis* (LLNL, 1994a), Fire Hazards Analysis Qensen 1994), and the *Preliminary Safety Analysis Report* (PSAR) (LLNL, 1996a). DOE has reviewed these documents and, in their *Safety Evaluation Report* (DOE, 1996c), concurred in the hazards category for NIP as "a low hazard, radiological facility. This DOE hazards category designation means that the construction and operation of the NIP will have negligible offsite impacts and minor onsite impacts.

2. Initiating the Process of Criteria Definition and Control

This section discusses how the process was identified; the team formation, including the supporting groups, other review groups, stakeholder inputs, and approval authorities.

2.1 Recognizing that the Process Was Required

The criteria definition and control process was initiated in 1993 when the DOE approved the start of conceptual design and transmitted the *Justification of Mission Need* (DOE;'1993), which was approved by the Secretary of Energy. The DOE and Laboratory Project'Offices recognized that this DOE Strategi~ Initiative required a set of guiding criteria for the conceptual design. It was rec6~d that successful completion of the NIF Project would require a team effort with clear definition of roles, responsibilities, interfaces, and open communications among all participants. The NIP *Project Execution Plan* (DOE, 1996a) provided that. organization, and ensured that all participantS would work together in a manner that would foster teamwork and performance excellence through a system of continuousmteraction, review, and feedback.

The DOE conducted a safety evaluation of the NIP PSAR (LLNL, 1996a), which was documented in the *Safety Evaluation Report* completed in October 1996 (DOE,1996c). The DOE ES&H Manager was designated as the lead for the review with the support of several other organizations. The PSAR was reviewed by technical suBport personnel from DOE *OAK*, DP /RQ, and OAK support Services conti-act personnel. Several issues were identified during the review that were provided to the LLNL PSAR development team for resolution. All comments were resolved satisfactorily and signed~off by the approving official. Final review of the PSAR safety evaluation was done by the DOE/OAK Safety Analysis Manager.

This process for developing these criteria in 1993 was based on the requirements of DOE 4700.1, Project Management, which was in place at the time. DOE M450.3-1 was not issued until March 4,1995. However, the processes used for developing and controlling the criteria follow the general DOE policy on necessary and sufficient requirements (DOE P450.3) and many of the specific DOE M450.3 guidelines. The Baseline Change Control Board process described in DOE Order 4700.1 requires that the criteria be tiered with the top level (Primary Criteria) approved by the Director of Office of ICF and NIP, the second level (Functional Requirements) controlled by the NIP DOE Field Manager, and the third level (System Design Requirements) by the Laboratory Proj~ct Manager. The regulatory requirements used initially were the DOE, other federal, and National Consensus Standards requirements existing in 1993.

2.2 Designating the Process Leader

The development of the criteria for the DOE was centered in the OAK ICF Division in the roles of the NIP DOE Field Project Engineer, Ken Zahora, and the DOE OAK ICF Division ES&H Manager, Charles Taylor. The Laboratory Project selected the Systems Integration Manager, Gary Deis, and the Assurances Manager, Jon Yatabe. These four formed the process leadership, with O1arles Taylor designated the senior DOE Manager and ove:rall process leader. The criteria used for the selections are listed below:

For aIlleaders:

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10 or more years of experience in managing major DOE Projects (Strategic Systems, Major System Acquisitions, major projects, or other Line Item ProjeCts) for project engineering.
Engineering or technical education and related experience applicable to laser systems, complex facilities, radiation; and computer control systems. Experience in Inertial Confu\ement Fusion (ICF).
Experience in engineering administration (confi~tion control, QA files, Baseline ~ge Control Process; etc.). ..
Knowledge of DOE Orders, Federal Regulations, and National Consensus Standards. .
Familiarity with the DOH'Project Management requirements (Independent Cost Estimate validation, etc.).
Experience in the University of California and DOE contract and related .agreements.

Additional requirements for ES&H leaders:
.Knowledge of the DOE, Federal, and State of California ES&H regulations. .Experience in the preparation of Environmental Impact Statements (HISs), Safety
Analysis Reports (SARs), Fire Hazards Analyses (FHAs), Construction Safety Programs, Preliminary Hazards AnalySes (pHAs),"etc.
.Knowledge of QA and security (desired) requirements for DOE facilities. .Experience in audit and independent reviews of ES&H programs. "

Additional requirements for Project Engineering leaders:
.10 or more years of experience in managing major DOE Projects (Strategic Systems, Major System Acquisitions, major projects, or other Line Item Projects) for project engineering.

The curriculae vitae of the four leaders are provided in Appendix B.

2.3 Designating Convened Groups

Two different groups were convened to develop the necessary and sufficient standards set for the Primary Criteria and Functional Requirements, one group

addressing the technical performance standards arid the other addressing the environmental and safety issues. .

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2.3.1 Technical Team

The technical team was required to have sufficient breadth and depth of expertise to understand the performance characteristics of ICF experiments (both indirect and direct drive), other user needs (radiation effects testing, weapons physics, and inertial confinement energy), and the detailed performance .capabilities of high-energy laser systems. The team needed to be composed of a mix of scientists, including experts in target desi~ and analysis, laser performance, laser optic materials, etc.; all of these individuals were required to be fully aware of the state of the art in these areas so that performance requirements could be developed that took advantage of planned advances in technology.

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The technical work was done under the NIP Project Scientist Gohn Hunt) who gathered a staff of key ICF scientists Gohn Murray, Steve Haan, Rick Sawicki, Howard Lowdermilk, Robert Kaufman, Ken Manes, and Mike Tobin) and worked with the Assurance Manager Gon Yatabe) to develop all of the key performance and availability criteria. The team drew heavily <?n the expertise and input from stakeholders and other resource authorities, such as NIP user groups from workshop inputs, other ICF laboratories, and DOE/HQ (Roland Frenck), who provided input regarding recovery from postulated events.

Once the fundamental technical performance sections of the Primary Criteria and Functional Requirements were developed, they were,presented to user groups (Weapons Effects, Energy, etc.) in a series of meetings.

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2.3.2 Environment and Safety Team

The second convened group was the environment and safety (E&S) teafu, which was formed by the specialists evaluating the ffi&H aspects of the NIF. This group was required to take the tecJmical.requirements and understand the hazards that affected their evaluations (neutron yields, hazardous chemical inventories, activation of materials of construction, tritium, etc.) of the E&S impacts of the NIP construction and operation. The environmental and safety team was required to have sufficient capability among its members to work with the technical team to understand and quantify the hazards resulting from the anticipated technical requirements. This team required broad experience in E&S issues, as well as in large-project E&S planning. Specific expertise was also needed in ICF-related radiation protection, shielding analysis, environmental protection, tritium management, etc.

The E&S team included Sandra Brereton, Lead Engineer for Safety Analysis; Mike Singh, Lead Engineer for Radiation Protection; Jessie Lum, Fire Protection Control Engineer; Mike Trent, Hazards ContJ,"ol Team Leader; Charles Taylor, DOE ICF Division ES&H Manager; Bill Hatcher, Laser Assurances Manager; Mike Tobin, Lead Target Area Scientist; DeIUlis Peifer and Jim Wharton, Environmental Protection Engineers; Steve

Cerruti, NIP ES&H Coordinator; Tim Andrews and Tom Reitz, Waste Management and Tritium Systems Engineers; and Jon Yatabe, Assurances Manager. They determined the neutron and x-ray yields from the maximum-yield shots, the required tritium throughputs, inventories of tritium, etc.

2.4 Identifying Other Resource Authorities

The other Resource Authorities are DOE OAK and DOE HQ, the DOE mdependent Contractor for NEP A document preparation (Argonne National Laboratory), and the LLNL Laser Directorate Assurance Office (which concentrated on ES&H issues only). The key authority is the DOE OAK and HQ reviewers who represent the sponsoring agency for the construction and the operation of the NIP. They are.,alsothe regulators for the ES&H aspects of NIP and have the primary review of safety and environmental documents.

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DOE reviews included DOE OAK reViews of the criteria, especially the FS&H as~ of the criteria during the ConceptUal, Advanced Co:n~ptual, and Title I Design - reviews. DOE also reviewed the criteria during the review of the *Preliminary Safety Analysis Report* (LLNL, 1996). The NIF DOE Field Office contracted for technical support services with Advanced Data Concepts (ADC) to provide an independent technical review of the NIP mid-Title I design and the NIF final Title I design. ADC provided technical experts in the following areas: radiation protection life safety, structural,
HV AC, systems engineering,-laser engineering, laser systems, FS&H, cost estimating, and electrical safety.- -The ADC interim reports, design review comments, and final reports were provided to the NIF Project Office as part of the NIP DOE Field Office Title I design review comment transmittal, and they were used to support the DOE decisions to proceed with NIP Title n design, to proceed with NIP Long-Lead Procurement, and
to endorse the Nil'" Baseline Change Proposals submitted after &mpletion of the Title I - designreview.- DOE HQ reviews involved DOE Daense Progranl (DP) reviews during the Conceptual Design phase under Roland Fre:nck, who was supported by a team of SAIC reviewers that proVided DOE comments in areas such as radioactive confinement, security, recovery time, availability, and electrical safety. The DOE HQ DP also requested input from DP E&S organizations who were provided the PSAR for review. The role of DOE OAK and DOE HQ in the formal approval of the Primary Criteria and Functional Requirements is described in Section 2.6, Approval Authorities.

In addition, Argonne National Laboratory (ANL), in preparing the *NIF Project Specific Analysis* (DOE, 1996b) and the NIF *Mitigation Action Plan* (DOE, 1997a), independently reviewed the ES&H requirements for NIP as sited at LLNL, the preferred site, or the alternative sites: Los Alamos National Laboratory (LANL), Nevada Test Site (NTS), and Sandia National Laboratory, New Mexico (SNL-NM).

Other Laboratory Resource authorities included the Laser Directorate Assurances Office, led by Bill Hatcher, who provided review and guidance to ensure that NIF ES&H activities remained consistent with the overall Laser Programs Directorates and

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LLNL requirements. This office also reviewed the criteria from the standpoint of consistency with LLNL Health and Safety Standards. Hazards Control review included a review of the ES&H-related sections at the request of the Hazards Control Team Leader, Mike Trent. Th~ LLNL Laser Directorate technical staff was also used extensively to support the members of the technical team.

2.5 Identifying the Stakeholders

NIP Stakeholders are of two types. The first group is the public, and more specifically the public living in the areas potentially affected by the NIF siting and the socioeconomic impact of the construction, procurement, activation, and operatio~ The second group of stakeholders is the potential users and beneficiaries of NIF, including the ICF-program groups at LLNL, LANL, SNL, University of Rochester Laboratory for Laser Energetics (UR-LLE), etc.; weapons-physics groups atLLNL, LANL, and SNL; the National Academy of Science; the Inertial Confinement Fusion Advisory Commjttee; the JASONs; radiation-effects users, such as DSW A (formerly DNA); and the inertial fusion energy and high-energy-density physics commtlI\:ity. mput has been solicited from stakeholders in many forums, as described below, and stakeholders have taken advantage of these opportunities to input verbally and in writing as listed in the following sections. ...

2.5.1 Public Groups Concerned with NIP Environmental I~pactl

The *Programmatic Environmental Impact Statement for Stockpile Stewardship and Management* (PElS) (DOE, 1996b) included the N1F *Project Specific Analysis,* which is an evaluation of the environmental impacts aSsociated with the construction and operation of the NIF at four alternative sites. Public stakeholders were invited to review the documents and attend document review meetings held at all of the alternative sites and Washington DC. The public and the interested organizations made a significant number of comments on the NIF ("name the specific weapon reliability iSsues that NIF will address," "discuss the cumulative impact ofNIF waste," etc.). These comments were recorded and addressed in the Final PElS (DOE, 1996b).In addition, ANL, the Independent NEP A document preparer, prepared a supporting document (ANL, 1996) that addressed many of the issues raised. The *Record of Decision* (in DOE, 1996b) incorporated all of the conunents and selected LLNL as the NIP construction site.

2.5.2 Public Groups Concerned with Non-Proliferation Aspects of NIF

In 1995, in response to stakeholders comments and at the request of Congressman Ronald Dellums, the Secretary of Energy directed the preparation of an evaluation of the non-proliferation aspects of the NIP. This report, prepared by DOE NN, included public stakeholder meetings at Oakland, Livermore, and Washington DC. The stakeholders provided general and then specific comments on the draft document. These comments were conSidered in the final DOE NN document on the non- proliferation aspects of the NIF (DOE, 1995).

2.5.3 NIF Public ES&H Working Group

The Associate Director of Laser Programs, E. Michael Campbell, fonned a public ES&H working group in 1996 that consists of members selected by intervenor groups, appropriat~ congressional offices, labor organizations, the city of Livennore, business groups, and the California Department of Health Services. The group meets approximately quarterly and discusses ES&H issues (e.g., accident analysis) related to the NIF. Minutes are kept and action items assigned (e.g., "present the basis for background radiation at Livermore") and transmitted to all of the members. The DOE OAK ICF ES&H Division Office, Charles Taylor, and'the NIF Project Assurance Manager, Jon Yatabe, provide support (e.g., provide ES&H evaluations) to the working group as ex officio members.

2.5.4 The National-Academy of Science, the Inertial Confinement Fusion Policy Advisory Committee, and the JASONs ..' The National Academy of Science (NAS), the Inertial Confinement Fusion Advisory
Committee (ICF Aq, and the JASONs all represent the community of technical stakeholders-users and programs that will benefit from the scientific advances of NIF. On several occasions the NAS has been asked to review the need for and the required capabilities of the NIF by the DOE. The NAS has conducted several topical reviews of various aspects of the NIF (laser..systems, target experiments, management, etc.) and continues to provide independent input to DOE on NIF. In November 1995, the ICFAC stated that as far as ignition was concerned, there was sufficient confidence that the ICF Program was ready to proceed to the next step in the NIF Project-the final design phase (ICFAC, 1995). The JASONs, another indeEendent committee, in 1996 affirmed the value of the NIF for stockpile stewardship after reviewing the NIF design and
requirements. .-'

2.5.5 NIF User Groups

The NIP will be used primarily for four m~ types of experiments: ICF ignition, weapons physics, radiation effects, and inertial fusion energy and basic science of high- energy-density physics. The scientists and program leaders in each of these areas are significant stakeholders, particularly in the technical performance issues. Input was solicited from these groups, and active discussions were held, resulting in "white papers" detailing proposed experiments and resulting NIF requirements in each area. ICF indirect-drive igniti~on stakeholders (DOE, 1994c) are located in many ICF programs and had opportunity to provide input through the ICF Program managers' meetings; LLNL scientists were, of course, directly coupled in through the technical team. Direct- drive stakeholders led by the University of Rochester's Laboratory for Laser Energetics (Eimerl, 1995) also prepared a white paper as a means of documenting their input. Weapons physics stakeholders (Perry, 1995; Hsing, 1995; Heidrich, 1995; Spillman, 1982; Goldstein, 1994) are located primarily at LLNL and LANL, and they too, provided white-paper input. Radiation effects stakeholders from DOE and DSW A (formerly DNA) formed a NIP radiation science user group (NRSUG) to develop requirements for radiation effects testing. These requirements have been documented in a classified "white paper" (Ballard, 1995). The DOE Defense Programs has established a memorandum of understanding with DSW A (DSW A, 1996), and representatives were involved with the project team in the development of the requirements. The inertial fusion energy and basic sciences stakeholders have had workshops on potential uses of NIP for studying high-energy-density physics, and their conclusions have been documented in a white paper (Lee, 1995).

2.6 Approval Authorities

The set of necessary and sufficient standards that results from this process is approved by four individuals: the Laboratory Project Manager, Jeff Paisner, supported by the level 3 Change Control Board; the NIP DOE Field Manager, Scott Samuelson, . suppo~ed by the level 2 CCB; the Director of Office of ICF and NIP, Dave Crandall and the DOE ICF Program Manager, Marshall Sluyter (retired, subsequently replaced by Dav~C:randa11), supported by the levell CCB.

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3. Producing the Necessary and Sufficient Standards for the NIF

The preparation of the necessary and sufficient standards (DOE, 1996d) for the NIF are discussed in this section.

3.1 Work, Performance Expectations, and Hazards Definition

The overall technical goal of the NIP, as stated in the Justification of Mission Need (DOE, 1993), is threefold: (I) to play an essential role in accessing physics regimes of interest in nuclear weapon design and to provide nuclear-weapon-related physics data, particularly in the area of secondary design; (2) to provide an above-ground simulation capability for nuclear weapons effectS on strategic, tactical, and space assets (including sensors and comman~ and <;antral); and (3) to develop inertial fusion energy for civilian power production. These ICF applications require the achievement of ignition and propagating thermonuclear fusion burn.

To achieve these goals, the facility will use compact, multipass glass lasers to produce the power necessary to drive the ablation that compresses small capsules . containing a mixture of bitium and deuterium sufficiently to result in ignition and modest energy gain (1-10). Full definition of the facility conceptual design followed ~y Title I (preliminary) (reviewed by independent agencies) and Title n (detailed) design will be performed by the Laboratory Project Office. The basis of the d.~ign is the design criteria prepared at the beginning of conceptUal design and then updated at each phase of design. The total set of criteria is shown in Figure 1. The-top level criteria (to be controlled by the Director of Office of ICF and NIF using the Levell BCCB) the *Primary Criteria* and the second level (to be controlled by the NIF DOE Field Manager using the Level 2 BCCB) are the *Functional Requirements.* These are published as a single document with the DOE HQ-controlled primary criteria denoted by an asterisk (*). These criteria are divided into two categories: (1) mission-related technical requirements and (2) Safety, Environment, Health, and Assurance (security, quality assurance, etc.).

3.1.1 Technical PerfQrmance

The Technical Criteria group, under John Hunt and Ken Manes, prepared a design basin document consistent with the original Primary Criteria letter signed by the ICF Program Directors and Laboratory Program Managers (Campbell et al., 1993) that summarized the scientific basis of the NIP. A series of memos was prepared (e.g., "Confidence Level of Ignition vs. Cost Scaling," Manes, et al., JTH:LHS:10-10/9/92-1), which predicted target performance by scaling from existing studies. Based on these analyses, together with the predicted laser science capabilities, the overall top-level technical performance goals were established for the NIP Conceptual Design: the

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overall power and energy envelope of the laser, and the laser wavelength and pulse format. In addition, technical goals included the ability to perform experiments using direct or indirect drive, to perform an adequate number of experiments over the lifetime of NIF, and to facilitate experimental capabilities for all user groups. All NW technical design criteria were evolved through the Advanced Conceptual Design leading to a Baseline Change Proposal accepted by the Levell BCCB in support of Title I Design (Aprill996). The Project baseline (cost, schedule, and scope) concuiTed by the Level 0 BCCB is based on a complete self-consistent set of technical performance (and, as discussed below, ES&H safeguards and security and quality assurance) design requirements.

3.1.2 Hazard Definitions, Hazard Categories and Performance Expectation and Objectives

Th~'~&H Working Group took responsibility for these evaluations. They first developed from the technical work definition the source terms for radiation protection, bitiwIi1nventory and throughput, waste generation, and postulated accident releases. They were at this time using these ~ts to develop two key documents: the *Radiological Analysis of the National Ignition Facility* (LLNL, 1993a) and the *NIF Preliminary Hazards Analysis* (LLNL, 1994a), which was the basis for the DOE concurrence on the facility hazards category (DOE, 1994c). The DOE hazards categorization of low hazard radiological means that the construction and operation <;>f the NIF will have negligI"ble offsite impacts an minor onsite impacts. At this point, the first hazards table of the Nil" was generated and led to the ES&H criteria ~tegories that became primary criteria: radiation protection, life safety, laser safety, indusbial hygiene and construction and occupational safety, fire protection, waste management, decontamination and decommissioning, and effluents. These were joi:1)ed by the assurance criteria for safeguards and security and by quality assurance. For each of these general areas, performance goals were adopted as shown in Table 1..

3.2 Creation of the Teams

3.~~:Technical Criteria Team

The Technical Team to develop the technical performance requirements had the following selection criteria:

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Team Leader has advanced scientific degree and a minimum -of 10 years of experience in large ICF experimental systems, knowledge of indirect-drive and direct-drive operation. Understanding of the underlying physics of the ICF process. Experience in the start-up or operation of a major ICF facility. I-Gmega Chief Scientist has advanced degree and a minimum of 10 years of experience in lasers, specializing in the performance of the system up to the tripling of the wavelength. Capable of performing the design optimization evaluations of various laser systems.

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Table 1. Performance goals for ES&H criteria categories, safeguards and security, and quality assurance.

Area

Industrial Environmental

Ra,diation **Protection**

I Industrial
Occupational Safety

~er Safety

I**Construction and Occupational Safety**

Fire Protection

Waste Management

Decontamination and I Decommissioning

E££1uents

I **Safeguards and Security**

Quality Assurance

! Industrial Hygiene

Accidental Releases of Hazardous Materials

Goal

.To have minimal environmental impact during NIF construction and operation
.To follow all mitigation measures identified in the mitigation Action Plan prepared by DOE for impacts described in the ROD (DOE, 1996)

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.Exposure to workers as low as reasonably achievable.
.Design objective 10 person rem/y total worker dose, 500 mrem/yr maximum individual dose from direct radiation."
.Exposure to public <1% of DOE guidelines.

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.Remain in the upper quartile of Bureau of Labor Statistics for all industry during operation.

.No significant worker injury due to exposure to hazardous levels of laser radiation.

.No fatalities during construction.
.For injuries, illness, and acddents,l:emain in the upper quartile of ~ureau of Labor Statistics for all industry.

.Meet improved risk criteria as verified by independent fire hazards
analysis.

.Waste minimization to meet Mitigation Action Plan goals of Waste Minimization Plan.

.Minimize worker exposure during Gower activation material, frequent cleaning, etc.).
.Minimize total waste generation from D&D.

.Exposure to public less than 10% of DOE guidelines for airborne effluents.
.Pollution prevention considered in de$ign.

.Safeguarding of classified information and government program while achie~ transparency (DOE 1995).

.Establish and implement quality levels for all systems.

.Exposure to workeIS as low as reasonably achievable
.Negligible offsite impacts from routine releases of hazardous chemicals

~ .Have negligible offsite/public impacts from accidents
.Remain less than 1% siting criterion for accidental radiological releases .Remains less than ERPG-Z or equivalent offsite for accidental releases of hazardous chemicals
.Maintain a low hazard radiological classification

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3-Gmega Chief Scientist has advanced degree and a minimum of 10 years of experience in lasers, specializing in the performance of the system after the tripling of the wavelength. Capable of performing the design optimization evalu~tions of various laser systems.
Engineering leader has advanced degree plus 10 years experience in project engineering and large laser systems, broad knowledge of laser engineering aspects, with capability of formulating engineering requirements from
physics needs.
Lead Target Designer has advanced degree and a minimum of 10 years in the .design or testing of ICF targets. Broad knowledge of weapons physics and fusion
energy process. Capable of performing detailed calculations of target behavior and performance.

Target Experimental Planners have a minimum of 10 years experience in the .;..general area of ICF experiments and diagnostic require.ments. They also have ::;~ccess to the communities of NIP Users: weapons physics, weapons effects, c ,:inertial fusion energy, and science.

The team members were selected by Jeffrey Paisner (the NIF Project Manager) and were Jolin Hunt, Team Leader; John Murray, 3-Gmega O1ief Scientist (designated leader for the first technical criteria preparation); Ken Manes, 1-0mega QUef Scientist; Rick Sawicki, Engineering Leaqer; Steve Haan, Lead Target Desigr:Ler; and Mike Tobin, Robert Kaufman, and Howard Lowdermilk (also the NIF LLNL Project Deputy), Target Experimental Planners. The laser scientis"ts selected each have more than 20 years of relevant experience, and collectively bring experience from all large LLNL laser systems. .The initial criteria development and flowdown were assigned to Ken Manes. He coordinated wiUt the Engineering Leader, Rick Sawicki, and Ute NIF Assurance. Manager, Jon Yatabe, who was integrating these criteria with Ute ES~ criteria.
Jon Yatabe also coordinated comments from the DOE Team Leaders during this inception phase.

The work of the Technical Team was derived from two sources: the target calculations prepared by or coordinated through Steve Haan and the optimization of the laser systemaesign options through the QIAIN-OP cod~, coordinated through Ken Manes and John Trenholme, Group Leader for Laser Modeling and Optimization at LLNL~'Pnce the core set of criteria was developed quantitatively, the E&S Working Group could begin quantifying the hazards associated with radiation protection, decontamination and decommissioning, etc. These results were then reviewed, diagnostic requiremen~ developed, arid specific parameters required by the various user groups coordinated by Ken Manes and Mike Tobin and supported by Mike Cable and Joe Kilkenr\Y of the LLNL ICF Program. Once the initial effort was complete, John Hunt maintained the coordination with the support of Ken Manes and John Murray.

3.2.2 Environment and Safety Criteria Team

The E&S Team was formed as the Nil" E&S Working Group to develop the NIP input to the 1992 LLNL Sitewide ErS/Em (DOE, 1992). The selection criteria was for

specialists in the field of environment, health, and safety plus the associated areas of security and quality assurance. The selection criteria emphasized were experience and knowledge of the discipline required to evaluate the ES&H aspects of the NIF (fire safety experience in major DOE installations, knowledge of all DOE, Federal, State, and local fire protection requirements, experience in life safety requirements, familiarity with the LLNL-specific fire protection infrastructure, etc.). The E&S Team has met and continues to meet (since 1992) every other week for two hours to review and coordinate all of the ES&H aspects of the NIF. The DOE ICF Division ES&H Manager (Charles Taylor) was made a member of the working group to ensure total coordination between the"DOE and the LLNL teams. ' ,

The selection criteria for the E&S Team were as follows:

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Group coordinator has to have an applicable .technical degree and at least 10 years of experience in NEP A determinations for major DOE facilities, safety analysis, radiation protection, quality assurance, and security. The coordinator. must have interface; with the ICF Program and th~ NIP Project. He or she must be able to budget and schedule the FS&H activiti~ requjred for ~.
DOE Representative is the DOE ICF Division ES&H Manager. The criteria for the position are in Section 2.2 of this document.
Lead Engineer for safety. analysis has to have an applicable technical degree and at least 10 years of experience in the safety evaluation of major DOE facilities. Experience with tritium, radiation, and hazardous chemical required, along with knowledge of DOE and Federal safety requirements.
Lead Engineer for construction safety and environmental evaluation has to have an applicable technical degree and at least 10 years of experience in environmental permits, hazardous waste management, and environmental evaluation. This engineer must also be familiar ~th the constrUction safety and applicable DOE, Federal, State, and local requirements for environment and consh"uctionsafety. .
Lead Engineer for radiation protection has to have an applicable technical degree and at least 10 years of experience in the establishment and implementation of radiation protection programs in major DOE facilities.l1tis engineer must be familiar with LLNL radiation protection requirements and practices in addition to DOE and Federal requirements. Knowledge of decontamination and decommissioning is desired.
Lead fudustrial Hygienist and Occupational Safety Engineer has to have applicable technical degree and at least 5 years of experience in DOE facility industrial hygiene and occupational safety. The Lead Hygienist must be knowledgeable of the DOE, Federal, State, and local regulations.
Lead Fire Protection Engineer has to have an applicable technical degree and at least 5 years of experience in DOE facility fire protection requirements. The lead Fire Protection Engineer must be familiar with DOE, Federal, State, and local requirements for fire protection, and must also be familiar with the LLNL fire- protection infrastructure.

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Team Leader of Hazards Control must have a suitable degree and experience to lead the team of safety experts who support the NIP E&S Working Group.

The E&S Team Coordinator is Jon Yatabe, with Olarles Taylor as the DOE Coordinator. The lead engineer for safety analysis is Sandra Brereton. The lead engineer for environment is Steve Cerruti. The lead engineer for industrial hygiene and occupational safety was Lany McLouth, replaced by Geoff Dorsey and AI Buerer. The lead engineer for radiation protection is Mike Singh in conjunction with Jeff Latkowski and Mike Tobin. The fire protection engineer is Jessi.e Lum. The LLNL Hazards Control Team Leader is Mike Trent.

The E&S Team Coordinator assigns key individuals to prepare specific evaluations (radiation protection criteria, including all calculations to Mike Singh), and the group mem~ support those key individuals as required. The team, using the LLNL Hazards Contro~ format, ~o reviews all studies and documents for consistency. m the ES&H criteri~~:,each assigned lead person evaluated the specific guidance required (e.g., HV AC system to have a negative pressure just prior to and during a yield shot to hold up activation products) and the suitable standards, whetl)~ it be DOE Order, Federal Regulation, National Consensus Standards

(NCRP, ANSL etc.) or other expectations. When.these were completed in draft form, they were reviewed by the remainder of the E&S Team plus by Project mtegration{Gary Deis) and his support staff from SAIC (Gaspare Maggio, AI DiSabatino, etc.) and XEC (Rob Knawa, etc.). An independent reviewer brought in by the DOE ICF Division Manager was John Jensen, an independent fire protection consultan.t who prepared Fire Hazards Analyses at the Conceptual Design and later Title I design phases. When this phase was complete, the managers of System Integration and Assurance put the Primary Criteria and Functional Requirements into a single document for formal project and DOE revi..ew.

3.2.3 Confirmation T earns

The confirmation tean\S included LLNL, DOE, and other agency revieWs of the NIF conceptual, advanced conceptual, and Title I design, plus the derivative safety analyses. The d~ign review teams were generally selected by the Laboratory Project Office, and DOE selected a team to either overview (as in the case of the conceptual design) or independently review (as in the case of Title I design).

The review teams for each phase of the design were selected by Steve Kumpan, the NIP Project Engineer. The Chairman and the discipline reviewers were independent of those who performed the design. The list of chairmen and the members and their charge for the final Title I design review are provided in Appendix C as a detailed example of the review process!

3.2.3.1 Project-Organized Design Review Confinnation Teams

The NIF engineering design has been formally reviewed on three occasions: at the Conceptual Design, after the Advanced Conceptual Design and at the end of Title I
Design. In addition, an internal "Mid-Title I Design Review" was held. While each of

these reviews focused on the conformance of the design with the design criteria that existed at the time, reviewers sometimes offered their comments regarding the technical requirements themselves. This was particularly true during the earlier reviews, such as at conceptual and advanced-conceptual design. Reviewers' comments. were considered by the technical team and were incorporated, where appropriate, via updates in the Primary Criteria and Functional Requirements. (See, for example Baseline Olange Proposal 96-005, which effected changes recommended in part during the Advanced Conceptual Design Review.)

The NIF DOE Field Office contracted for technical *support* services with Advanced Data Concepts (ADC) to provide an independent technical review of the NIP mid-Title I design and the NIP 6na1 Title I design. ADC provided technical experts in the following areas: radiation protection, life safety, structural, HV AC, systems engineering, laser engineering Jaser systems, &S&H, cost estimating, and electrical safety. The ADC interim reports, design review comments; and final reports were provided to the NIP Project Office as part of the NIF DOE Field Office Title I Design Review comment transmittal, and they were used to support the DOE decisions to proceed with NIP Title n desig11, to proceed with ~ Long-Lead Procurement, and to endorse the NIP Baseline Change Proposals submitted after completion of Title I
Design Review. .

Specific inconsistencies in the functional requirements were identified during the ADC review. As a result DOE and NIF Project Management made a determination of applicability and corrected specific NIF requirements (e.g., seismic criteria).

3.2.3.2 Preliminary Safety Analysis Confirmation Teams

.The PSAR was reviewed by ~ LLNL internal team prior to approval by the Associate Directors of Lasers and Plant Operations. The reviewers consisted of the Hazards Control Deparhnent Head, George Campbell, the Hazards Control Deputy . Department Head, Jim Jackson, and a radiation protection review by the NCRP representative, Dave Myers, the Hazards Control Department Technical Support and Policy Division Leader. For Lasers, the Directorate Assurance Manager, Bill Hatcher, reviewed the document. Additional LLNL-reviewers included Judy Steenhoven and Harry Galles of EPD, Jeff Paisner, Paul Kempel, Jerry Hands, Mike Trent, and Scott Hildum.

3.2.3.3 DOE OAK an.d HQ PSAR Review

The DOE conducted a safety evaluation of the NIP PSAR, which was documented in the *Safety Evaluation Report* completed in October 1996 (DOE, 1996c). The DOE ES&H Manager was designated as the lead for the review with the support of several other organizations. The PSAR was reviewed by technical support personnel from DOE OAK, DP /HQ, and OAK support services contract personnel. Several issues were identified during the review that were provided to the LLNL PSAR development team for resolution (e.g., seismic design criteria, fire protection standards etc.). These were resolved by the DOE and LLNL teams in the latest update of the PC/FR. All comments

were resolved satisfactorily and signed off by the approving official. Final review of the PSA safety evaluation was done by the DOE/OAK Safety Analysis Manager.

3.2.3.4 M. Chew and Associates Review of Tit:le I Design

This review, prepared for R. M. Parsons, provided an independent review of the ES&H aspects of the design. The review generally confinned the criteria and in some areas added supplemental criteria useful for lower-tier criteria, such as the Subsystem Design Criteria (e.g., "HV AC design with respect to hazardous material protection meets ASHRAE GL-1989"). This review confirms many of the Title I calculations of radiation, chemical release, etc. by independent checks. The original calculations were the basis of major quanti~tive criteria in the Primary Criteria and Functional Requirements.

3.2~-.5 John Jensen, Independent Fire Protection Consultant

The'-OOE hired a qualified and independent fire protection engineer to prepare fire hazards analyses of the NIF experimental buildings: the first at the conceptual design point, the second after Title I design was completed.-

3.3 Define Protocols and Documentation Requirements

3.3.1 Product Defined

To establish the technical baseline, the NIP Project needed top-level criteria that quantitatively define the requirements to meet the goals in the *Justification of Mission Need* (DOE, 1993), the *Laser Design and Cost Basis* (LLNL, 1993b), and the applicable regulatory documents. The product of the necessary'and sufficient process was to be a document called the *NIF Primary Criteria and Fu,nctional Requirements,* containing these quantified, top-level design criteria. These criteria form the top two tiers of the NW Project criteria, as shown in Figure 1. These top-level criteria are approved and controlled by the Levell BCCB (primary Criteria) and the Level 2 BCCB (Functional Requirements), and they flow down to alllower-tiex: criteria. The Primary Criteria and Functional Requirements criteria are divided into the mission-supporting t~cal performance requirements and the specific ES&H requirements to be met at the selected construction site. (Note: the original Primary Criteria and Functional Requirements were prepared when there was no preferred site. LLNL was named the preferred site at KD 1 [DOE, 1994d] and LLNL was finally selected when the ROD [in DOE, 1996b] was published). The ES&H requirements include specific requirements for work performance, including the applicable sections of DOE Orders and Federal Regulations and National Consensus Codes and Standards. The ES&H requirements include specific requirements for work performance including applicable federal, state and local regulations and laws, and appropriate DOE Orders, sections thereof, and National Consensus Codes and Standards.

3.3.2 Teams Identified

Section 2.3 describes the details of the two teams: the Technical Group under John Hunt and the E&S Working Group coordinated by Jon Yatabe and Charles Taylor. Ken Zahora, the other DOE Process Leader, was instrumental in the review of the criteria, and Gary Deis was alSo responsible for the fIowdown of criteria to all of the lower-tiet criteria shown in Figure 1. Each Team included multidisciplinary members whose work was coordinated and integrated by the Team Coordinators. The team members are identified in Section 3.2. The team members' curriculae vitae are available in the Project personnel *meso* ..

3.3.3 Work Process Defined

The wo.rk process is defined in NIF *Project ControlManuaI* as Procedures, specificclny 6.0 .(preparation of Design Criteria), 6.1 (preparation and Revision of System Design Requirements), 6.2 (preparation and Revision of futerface Control Documents), 6.4 (Engineering Change Requests), 5.2 (PSAR Preparation and Revision), and 1.7 (project Change Control). The process of developing the technical baseline is descnDed in the NIF *Project Execution Plan* (DOE 1996). The management responsibilities are defined in specific detail in the NIF *Management Position Descriptions* (LLNL 1996). The basic process is shown in Figure 2. The definition of the Primary Criteria and Functional Requirements begins with two interactive steps: (1) Technical Team review of the key sources (e.g., Justification of Mission Need), development of qualitative analyses to form the sciCl1ti.fic basis for the criteria, and finally the definition of the technical criteria; (2) E&S Working Group review of the technical performance cr.iteria to develop quantitative source terms (e.g., neutron yield, tritium inventory, etc.) for environmental and safety analysis followed by comparison to Federal, state, and local FS&H regulations and other appropriate standards to develop the *ES&H Primary Criteria and Functional Requirements.* fu step 3, the criteria are me~ged into one document and the division into Primary Criteria and Functional Requirements made. fu step 4, various confirmation teams (such as LINL PSAR, DOE OAK, and HQ PSAR review teams, Conceptual, Advanced Conceptual, and Title I design review teams, and.independent safety and fire reviewers) give feedback on the criteria. (One specific review from the LLNL PSAR review team led to a revision of the FS&H criteria to consider "necessary and sufficient" in the areas of fire protection, radiation protection, and other FS&H areas.) In step 5, the approval authorities review and approve the criteria, beginning with the Laboratory Project Manager through the Level 3 BCCB, which concurs and submits the ES&H Prim.ary Criteria and Functional Requirements with their endorsement (or returns. them to the Teams with comment). The NIF DOE Field Manager supported by the DOE Process Leaders and the Level 2 BCCB then approves the Functional Requirements (or returns them to the Level 3 BCCB with comment) and submits the Primary Criteria with his endorsement to the Levell BCCB. The Director of Office of ICF and NIF Project then reviews the Primary Criteria supported by the Level 1 BCCB and approves the Primary Criteria (or returns them to the Level 2 BCCB with comments). The signed Primary Criteria are then provided to Project Control to be entered into the baseline. At this time, the original and several revisions to the Primary Criteria and Functional Requirements have been approved. Each set of proposed

Technical Performance Criteria

ES&H Criteria

Review JMN/user-
defined needs

Prepare Design
Basis Documents

PC

PC
review

No

BCCB1 approval

Review ES&H
regulations

Prepare N&S ES&H criteria

Merge top
level. criteria'

,.

PC
or
FA

FR
review

BCCB2 approval

No

Yes

Incorporation
into baseline

Project scientists

Project scientists and technical team

Assurance Manager
and ES&H working group

Project **Inl** Manager Assurance Manager

ES&H working group

FA

Project **Into Mgr./DOE**
Assurance Manager

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.Confirmatlonteams

-DOEHQ/OAK
--Independent revIewers --PSAR revIewers

Yes

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Figure 2. Process for developing the NIF Primary Criteria and Functional Requirements.

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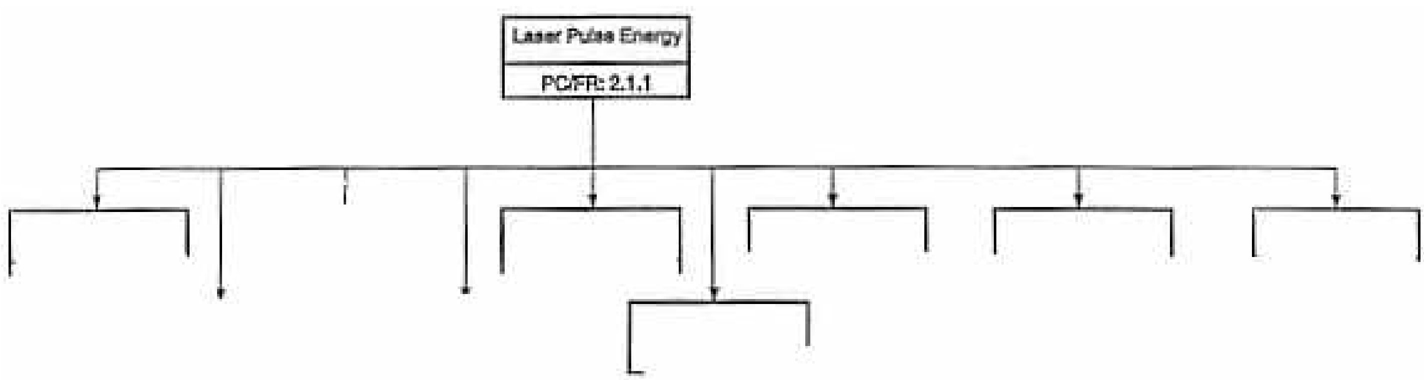
Primary Criteria! Functional RequIrement



System Design Requirements

Routfne Operating I -Opef8u;'Enefgy& I ' 1mWavelength -~~~&_~~r- **I PowerEnw**
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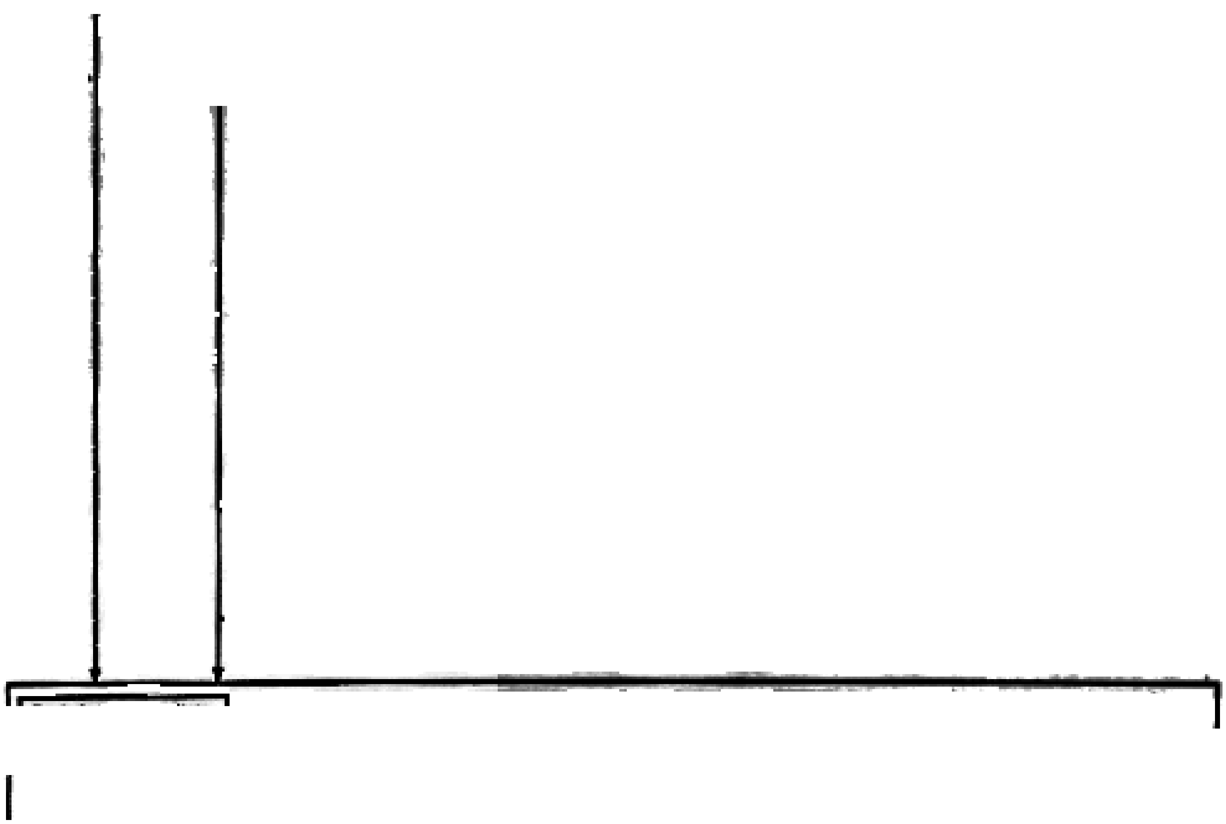
Subsystem Design Requirements



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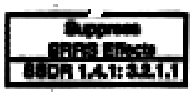

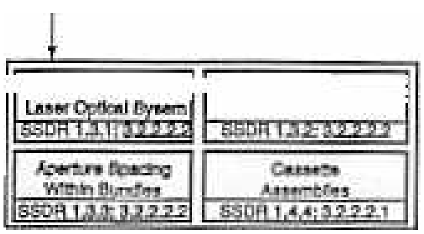

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changes to the criteria have been approved through the BCCB formal change control process. The BCCB secretaries have kept a record of the proceedings, and a baseline change proposal log is maintained and published quarterly by the NIF Project office.

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3.3.4 Sources

The main sources used in the development of the Primary Criteria and Functional Requirements were (1) Justification of Mission Need, (2) User and Stakeholder inputs, (3) Design Basis Documents, (4) DOE Orders, (5) National Consensus Codes and Standards, and (6) Federal, state, and local regulations. The teams also had access to a body of technical (target design, prediction and performance, laser optimization, experience with Nova and Omega operation, etc.), ES&H (preliminary Hazards Analysis, Preliminary Safety Analysis Report, Fire Hazard Analysis, Radiation Protection Plan, ES&H Management Plan, etc.), assurance *(Quality Assurance Program Plan, Pioject Control ManuaZ)*, and management documents *(Project Execution Plan, Positio~;.-Descriptions*, etc.).

3.3.5 Criteria Hier~chy arid Ute Flowdown Process '. .

The NIF crit~ria are tiered criteria (see Figure 1 for example). The top-level criteria are the Primary Criteria (Levell) and the Functional Requirements (Level 2). These flow down into the System. Design R:equirements (Level 3), which in turn flow down to the Subsystem Design Requirements {Level 4) and Interface Control Documents (Level 4). Figure 3 shows the process 9f flowdown using examples of top-level criteria forming the basis for lower-level criteria down to the Subsystem Design Requirements documents. Within the project, this flowdown has been developed and maintained for allspecial-equipment requirements by specifying that each system or subsystem design requirement i.deI;\tlfy "parent" requirements. A lower-level requirem~t exists because it is necessary to meet the parent requirement(s). By tracking the parents of each requirement, it is straightforward to identify those higher-level z:equirements that could be affected if a lower-level requirement is changed. It is also possible to id.entUyall the requirements that flow down from a given Functional Requirement or Primary Criteria by simply identifying all the requirements that list that FR/PC as the parent. This proceSs-therefore allows the complete tracking of flowdown of requirements from the FR/PC 10 the Subsystem Design Requirements. In addition to tracking the parents of each lower-level requirement, there are often "justification documents," which support the choice of the specific values in

lower-level requirements documents. These documents include "error budgets" and other system allocations, or simply analyses that describe the logic uSed to develop requirements. These ate documented within the special equipment areas and are useful in identifying interrelated requirements between parallel requirements documents. In the conventional facility area, requirements flowdown is not as useful, since many facility requirements result from the need to support diverse technical requirements in special equipment areas. The flowdown of requirements is therefore not as rigorously tracked within the conventional facility area.

3.3.6 Project Baseline Approval and Change Control

The *NUl* Project Baseline approval and cl1ange control follows the. guidelines of the .DOE Order on Life Cycle Asset Management (DOE Order 0430.1) and the LCAM Good Practice Guidance and is described in the NIF *Project Execution Plan* (DOE, 1996a). Technical, cost, and schedule baselines established in the *Project Execution Plan* are subject to the baseline change control board review process. Baseline .Q\ange Control Boards are established at three levels to approve, disapprove, or endorse (i.e., recommend approval to a higher-level Baseline Ch~ge Control Board) all proposed baseline changes. The Energy System Acquisition Adv:isory Board (FSAAB), a forum that provides advice, assistance, and recommendations to the DOE Secretary, considers and disposes of baseline change proposals within the Acquisition Executive Level 0 authority. The operation of this board, the ESMB process, is specified in DOE 0 4700.1 *aune* 2, 1992); this process is expected to be updated in the near future, with emphasis on Life Cycle Assess Management, DOE 0 30.1, using Good Practice Guide on Baseline Otange Control, GPG-FM-009. The operation of the Levell BCCB at the DOE program office"is also as specified. in DOE 4700.1, with the Defense Program Operating Manual (DPOM, February 1, 1992). The operation of the Level 2 BCCB at the DOE field office is specified in the "Level 2 Baseline O1ange Control Board Charter" and the "Level 2 Baseline Olange Control Board Operating Procedures" (both revised June 27, 1996).
The BCCB hier'4rchy is shown in FigUre 4, and the change thresholds are listed in Table 2. Each lower-level board-othat 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 but must be fully evaluated by the appropriate BCCB, as defined by Table 2. The cl1arters of each level BCCB are published and describe the authors, membership, delegation, method of decision making, etc~ '

3.4 Identify the Necessary and Sufficient Standards

The objective of the criteria development process was to identify and reach team consensus on the necessary and sufficient set of standards for the NIF Project.

3.4.1 Technical Performance Requirements

The consensus was 4eveloped by the Technical Team performing the detailed analyses of the NIP design basis based on the requirements of *justification of Mission Need* (DOE, 1993) (e.g., achieve fusion ignition and modest gain) and user/stakeholder inputs. These quantitative calculations provided the best estimates of what laser and target performance (peak pulse power, energy, maximum credible yield, etc.) would assure ignition. Then laser design and .optimization codes such as ~INOP and PROP92 were used to define the integrated system performance.

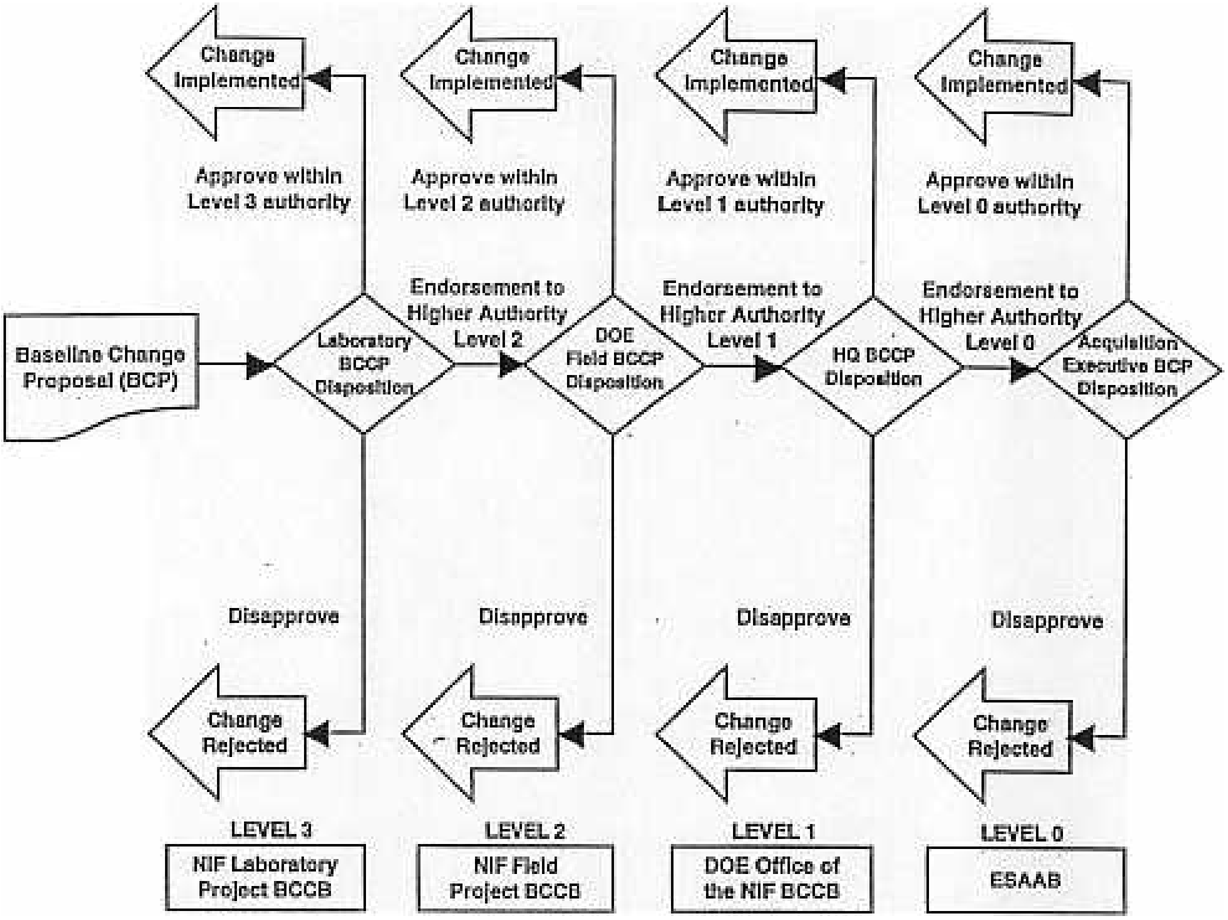

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Figure 4. Baseline Change Control process.

The main document used as the basis was the *Laser Design and Cost Basis* (LLNL, 1993b), produced in th~ first few months of conceptual design. It has been updated in a series of reference analyses through Title I design. The fundamental laser design basis came from projections of target performance, based on scaling from existing target studies. These projections provided the laser power / energy envelope needed to acNeve ignition, with the desir~d margin. The analyses are summarized in Volume 2: Design Basis and Requirements; of the *Conceptual Design Report* (LLNL, 1994b). The Technical Team interacted with Project Management *Geff* Paisner) and Program Management (Mike Campbell, Joe Kilkenny, and Howard Powell) to determine the margin that should be introduced to ensure that ignition would be achieved based on calculational and order-of-magnitude cost impacts of margins from 5 to 20%. These considerations determined the laser performance criteria that would, with a reasonable safety margin, assure fusion: laser pulse wavelength, laser pulse energy, laser pulse peak power, laser pulse shape, beamlet power balance, pointing accuracy, etc. (Campbell, 1993). In the target experimental capability, the need to be able to test direct and indirect drive

Table 2. Baseline change control levels.

National Ignition Facility (NIP)
Summary of Baseline Change Control Thresholds

Technical (Scope) Baseline Thresholds

Schedule
(Milestone)
IBaseline Thresholds

Cost {dollar} Baseline
I Thresholds

DOE Acquisition
Executive
(Level 0)

.Any deviation from the NIP
Justification of Mission Need

.Otanges to Level 0 milestones m
...
excess of six months

.C\anges to
TEC/TPC in
excess of ~M

DOE Office of the
NIP"
(Levell)

.Any <;leviation
from primary criteria and selected functional requirements (as identified in
reference 3)

.Otariges to
Levell
milestones in
excess of six months

.O1anges
between:f:$25M
and :f:$5OM that do not affect the TEC/1PC
.O1anges to TEC/1PC less than :f:$5OM
.O1anges to
Project Data
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profile

DOE NIP Field
Office
(Leve12)

.Any deviation

from functional requirements, other than selected functional requirements (as identified in reference 3)

eO1angesto Level 2 milestones in excess of six months

.O1anges between :f:$5M and :l:$2?M that do not affect the TEC/TPC
.O1anges requiring contingency allocations of greater than $5M
.O1anges to dishibution of funds between participants

NIP Laboratory Project Office (Leve13)

.Any deviation from system design requirements that affect system performance

.O\anges to Leve13 mllestonesin excess of six months

.O1anges less than:i:$5M that i do not affect the TEC/TPC .O1anges requiring contingenCJ' allocations of i I less than $5M :
.O\anges that are greater than 5% of remaining total Project contingency will have NIP DOE Field Manager participation

(capsule contained in a metal hohlraum), maximum credible yield, and the envelope *of* annual number of tests with fusion yield were also defined.

The target yields were based on the predictive calculations of target performance and include the largest single shot yield estimate (e.g., 20 megajoules with a

45-megajoule maximum credible yield) and the total yield envelope, originally set at 385 megajoules/year and later due to NIP user requests augmented to 1,200 megajoules/year. ~put on other user requirements was received in the form of position papers. These requirements were considered by the Technical Team and incorporated based on team consensus and the process described in the *NlF Conceptual Design Scope and Plan* (LLNL, 1994c). Functional requirements in the target area include target positioner, time between shots, target chamber vacuum, availabilitY (in the context of reliability, availability, and maintainability), and recovery time, diagnostic instrument capabilities for laser performance and for ignition and applications experiments. In discussions with the DOE HQ during the Conceptual Design ~o~and Frenck), criteria were developed for availability and system recovery from postulated events (e.g., recovery from the design basis earthquake). Finally, the diagnostic-requirements to me~ure all of the performance and test parameters were developed by team members interacting with the user groups at the ICF Laboratories through a NIP Joint Central Diagnostics Team established by-an MOU (Campbell, 1993) between the participating ICF Programs.

Obtaining a consensus on which ~teria were Primary Criteria vs. Functional Requirements involved the DOE Process Leaders. The development of a consensus was easily reached since the calculational models clearly identify the integrated set of top- level criteria to define the NIP performance requirements. These are shown by an asterisk (*) in the current version of the *Primary Criteria and Functional Requirements* (DOE, 1997b). These quantitative criteria become the basis for the ES&H criteria.

3.4.2 Identification of ES&H Criteria

The ES&H criteria basis. started with the technical performance requirements. The target yields, annual tritium throughput, and triti~ inventory all foim the basis of radiation protection, safety, and environmental quantitative calculations of neutron yield, source terms for shielding purposes, tritium emissions, accidental releases, etc. These parameters were used as input to perform environmental, radiation protection, decontamination and decommissioning, and safety analyses. The results of these analy~es allowed quantitative criteria for key parameters (tritium inventory limits, work~r annual dose-cumulative person rem/year, tritium emissions, etc.) When the users:iequested an enhanced operational envelope, these models allowed the NIF to expand criteria from 385 megajoules/year up to 1,200 megajoules/year (DOE, 1996b), which resulted in changes during the Advanced Conceptual Design to all of the key ES&H parameters (triti4In emissions, throughput, cumulative dose, etc.). The complete set of hazards from the construction and operation of the NIF were then developed into a large matrix and evaluated. The results were documented in the *Preliminary Hazards Analysis*, which led to a DOE hazards category of a low-hazard, radiological facility. More detailed environmental and safety evaluations were done in the *Project Specific Analysis* for the NW, which appeared in the *PElS for Stockpile Stewardship and Management,* the PSAR, and the *Fire Hazards Analysis.* In all of these documents, the final ES&H values for NIF were compared to applicable regulatory limits (e.g., 10 CPR 835 worker dose limits) and also to cumulative impacts at the NIP site (e.g., what percent of

~he total LLNL mixed waste is NIP mixed liquid and solid waste streams). When compared to the applicable ES&H regulations to protect the public, the environment, and the workers, the NIP levels I.11et all regulatory requirements and in some cases were significantly more stringent (e.g., total site boundary dose from routine exposures. was only a fraction of one percent of the DOE limit). The selection of the applicable standards was first made by the E&S Working Group, who chose the requirements first from national consensus standards where the hazards are standard indushial hazards (working

in confined spaces, fire protection, etc.). DOE Orders and Federal Regulations were used as the basis for radiation, decontamination and decommissioning, and other areaS not covered by national nonsensus standards.

The ES&H performance goals in Table 1 were the basis for developing the specific requirements. For example, in the area of radiation protection the key NIP goals are to achieve (1) worker exposure as low as reasonably achievable with no worker receiving more than SOO mrem/y and the total worker dose being 10 person rem/y, and (2) expo- sure to the public <1% of DOE guidelines: The-criteria and the supporting analysis list the applicable regulatory requirement, here DOE Order N441.1 and 1OCFR 83S and then specify the methods (e.g., s:hielding control of workplace ventilation, ~onitoring of personnel, confinement of radiation, and routine contamination monitoring) to ensure by design that the maximum wQrker dose remain at 10% (e.g., SOO mrem/y) of the DOE requirement. The combine;d cri~a were then evaluated by time-motion studies of the NIF Title I design to ensure that the worker radiation protection goals of Table 1 were met. The rest of the goals were achieved through the same process.

In developing the criteria for each RS&H area, the team evaluated the specific need for NIF at any of the alternative sites, later made site-specific when the DOE selected a preferred site in 1994 (DOE, 1994d). The evaluation of criteria include,d DOE, Federal Regulations, and national consensus standards. The criteria also reflected the specific requirements that NIF would. have to follow. For example, in laser safety compliance with ANSI 2136.1, Laser Safety and occupational OSHA requirements were quoted and then specific practices suitable for the eXtremely powerful lasers used in the NIF"were specified by the working group (e.g., Interlock systems shall be dedicated and designed to fail safe and shall activate lase;r shutters or shut off electric power to laser systems if access doors are opened and hazardous exposures are possible). This sort of evaluation was performed by the working group and reviewed by the other members representing other ES&H expertise.

The E&S Team developed the requirements for life safety, laser safety, radiation protection, electrical safety, fire protection, etc. based on the technical definition of the NIF and the applicable regulatory requirements: DOE Orders, the Code of Federal Regulations, and specific National Consensus Standards (e.g., NFP A 101 governing life safety requirements).

The DOE hired a qualified and independent fire protection engineer to prepare two fire hazards analyses of the NIF experimental buildings: the first at the conceptual design point and the second after Title I design was completed (see Section 3.2.3.5).

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These fire hazards analyses are reviews of the adequacy of the fire protection design and compliance to the suitable regulatory requirements. The recommendations in the FHA on the use of DOE Orders and National Consenses Fire Protection Standards (e.g., NFP A, etc.) were considered in each revision of the Functional Req~irements and Primary Criteria.

The process was guided by the *Quality Assurance Program Plan* and the project procedures contained in the *Project Control Manual* (LLNL, 1994e). The result of these evaluatioIis was that the Primary Criteria and Funcijonal Requirements would be submitted to the confirmation reviews. The documentation is shown in Figure 2. This flowchart is from ~roject Procedure 6.5, and shows how the criteria begin with the Justification of Mission Need, User requirements, and applicable ES&Hregulatory documents (and goals) and proceed through the preparation of criteria, merge of the techni~ and ES&H criteria, review and approval processes. The process for changing the apEroved criteria is shown in Figure 4, in which tiered O1ange Control Boards contro.~{;changes at each criteria level (e.g., Level 2 BCCB approves Functional - Requirements and all baseline change proposals to those criteria).

3.5 Confirm the Necessary and Sufficient Criteria

The confirmation teams included LLNL, DOE, independent-expert, and other agency reviews of the NIF Conceptual, Advanced Conceptual, and Title I design, plus thed~rivative safety analyses. The design review teams were generally selected by the Laboratory Project Office, and DOE selected a team to either overview (as in the case of the conceptual design) or independently review (as in th.e case of Title I design review). These teams reviewed the desi~ against the criteria but in several cases made comments on the criteria, which were resolved by the Project. The National Academy of Science and the]ASONs have reviewed specific NIF issues and have provided feedbq.ck, largely co~rmatory , to the DOE.

The technical criteria were reviewed as a part of the Conceptual Design Review, and ~o during the Advanced Conceptual Design Review, Mid-Title I Design Review, and Title illesign Review. The teams involved with each of these reviews are described in Section 3.2.3.1. Initially, numerous comments on the technical criteria were received and resolved by the Project using the change-control process. In more recent reviews, particularly in the Title I Pesign Review, few criteria-related comments were generated, indicating that they are sufficiently mature and stable for the design effort to proceed.

The *Preliminary Hazards Analysis* was reviewed by DOE OAK to establish the hazards category: low-hazard, radiological. The *Preliminary Safety Analysis Report* was reviewed by an LLNL internal team prior to approval by the Associate Directors of Lasers and Plant Operations. The reviewers consisted of the Hazards Control Department Head, George Campbell, the Hazards Control Deputy Department Head, Jim Jackson, Judy Steenhoven,'Harry Galles, Jeff Paisner, Paul Kempel, Jerry Hands, Mike Trent, Scott Hildum, and a radiation protection review by the National Council of

Radiation Protection representative, Dave Myers, the Technical Support and Policy Division Leader. For Lasers, the Directorate Ass~ce Manager, Bill Hatcher, reviewed the document. The key comment expressed in their review of the PSAR was not the analyses or the conclusions but of the safety criteria and the need to use work-smart standards in areas where there are several sources" of input and choices have to be made.

An example is the area of fire protection, where there are national consensus standards (e.g., NFP A), Federal Regulations (OSHA), and DOE Orders. The Fire Protection experts Jessie Lum and Steve Leeds of Hazards Control came up with the following for NIF fire protection requirements ~t are specific to the NIF. The NIF shall meet the design and fire protection requirements of all NFP A codes and the Uniform Building Code. 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 structure, isolating hazardous areas, and protecting egress paths: The NIF shall meet the requirements of an I'improved risk" level of fire protection sufficient to attain DOE objective. To achieve this level of protection *I* automatic fire sprinklers shall be installed tluoughout 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 hazards analyses will be completed as required by all NFP A Codes.

The PSAR Confirmation Team Leader Jim Jackson met with three of the DOE/LLNL Process Leaders: Olarles Taylor, Gary Deis, and Jon Yatabe. They went through the logic. of the changes and placed them in a revision to the Primary Cri~.eria and Functional Requirements that was submitted to the Level I BCCB *for* approval.

The DOE review of the PSAR was conducted by Charles Taylor using DOE OAK, DOE HQ, and consultants. This review confirmed the Assurance requirements and generally focused more on the calculational assumptions and results. Other reviews included a Parsons review of the ES&H aspects of the design, focusing mainly on the facility, performed by M. Chew and associates. This review was largely confumatory in terms of criteria evaluations.

3.6 Approve the Necessary and Sufficient Standards

The approval process for the *Primary Criteria and Functional Requirements* (included as Appendix A) is described in the *NIF Project Execution Plan* (DOE, 1996a). The approval authorities review and approve the criteria, beginning with the Laboratory Project Manager acting as the Chairman of the Level 3 BCCB, which concurs and submits the *Primary Criteria and Functional Requirements* with their endorsement (or returns them to the Teams with comment) to the Level 2 BCCB. There, the NIF DOE Field Manager, supported by the tWo DOE Process Leaders and the Level 2 BCCB, then

approves the Functional Requirements (or returns them to the Level 3 BCCB with comment) and submits the Primary Criteria with his endorsement to the Level.l BCCB. The Director of Office of ICF and NIP, as the chainnan of the BCCB 1, reviews the Primary Criteria supported by the Levell BCCB and approves the Primary Criteria (or returns them to the Level 2 BCCB with comments). The level 0 BCCB is provided an information copy of the approval action. The signed Primary Criteria (Acquisition Execution) or revised Primary Criteria and Functional Requirements are then provided to Project Control to be entered into the Project baseline. At this time, the original and several revisions to the *Primary Criteria and Function:al Requirements* have been approved. Each set of proposed changes to the criteria has been approved through the BCCB formal change control process. The BCCB secretaries have kept a .record of the proceed- ings, and a baseline change proposal log is maintained and published quarterly. The change control process is described in the *Project Control Manual's* Project Procedure 1.7, Project. Change Control. .

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4. Using the Approved Standards

The process for assuring that the Primary Criteria and Functional Requirements are in use is demonstrated in the attached Engineering Change Request (Appendix C). This ECR provides a detailed flowdown of criteria from the Primary Criteria and Functional Requirements to all lower-tier documents that provide the detailed guidance to the Title II design. The ECR is approved by the Level 4 Configuration Control Board and ensures through the Configuration Control System (LLNL, 1996b) that all-iower-tier criteria are revised and reissued to reflect the approved changes to the higher-level criteria. m the design review process, the conformance of the design to the governing criteria is reviewed. This process of flowdown is-codified in thefollowingNIF Project Procedures: 1.7 (project Change Control), 1.8 (project Action Tracking System), 4.1 (Document and Records Control), 5.1 (Title II Design Review), 6.0 (preparation and Review of Project Criteria), 6.1 (preparation and Revision of System Design Requirements), 6.2 (preparation and Revision of mterface Control Documents), and 6.4 (Engineering Olange ~ests). .': ' .

Responsibility for the configuration control of :NIP Project criteria has been assign~ to. the System Integration Manager, Gary Deis. He will ensure that the flowdown of criteria takes place to the lowest tier and also that the revised criteria are used in the Title II design. The Quality Assu.t:ance Managers will ensure that independent assessments (audits) on various design activities (e.g., Architect Engineering design control) are conducted to ensure that the process is working.

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