NIF..QOO1566

Appendix A: Primary Criteria and Functional Requirements

A-I

Attachment A

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NIF-LLNL-9~58
L-15983-2

National Ignition Facility Functional Requirements and Primary Criteria

Revision 1.3

March 1994

NIF
The National Ignition Facility

NIF-LLNL-93-058
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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). Mission goals, as defined in the Justification of Mission Need, are translated into laser power, laser beam characteristics, and other performance specifications. Top level operability, safety, and environmental requirements are defined and discussed. Finally, key requirements that must be met to satisfy Department of Energy (DOE) Orders, state, and federal regulations, national consensus standards and preferred procedures are highlighted to help ensure that they are incorporated by the design teams.

Application

The Functional Requirements and Primary Criteria serves as a technical baseline for the project. Any modifications must be processed through the ci1ange control mechanism specified in the NIF Conceptual Design Scope and Plan and formally approved. Each individual requirement or criteria has been placed in one of two hierarchy levels for control purposes. Those items which are Levell are marked with either a single or a double asterisk and are controlled by DOE Headquarters. Nonasterisked items are classified as Level 2 and are controlled by the Oakland Operations Office. The control of double asterisk requirements may be delegated to Oakland Operations Office at some point in the future as part of the ongoing decentralization process.

Terms

The terms "should" and "shall," have important implications beyond what might be implied by common usage. "Shall" denotes a requirement which is mandatory and must be met. "Should" denotes a requirement which is not mandatory, but which is a recommendation or goal.

1.4 Site-Specific Requirements

These requirements have been written for a generic site, such that NIF could be located at many different sites with only minor modifications. When a site selection is made, these requirements will be revised as necessary to include site- specific natural phenomena, environmental characteristics, and potential use of existing infrastructure, facilities, and services.

2.0 MISSION-RELATED REQillREMENTS

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

2.1 Laser

2.Ll 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 targethohlra urn.

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 (fW).

2.1.3 Laser Pulse Wavelength"
The wavelength of the laser pulse delivered to the target shall be 0.35 microns
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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 Pointing Accuracy.
The rms deviation in pointing of the centroids of all beams from their specified aiming points shall not exceed 50 micrometers (1.1n1).

2.1.6 Laser Pulse Duration
The laser shall be capable of producing a pulse with overall duration of up to 20ns.

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.

2.L8 Capsule Irradiation Symmetry

Variations in the x-ray energy deposited on the fusion capsule, located in the target hohlraum, should be 52% rms. Current target design and performance calculations indicate that this level of irradiation uniformity can be achieved by two-sided laser illumination of the hohlraum.. Multiple laser beams on each side enter the hohlraum along two concentric cones with cone half-angles of approximately 27 degrees and 53 degrees, and with two-thirds of the beams on the outer cone and the remaining one-third on the inner cone. Each cone shall consist of *B* or more beams. The capability shall be provided for the pulse shape delivered by beams on the inner cone to be different from the shape delivered by those on the au ter cone.

2.1.9 Pre-pulse Power

The laser intensity delivered to the target during the 2D-ns interval prior to arrival of the main laser pulse shall not exceed 108 W / cm2.

2.1.10 Laser Pulse Spot Size

The laser spot size shall be 500J.lffi, to be defined as follows: The envelope of the laser pulse spatial intensity distribution shall approximate an eighth order super Guassian at best focus. The laser beam profile diameter at *e-1* in intensity shall not exceed SOOJlffi, with 98% or more of the 1.8 MJ pulse energy contained within a circle of 600-J1m diameter.

2.1.11 Beam Smoothness

The NIP shall have flexible beam smoothing capability for the suppression *of* laser plasma instabilities in indirect drive targets and potentially for the suppression *of* hydrodynamic instabilities if utilized for direct drive targets. The capability shall include:

Phase plates at the output of the laser for the control of the spatial irradiance distribution on the target The resulting fluctuations in the laser pulse delivered to the fusion target shall not exceed 25% of the average intensity measured over a 30 ~ diameter circle and integrated over a time of 10 ps.

Four different centerline frequencies in each beamlet of a 2x2 array separated nominally by a 1 nm at 1 CJ) which are superimposed on target to increase the total bandwidth that is available at 3 (J).

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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 remotely located users with diverse needs. The baseline facility design shall not preclude future upgrade for weapons physics experiments, direct-drive, and/or weapon effects target d1.ambers. The following requirements are intended to satisfy the most basic of these needs.

2.2.1 ICF Target Compatibili~

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

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

The NIP facility shall be capable of 100 shots per year with a fusion yield in the range of 1 to 100 kJ; 35 shots per year with yield in the range of 100 kJ to 5 MJ; and, 10 shots per year with yield in the range of 5 to 20 MJ.

2.2.3 Maximum Credible DT Fusion Yield~

The target chamber shall be designed based on routine DT fusion yield of 20 MJ, with the capability to withstand a DT fusion yield produced by a single shot of up to 45 MJ (a 45 MJ yield corresponds to 1.6 x 1019 neutrons).

2.2.4 Oassification level of Experiments.

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

2.2.5 Target Positioner

The target positioner shall be capable of placing and holding targets 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

The laser and experiment area should be capable of conducting experiments with a time between shots of 8 hours for shots with no fusion yield.

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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 Laser Performance The facility shall have the following measurement capabilities which are required to verify the Primary Criteria and Functional Requirements:

.Laser pulse energy and power.

.Laser pulse duration and dynamic range.

.Laser beam power balance.

.Simultaneity of arrival of pulses from individual beamlines at target chamber center with 10 ps accuracy.

.Laser beam pointing accuracy with 10-20 micron spatial resolution.

Laser prepulse intensity.

.Laser pulse spot size.

.Laser pulse smootlmess.

.Laser beam thermal recovery time.

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

.Symmetry of x-ray emission from imploded cores with 5-10 micron spatial resolution.

.Motion of the x-ray emitting volumes in hohlraums with 20 micron spatial resolution.

.Laser light backscattered into the focusing lens.

.Radiation flux out of hohlraums within the photon energy range 0.15-2,5 keY with 100 ps time resolution and 20% accuracy.

.Strength of radiation driven shocks with 5-10 micron resolution and time resolution of 10 ps.

.Fusion yield over a range from 1011 to 1019 neutrons.

Symmetry of neutron emission from imploded cores with 20 microns spatial resolution.

Temperature of the compressed fusion fuel with 20% accuracy for ion temperatures of 2 keVor greater.

Number and energy distribution of fast electrons in hohlraums in the band from 5 keY to *300* keY.

.Radiation flux out of hohIraums within the photon energy range 2.5-100 ke V with 20%' accuracy.

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

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

3.0 SAFETY REQUIREMENTS**

The NIF shall be designed, constructed, and operated as a low-hazard, non- nuclear 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 Orders 5480.23, Nuclear Safety Analysis Reports and 5481.1B, Safety Analysis Review System). Administrative controls shall be established prior to KD-4 to ensure that inventory limits for a low-hazard, non-nuclear facility are not
exceeded.

3.1 Radiation Protection*

Collective and individual ionizing radiation doses to the public from all exposure pathways from the NIP shall meet the requirements of DOE Order 5400.5, Radiation Protection of the Public and the Environment, and 40 CFR 61, National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities. These requirements state that exposure of members of the public from emissions of radionuclides in the ambient air from normal NIP operations shall remain below 10 mrem/y. The facility shall also meet the requirements of DOE Order 5400.5 [ICRP 60 540 (1990 Recommendations of the International Commission on Radiological Protection), 10 CFR 20.1301.a.1 (Code of Federal Regulations-Standards for Protection Against Radiation)] to remain below the public dose limit of 100 mrem/y from all exposure modes and all sources of radiation.

The NIF personnel radiation protection program shall follow DOE Order 5480.11, Radiation Protection for Occupational Workers and 10 CPR 835 Occupational Radiation Protection. The ALARA (as low as reasonably achievable) principle shall be utilized in both design and operation of the facility to eliminate wmecessary radiation dose to workers in the Laser and Target Area Building, co-located employees, and visitors from both routine and off-normal operations. Radiation protection shall include: shielding; control of workplace ventilation; monitoring of personnel for external and internal radiation dose; establishment of a routine contamination monitoring program including air monitoring; and the proPer containment of radiation and radioactive materials.

The radiation shielding design shall be more conservative than required by DOE Order *6430.1A* Section 1300-6.2 in that maximum doses to an individual worker shall be limited to one tenth (shielding design goal) of the occupational external dose limits specified in DOE Order 5480.11. Concrete shielding shall comply with AD 318 which provides adequate strength for DBE loads.

The requirements for the confinement of tritium for Fusion Test Facilities in OOE Order 6430.1A Section 1328 should be evaluated by the designers and incorporated when they are determined to be cost effective, even though the projected inventory of tritium in NIF (-0.03 g or 300 G) is well below the threshold for a nuclear facility. The target chamber and tritium processing systems shall form the primary confinement barrier. Leakage past these barriers shall be ALARA. The experimental area ventilation system shall be designed to operate at negative pressures during and immediately after shots of greater than one megajoule and provide secondary tritium confinement.

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

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3.2 Life Safetr.

The NIF shall fully comply with the requirements for life safety contained in DOE Order 5480.7 A Particular focus shall be directed towards features related to exiting, such as protection of vertical openings, travel distances, capacities, and emergency lighting.

3.3 Laser Safety*

The laser safety shall comply with ANSI Z136.1 and OSHA requirements. Exposure to hazardous levels of laser light shall be prevented by the use of physical barriers, personnel training, interlocks, and personnel entry controls. Protective equipment, such as laser goggles, shall be used when necessary for operational purposes. Interlock systems shall be dedicated and designed to fail safe and shall activate laser shutters or shut off power to laser systems if access doors are opened and hazardous exposures are possible.

3.4 Industrial Hygiene and Occupational Safety*

Industrial hygiene and occupational safety shall comply with 29 CFR 1910. and DOE Order 5483.1A, Occupational Safety and Health Program for Contractor Employees at GOCO Facilities (which lists additional ANSI/ ANS, NFPA, IEEE, AlliA, FM and other applicable occupational safety standards). DOE Order 5480.10, Contractor Industrial Hygiene Program, shall be followed in addition to the industrial hygiene requirements in the previously mentioned standards.

Construction safety shall comply with the requirements of 29 CFR 1926, OSHA and DOE Order 5480.9, Construction Safety and Health Program.

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

3.5 **Fire Protection***

The NIF shall meet the design and fire protection requirements of DOE Orders 6430.1A and 5480.7A, Fire Protection. The structural members of the Experimental Building (including exterior walls, interior bearing walls, columns, floors, roofs, and supporting elements) shall, as a minimum, meet UBC fire- resistive standards. Appropriate fire barriers shall be provided to limit property damage, fire propagation, and loss of life by separating adjoining structures, isolating hazardous areas, and protecting egress paths. The ~ shall meet th.e requirements for an "improved risk" level of fire protection sufficient to attain DOE objectives. To achieve this level of protection, automatic fire sprinklers..

shall be installed throughout the complex. The sprinklers shall be coupled with adequate fire protection water supplies and automatic and manual means for detecting and reporting incipient fires.

4.0 ENVIRONMENTAL PROTEcnON

4.1 Waste Management**

The NIF shall minimize the generation of wastes at the source per DOE Orders 5400.1, General Environmental Protection Program; 5400.3, Hazardous and Radioactive Mixed Waste Program; and 5820.2A, Radioactive Waste Management; and the Resource Conservation and Recovery Act (USC 6901 et seq.). The NIF waste handling areas shall comply with the standards of confinement and ventilation requirements specified by DOE Order 5820.2A, Radioactive Waste Management.

The NIP will generate hazardous waste, low-level radioactive waste (LLW), and mixed (LLW and hazardous) waste. These wastes shall be collected in approved containers, labeled, packaged, sorted, treated, and shipped to an EP A/DOE-approved treatment or disposal site according to the following regulations: hazardous.waste per 40 CFR 260; Hazardous Waste Management and USC 6901 et seq; low-level waste per OOE Order 5820.2A; and mixed (LLW and hazardous) waste per DOE Orders 5400.3 and 5820.2A, and 40 CFR 260. The LLW packages shall meet the radioactive solid waste acceptance criteria of the final approved disposal site.

4.2 Effluents*

Liquid effluent discharges from NIF discharge points shall be monitored and controlled in compliance with DOE Order 5400.5, Radiation Protection of the Public and the Environment; the Oean Water Act (33 V.S.C. 1251); and by conditions on federal National Pollutant Discharge Elimination System.

Gaseous effluent discharges shall meet the requirements of Section 3.1 (radiation shielding and confinement) for radionuclides and the requirements of the Clean Air Act, National Emission Standards for Hazardous Air Pollutants (NESHAPs), and state and local air quality management district requirements.

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5.0 SAFEGUARDS AND SECURITY**

The NIP safeguards and security features shall meet the requirements of DOE Order 5632.5, Physical Protection of Classified Matter, for the physical protection and control of classified data and equipment This requirement includes physical protection of classified data and equipment This requirement includes physical protection of classified matter and items in use and in storage. For the facility security areas and access control, requirements shall be established based on nature of the experiments (i.e., classified or unclassified) being performed. The limited areas shall be the target area, target receiving and inspection, final target alignment, classified data acquisition and office areas where classified computing is performed. Automated Data Processing (ADP) systems handling classified information shall meet the requirements of DOE Orders 5637.1, Classified Computer Security Program, and 53OO.4C, Telecommunications: Protected Distribution Systems.

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

Because the continuous operation of the NIP is not required to prevent adverse impacts on national security or the health and safety of the public, it is not classified as a vital facility, per DOE Order 5632.2A, Physical Protection of Special Nuclear Material and Vital Equipment.

6.0 BUILDING SYSTEMS

6.1 Design Life Requirements

The NIF shall be designed for at least 30 years design life. Systems or portions of systems for which that is impractical shall be designed for ease of replacement. Ease of replacement means that replacement is feasible at reasonable cost and can be accomplished in a timely manner, consistent with plant availability requirements. "Replacement" here also includes removal, refurbishment, and reinstallation of original equipment.

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

6.2 Vibration Requirements

Certain facilities or areas within facilities will house vibration-sensitive special equipment. The structural design of these areas shall provide means to effectively isolate this equipment to control vibration within specified displacement and rotation requirements. The laser bay experimental area vibration limits must allow the laser system to meet its ~ rms pointing accuracy requirement.

6.3 Cleanliness Requirements

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

6.4 Temperature Control

Temperatures in the laser bays and experimental areas must be controlled ,:to.30C in order to maintain a stable laser alignment.

6.5 Electrical Power

Electric power shalli?e installed in accordance with NFP A 7.0, 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 (60HZ). Electrical supply systems shall operate within the limits specified for Range A of this specification. Voltage occurrences outside these limits should not exceed the Range B limits. These variances should be limited in extent, frequency, and duration. Computers shall be protected with low voltage drop-outs requiring manual restart.

6.5.2 Standby Power
Standby power shall be available for health, life, property, and safeguards
and security loads, including emergency egress lighting, fire alarms and sensors, security systems, and radiation monitors. Power for safety and security
functions shall be installed and operated according to NFP A 101, the Ufe Safety Code; IEEE 466 (the Orange Book), the Standard for Emergency and Standby Power Systems; NFP A 72, the Standard for the Installation, Maintenance, and use of Protective Signaling Systems; and other applicable NFP A and OSHA standards.

6.5.3 Uninterruptible Power
Uninterruptible power systems (UPS), as specified in DOE Order 6430.1A, Section 1660-3, 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 rapid recovery from unplanned shutdowns.

7.1 Reliability, Availability and Maintainability (RAM)*

The components, systems, and processes that llinit overall facility availability sha1l be identified during the design process through analyses of turnaround times, mean-times-between failures, mean-times-to repair, preventative maintenance requirements, etc. Techniques such as in-site backups, on-hand spares, modular components, on-call maintenance forces, and more robust designs sha1l be used to increase availability if the following goals can not otherwise be achieved:

The facility shall be available for three shift operations at least 253 days per year (72% availability). .

The facility shall be available for at least 616 no yield (T = O.33d) target shots per year.

.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 Time*

Because of its importance to the DOE, the NIF shall be designed to survive any abnormal event...including accidents and natural phenomena...expected to occur more frequently than once in 5000 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.

Prob~bility **of**
Occurrence **Per Year, P**

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Maximum
Recovery Time

24 hours
1 week
3 months

The probabilities of occurrence listed in UCRL-15910 shall be utilized for natural phenomena.. A supplemental risk assessment shall be performed in accordance with Appendix I of NFP A 78 to determine the risk of loss due to lightning.

Standby power shall be available to preserve process continuity in cases designated by the NIP Project and specified in the System Design Requirements. Neither uninterruptible power systems nor standby power is required for the computer systems. Computers shall be protected by low-voltage drop-outs with manual reset.

8.0 DECONTA MINA nON AND DECOMMISSIONING*

The NIP design shall meet the requirements of DOE Order 6430.1A, Section 1300.11 and site-specific requirements. The NIP shall be designed for periodic cleaning of the interior of the test chamber to maintain tritium levels below -10 0. The NIF design shall include considerations which will allow for cost effective future decommissiqning of the structures and equipment.

A plan for NIF Decontamination and Decommissioning (0&0) shall be developed in accordance with DOE Order 5820.2A, Radioactive Waste Management, and DOE Order 6430.1A. A 0&0 assessment shall be made during conceptual design to ensure that features and measures are incorporated in NIF to simplify 0&0. The NIF 0&0 plan will be prepared before the end of the Title I design.

9.0 QUALITY ASSURANCE**

The NIF Quality Assurance Program shall meet the requirements of DOE Order 5700.6C, Quality Assurance. As specified in this Order, a graded approach using quality levels based on risk assessment shall be spelled out in the NIF Quality Assurance Program Plan and utilized throughout the project. The 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

DOE Orders*

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

It is recognized that updates and additions to DOE Orders and Federal Regulations are outside of the control of the project team and are a frequent source of cost and schedule growth. The impact of all updates and additions issued after October 1, 1993, will, therefore, be reviewed by the project prior to incorporation. Any negative impacts will be identified and either a formal baseline change request or a DOE backfit (i.e., cost/benefit) determination sought. .

10.2

Codes and Standards

Nationally recognized codes, standards, and guides should be utilized whenever available. A partial listing of these documents is included as Appendix A. AdditionaJ references may be identified and formally added during the Conceptual and Title I design phases, with the list baselined at the end of Title I design. Updates and additions to the baselined list codes and standards after the completion of Title I design shall be approved through the Project Change Control Process.

Compliance Verification*

NIP Project documents shall reference the DOE Orders, Federal Regulations, and National Consensus Codes and Standards listed in Section 10.4 of the Functional Requirements document.

After the conceptual design is completed, a relevancy and compliance review of the DOE Orders, Federal Regulations, and National Codes and Standards quoted in the Functional Requirements document will be performed to update the initial set and to assess NIF design compliance. This review shall document that each individual DOE Order has been fully satisfied. A stand-alone document, in a form readily understandable to an independent reviewer, shall be issued to record the review results in outline form for KDl and in final fonn for KD2. The relevancy and compliance review shall be developed in conjunction with the PSAR and shall also be submitted with that document.

10.4

Applicable Orders, Codes, and Standards

This section lists DOE Orders, codes, and standards considered applicable on October 1, 1993. The listing begins with DOE and other federal regulations (e.g., Resource Conservation and Recovery Act) followed by national consensus standards and finally other documents which establish facility requirements. The applicable portions of these documents will apply.

10.4.1 DOE Orders

.4O10.1A -Value Engineering
.4300.1B -Site Development Planning
.4330.4A -Maintenance Management
.4700.1 -Project Management System
.5300.4C -Telecommunications: Protected Distribution System
.5400.1 -General Environmental Protection Program
.5400.3 -Hazardous and Radioactive Mixed Waste Program
.5400.5 -Radiation Protection of the Public and the Environment
.5440. IE -NEP A Compliance Program
.5480.1B -Environmental Protection, Safety, and Health Protection Program for DOE Operations
.5480.3 -Safety Requirements of the Packaging and Transportation of Hazardous Materials, Hazardous Substances, and Hazardous Wastes
.5480.4 -DOE Environmental Protection, Safety, and Health Protection Standards
.5480.7 A -Fire Protection
.5480.9 -Construction Safety and Health Program
.5480.10 -Contractor Industrial Hygiene Program
.5480.11 -Radiation Protection for Occupational Workers
.5480.23 -Nuclear Safety Analysis Reports (used for Hazards Categorization only)
.5480.28 -Natural Phenomena Hazards Mitigation
.5481.1B -Safety Analysis and Review System (for non-nuclear facilities and hazards only)
.5483.1A -Occupational Safety and Health Program for Conttactors and GOCO Facilities
.5500.2B -Emergency Categories Classes and Notification and Reporting Requirements
.5500.3A -Planning and Preparedness for Operational Emergencies .5630.11 A, Safeguards and Security
.5630.16A -Safeguards and Security Acceptance and Validation
.5632.2A -Physical Protection of Special Nuclear Material and Vital Equipment (for criteria of vital facility)
.5632.5 -Physical Protection of Classified Matter
.5632.6 -Physical Protection of DOE Property
.5637.1 -Classified Computer Security Program

.5700.6C -Quality Assurance

.5820.2A -Radioactive Waste Management
.6430.iA -General Design Criteria

10.4.2 Other Government Standards

.10 CPR 835 -Occupational Radiation Protection
.10 CPR 20 -Standards for Protection Against Radiation
.29 CPR 1910 -Occupational Safety and Health Act (OSHA)
.29 CPR 1926 -Occupational Safety and Health Act (OSHA)
.40 CPR 125 -Criteria and Standards for NPDFS (National Pollutant Discharge Elimination System)
.40 CPR 260 -Hazardous Waste Management System
.40 CPR 61 Subpart 1 -National Emission Standard for Radionuclide Emissions from Department of Energy Facilities
.FED-Sffi-209E -Airborne Particulate Cleanliness Classes in Cleanrooms and Clean Zones
.33 USC 300 et seq.. Clean Water Act
.42 USC 7401, Clean Air Act
.42 USC 4321 et seq.. NEPA (National Environmental Policy Act)
.40 USC 6901 et seq.. Resource Conservation and Recovery Act (RCRA)

10.4.3 National Consensus Standards

The order standards and codes listed as mandatory in DOE Orders are not referenced in this list. .

Air Movement and Control Association (AMCA): Certified ProgI3.ID-Air Performance, 211
American Concrete Instiwte (ACI):
-Specifications for Structural Concrete for Buildings, ACI 301
American National Standards Institute (ANSI):
-ANSI B40.1, Gauges-Pressure. Indicating Dial Type Elastic Element -ANSI MC96.1 -Temperature Measurement Thennocouples -ANSI/IEEE Sill 241 -IEEE Recommended Practice for Electric Power Systems in Commercial Buildings
-ANSI Z136.1 -Laser Safety
American Society for Testing and Materials (ASTM)
-ASTM C150 -Standard Specification for Portland Cement
-ASTM C33 -Standard Specification for Concrete Aggregates
-ASTM C94 -Standard Specification for Ready-Mixed Concrete -ASTM C260 -Standard Specification for Air-Entraining Admixtures -ASTM C494 -Standard Specification for Chemical Admixtures for Concrete
-ASTM C618 -Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement-Concrete

-ASTM A615 -Standard Specification for Defonned and Plain Billet-Steel Bars for Concrete Reinforcement
-ASTM A416 -Standard Specification for Steel Strand, Uncoated Seven- Wire Stress Relieved for Prestressed Concrete
-ASTM A36 -Standard Specification for StructUral Steel
-.4\STM A307 -Standard Specification for Carbon Steel BoltS and Studs, 60000 psi Tensile Strength
-ASTM A325 -Standard Specification for High Strength BoltS for StructUral Steel JointS
-ASTM A449 -Standard Specification for Quenched and Tempered Steel BoltS and SttIds
-ASTM A4.90 -Standard Specification for Heat-Treated Steel StructUral Bolts, 150 ksi Minimum Tensile Strength
International Commission on Radiological Protection:
-Publication 30 (methodology only) -LimitS of Intakes of Radionuclides by Workers
-Publication 60 -1990 Recommendations of the International Commission on Radiological Protection
-Publication 61 -Annual LimitS on intake of Radionuclides by Workers Based on the 1990 Recommendations
Instrument Society of America (ISA):

-ISA *S5.1* -Instrument Symbols and Identification
-ISA-S5D.l -Compatibility of Analog Signals for Electronic Industrial Process InstrumentS
UCRL 15910 -Design and Evaluation Guidelines for DOE Facilities
UCRL *S3526* Rev. 11 -ExttemeWind/fomado Hazard Models
UCRL *53582* -Seismic Hazards Models

May 3, *1994/RF-la75*

DEPARTMENT OF ENERGY

BASELINE CHANGE PROPOSAL
LEVEL 1 DISPOSmON

PROJECT TITLE: National Ignition Facility
11130) BCP Number: 31) BCP Title:
96-003 Addition ofOAB to Project Data Sheet

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32)MEMBERS (ReQuired) RECOMMENDATION

NAME (Printtrype)

SIGNATURE -Dir. Office of Inertial Confinement Fusion

NAME (Prin ttrype)

I **SIGNATURE** -~r. Office ofR&D Programs Financial Ma~~ment

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________________**ADVISORS (As Reauired) RECOMMENDATION**

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33) Remarks (If **BCP** is Approved with Conditions, Deferred, or Rejected)

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National Ignition Facility
Baseline Change Proposal
Request Form and Record of Decision

1. BCP number: 96-003 2. BCP title: Addition of GAB to 3. Submi~ by ~ Project Data Sheet i
lGary *Deilla'itd* J~ '1 at4lbe Phone #: 2-7657
Fax #: 3-6506

'" LJate received:
Level 3: 2/12/96 Level 2 Levell Level 0
-:-t~ge Priority 6. BCP Level ~ '" 7. Directed ~~:*e* I
__.Routine 0 LevelO I
I0 Yes
0 Priority .Levell .No
0 Level2 Basis:
~o Level3

8. Change description: X.§ -Scope
The Optics Assembly Building (OAB) including optics assembly equipment, a new common facility required at all sites, is added to the Project Data Sheet.
9. Justification and impact of change (see worksheet)
I This change is required to include the OAB within the project scope. All sites identified in the PEIS will i require the OAB, and it is not presently included in the project data sheet. Immediate inclusion is required in order to include it in the FY97 budget submittal to permit Title I design of the OAB to proceed on schedule with the other elements of NIP.
10. Impact of not approving BCP

r~ -Schedule

.!.§ -Cost

If this BCP is not approved, effort on the OAB design will cease after conceptual design is completed in March 1996, and the OAB scope would not be included in the Project Data Sheet (FY97 budget submission). Significant project delays (estimated to be 9 months) will occur if the OAB Title I design studies at the alternative sites are not included during the NIP overall Title I design phase. The overall cost of NIP would be increased above that contained in the attached, revised FY97 Project Data sheet.

Record of BCCB decision

.~ecor 0 BCCB ecision ., ". Passe CB 13. Date of BCCB ecision JZ9 Approved (see II) ~ Yes *}../I$"t'i(UI/U ~*
0 Disapproved 0 BCCB
~ Returned for specific data

14. Approval signature

f~~~4-~.l~ **Date** *~~.s-/ft:*

________________'ons:

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National Ignition Facility
Baseline Change Proposal Worksheet

1. BCP number: 96-003 2. BCP title: Addition of OAB to 13. Submitted by Project Data Sheet

4. Technical baseline change inputs

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

Other technical baseline documents:

(See BCP 96-002 for criteria changes)

5. Cost input

Inputs: TEC: 43.3 M $
I arc: 2.0M$
, Annual Operation: ~

Budget analysis

Original budgeted amount: -
Construction*
Project to date actual cost: QM..$.
OPC Conceptual Design
Current lien balance: 0.2 M $ **
____..QP.s;:.

.TBD in FY96 Project Data Sheet
..See attached reference letter
Change to ftmding profile included: .Yes
(attached revised FY97 Project Data Sheet) ONo

I 6. Schedule input: None
0 Level 0 milestone 0 Levell milestone I 0 Level 2 milestone
i 0 Level 3 milestone
.Oetennination required by March 1, 1996 or will impact Title I design schedule

7. ES&H impacts

None

I0 PSAR/FSAR
0 PElS
0 QA Program
0 Other documents Titles

Milestone title/months 8

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8. Other impacts (e.g., security, stakeholders)

The scope of this change includes the increased throughput of NIP optics components assembly and refurbishment required by the User needs identified in the revised Primary Criteria/Functional Requirements in BCP 96-002

Gary Deis and Jon Yatabe Phone #: 2-7657
Fax #: 3-6506

TI

3.4.1. Facililies Required for NIF Operalions at LLNL, LAI

NTS Area 22, North Las Vegas, and SN~

No.	Required Facility	Size Required (m^2)	LLNL	LANL	NTS – Area 22	NTS – NLV Site	SNL (Preliminary)

1

2

La.~er and Target Area Bldg.

Target **Receiving/Inspection**

16,722

1,393

New facility

B298 lCF Target
Fabrication

New fncilily T A-58

TA-35-213

New focility

New focility

New facility

C-3 High Intensity Source Laboratory

New facility

New facility

3

Optics Assembly Building

1,858

New facility

New focilily
TA-58

New facility

New focility

New focility

4

General Assembly Area

2,787

B 166 ICF High Bay, B391 High Bay

New focility
TA-58

6-800 Heavy Duty
Shop (1,866 m1
6-624 Heavy Duty
Shop (1,187 m1

A-I High Bay

Existing facility

5

Optics **Maintenance Area**

3,7]6

B391 NOY A. B321 Optics
Fabrication

TA-3-287 (upgrade)

New focility

New rocility

New focility

6

Optics Storage Area

2,090

B392. **ICF R&D and** storage area,
B494 Warehouse- Optics

TA-3-10S
(upgrade)

New focility

New focility

New focility

Office Building

7,432

B48 t ICF Office
Building

TA-3-40
T A-3-287 TA-3-105
TA-3-100
New facility
(1,860 m1)

23-117 A&:.E Bldg.
(2,104 m1
23-600 L.L. &:. FJ1g.
(3,498 m1
23-113 REECo Tm.
(962 m2)
23-112 REECo Safety (889 m2)

Conversion of B-1 or new facility

Existing
focility

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No.

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11

12

13

14

: 3.4-1. (Cont.)

~

R~uired Facility

Size
Required

(m2)

llNL

LANL

NTS -A~ 22

NTS -NLV Site

SNL
(Preliminary)

Electrical and Mechanical Shops

t,t t5

B511 Maintenance
Shop
B383 Machine'Shop, B321 Machine Shop

T A-3-39

23-710 Crafts Bldg.
(1,919 m1

A-I Low Bay

Existing facility

Warehouse

2,787

8494 Warehouse, **0041** Warehouse

T A-3-30
TA-3-142

23-Wt. W2. W3.
W3A (total
2.787m1W4.
W4A.W5

A-2 Warehouse

New facility

Shipping, Receiving, and
Stores

1,300

B41 1 Central Stores

T A-3-30

23-W6 (372 m2)

A.2 Warehouse

Existing
focility

Medical Facility

Cafeteria

278

743

B663 Medical Services

T467S Cenb"al Cafeteria

TA-43

TA-3-261

23-650 Medical F~ility
23-300 Cafeteria

C-l Medical
Focility
C-l Cafeteria

Existing focility

Existing
focilily

I.A.
, tv
c:;)

Garnge, Gas Station

223

B611 Garage

T A-3-36

23-750 fleet Service

Not required on
site

Existing

facility

Fire Slation

'650

B323 Fire Station

TA-3-41

23-425 Mercu~ fire
Station (929 m) I

Not requ~ on
site

Existing
focility

15	Security and Badge Office	223	B071 West Badge Office B271 Security	TA-3-490	23-1000 Badge Office	C-1 Administrative Security	Existing facility

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DEPAR~ OF ENERGY
FY 1997 a-m aJI:X:;Er SUB-lISSICN
(Changes from FY 1996 Congressional Budget Request are denoted with bold lettering or strikeouts,)

~S ACTIVITIES
(Tabular dollars in thousands. Narrative material in Whole dollars.

1. Title and Location of Project:National Ignition Facility 2a. Project No. 96-D-111 ..
Site To Be Determined 2b. Construction F\mded
3a. Date A-E Work Initiated, (Title I Design Start SCheduled): 1st Qtr. FY 1996 5. Previous Cost Estimate:
Total Estimated Cost JTEX:;) --$ 842,600
3b. A-E Work (Titles I & II) Duration: 24 months Total Project Cost (TPC) --$1,073,600
4a. Date Physical Construction Starts: 3rd Qtr. FY 1997 6. CUrrent Cost Estimate:
TEC-- $ **885,900**
4b. Date Construction Ends: 3rdQtr. FY2002 TPC-- **$1,118,900**

Financial Schedule (Federal F\mds):

Fiscal Year APDropriationa Adiustrnents ObliGations Costs

Prev

'ious
1996 1997 1998 1999 2000 2001 2002

$

37, 131,
227, **212,**
191, 75, 10,

0 400 900
800 100
300 400 000

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0 0
0 0
0 0
0
0

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37, 131
227, 212,
191
75
10

0
,400 ,900 **,800 ,100** ,300 ,400 ,000

$

37,
49
206, 247, 184 113 47

400 ,500 **700 100** ,400 ,300 ,500

Funding requirements (BA) represent total estimated cost (TEC) of the project only. Activities included under other project cost (O~) are explained in Itan .12. a. 2. and the corresponding operating expense funding identified in Itan 11 .a .2. are essential to achieving the proj ect scope and schedule for the NIF.

Attachment B

Basis for Directed Changes
(Attachment to BCP96-O02)

1. Direct Drive -Letter from M.M. Sluyter to D.H. Crandall, "Direct Drive Capability on the NIP:' dated November 1995.

2. Radiation Testing -Letter from G.W. Ullrich to D.H. Crandall, "N!F and DNA," dated December 21, 1995.

3. User Requirements and Increased Shot Rate -"NIP System Design Requirements for Nuclear -Weapons Physics Experiments," UCRL-ID-120738, April 1995.

Baseline Change Proposal 96-002. 'w
Impact Assessment and Change Description
RevB

Requirements changes
Functional Requirements! Primary Criteria (based on Rev 1.3, March 1994) [New text **in bold.** Deleted text in stfil~et..h.r-..l. Editor's notes in *italics.]*

l2 AJ?plic~tio~ ---
The Functional Requirements and Primary Criteria I serves as a technical baseline for the project. Any modifications must be processed through the change control mechanism specified in the NIF Ge:-.eept-..:.al gesi'(;:'. ~eepe ar.e Pla:-. Project Execution Plan and formally approved. Each individual requirement or criteria has been placed in one of two hierarchy levels for control purposes. Those items which are , Levell, Primary Criteria, are marked with either a single or a double asterisk and are controlled by DOE Headquarters. Nonasterisked items are ! classified as Level 2, Functional requirements, and I are controlled by the Gal"Ja:-.e Gpefatie:-~ Gfflee NIF DOE Field Qffiee Manager. The control of double asterisk requirements may be delegated to Gakl::1r.e Gpefatie~.G Gfflee the NIF DOE Field Qffiee Manager at some point in the future as part of the ongoinR decentraliz~erocess.

if3Terms

The fe-rms"should" and "shall," have important: implications beyond what might be implied by I common usage. "Shall" denotes a requirement which is mandatory and must be met. "Should" denotes a fetlWfemeftt v,'~.ie~. is ~.et ::-.:):F.Elate:j', BHt v,'fliefl is a **nonmandatory** recommendation or goal.
1.4 Site-Specific Requirements --

These requirements have been wrItten for a generic site, such that NIP could be located at many different sites with only minor modifications. When a site selection is made, these requirements will be revised as necessary to include site-specific natural phenomena, environmental characteristics, and potential use of existing infrastructure, facilities, and services. The two buildings required at all candidate sites are: Laser and Target Area Building (L TAB) and the Optics Assembly Building (OAB) as described in these criteria.

.General update

.Generalupaate -clarification- of wording

.Addition of OAB

The wavelength of the laser pulse delivered to the target shall be 0.35 microns (~m). The design should not preclude delivering 0.53 ~m and 1.053 ~m wavelength light to the target with reasonable modifications.

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_SQQII~ y.,~4-1.. 000/ ~- -~-~ ~£ 4-1..~ 1 0 ~A"T _..1""""",",,, ,
~~~r~~.' "~~. -"-'*IV* '-'.. V v.. '" ~.~ ~'~*J t'~..v... """""0]*

_ee:'".taL'"'.ea v,"itl--.~-. a eifele ei 699~~. Eiia:-:.etef. Each beam shall deliver its design energy and power encircled in a *600* J.lm diameter spot at the target plane *or* its equivalent. In the appropriate configuration, each beam should deliver *50% of* its design energy and power encircled in a 100J.lm
: diameter spot at the target DIane *or* its eQuivalent.

-The NIP shall have spatial and temporal beam conditioning to control intensity fluctuations in
the target plane. -l--.a~Ye fle*ible beam s~.eet~.ir.g eaf3abilit}' fef t..1.-.e sHf3f3fessieR ef lasef f31as~.a
~ :;tabilities iR ~~.aifeet afi~,'e tafgets =...~.e f3ete~.tiallJ' fGf tfte sHf3f3fessie::-. ef ~.j'efeej7.="'7.ie ~~.:;tabilities if Hti~ea fef aifeet efi~'e tafgets. ~.e eaf3abilit}' sftall ~"'.elHee;
.Pl--.ase f31ates at t..1.-.e eHtf3Ht ef t~.e lasef f~f *t..1...e* eeRtfel ef t..1.-.e sf3atial iffaeiar.ee eistfibHtie~. e~. *tl-.e* tafget. ~.e fesHlf..:::'".g flHet-..:.atie~.:; ~ t..1.-.e lasef f3Hlse eeliy,'efea te tfte f-..:.sieR tafget s~.all ::-.et e*eeee *2:§~1o* ef tl--.e a~Yefage iRteRsit}' ~.easHfea e~.'ef a 3f) t1~. eiametef eifele aHa ~ tegfatee e~'ef a f~7.e ef If) f3s. .FeHf aiffefeRt ee~.tefl~ e f:eElHeReies ~. eae~. bea~.let ef a 2:~..2. affaj' sef3afatee ~.em~ allJ' by a 1 i""Wl at 1 fi) ~'y-~.iel-. are stlperiulposed Oi""l taL-get to ~-.erease tl-.e total ba~.d~y-idtl-. tl-.at is av-ailable at 3 ft};

.User Requests -Radiation Effects and others

.General update -technical correction

.General update
.Users request -Weapons and others

.General update--
.Addition of Direct Drive

~ 1~ ~r Pulse WraveIen:v;ili*

1 2.1.5 Beamlet ~e~ t~-Lg Positioning Accuracy"'
,- The fInS deviation in ~e~ f";:-Lg the position of the centroids of all beams from their specified aiming points shall not exceed 50 micrometers (~m) at the target plane ~_equivalent. --

'2.1.10 Laser PulsesDOt Size

~ 2.1.11 Beam Smoothness

2.1.12 **Direct-Drive Requirements**

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

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

Direct-Drive Cone Half-
_~ Angle (al2l2roximate)
Inner same as indirect drive Outer same as indirect drive Waist 75 degrees

Fraction of Total
Beams
~~~

~ 1/6
1/3
1/2

2.1.13 Beam Focusing and Pointing
The NIF should have flexibility in beam focusing and pointing to address the needs of radiation effects testing and other users.

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 femetelj'leeateEi
i users with diverse needs. The baseline facility design shall not preclude future lfpgFaEie addition of target chambers for additional weapons physics e*pef~~Leflts, Eiifeet EifiT.'e, and/or radiation effects testing ~','eapefl etteets tafget e1"La~Lbefs. The baseline design and operation should be capable of performing radiation effects testing of important national assets, up to system level components, to maintain and certify their reliability. The following requirements are intended to satisfy the most basic of these needs.

2.2.2 Annual Number of Shots with FusionYleld~r Chamber Design*

The NIF facility shall be capable of 199 sflets pel' leaf V:itfl a f.:.siefl }'ielEi ift t..'".e faflge ef 1 te 199 *l~Ji* 3.9 sflets pef }'eaf ~'.'i*L }'ielEi ~ t..'".e faflge ef 199 *l~J* te .9 ~,*1Ji* = a, 19 sflets pef j'eaf ~'.'itfl }'ielEi ~-L t..'".e faflge ef.9 te ~9 ~*.1J.* performing yield shots with total DT fusion yield of 1200 MJ/year. The NIF shall be capable of performing up to 50 shots per year with a routine DT fusion yield of 20 MJ.

.Addition of Direct Drive

.Addition of Direct Drive

.Users Request -Radiation Effects and others

.General update -clarification of wording
.Users Request -Radiation Effects and others

I .General-upaa ti (enhanced envelope)
.Increased shot rate

2.2.4 ClasSIfiCation Level of Experiments* -

-
The facility shall b~signed to allOW both classified **(at the SRD level)** and unclassified experiments. Its design should permit changing classification levels with m~al impact on operations and cost.

To address the needS of indirect-drive;dlrect-drive and other users, the laser and experiment area should be capable of conducting experiments with a time between shots of 8 4 hours for shots with no fusion.

~ Per~onnel AccesS1i1SIde the Target Chamber*

Personnel access to the inside *of*~ 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 capabilityiO- - allow laser irradiation of distributed target arrays
'
I with future upgrade. The target chamber should allow flexibil~~~_eam dump placement.

-the NIP shall be designedCoonstructed, and operated as a low-hazard, nonnuclear 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 9GB Gfaefs §48g.~3, ~JHeleaf 6atetj' ~A~~.alJ'sis Repefts ~ a §481.18 10CFR 830.110 Nuclear Safety Management, Safety Analysis Report, and DOE Order 5481.1B, Safety Analysis Review System). Administrative controls shall be established prior to 1<;9-4 CD3 to ensure that inventory limits for a radiological low-hazard, non -nuclear facility are not exceeded.

.User Request -Radiation Effects

.IncreasedShot rate for bOth: .Addition of Direct Drive .Users request

.Generarupdate .Regulatory update

user Request -Radiation Effects

.Generarupdate .Regulatory update

~ 2.2.6 TimeBetween Shots Wltn No Fusion Yield

'~Safety Reauirements**

3.1 **Radiation ProtecHOi1***

Collective and ~ividual ionizing-radiation doses to the public from all exposure pathways fromthe NIF shall meet the requirements of DOE Order 5400.5, Radiation Protection of the Public and the Enviornment, and 40 CFR 61, National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities. These requirements state that exposure of members of the public from emissions of radionuclides in the ambient air from normal NIF operations shall remain below 10 mrem/y. The facility shall also meet the requirements of DOE Order 5400.5 [ICRP 60 540 (1990 Recommendatin sof the International Commission on Radiological Protection), 10 CFR 20.1301.a.1 (Code of Federal Regulations-Standards for Protection Against Radiation)] to fema~~L helev: not cause the public dose limit et 199 mfe~Ltj" from all exposure modes and all sources of radiation at the site boundary to exeed 100 mrem/y.
The NIP personnel radiation protection program shall follow DOE Order §489.11 N441.1, Radiation Protection for Occupational Workers and 10 CFR 835 Occupational Radiation Protection. The ALARA (as low as reasonably achievable) principle shall be utilized in both design and operation of the facility to eliminate unnecessary radiation dose to workers in the Laser and Target Area Building, co-located employees, and visitors from both routine and off-normal operations. Radiation protection shall include: shielding; control of workplace ventilation; monitoring of personnel for external and internal radiation dose; establishment of a routine contamination monitoring program including air monitoring, and the proper containment of radiation and radioactive materials. The radiation shielding design shall be more conservative than required by DOE Order 6439.1"A.. SeeBeR 1399 6.~ 420.1, Facility Safety, in that maximum doses to an individual worker shall be limited to one tenth (shielding design goal) of the occupational external dose limits specified in 9GE Gfaef 5489.11 10 CPR 835.

.General update
.Regulatory update .Enhanced Envelope
(referenced letter from D.H. Crandall to S.L. Samuelson, "Capability Boundaries for the National Ignition Facility (NIP)," Sept. 12,1995)

1 Concrete shielding shall comply with ACI 3l-8 - 301 which provides adequate strength for DBE loads.
The requirements for the confinement of tritium for Fusion Test Facilities in DOE Order 64aO.l~A.. Seeti8~L la~8 420.1, Facility Safety, should be evaluated by the designers and incorporated when they are determined to be cost effective, even though the projected inventory of tritium in NIP (--o.oa g 81' aoo Gi -0.05g or 500 Ci) is well below the threshold for a nuclear facility. The target chamber and tritium processing systems shall form the primary confinement barrier. Leakage past these barriers shall be ALARA. The experimental area ventilation system shall be

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

3.2 Life Safety**

The NIP shall fully comply with the requirements for life safety contained in DOE Order *§480.7* ~A.. 420.1, Facility Safety. Particular focus shall be directed towards features related to e~~'"Lg means of egress, such as protection of vertical openings, travel distances, capacities, I and emergency li~hting.

.General update .Regulatory update

.General update .Regulatory update

3.3 Laser Safety""

The laser safety shall comply with ANSI Z136.1 ~ e GSKA.. i'eEltiii'err.er"'.ts. Exposure to hazardous levels of laser light shall be prevented by the use of physical barriers, personnel training, interlocks, and personnel entry controls. Protective equipment, such as laser goggles, shall be used when necessary for operational purposes. Interlock systems shall be dedicated and designed to fail safe and shall activate laser shutters or shut off power to laser systems if access doors are opened and hazardous exposures are possible.

! 3.4 Industrial Hygiene and Occupation~l S~fety:

Industrial hygiene and occupational safety shall comply with 29 CFR 1910 and DOE Order §483.1..A.., Geeti}3aee:,.al ~a~e~' ar"'.e Heal~h. Pi'egi'a~. ~ei' Ge:,.tl'aetei' E~.}3leJ'ees at GGGG Paeilities (v.'l"'.iel\ lists aeeitiefl:al..AA~J6It £A..~J~, !"JPP..A..,IEEE, ..A..IH..A.., P~.4 a:,.e et!'.ef applieable -

.General update .Regulatory update

eee\:f:!3atIE;:"'.al saf~~' sta1"'.aal'as) 440.1, Worker Protection Management for DOE Federal and Construction Employees. 9GB Gl'ael' §489.19, Gefltl'aetel' I:"'.a\:f:stl'ial Hj'gie:"'.e Pl'egl'am, snail be {ene~..'ea ~ aaaitie:"'. te tl-.e 1r.a\:f:stl'ial !--.j'giefle l'eEI\:f:il'eme:"'.ts ~ tne !3l'eY,'ie\:f:slj' mefleeflea st~-.aal'as.

Construction safety shall comply with the requirements of 29 CFR 1926, OSHA and DOE Order §489.9, Ge:"'.stl'\:f:etiefl ~a{et' a:"'.a Heal~t... Pl'egFa~L 440.1, Worker Protection Management for DOE Federal and Contractor Employees. Facility subsystems (e.g., capacitor banks, vacuum systems, tritium recovery, nitrogen supply, and personnel safety interlock systems) shall be designed to default to a safe state upon loss of Dower.

.General update .Regulatory update

.General update .Regulatory update

I 3.5 Fire Protection*

The NIF shall meet the design and fire protection! requirements of DOE Orders 6439.1.LA.. a~Ld I .3489.7.LA.., Fife Pfeteetie~L 420.1, Facility Safety,

and the Uniform Building Code (UBC). The structural members of the Experimental Building (including exterior walls, interior bearing walls, columns, floors, roofs, and supporting elements) shall, as a minimum, meet UBC fire resistive standards. Appropriate fire barriers shall be provided to limit property damage, fire propagation, and loss of life by separating adjoining structures, isolating hazardous areas, and protecting egress paths. The NIP shall meet the requirements for an "improved risk" level of fire protection sufficient to attain DOE objectives. To achieve this level of protection, automatic fire sprinklers shall be installed throughout the complex. The sprinklers shall be coupled with adequate fire protection water supplies and automatic and manual means for detecting and reporting incipient fires. Fire hazard analyses will be completed as required by DOE Order 420.1

I 3.6RObOtlc System Safety

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

I 4.1waSte Manag-ement**

The NIF shall minimize the generation of wastes at the source per: DOE Gfaefs Policy 8499.1 P450.1, Environmental Safety and Health Policy for the DOE Complex, General Environmental Protection Program~ 8499.3, Ha~afaeHs aF.a RaaieaetiWy"e ~y4HEea '.A!aste Pfegpam: and DOE Order 5820.2A, Radioactive Waste Management; and the Resource Conservation and Recovery
Act (USC 6901 et-seEJ; to 6992) and the Toxic Substance Control Act (15 USC 2601-2692). The NIF waste handling areas shall comply with the standards of confinement and ventilation requirements specified by DOE Order 5820.2A, Radioactive Waste Management.
The NIP will generate hazardous waste,
low-level radioactive waste (LLW), and mixed
(LL Wand hazardous) waste. These wastes shall be collected in approved containers, labeled, packaged, sorted, tfeatea, and shipped to an EP AI DOE-approved treatment or disposal site according to the Resource Conservation and Recovery Act and the following regulations: hazardous waste per 40 CFR 260, 261, and 262; Ha~afaeHs \A!aste ~.4:: ageme~.t a~.el g~G 6991 et I 8eElo1low-level waste per DOE Order 5820.2A;
and mixed (LL Wand hazardous) waste per DOE Orders 8499.3 ar.a 5820.2A, and 40 CFR 260. The LL W packages shall meet the radioactive solid waste acceptance criteria of the final approved disposal site.

4.2 Effluents*

Liquid effluent discharges from NIF discharge points shall be monitored and controlled in compliance with: 10 CFR 835; DOE Order 5400.5, Radiation Protection of the Public and the Environment; the Clean Water Act (33 V.S.C. 1251 et. seq.; and by conditions on 40 CFR 125 criteria and standards for National Pollutant Discharge Elimination System.

baseeHs eff}Hent Eiiser.afges Air emissions shall meet the requirements of Section 3.1 (radiation shielding and confinement) for radionuclides and the requirements of the Clean Air Act, (42 V.S.C 7401) including National Emission Standards for Hazardous Air Pollutants (NESHAPs), and state and local air quality management district requirements.

.General update .Regulatory update

.Generarllpdate
.Regulatory update

~Safe~ard!! **And** Security**

The NIF safeguards and security features shall meet the requirements of DOE Order §63~.§, PRJ'sieal Pfeteetiefl et Glassitiea ~,4attef, tef t~.e ~RJ'sieal ~feteetie:--. ar.a eefltfel et elassitiea elate e..'".a eEIeiF~.er'".t 5632.1C, Protection of Safeguards and Security Interests, and DOE Order 470.1, Safeguards and Security Program. The requirements include T!--Jc feEIeife~.er'".t L'".eleaes physical protection of classified data and equipment. T!--.is feEIeifeme:--.t i eleaes
~!:-. J'sieal ~feteetie:--. et elassitiea mattef and items in use and in storage. For the facility security areas and access control, requirements shall be established based on nature of the experiments (i.e., classified or unclassified) being performed. The limited areas shall be the target area, target receiving and inspection, final target alignment, classified data acquisition and office areas where classified computing is performed. Automated Data Processing (ADP) systems handling classified information shall meet the requirements of DOE Orders 5637.1, Classified Computer Security Program, and 5300.4(;: D, Telecommunications: Protected Distribution Systems. Elements of DOE Orders 470.1 Safeguards and Security Program and 472.1 Personnel Security Activities will also be incorporated into the security plan.
The NIP complex shall also meet the requirements for physical protection of DOE property and unclassified facilities, protection program operations, and personnel security, including issuance, control, and use of badges, passes, and credentials.
Because the continuous operation of the NIF 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 §63~.2..A.., PRJ'sieal Pfeteetiefl et ~~eeial ~!eeleaf ~.1atefial ~ a '.'ital

BEIei~meflt
5632.1C.

The L TAB and the Optics Assembly Building (DAB) represent the only newly constructed facilities common to all of the candidate sites. The NIF shall be designed for at least 30 years ~gn life fo~ permanent structures.

.Generarupdate .Regulatory update

.Addition of GAB
.General update -clarification
of wording

/ 6.1 Desi~ Life Requirements

Systems or portions of systems for which that is impractical shall be designed for ease of replacement. Ease of replacement means that replacement is feasible at reasonable cost and can be accomplished in a timely manner, consistent with plant availability requirements. "Replacement" here also includes removal, refurbishment, and reinstallation of original equipment
The performance category for Target Area and Laser Structural sytems shall be category 2 with a graded approval for other systems. Where alternative designs and modes of construction are possible at essentially equivalent cost, the design and construction method which most readily allows for future reconfiguration and modification should be selected.

6.2 Vibration Requirements
__Certain facilities or areas within facilities will house vibration-sensitive special equipment The structural design of these areas shall provide means to effectively isolate this equipment to control vibration within specified displacement and rotation requirements. +l\e lasef bay e;..-pefi..7.e;-.tal afea w:i!:;fatie;-. li..~its mHSt aile\': *t..1-..e* lasef sJystem te ~.eet its §Qt!~. ~.s 13eir.f~ g aeeHfaqY feElHifeme~.t. Specific constraints are specified in the System Design Requirements for L TAB and DAB.

~3Cleariliness Requirements

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

6.4 **Temperature Control**

Temperatures in the laser bays and experimental areas must be controlled te 3:G.3°G in order to maintain a stable laser alignment. Specific constraints are specified in the System Design Requirements.

.General update .Addition of OAB

.Addition of DAB

.General update

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.

6.5.2 Standby Power
__Standby power shall be available for health, life, property, and safeguards and security loads, including emergency egress lighting, fire alarms and sensors, security systems, and radiation monitors. Power for safety and security functions shall be installed and operated according to

NFP A 101, the Life Safety Code; IBBB 466 (t.h.e GfaRge Beek~ ANSI/NFPA 110-1993, the Standard for Emergency and Standby Power Systems; NFP A 72, the 6ta eafe tef t.t-..e I~.::,tallaee~., ~,4ai."'.te~.a~.ee, aRe Hse et Pfeteetiy.'e 6igr-.ali g 6jTsterr.s National Fire Alarm Code; and other applicable NFP A and OSHA standards.

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

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

.The facility shall be available for three shift operations at least 253 days per year (72% availability).

.The facility shall be available for at least 616 no yield (~- 9.33Ei) 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 shots per_y~r.

.General update .Regulatory update

.General update .Regulatory update

.Increase shot rate .Addition of Direct Drive .Users request

.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 Time***

Because of its importance to the DOE, the NIP shall be designed to survive any abnormal event, including accidents and natural phenomena, expected to occur more frequently than once in 5000 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=l	24 hours
1 > P ~ 10-2	1 week
10-2 > P ~ 5 x 10-4	3 months for laser, target, and associated building structures 6 months for support system

The probabilities of occurrence listed in YGRL 1§919 DOE-STD-IO20-94 shall be utilized for natural phenomena. A supplemental risk assessment shall be performed in accordance with Appendix I of NFP A 78 to determine the risk of loss due to lightning.

Standby power shall be available to preserve process continuity in cases designated by the NIP Project and specified in the System Design

Requirements. Neither uninterruptible power systems nor standby power is required for the computer systems. G6mf3Htefs sl-.all be f3f6teetea *bJT* 16\': ~T61tage af6f36Hts ~':it..h. ~LaflHal feset.

.General update .Regulatory update

8.0 Decontamination-And Decommissioning-- The NIF design shall meet the requirements of DOE Order 643Q.l~A.., 8eetie:-. 13QQ.11420.1 and site-specific requirements. The NIP shall be designed for periodic cleaning of the interior of the test chamber to maintain tritium levels on interior surfaces eelev: -lQ Gi as low as reasonably achievable. The NIF design shall include considerations which will allow for cost effective future decommissioning of the structures and equipment.

A plan for NIF Decontamination and Decommissioning (D&D) shall be developed in accordance with DOE Order 5820.2A, Radioactive Waste Management, and DOE Order 643Q.LA.. 420.1. A D&D assessment shall be made during conceptual design to ensure that features and measures are incorporated in NIP to simplify D&D. The NIF D&D plan will be prepared before the end of the Title I design.

10.1 DOEOrders* I

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

It is recognized that updates and additions to DOE Orders-aflEi, federal regulations, and consensus industry standards are outside of the control of the project team and are a frequent source of cost and schedule growth. ~e ~~paet ef all epeates a~.e aeeitie~.:; isseee aftef GeteBef I, 1993, v."ill, tl"'.efefefe, Be fe~"ie~'."eel BJ" tne pfejeet pfief te 1r.eefl3efatiefl. £A..:'.J" ~LegatiT:e i~.paets v.'ill Be iele~Ltifieel ~-Lel ei~h.ef a fefmal

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eest/Be;-.etit~ eetef~.1r.atie~L seegnt. These requirements are all frozen as of March 1, 1996.

10.2 Codes and Standards

.General update .Regulatory update

.General update .Regulatory update

Nationally recognized codes, stanaaras, and guides should be utilized whenever available. A partial listing of these documents is included as ~A..ppeREl~ ~AA **in the following sections.**

Additional references may be identified and formally added during the Conceptual and Title

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.General update .Regulatory update

Tdesign phases, with the list baSclined at the end of Title I design. Updates and additions to the baselined list codes and standards after the completion of Title I design shall be approved ~ugh the Proje<:!~ge Control Pr~~s.

10.3 Compliance Verifications

~!IP Pfej~eu..~.e:,.ts s~.all fetefe:,.ee t,.~e 9GB GfeefS, Feeefal Reb.:.latie:,..:::, ~ e ~tatie:,.al GeflSe:'..:::US Geees ar.e ~tar.eafeS listee 1r. ~eetiefl 19.4 et t,.~e Fu..~.etieflal ReEluifeme:".ts eeeu..-::-.eflt. 4AAttef t,.h.e ee:,.eeI:J~.:.al eesigH is eemI:Jletee, a feleT.'~ ej' a:'.e ee::"I:Jli~ ee feT:iev: et t,.h.e 9GB Gfeefs, Feeefal Reb.:.latie:,..:::, ar.e ~ tatie:'.al Geees a:,.e 6t~~.eafes Eluetee 1r. the Fu etie:,.al ReEluifemeflts eeeu..~.e:,.t v.'ill Be I:Jeftefffiee te uI:Jeate t~.e ~~.itial set =.;:o.e te assess ~!IF eesigH ee::"I:Jliaflee. 'T'!--.is feT,'ie\..' s~.all ee::.:.::,.e:,.t t,.h.at ea:..1... ~ eiT,'ieual 9GB Gfeef ~.as Beefl f.:.llJ'

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1M 10.3 Applicable Orders, Codes, and Standards This section lists DOE Orders, codes, and standards considered applicable on Geteeel' 1, 1993 March 1, 1996. The listing begins with DOE and other federal regulations (e.g., Resource Conservation and Recovery Act) followed by national consensus standards and finally other documents which establish facility requirements. The applicable portions of these documents will

19.4.110.3.1 DOE Orders

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.43QQ.IB ~ite ge~Fele~~Le~Lt Pla~~LbLg *.433Q.* 4..A~ ~.4ai..~Ltefl:a~Lee ~.4a~Lage~Le~Lt .47QQ.l -Pl'ejeet ~.4a~Lage~Le~Lt ~yste~L
.5300AGD -Telecommunications: Protected Distribution System
.5400.1 General Environmental Protection Program
.*§4QQ.3* Ha~al'eleHS ~ el Raelieaetive ~.4i*eel '.AI aste Pl'eg;:~~~

.General update .Regulatory update

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.General update .Regulatory update

.5400.5 -Radiation Protection *of* the Public and
the Environment
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.§489.9 Ge1"'.:;tl'1:leeeR 6a~e~' aF.e Heal~t... Pl'egl'a1r'.
.§489.19 Ge:"'.tl'aetel' ~-.e1:lsHial Hygie1"'.e Pl'egl'a1r'.
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.5481.1B -Safety Analysis and Review System (for non -nuclear facilities and hazards
only)
.§48a.I£A~ Gee1:lf)aeeftal ~ate~' afte Healt..1... Pl'egl'a1r'. tel' Ge1"'.HaeteI'S = e GGGG Paeilities
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.§6a9.16£A.. ~afCb..1al'es a1"'.e ~ee1:ll'it"i ..A..eeef)t= ce aRe ¥alieatieR
.5632.1C -Protection of Safeguards and Security Interests
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.5637.1- Classified Computer Security Program .5700.6C- Quality Assurance
.*5820.2A* -Radioactive Waste Management
.64a9.I~A.. Geftel'al gesi~ Gl'itel'ia

.151.1 -Comprehensive Energy Manag-ement Program
.420.1 -Facility Safety
.430.1 -Life Cycle Asset Management
.440.1 -Worker Protection Management for DOE Federal and Contractor Employees
.N441.1 -Protection for DOE Radiological Activities
.P450.1 -Environment, Safety and Health Policy for the Department of Energy Complex
.451.1- National Environmental Policy Act Compliance Program
.460.1 -Packaging and Transportation Safety .470.1 -Safeguards and Security Program .471.1 -Information Security Program
.472.1 -Personnel Security Activities

19.4.2 10.3.2 Other Government Star.aafas

I Re~ulations

.10 CFR 830.110 -Nuclear Safety Managemeni~- Safety Analysis Report
.10 CFR 835 -Occupational Radiation
Protection
.10 CFR 20 -Standards for Protection Against Radiation
.29 CFR 1910 -Occupational Safety and Health Act (OSHA)-operation
.29 CFR 1926 -Occupational Safety and Health Act (OSHA)-construction
.40 CFR 125 -Criteria and Standards for NPDES (National Pollutant Discharge Elimination System)
.40 CFR 260, 261, 262 -Hazardous Waste Management System
.40 CFR 61 Subpart H -National Emission Standard for Emissions of Radionuclides other than Radon from Department of Energy Facilities
.FED-STD-209E -Airborne Particulate Cleanliness Classes in Cleanrooms and Clean Zones
.33 USC JOO 1251 et seq., Clean Water Act
.42 USC 7401, Clean Air Act
.42 USC 4321 et seq.. NEPA (National Environmental Policy Act)
.40 USC 6901 et seE!. to 6992, Resource Conservation and Recovery Act (RCRA)

.Lieneral update .Regulatory update

.15 USC 2601-2692, 1 oxic Substance Control
Act
A~' 19.4.3 10.3.3 National Consensus Standards

The oraer standards and codes listed as mandatory in DOE Orders are not referenced in this list.

.Air Movement and Control Association (AMCA): Certified Program -Air Performance, 211-1994
.American Concrete Institute (ACI): -Specifications for Structural Concrete for Buildings, ACI 301 -1996
.American National Standards Institute (ANSI): -ANSI B40.1 -1991, Gauges-Pressure, Indicating Dial Type Elastic Element -ANSI MC96.1-1982, Temperature Measurement Thermocouples
-ANSI/ IEEE STD 241 -1991, IEEE Recommended Practice for Electric Power Systems in Commercial Buildings
-ANSI Z136.1 -1993 Laser Safety
-ANSI C2 -1993, National Electric Code -ANSI C84.1 -1989, Electrical Power Systems and Equipment -Voltage Rating (60 Hz)
-ANSI/NFPA 110-1993, Standard for Emergency and Standby Power Systems -ANSI/RIA R15.06-1992, Industrial Robots and Robot Systems -Safety Requirements
.American Society for Testing and Materials (ASTM)
-ASTM ClSO -1995, Standard
Specification for Portland Cement
-ASTM C33 -1993, Standard Specification for Concrete Aggregates
-ASTM C94 -1994, Standard Specification for Ready-Mixed Concrete
-ASTM C260 -1994, Standard Specification for Air-Entraining Admixtures
-ASTM C494 -1992, Standard Specification for Chemical Admixtures for Concrete
-ASTM C618 -1994, Standard
Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement
Concrete

-ASTM A615 -1995, Standard Specification for Deformed and Plain BilletSteel Bars for Concrete Reinforcement
-ASTM A416 -1994, Standard Specification for Steel Strand. Uncoated Seven Wire Stress Relieved for Prestressed Concrete
-ASTM A36 -1994, Standard
Specification for Structural Steel
-ASTM A307 -1994, Standard Specification for Carbon Steel Bolts and Studs, 60000 psi Tensile Strength
-ASTM A325 -1994, Standard Specification for High Strength Bolts for Structural Steel Joints
-ASTM A449 -1993, Standard Specification for Quenched and Tempered Steel Bolts and Studs
ASTM A490 -1993, Standard Specification for Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength

.International Commission on Radiological Protection:
-Publication 30 (methodology only) - Limits of Intakes of Radionuclides by Workers
-Publication 60 -1990 Recommendations of the International Commission on Radiological Protection
-Publication 61- Annual Limits on intake of Radionuclides by Workers Based on the1990 Recommendations

.Instrument Society of America (ISA):

-ISA S5.1 -1992, Instrument Symbols and Identification

-ISA-S50.1-1992, Compatibility of Analog Signals for Electronic Industrial Process Instruments

.YGRL 1§91Q gesigR a:".e B~'al\iatieH G\iiee~~.es fCf 9GB Faeilities

.UCRL 53526 Rev. 1 -B*tfe~.e '.A!~~.e/+e::".aee Ha~afe ~.4eeels Natural Phenomena Hazards Modeling Project for Department of Energy Sites (1985)

-.UCRL 53582 Rev.l- geismie Ha~afels ~4e8:ei Natural Phenomena Hazards Modeling Project for Department of Energy Sites (1984)

.DOE-STD-I020-94, Natural Phenomena Hazards Design and Evaluation Criteria for DOE Facilities

.DOE-STD-I021-93, Natural Phenomena Hazard Performance Categorization Guidelines for Structures, Systems, and Components

.NFP A 70 -1996, National Electric Code .NFPA 72 -1993, National Fire Alarm Code .NFP A 101 -1994, Code for Safety to Life from Fire in Buildin~s and Structures

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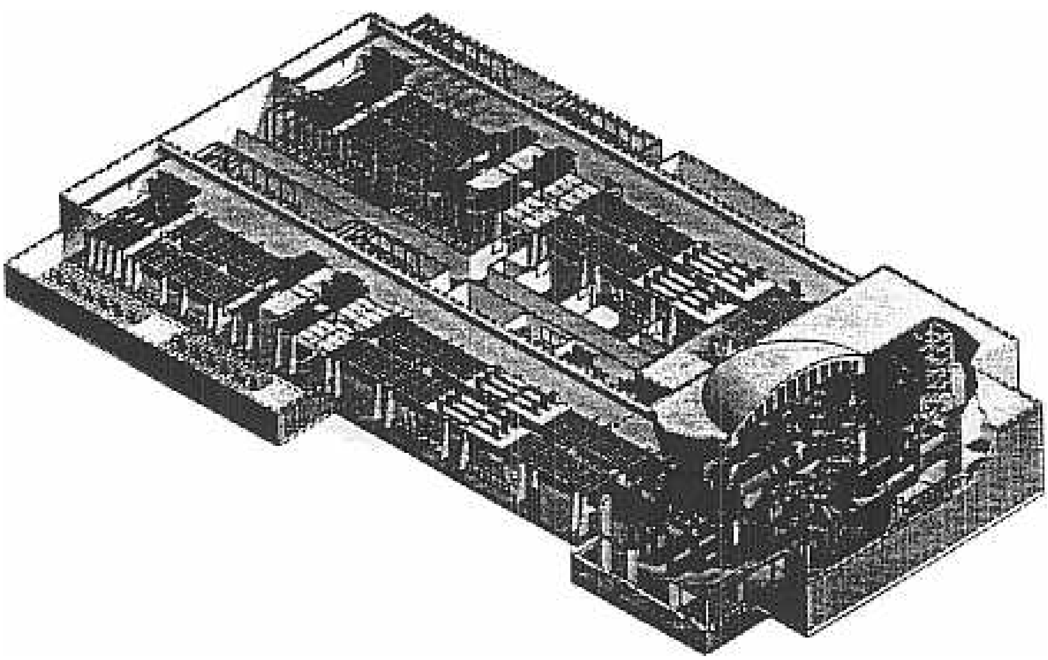
UCRL-ID-UO73ti
L-20Q72-1

NIF System-Design Requirements for Nuclear-Weapons Physics Experiments

Theodore S. Perry
Lawrence Livermore ~~ational Laboratory
and
Bernhard H. Wilde
Los Alamos NatiIJlnal Laboratory
Scientific Editors

April 1995



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Work performed under the auspices of the U.S. Department of Energy by the Lawrence Livermore National Laboratory under Contract W-7405-Eng-48.

UCRL-ID-120738

NIF System-Design Requirements for Nuclear-Weapons Physics Experiments

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Lawrence Livermore National Laboratory
and
Bernhard H. Wilde
Los Alamos National Laboratory
Scientific Editors

April 1995

Lawrence Livermore National Laboratory
University of California. Livermore, CA .94550

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UCRL-W-120738

NIF System-Design Requirements for Nuclear-Weapons Physics Experiments

April 1995

Lawrence Livermore.National Laboratory
University of California. Livermore, CA .94550

Table of Contents

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Foreword

The role of NIF

One of the primary objectives of the National Ignition Facility (NIF) project is to provide an aboveground experimental capability for conducting weapons-physics experiments, which is necessary for maintaining nuclear competence. The NIF is expected to produce the temperatures and pressures required for fusion ignition and to make significant contributions to the mission of DOE defense programs. To achieve the high-energy- density regimes needed for a science-based stockpile stewardship program, the NIF must be capable of producing conditions similar to tt¥>se in nuclear weapon explosions. This qualifier imposes fundamental facility design requirements on the NIF. This docUnett summarizes those requirements; full justification is included in the NIF white paper (Heidrich, 1995). This document concentrates on necessary additions to the current NIF Conceptual Design Report (COR) (see UCRL-PROP-117~3) if NIF is to fulfill its defense mission.

Nuclear weapons physics and NIF

The NIP will be an ideal facility for studying much of the physics involved in nuclear weapons both as isolated processes and as compound events. The NIP will be particularly important for studying opacity, radiation flow, equation of state, non-local thennodynamic equilibrium (non-LTE) physics, hydrodynamic instability, and fusion capsule design. Each of the weapons experiments designed for the NIP have their own requirements. The experimental plans and facility requirements unique to each

area are reviewed in separate sections. Facility requirements from each of the experi~ts have been collected from the individual sections and listed in Section I, "Common Requirements for Weapons-Physics Experi~ts."

Reference

Heidrich, J. Ed., *Weapons Physics on the* NIF: *Experimental Opportunities* to *Improve Predictive Modeling Capabilities of Nuclear Weapons Phenomena,* Lawrence Uvennore National Laboratory, Uve~re, CA (UCRL-MI-119594) 1995.

The National Ignition *Facility Conceptual Design Report,* (CDR for the 192-beam facility) Lawrence Uvennore National Laboratory, UvermJre, CA (UCRL-PROP-117093) 1995.

ill

Lawrence Livermore National Laboratory

August 15, 1995

NIF-LLNL-9S-436 L-201SS-Q1, WBS 1.1.1

Dr. David H. Crandall
U.S. Dept. of Energy, DP-16 1000 Independence Ave., S. W. Washington, DC 20585

Re:

Facilities Required for NIF Assembly and Operations

Dear Dr. Crandall:

Attached is the table from the NIP section of the Programmatic Environmental Impact Statement for Stockpile Stewardship and Management generated by ANL from site data. An Optics Assembly Building is required as a new facility for all sites and locations.

I request that the Office of the National Ignition Facility give the Laboratory Project Office concurrence to proceed with the non-site specific Advanced Conceptual Design for this facility since its construction completion (October 1998) will be on the critical path for staging amplifier hardware into the LTAB.

Yours truly,

Jeffrey A.

Paisner
Project Manager
National Ignition Facility

(/

Concurrence:

cc:
D. Foley
A.Levy
J. Post
D. Rardin
S. Samuelson J. Yatabe

David H. Crandall

Director, Office of the National Ignition Facility

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Paper

Lawrence Livermore National Laboratory

August 15, 1995
NIF-LLNL-95-436 L-20155-Ql, WBS 1.1.1

Dr. David H. Crandall
U.S. Dept. of Energy, DP-16 1000 Independence Ave., S. W. Washington, DC 20585

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~(J~
U:~ey~. Paisner
Project Manager National Ignition Facility

Concurrence:

cc:
D. Foley
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randall Director, Office of the National Ignition Facility

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Title and Location of Project

National Ignition Facility
Site To Be Deteffilined (Continued)

Proiect ~scriDtion. Justification and SCODe

28. Project No. 96-0-111 2b. Construction Funded

'!he Project provides for the design, procurement, and construction of the National Ignition Facility (NIF) , an experilrental inertial confinanent fusion facility intended to achieve controlled thenronuclear fusion in the laboratory by iroploding a small capsule containing a mixture of the hydrogen isotopes, deuterium, and tritium. '!he NIF will be constructed at a site determined by a fonralized roE site selection process and National Environmental Policy Act (NEPA) documentation. The roE designated preferred site is the Lawrence Livern¥:>re National Laboratory (UNL), Livern¥:>re, California.

The mission of the National Inertial Confinanent Fusion (ICF) pr~am is to achieve controlled thenronuclear fusi'c;h in the laboratory. This program supports the roE mandate of m:lintaining nuclear weapons science expertise required for ster.olardship of the stockpile, testing of nuclear weapons effects, and the developrent of fusion p<:1.'ler by providing a database for inertial fusion ignition. As a key elanent of its Stockpile Ster.olardship Program to achieve these goals, the roE is proposing to construct the NIF which is designed to achieve ignition within two or three years of initial operation, propagating fusion bJrn, and Irodest (1-10) energy gain in accordance with the ICF experillEntal plan. This mission was identified in the NIF Justification of Mission Need, which was endorsed by the Secretary of Energy. Identification of target ignition as the next iIIportant step in ICF developrent for ooth defense and non-defense applications is consistent with the earlier (1990) recarmendation of roE's Fusion Policy Advisory Coomittee, and the National Academy of Sciences Inertial Fusion Review Group.

'!he NIF project supports tile roE m3.ndate to naintain nuclear weapons science expertise required for stewardship of tile stockPile. Since tile Hatfield Amendment to Public Law 102-377, Section 507, calls for tile end of underground testing in 1996, tile weapons laboratories will begin to lose tile ability to certify tile safety and reliability of this country's nuclear weapons. roE-DP has developed a stockpile stewardship program to respond to tile loss of tile underground testing capability. '!he NIF is one of tile JOOst vital facilities in that program. '!he NIF will provide tile capability to conduct laboratory experiments to address tile high energy densi ty and fusion aspects that are so important to ootil primaries and secondaries in stockpile weapons.

At present, the Nation I s computational capabilities and scientific knowledge are inadequate to ascertain all of the performance and safety impacts frcrn changes in the nuclear warhead physics packages due to aging, rananufacturing, or engineering and design alterations. Such changes are inevitable if the warheads in the stockpile are retained well into the next century, as expected. In the past, the impacts of such changes were evaluated through nuclear \oIeapon tests. Without undergro1.Uld tests, we will require better, more accurate comPUtational capabilities to assure the reliability and safety of the nuclear weapons stockpile for the indefinite future.

To achieve the fequired level of confidence in our predictive capability, it is essential that we have access to near-weapons conditio~ in laboratory experiments. The importance of nuclear weapons to our national security requires such confidence. For detonation of weapon primaries, that access is provided in part by hydrodynamic testing. For secondaries and for same aspects 0 prim3.ry performance, the NIF will be the principal laboratory experimental physics facility.

Title and Location of Project:

National Ignition Facility
Site To Be Determined (Continued)

2a. Project No. 96-0-111 2b. Construction Funded

Proiect Descriotion. Justification and SCODe (Continued)
Because of \-IOrld events and changes in nuclear weapons policy *I* there will already be at least a 5-year gap between the cessation of underground tests and the operation of the NIF. Other ICF facilities will have to be used W1til the NIF is o~rational, b..1t their capabilities will be largely exhausted by the end of this decade in terms of rraking new scientific headway on the il!portant problal1S facing the \'Ieapon analysis and weapon effects programs. .

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

The ignition of an inertial fusion capsule in the laboratory will produce extremely high temperatures and densities in matter. the NIF will also becoo-e a unique and valuable laboratory for experilrents relevant to a number of areas of basic science and technology .

Thus,

The NIF is an experimental fusion facility consisting of a laser and target area. and associated assembly and refurbishment facilities. 'nle laser will be capable of providing an outplt pulse with an energy of 1.8 megajoules (MJ) and an output pul.se power of 500 terawatts (TW) at a wavelength of 0.35 micrometers (~) and with specified symmetry, beam balance and pllse shape. Th~ NIF experimental facility will house a multibeam line, neodymium (Nd) glass laser capable of generating and delivering the pulse~ to a target chamber. In the target chamber, a positioner will center a target containing fusion fuel, a deuterium-tritium mixture, for each experiment. Diagnostics provided py this project will provide the test data to demonstrate SUbsystem performance and initial operations.

The NIF experimental facili~, titled the Laser and Target Area Building, will provide an optically stable and clean environment. This laser bolilding will be shielded for radiation confinanent around the target chamber and will be designed as a nonnuclear, low hazard facility capable of withstanding the natural phenomena specified for the host site. The baseline facility is for one target chamber, bolt the design shall not preclude future upgrade for additional target chambers. Optical assembly and refurbishment functionalit not housed within the Laser and Tar et Area Buildin are lar el rovided for b the 0 tics Assembly Buildina.

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Title and Location of Project

National Ignition Facility
Site To Be Detennined (Continued)

Proiect DescriDtion. Justification and Score (Continued)

The NIF project is broken down into conventional and special facilities. Integrated Cayputer Control Systan, and Optics.

2a. Project No. 96-0-111 2b. Construction Funded

special facilities include the Laser System, Target Area

Site and Conventional Facilities include the land ~rovements (e.g., grading, roads) and utilities (electricity of 58,000 megawatt- hours per year, heating gas at 40,900,000 megajoules per year or equivalent, water at 25,600,000 liters per year). The laser building *is* an approximately 16,000 square meters reinforced concrete and structural steel building that provides the vibration-free, shielded, and clean space for the installation of the laser, target area, and integrated control system. The las'er building consist~ of two laser bays, each 24 meters (m) Py 130 m long, and a central target area--a heavily shielded (1.8 m thick concrete) cylinder)C m *in* diameter and 29 m high. The laser building includes security systems, radioactive confinement and shielding, control roams, supporting *utilities,* fire protection, monitoring, and decontamination and waste handling areas. The oDtica1 assembly bui1dina is an a roximate1 2310 s uare meter reinforced steel and concrete buildin that royides the clean assembl and refurbishment ired for initial installation and 0 erational maintenance of the s ecial e ui ment assemblies,

Special Facilities:

The laser system will generate and deliver high power optical pulses to the target chamber. The system consists of 192 l~ser bearnlets configured to illuminate the target surface with a specified symnetry, unifonnity, and temporal pulse shape. The laser pulse originates in the pulse generation system. This precisely formatted low energy pulse is amplified in the main amplifier. To minimize intensity fluctuation, each beam is passed through a pinhole in a spatial filter on each of the four passes through the amplifier and through a transport spatial filter. The beam transport directs each high power laser beam to an array of ports distributed around the target chamber Where the frequency of the laser light is tripled to o. 35 ~, spatially modulated by phase plates and focused on the target. Systems are provided for autcm:itic control of alignrrent and the ~asuranent of the power and energy of the beam. Structural support and auxiliary systems provide the stable platfo~ and utilities required.

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

Title and Location of Project:

National Ignition Facility
Site To Be Detennined (Continued)

Pro;ect ~scriDtion. Justification and Scope (Continued)

2a. Project No. 96-0-111 2b. Construction Funded

The integrated c~ter control system includes the computer systems (note: no individual c~ter will cost over $100,000) required to control the laser and target systems. The system will provide the hardware and software necessary to support NIF operations. Also included is an integrated timing system for experimental control of laser and diagnostiG operations. Safety interlocks and access control will also be provided.

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

The DOE is undertaking a site selection process to determine the DOE-DP host site for the NIF. The current TEC includes the site, conventional and special facilities described above. The site infrastructure ~rovements to accommodate the NIF, such as e~tieal laGetateties, warehousing, fire stations, cafeterias, shops, etc., are not included. Much of this infrastructure is expected to exist at an adequate capacity to accommodate the NIF operations at most of the proposed DOE-DP sites. Any additional estimated costs for the infrastructure required at any particular site will be provided later, following the site selection process.

Title and Location of Project

National Ignition Facility
Site To Be Determined (Continued)

9. Details of Cost Estimate

2a. Project No. 96-0-111 2b. Construction Funded

Itan Co§t Total Cost

a. ~signandManagenentCosts ' $ 161,400
  1. Engineering, ~sign and Inspection at Approximately 16.6 Percent of Construction Costs, (Item C) $ 95,100
  2. Construction Management **at** approximately 2.2% of Construction Costs (Item C) 12,700
  3. Project Managenent at approximately 9.4 percent of Construction Costs (Item C) 53,600
b. LandandLandRights '. 0
c. Construction Costs 572,500
  1. rnprovarents to Land 1,800

2. Buildings Modification -laset =~il3L~~ ees&s ate $6,4QQ.'s~ ffi. 128,100
..
f'.
fTEDb
SJ.te-specJ. J.C J.n rastructure 3. Other Structures 0
4. Utilities 6,300
5. Special Facilities 436,300

d. Standard Equipment 700
e. Major Conputer Itens 0

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f. Raooval Cost Less Salvage 0 .
g. ~sign and Project Liaison, Testing, Checkout and Acceptance 0 SUbtotal. $ 734,600
h. Contingencies of Approximately 20.6 Percent of Above Costs 151,300
i. Total Line ItanCost (Section l2.a.1.(a) $885,900C j. Non-Federal Contrib.ltion 0 k. Net Federal Total Estimated Cost (TEC) $ 885,900

The cost estimate assumes a project organization and cost distribution consistent with the management requirements appropriate for a DOE Strategic System as outlined in the December 19, 1994, Draft Directive of DOE 4700.X, DOE Project Management System. Actual cos distribution will be in conformance with accounting guidelines in place at the time of project execution.

b Site-specific infrastructure costs will be deteumined after site selection. I~e~ ~~e ~~ site. ~~e ~~E~ast~~etUFe eests ~~';e 8e=-~ est=--:-.:.tea =.." ~~ te Be ab::"d.t $d& ~.:!.llieR.1
C Based on 100 percent conceptual design completion.

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Title and Location of Project:

Method of PerfonMnce

National Ignition Facility
Site To Be Determined (Continued)

2a. Project No. 96-0-111 2b. Construction Funded

Method of perfonTlance will vary slightly with the site selected by the roE. HC1Ilever, the n-ain approach will .be that the NIF Laboratory Project Office (consisting of LLNL, LANL, SNL, and UR/LLE and supported by competitively-selected contracts with Architect Engineering fintlS, a Construction Manager, equipnent and m:l.terial vendors, and construction fintlS) will prepare the design, procure equipnent and m:l.terials, and perform conventional construction, safety, system analysis, test, and operations. roE will m:l.intain oversight and coordination through the Headquarters Office of the National Ignition Facility and the field office. roE will conduct the site selection and the NEPA determination. LLNL has been designated as the preferred site. The procurement Qnd installation/test of special equipment will be performed by the NIF Laboratory Project Office. Inspection and Title III engineering contracts for the conventional systems will be competitively award~. NIF start-up will be conducted by the NIF laboratory operations staff.

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Title and Location of Project

National Ignition Facility
Site To Be Determined (Continued)

2a. Project No. 96-0-111 2b. Construction Funded

Schedule of Proiect F\mdinq and Other Related F\mdinq Reauiranents

a. Total Project Costs
1. Total Facility Costs
(a) Contruction line itan
(b) Expense funded equipnent
(c) Inventories
Total facility costs
2. Other Project Costs
(a) R&D necessary to complete construction (b) Conceptual Design
(c) Decontamination and Decamissioning (D&D) (d) NEPA documentation costs

(e) Other project related costs
Total Other Project Costs
Total Project Cost
(f) Non-Federal contrib.ltion
(g) Net Federal Total Project

Prior Years	FY 1996	FY 1997	FY 1998	Outyears	Total

$

$

$37,400

$ 49,500

$206,700

$592,300

$

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885,900

J 8,800 $ 43,900 : 38,400 $ 17,400 $ 108,500 12,000 250 ---12,250
2,100 1,200 500 600 1,200 5,600
4,100 7,950 4,800 4,800 85,000 106,650 -..
$ 18,200 $ 18,200 $ 49,200 $ 43,800 $103,600 $ 233,000 $ 18,200 $ 55,600 $ 98,700 $250,500 $ 695,900 $1,118,900
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18,200

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55,600

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$ 98,700

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250,500

$695,900

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Note:BARequirarents 'lB::d 0 37,400 131,900 227,800488,800
o~e 18,200 23,600 59,200 31,300 100,700

b. Related Annual Funding (estimated life of project--30 years)
1. Facility Operating Costs
2. Facility maintenance and repair costs
3. Programmatic operating ~es directed related to the facility
4. Capital equipment not related to construction, but related to the programmatic effort in the facility
5. GPP or other construction related to programmatic effort in the facility
6. Utility Costs
7. Other Costs
Total Related Annual F\mding

$ 22, 31, 55,
2,
.4 -,
$ 115,

885,900 233,000

200
BOO OOOf
200 200 300
QQQ.
700

d Specific long-lead procurements and contracts (e.g., ~ building construction; major laser, optics, and target area special equipment) require an. in advance of 00.
'Specific long-lead procurements and contracts (e.g., optics facilitization and pilot production) require an. in advance of BO.
t This prbrery experimental operating expense will be included in the rese Inertial Confinarent F\lSion Program budget.

Title and Location of Project:

National Ignition Facility
Site To Be Determined (Continued)

2a. Project No. 96-0-111 2b. Construction Funded

Narrative lanation of Total Pro' .and Other Related Flmdin R irenents

a.

Total Project F\1I1ding
1. Total Facili ty Costs " .
(a) Construction Line Item -Narrative not required. .
(b) Expense Funded Equiprent -None.
(c) Inventories -None.
2. Other Proj ect Costs ..
(a)R&D Necessary to Complete Construction -Costs include optics vendor facilitization ($60,300), pilot production (e.g., optics components) $20,900), component production prototyping ($6,900), target diagnostics ($12,500) not required to determine project subsystem performance for project acceptance, and pilot optics Quality Assurance ($7,900).
(b) Conceptual Design and ~gineering Studies -Narrative not required.
(c) Decontamination and Decatmissioning -None.
(d) NEPA Documentation -Preparation includes an ~vironmental Impact Statement ($3,200), environmental monitoring and pennits ($2,400) .
(e) Other Project Related Costs -~gineering studies (including advanced conceptual design) of project options ($6,950); assurances, safety analysis, and integration ($13,300); start-up planning, management, training, and staffing ($10,400); procedure preparation ($4,200); operating spares ($12,800); costs incurred during construction, installation, component and

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systems test and Checkout prior to Operational Readiness Review (ORR), electricity ($5,600), start-up ($37,300), argon, nitrogen, and building maintenance ($14,100) *;* and ORR ($2,000).
(f) Non-Federal Contribution -None.

b. Related Annual F\JI1ding
1. Facility Operating Costs -Includes operator labor, engineering support and materials for upgrades and modifications, and consumables for operation of special equipment.
2. Facility Maintenance and Repair Costs -Includes cost of labor, engineering support, and consumables for special equipment maintenance and refurbishment, including optics. Also includes maintenance for the laser wilding and support wildings.
3. The current OOVA experiIrental program, including LIM.., L.n.NL, SNL, and General Atanics, is approxiInately $37,000. Based on use of complex cryogenic targets,

increased diagnostics support, and higher levels of three dimensional physics modeling, the direct NIF experiIrental program costs are estimated at $55,000. Additional program costs will be associated with use of the facility.

4. Fabrication accounts, procurements, such as small lasers and same laser parts, Computer-Aided Design systems, etc. to support upgrades. "-
5. Mirlbr additions and modifications to the facility related to programmatic effort.
6. Electricity only. Gas, sewer, water, etc. are paid out of overhead included in labor rate tables.
7. Nitrogen and argon for laser and transport beam tubes, stock inventory, and procurement support.

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Title and Location of Project:

National Ignition Facility
Site To Be Determined (Continued)

Desiqn and Construction of Federal Facilities

2a. Project No. 96-0-111 2b. Construction Funded

The total estimated cost of this project includes, Where appropriate, the cost of measures necessary to assure compliance with OMB Circular No. A-106, and Executive Order No. 12088, "Federal Compliance with Pollution Control Standards"; Section 19 of the CX:cupational Safety and Health Act of 1970, the provisions of Executive Order No. 12196, and the related Safety and Health provisio~ for Federal Employees (CFR Title 29, Chapter XVII, Part 1960); and the Architectural Barriers Act of 1968." The project will be located in an area not subject to flooding determined in accordance with Executive Order 11988.

Supplementary pro;ect data for facility utilization

The NIF will provide new space and capacity
selected.

SUpplemental information on facili~ utilization will be provided after a site is

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f.

Attachment C

NIF -LLNL-93-058
L-15983-3

National Ignition Facility Functional Requirements and Primary Criteria

Revision 1.4

February 1996

NIF Functional Requirements and Primary Criteria
Approval Sheet

NIP Project Manager

NIF DOE Field Manager

Director, Office of the National Ignition Facility

Director, Office of Research and Inertial Fusion

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L-15983-3

1.0 Introduction

1.1 Objectives

This document establishes the scientific and engineering requirements that must be achieved by the National Ignition Facility (NIF). Mission goals, as defined in the Justification of Mission Need, are translated into laser power, laser beam characteristics, and other performance specifications. Top-level operability, safety, and environmental requirements are defined and discussed. Finally, key requirements that must be met to satisfy Department of Energy (DOE) Orders, state, and federal regulations, national consensus standards and preferred procedures are highlighted to help ensure that they are incorporated by the design teams.

1.2 Application

The Functional Requirements and Primary Criteria serves as a technical baseline for the project. Any modifications must be processed through the change control mechanism specified in the NIF Project Execution Plan and implementing procedures and formally approved. Each individual requirement or criterion has been placed in one of two hierarchy levels for control purposes. Those items which are Levell, Primary 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 NIP DOE Field Manager. The control of double-asterisk requirements may be delegated to the NIP DOE Field Manager at some point in the future 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 nonmandatory recommendation or goal.

1.4 Site-Specific Requirements

These requirements have been written for a generic site, such that NIF could be located at many different sites with only minor modifications. When a site selection is made, these requirements will be revised as necessary to include site-specific natural phenomena, environmental characteristics, and potential use of existing infrastructure,

facilities, and services. The two buildings required at all candidate sites are: Laser and Target Area Building (L TAB) and the Optics Assembly Building (GAB) as described in these criteria.

2.0 Mission-Related Requirements

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

2.1 Laser

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

2.1.2 Laser Pulse Peak Power*
The laser shall be capable of producing a pulse with peak power of at least 500 trillion watts (TW).

2.1.3 Laser Pulse Wavelength*
The wavelength of the laser pulse delivered to the target shall be 0.35 microns *(Jim).* The design should not preclude delivering 0.53 Jim and 1.05 J.lIn 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 (J!m) at the target plane or its equivalent.
2.1.6 Laser Pulse Duration
The laser shall be capable of producing a pulse with overall duration of up to 20 ns.

2.1.7 Laser Pulse Dynamic Range

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

2.1.8 Capsule Irradiation Symmetry

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

2.1.9 **Prepulse Power**

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

2.1.10 Laser Pulse Spot Size

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

2.1.11 Beam Smoothness

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

2.1.12 Direct-Drive Requirements*

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

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

2.1.13 Beam Focusing and Pointing

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

<u>Direct-drive cone Cone half-angle (approximate) Fraction of total beams</u>

Inner same as indirect drive 1/6 Outer same as indirect drive 1/3 Waist 75 degrees 1/2

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 assets, 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 Compatibility""

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

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

The NIF shall be capable of performing yield shots with total DT fusion yield of 1200 MJ /year. The NIF shall be capable of performing up to 50 shots per year with a routine DT fusion yield of 20 MJ.

2.2.3 Maximum Credible DT Fusion Yield*

The target chamber shall be designed based on routine DT fusion yield of 20 MJ *I* with the capability to withstand a DT fusion yield produced by a single shot of up to 45 MJ (a 45 MJ yield corresponds to 1.6 x 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. The facility shall also be designed to not preclude the contact of experiments at the Secure Compartmented Information (SCI) Facility level, per (ref. TBD), with the use of additional physical security measures.

2.2.5 Target Positioner

The target positioner shall 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 should be capable of conducting experiments with a time between shots of 4 hours for shots with no fusion yield.

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 Laser Performance

The facility shall have the following measurement capabilities that are required to verify the Primary Criteria and Functional Requirements:

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

2.2.9 Diagnostic Instrument Capabilities for Ignition and Applications Experiments

The target chamber and area shall be capable of accommodating diagnostic instruments for the following measurements necessary for fusion ignition and applications experiments:

.Symmetry of x-ray emission from imploded cores with 5- to 10-micron spatial resolution.
.Motion of the x-ray emitting volumes in hohlraums with 20 micron spatial resolution.
.Laser light backscattered into the focusing lens.
..Radiation flux out of hohlraums within the photon energy range 0.15-2.5 keY with 100-ps time resolution and 20% accuracy.

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

2.2.10 Removal and Replacement of Diagnostic Instruments*

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

2.2.11 Personnel Access Inside the Target Chamber*

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

2.2.12 Distributed Laser Plasma Radiation Source Compatibility*

The 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 NJF shall be designed, constructed, and operated as a radiological low-hazard, non-nuclear 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 10 CFR 830.110 Nuclear Safety Management, Safety Analysis Report, and DOE Order 5481.1B, Safety Analysis Review System). Administrative controls shall be established prior to CD3 to ensure that inventory limits for a radiological low-hazard, non-nuclear facility are not exceeded.

3.1 Radiation Protection*

Collective and individual ionizing radiation doses to the public from all exposure pathways from the NIF shall meet the requirements of DOE Order 5400.5, Radiation Protection of the Public and the Environment, and 40 CFR 61, National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities. These requirements state that exposure of members of the public from emissions of radionuclides in the ambient air from normal NIF operations shall remain below 10 mrem/y. The facility shall also meet the requirements of DOE Order 5400.5 [ICRP 60 S40 (1990 Recommendations of the International Commission on Radiological Protection), 10 CFR 20.1301.a.1 (Code of Federal Regulations-Standards for Protection Against Radiation)] to not cause the public dose limit from all exposure modes and all sources of NIP radiation at the site boundary to exceed 100 mrem/y.

The NIF personnel radiation protection program shall follow DOE Order N441.1 Protection for Radiological Activities, and 10 CFR 835, Occupational Radiation Protection. The ALARA (as low as reasonably achievable) principle shall be utilized in both design and operation of the facility to eliminate unnecessary radiation dose to workers in the Laser and Target Area Building, collocated employees, and visitors from both routine and off-normal operations. Radiation protection shall include: shielding; control of workplace ventilation; monitoring of personnel for external and internal radiation dose; establishment of a routine contamination monitoring program including air monitoring; and the proper containment of radiation and radioactive materials.

The radiation shielding design shall be more conservative than required by DOE Order 420.1, Facility Safety, in that maximum doses to an individual worker shall be limited to one- tenth (shielding design goal) of the occupational external dose limits specified in 10 CFR 835. Concrete shielding shall comply with ACI 301, which provides adequate strength for DBE loads.

The requirements for radiological safety in DOE Order 420.1, Facility Safety, should be evaluated by the designers and incorporated when they are determined to be cost effective, even though the projected inventory of tritium in NIF (-0.05 g or 500 Ci~ is well below the threshold for a nuclear facility. The target chamber and tritium processing systems shall form the primary confinement barrier. Leakage past these barriers shall be ALARA. The experimental-area ventilation system shall be designed to

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

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

3.2 **Life** Safety**

The NIF shall fully comply with the requirements for life safety contained in DOE Order 420.1, Facility Safety. Particular focus shall be directed towards features related to the means of egress, such as protection of vertical openings, travel distances, capacities, and emergency lighting.

3.3 ,Laser Safety*

The laser safety shall comply with ANSI Z136.1. Exposure to hazardous levels of laser light shall be prevented by the use of physical barriers, personnel training, interlocks, and personnel entry controls. Protective equipment, such as laser goggles, shall be used when necessary for operational purposes. Interlock systems shall be dedicated and designed to be fail-safe and shall activate laser shutters or shut off power to laser systems if access doors are opened and hazardous exposures are possible.

3.4 Industrial Hygiene and Occupational Safety*

Industrial hygiene and occupational safety shall comply with 29 CFR 1910 and DOE Order 440.1, Worker Protection Management for DOE Federal and Contractor Employees.

Construction safety shall comply with the requirements of 29 CFR 1926, OSHA and DOE Order 440.1, Worker Protection Management for DOE Federal and Contractor Employees.

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

3.5 **Fire Protection ***

The NIF shall meet the design and fire protection requirements of DOE Order 420.1, Facility Safety, and the Uniform Building Code (UBC). The structural members of the Experimental Building (including exterior walls, interior bearing walls, columns, floors, roofs, and supporting elements) shall, as a minimum, meet UBC fire-resistive standards. Appropriate fire barriers shall be provided to limit property damage, fire propagation, and loss of life by separating adjoining structures, isolating hazardous areas, and protecting egress paths. The NIF shall meet the requirements for an "improved risk" level of fire protection sufficient to attain DOE objectives. To achieve this level of protection, automatic fire sprinklers shall be installed throughout the complex. The sprinklers shall be coupled with adequate fire protection water supplies and automatic and manual means for detecting and reporting incipient fires. Fire hazard analyses will be completed as required by DOE Order 420.1.

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3.6 Robotic Systems Safety

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

4.0 Environmental Protection

4.1 Waste Management**

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

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

4.2 Effluents*

Liquid effluent discharges from NIF discharge points shall be monitored and controlled in compliance with 10 CFR 835, DOE Order 5400.5, Radiation Protection of the Public and the Environment; the Clean Water Act (33 V.S.C. 1251 et seq.); and by conditions on 40 CFR 125 Criteria and Standards for National Pollutant Discharge Elimination System.

Air emissions shall meet the requirements of Section 3.1 (radiation shielding and confinement) for radionuclides and the requirements of the Clean Air Act, (42 V.S.C. 7401) including National Emission Standards for Hazardous Air Pollutants (NESHAP), and state and local air quality management district requirements.

5.0 Safeguards and Security**

The NIF safeguards and security features shall meet the requirements of DOE Order 5632.1C, Protection of Safeguards and Security Interests, and DOE Order 470.1, Safeguards and Security Program. These requirements include physical protection of classified data and equipment and items in use and in storage. For the facility security areas and access control, requirements shall be established based on the nature of experiments (Le., classified or unclassified) being performed. The limited areas shall be the target area, target receiving and inspection, final target alignment, classified data acquisition, and office areas where classified computing is performed. Automated Data Processing (ADP) systems handling classified information shall meet the requirements of DOE Orders 5637.1, Classified Computer Security Program, and 5300.4D, Telecommunications: Protected Distribution Systems. Elements of DOE Orders 470.1, Safequards and Security

Program, and 472.1, Personnel Security Activities, will also be incorporated into the security plan.

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

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

6.0 Building Systems

6.1 Design Life Requirements

The L T AB and the Optics Assembly Building (OAB) represent the only newly constructed facilities common to all at each of the candidate sites. The NIP shall be designed for at least 30 years design life for permanent structures. Systems or portions of systems for which that is impractical shall be designed for ease of replacement. Ease *of* replacement means that replacement is feasible at reasonable cost and can be accomplished in a timely manner consistent with plant availability requirements. "Replacementll here also includes removal, refurbishment, and reinstallation of original equipment.

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

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

6.2 **Vibration Requirements**

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

6.3 **Cleanliness Requirements**

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

6.4 Temperature Control

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

Electrical Power

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

6.5.1 Voltage Quality

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

6.5.2 Standby Power

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

6.5.3 Uninterruptible Power

Uninterruptible power systems (UPS), are not required for the NIF 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 rapid recovery from unplanned shutdowns.

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, mean times between failures, mean times to repair, preventive maintenance requirements, etc. Techniques such as in-site backups, on-hand spares, modular components, on-call maintenance forces, and more robust designs shall be used to increase availability if the following goals cannot otherwise be achieved:

- The facility shall be available for three shift operations at least 253 days per year (73% availability).
- The facility shall be available for at least 616 no-yield target shots per year. To address, the possible future needs of direct-drive and other users, the design should not preclude an increase in the availability to approximately 1200 total shots per year.
- The 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.

Recovery Time*

Because of its importance to the DOE, the NIP shall be designed to survive any abnormal event, including accidents and natural phenomena, expected to occur more frequently than once in 5000 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
$1 > P \geq 10^{-2}$	1 week
$10^{-2} > P \geq 5 \times 10^{-4}$	3 months for laser, target, and associated building structures 6 months for support systems

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

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

8.0 Decontamination and Decommissioning

The NIF design shall meet the requirements of DOE Order 420.1 and site-specific requirements. The NIP shall be designed for periodic cleaning of the interior of the test chamber to maintain tritium levels on interior surfaces as low as reasonably achievable. The NIF design shall include considerations that will allow for cost-effective future decommissioning of the structures and equipment.

A plan for NIP Decontamination and Decommissioning (D&D) shall developed in accordance with DOE Order 5820.2A, Radioactive Waste Management, and DOE Order 420.1. A D&D assessment shall be made during conceptual design to ensure that features and measures are incorporated in NIP to simplify D&D. The NIP D&D plan will be prepared before the end of the Title I design.

9.0 Quality Assurance**

The NIF 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.

10.0 Orders, Codes, and Standards

DOE Orders*

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

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

10.2 Codes and Standards

Nationally recognized codes, standards, and guides should be utilized whenever available. A partial listing of these documents and the applicable revisions is included in the following sections. Additional references may be identified and formally added during the Conceptual and Title I design phases, with the list baselined at the end of Tittle I design. Updates and additions to the baselined list codes and standards after the completion of Title I design shall be approved through the Project Change Control Process.

Applicable Orders, Codes, and Standards

This section lists DOE Orders, codes, and standards considered applicable on March I, 1996. The listing begins with DOE and other federal regulations (e.g., Resource Conservation and Recovery Act), followed by national consensus standards, and finally other documents which establish facility requirements. The applicable portions of these documents will apply.

10.3.1 **DOE** Orders

.5300.4D **-**Telecommunications: Protected Distribution System .5400.1 **-**General Environmental Protection Program

.5400.5 **-**Radiation Protection of the Public and the Environment .5481.18 **-**Safety Analysis and Review System (for non**-**nuclear facilities and hazards only)

.5632.1C **-**Protection of Safequards and Security Interests

.5637.1**-** Classified Computer Security Program

.5700.6C **-**Quality Assurance

.5820.2A **-**Radioactive Waste Management

.151.1**-** Comprehensive Energy Management System

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420.1 **-**Facility Safety

430.1 **-**Life Cycle Asset Management

440.1 **-**Worker Protection Management for DOE Federal and Contractor Employees

N441.1**-** Protection for DOE Radiological Activities

P450.1 **-**Environment, Safety and Health Policy for the Department of Energy Complex

451.1 **-**National Environmental Policy Act Compliance Program

460.1**-** Packaging and Transportation Safety

470.1- Safeguards arid Security Program
471.1 -Information Security Program
472.1 -Personnel Security Activities

10.3.2 Other Government Regulations

.10 CFR 830.110 -Nuclear Safety Management, Safety Analysis Report .10 CFR 835 -Occupational Radiation Protection
.10 CFR 20 -Standards for Protection Against Radiation
.29 CFR 1910 -Occupational Safety and Health Act (OSHA) -Operation .29 CFR 1926 -Occupational Safety and Health Act (OSHA) -Construction .40 CFR 125 -Criteria and Standards for NPDES (National Pollutant Discharge Elimination System)
.40 CFR 260, 261, 262 -Hazardous Waste Management System
.40 CFR 61 Subpart H -National Emission Standard for Emissions of Radionuclides other than Radon from Department of Energy Facilities
.FED-STD-209E -Airborne Particulate Cleanliness Classes 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 order standards and codes listed as mandatory in DOE Orders are not referenced in this list.
.Air Movement and Control Association (AMCA):
-AMCA 211 -1994, Certified Program Air Performance
.American Concrete Institute (ACI):
-ACI 301-1996, Specifications for Structural Concrete for Buildings .American National Standards Institute (ANSI):
-ANSI B40.1-1991, Gauges-Pressure, Indicating Dial Type Elastic Element -ANSI MC96.1 -1982, Temperature Measurement Thermocouples -ANSI/IEEE STD 241-1991, IEEE Recommended Practice for Electric Power Systems in Commercial Buildings
-ANSI Z136.1-1993, Laser Safety
-ANSI C2 -1993, National Electric Code

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-ANSI C84.1-1989, Electrical Power Systems and Equipment-Voltage Rating (60HZ)
-ANSI/NFPA 110-1993, Standard for Emergency and Standby Power Systems -ANSI/RIA R15.06 -1992, Industrial Robots and Robot System-Safety Requirements
~erican Society for Testing and Materials (ASTM):
-ASTM C150 -1995, Standard Specification for Portland Cement
-ASTM C33 -1993, Standard Specification for Concrete Aggregates
-ASTM C94 -1994, Standard Specification for Ready-Mixed Concrete -ASTM C260 -1994, Standard Specification for Air-Entraining Admixtures -ASTM C494 -1992, Standard Specification for Chemical Admixtures for Concrete

-ASTM C618 -1994, Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
-ASTM A615 -1995, Standard Specification for Deformed and Plain Billet- Steel Bars for Concrete Reinforcement
-ASTM A416 -1994, Standard Specification for Steel Strand, Uncoated Seven- Wire Stress Relieved for Prestressed Concrete
-ASTM A36 -1994, Standard Specification for Structural Steel
-ASTM A307 -1994, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
-ASTM A325 -1994, Standard Specification for High Strength Bolts for Structural Steel Joints
-ASTM A449 -1993, Standard Specification for Quenched and Tempered Steel Bolts and Studs
-ASTM A490 -1993, Standard Specification for Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength
International Commission on Radiological Protection (ICRP):
-Publication 30 (methodology only) -Limits of Intakes of Radionuclides by Workers
-Publication 60 -1990 Recommendations of the International Commission on Radiological Protection
-Publications 61 -Annual Limits on intake of Radionuclides by Workers Based on the 1990 Recommendations
Instrument Society of America (ISA):
-ISA S5.1-1992, Instrument Symbols and Identification
-ISA-S50.1 -1992, Compatibility of Analog Signals for Electronic Industrial Process Instruments
UCRL 53526 Rev 1 -Natural Phenomena Hazards Modeling Project for Department of Energy Sites (1985)
UCRL 53582 Rev 1 -Natural Phenomena Hazards Modeling Project for Department of Energy Sites (1984)
DOE-STD-I020-94, Natural Phenomena Hazards Design and Evaluation Criteria for DOE Facilities
DOE-STD-I021-93, Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, & Components.

February 21, 1996

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Uniform Building Code (UBC) 1994
NFP A 72 1993, National Fire Alarm Code
NFPA 701996, National Electric Code
IEEE 493 1990, IEEE Recommended Practice for the Design of Industrial and Commercial Power Systems
NF.P A 1011994, Code for safety to Life from Fire in Buildings and Structures

February 21,1996

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The IcF .Coll11mlnity has reached thc scientific consensus that ~u1ts fi:'Om direct drivc experiments to ~ are sufficiently promisiDg so as to JUerit the serious consideration of direct drivc capability on. the NIP_Based on oar CUIT~ k.nowi~gc of direct drl'le physics, thc NJF". design should. allow tho implc:m.a1tation of a. direct drive capability at some point in time that .

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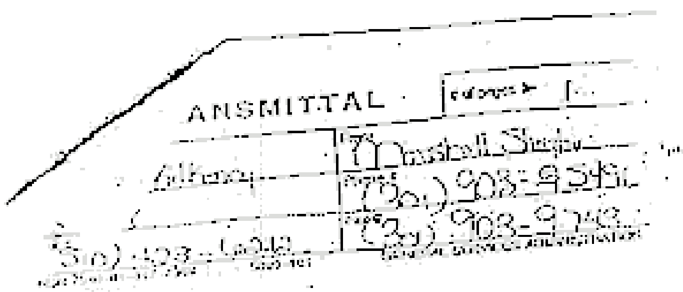
will be determined. Therefore, the Office of Research and Inertial Fusion (DP-11) formally requests by this memorandum that facility modifications necessary for the possible implementation of direct drive on NIF be incorporated in the NIF Title I design. A

.fomIal request to. fully Implement.a direct drive capability on the l:UF will be made jn the futurc based.
on upcoIDiD? 1asa" and ~get physics e:<pcriments:.

The inclusion of direct drive as a design option for the NIF will broaden the project mission (e.g., possible uses of the facility), and enhance the confidence in achieving ignition. This viewpoint was strongly and unanimously agreed to by all the ICF Program Directors at a ICF Program sponsored meeting at the University of Rochester on October 19-20, 1995.

Givetl; the proiDisiilg ot;Itlook for direct drive Im.d it:S in1po,rtance to the J <;F Progr:am and overall NIF-fi<:X1Dility. DP-ll hopes that. the qffice ofN:monal-IgIIition Eacility can accomritoCiat.e't9is t'ciluest. 1 look forward to working with you o~ this and other- appropriatc questions-regarding the d'esign of:NIf and its eventual use. Pl~ let me know if I can be of any [1.irthec: assiStance- -.' '



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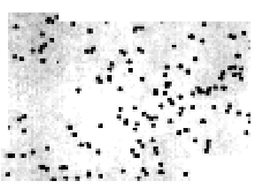

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Odonsc Nuclol1r Agency
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Dr. David It. Crantlall
Dir-eCtor
O£fi~e of National Ignition Facility
Department: *ot* Energy .
De£cnB~.Program9 -
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WaG~ington, D.C- 20585

Dear Dr- Crandall:

~or aome time, we have been following the Dep~ent of Energy (DOE) deve~o~ent p1an6 fo~ the National Iqnit~on Facility (NIP) in accordance uith our ongoing responsibility to provide adequate radiation teetlng capabil~~y for the Department of Defcnse (DOD). Ag part of this activity, we have participated in a joint DaD/DOE gtady~ to addres5 the utiL~ty of the NIF for meet~ng potential testing needB in the next d~cade. The DoD testing requirQmente in th~B period will depend upon a number of facto~9 that cannot be accurately predicted. In the face or thiG uncertain future, however, we bel~eve that the NIF can pro~ide a sLgnifLcant enhancemept o~er current And projected test c'apabil.~ty- The ab6.ence of unqerg~ound nuc1ear e£fectg testing makes the NIF even more important to the DoD for future hardneBB of deployed .cystemB ~d for hacdnes& validati?n of future systeme.

In view of this important nuclear effects testing oap~ility for the. future~ I am cequc~ting youc a.9Si9tance 1:0 ensure that the Title 1 Baseline NIF De:si.gn maintains ae much flexibility as possible to penn.it ~ broad.r4nge of effects t9sting that uould bQ useful for b9th the DaD and the DOE- Sevcral potentia1 effects testinq modif.ications have becn .identified as pa~ of the joint study. Thezc include provisions fo~:

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Thc increa6ed shot rate to accommodate the extra use1

Beam ~teer~ng to permit better utilization ~f the energy;

ExpQrLme~t~ with 1Q (red) light ~o provide bette~ radiation fidelLty for electroniC6 testing;

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e. Space And support "in the vLcintty of the teet chamber to accommodate experiment Get-up and calibration-

We recognize that thQ DoD and the DOE need6 for ef~ect6 tc9tinq in the next decade cannot be ~dequately predicted at thiG time- In view of tha~ and the severe budget rc~triction6 of both Department9, ~Q uould like to preserve the options *for* effecte tc~ting at the minimWII near term cozt --wherever'po~~ib1e deferring the expendtture tor the

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[1] Reference NIF NWET Report of May 1995

acquisition of hardware or build-out until the test requirements are better defined. Of course, certain things will have to be done during the initial construction in order to preserve the necessary capabilities for the future.

In deciding on the appropriate cost-effective options for NIF weapons effects testing, it is necessary to carry out additional engineering design studies above those that are required for the DOE Title I baseline design. However, these Nuclear Weapons Effects Testing (NWET) specific design studies must be closely connected to the DOE baseline work to have credibility and to ensure that the work is properly coordinated. In view of that, I am requesting that you expand your activities to include consideration of the NWET capabilities identified in the joint DoD/DOE study. While there is not much time before Title I change submission in early February, I hope that together we could do enough work to define the proper facility changes for preserving a useful and cost effective NWET capability as part of that submission. The Defense Nuclear Agency (DNA) will be glad to work with you in this endeavor and to provide support as would be mutually agreeable.

I would be pleased to discuss this further with you and I look forward to your positive response to this request.

GEORGE H.

ULLRrcu
Deputy Director

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cc:
Harshal~ Sluyter (DP-11) File