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NIF Functional Requirements and Primary Criteria Rev. 1.8

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NIF Functional Requirements and Primary Criteria

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NIF Functional Requirements and Primary Criteria
Rev. 1.8
Approval Sheet

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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.

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 Level 1, Primary Criteria, are marked with a single asterisk and are controlled by National Nuclear Security Agency (NNSA) Headquarters. Non-asterisked items are classified as Level 2, Functional Requirements, and are controlled by the NIF Federal Project Director.

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 non-mandatory recommendation or goal.

1.4 Site-Specific Requirements

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

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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 (μm). The design should not preclude delivering 0.53 μm and 1.05 μm 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 (μm) 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.

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2.1.8 Capsule Irradiation Symmetry

Variations in the x-ray energy deposited on the fusion capsule, located in the target hohlraum, should be ≤2% rms. Current target design and performance calculations indicate that this level of irradiation uniformity can be achieved by two-sided laser illumination of the hohlraum. Multiple laser beams on each side enter the hohlraum along two concentric cones with cone half-angles of approximately 27 degrees and 53 degrees, and with two-thirds of the beams on the outer cone and the remaining one-third on the inner cone. Each cone 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 Pre-Pulse Power

The laser intensity delivered to the target during the 20-ns interval prior to arrival of the main laser pulse shall not exceed 10^8 W/cm^2.

2.1.10 Laser Pulse Spot Size

Each beam shall deliver its design energy and power encircled in a 600 μm 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 μm 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 NIF design.

2.1.12.1 Direct-Drive Irradiation Symmetry

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

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

2.1.13 Beam Focusing and Pointing

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

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2.2 Experimental Area

The National Ignition Facility shall be operated in a manner consistent with its role as a national resource. Whenever possible, the design shall accommodate the requirements of users with diverse needs. The baseline facility design shall not preclude future addition of target chambers for additional weapons physics and/or radiation effects testing. The baseline design and operation should be capable of performing radiation effects testing of important national 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. The NIF design shall provide for life-cycle-cost-effective future addition of components that are needed only for high yield operations and are therefore not needed in the first one to two years of operations, such as shield doors, the Personnel and Environmental Protection Systems, and decontamination equipment.

2.2.3 Maximum Credible DT Fusion Yield*

The target chamber shall be designed based on routine DT fusion yield of 20 MJ, with the capability to withstand a DT fusion yield produced by a single shot of up to 45 MJ (a 45 MJ yield corresponds to 1.6×10^{19} neutrons).

2.2.4 Classification Level of Experiments*

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

2.2.5 Target Positioner

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

2.2.6 Time Between Shots with No Fusion Yield

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

2.2.7 Target Chamber Vacuum Capability

The target chamber shall be capable of achieving a vacuum level of $<1 \times 10^{-5}$ Torr.

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2.2.8 Diagnostic Instrument Capabilities to Verify Laser Performance

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

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

2.2.9 Diagnostic Instrument Capabilities for Ignition and Applications Experiments

The target chamber and area shall be capable of accommodating diagnostic instruments for the following measurements 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 keV 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 10^{11} to 10^{19} 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 keV or greater.
- Number and energy distribution of fast electrons in hohlraums in the band from 5 keV to 300 keV.
- 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.

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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.

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3.0 Safety Requirements

The NIF shall be designed, constructed, and operated as a radiological low-hazard facility. This classification shall be established through a Preliminary Hazard Analysis assessment of bounding accidents involving those radionuclides and/or chemicals presenting the most significant hazards. Administrative controls shall be established prior to the first use of tritium-bearing targets to ensure that inventory limits for a radiological low-hazard 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 to not cause the public dose from all exposure modes and all sources of radiation at the site boundary to exceed 100 mrem/y.

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

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

The requirements for radiological safety in 10 CFR 835, Occupational Radiation Protection, 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.

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3.2 Life Safety

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

3.3 Laser Safety*

The laser safety shall comply with 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 Occupational Safety and Health Act (OSHA) - Operation. Construction safety shall comply with the requirements of 29 CFR 1926, OSHA- Construction.

Facility subsystems (e.g., capacitor banks, vacuum systems, tritium recovery, nitrogen supply, 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, all NFPA Codes and the Uniform Building Code (UBC). The structural members of the Experimental Building (including exterior walls, interior bearing walls, columns, floors, roofs, and supporting elements) shall, as a minimum, meet UBC fire-resistive standards. Appropriate fire barriers shall be provided to limit property damage, fire propagation, and loss of life by separating adjoining structures, isolating hazardous areas, and protecting egress paths. The NIF shall meet the requirements for an "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 all NFPA Codes.

3.6 Robotic Systems Safety

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

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

4.2 Effluents*

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

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

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5.0 Safeguards and Security

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

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

Because the continuous operation of the 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.

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6.0 Building Systems

6.1 Design Life Requirements

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

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

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

6.2 Vibration Requirements

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

6.3 Cleanliness Requirements

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

6.4 Temperature Control

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

6.5 Electrical Power

Electric power shall be installed in accordance with NFPA 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.

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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 NFPA 101, the Life Safety Code; ANSI/NFPA 110-1993, the Standard for Emergency and Standby Power Systems; NFPA 72, National Fire Alarm Code; and other applicable NFPA and OSHA standards.

6.5.3 Uninterruptible Power

Uninterruptible power systems (UPS) are installed to ensure continuous operation of the oxygen monitoring system and the access control systems.

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7.0 Operational Availability

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

7.1 Reliability, Availability and Maintainability (RAM)*

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

- The facility shall be available for three shift operations at least 253 days per year (73% availability).
- The facility shall be available for at least 616 no-yield target shots per year. To address, the possible future needs of direct-drive and other users, the design should not preclude an increase in the availability to approximately 1200 total shots per year. The project shall provide the initial set of maintenance equipment, consisting of at least one unit of each piece of equipment that is required to maintain and operate NIF. Future addition of more units of maintenance equipment shall not be precluded. Continuous high-availability NIF operation, as defined above, may require future additional units of maintenance equipment.
- The lasers shall perform within specification (e.g., laser energy, beam balance, pointing accuracy) on at least 80% of all shots.

The project should also use this RAM process to determine how to achieve availability in the most cost-effective manner, to determine what spares in what quantities should be kept in inventory, to optimize turnaround procedures, 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 2000 years. The time required to recover from such events is allowed to vary in accordance with the probability of occurrence. Maximum recovery times are specified below.

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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-1020-94 and DOE-STD-1021-93 shall be utilized for natural phenomena.

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

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8.0 Decontamination and Decommissioning

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

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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 NIF Quality Assurance Program Plan and utilized throughout the project. The QA Program Plan shall cover all aspects of the NIF Project in a phased implementation, beginning with conceptual design.

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10.0 Orders, Codes, and Standards

10.1 DOE Orders*

The NIF shall be designed and constructed in full compliance with DOE Orders accepted as part of the Work Smart Standard process 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 Title II design. Updates and additions to DOE Orders and consensus standards will be evaluated for inclusion in the NIF specific Work Smart Standards (WSS) set and if accepted will apply to new construction or major renovations.

10.2 Codes and Standards

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

10.3 Applicable Orders, Codes, and Standards

.All operations, maintenance and construction activities occurring subsequent to the approval of revision OE of this document will be conducted in accordance with the LLNL WSS set defined in DOE-UC Contract ENG-48 or any subsequent LLNL management and operations contract. All design activities for designs that have not completed the preliminary design process (Title 1) prior to approval of revision OE of this document will be conducted in accordance with the LLNL WSS set. All documentation for the safety basis and operations will be based on the LLNL WSS set no later than the NIF Project Readiness Assessment.

10.3.1 DOE Orders

This section lists DOE Orders, codes, and standards that were in effect on March 1, 1996, that were applicable to the NIF Project and are the code of record for preliminary design.

- 1300.2A - Technical Standards Program
- 5300.4D - Telecommunications: Protected Distribution System

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- 5400.1 - General Environmental Protection Program
- 5400.5 - Radiation Protection of the Public and the Environment
- 5480.19 - Conduct of Operations
- 5481.1B - Safety Analysis and Review System (for non-nuclear facilities and hazards only)
- 5632.1C - Protection of Safeguards and Security Interests
- 5633.3B - Control and Accountability of Nuclear Material
- 5637.1 - Classified Computer Security Program
- 5700.6C - Quality Assurance
- 5820.2A - Radioactive Waste Management
- 151.1 - Comprehensive Emergency Management System
- 430.1 - Life Cycle Asset Management
- N441.2 - Radiological Protection for DOE Activities
- P450.1 - Environment, Safety and Health Policy for the Department of Energy Complex
- 470.1 - Safeguards and Security Program
- 471.2 - Information Security Program
- 472.1 - Personnel Security Activities

10.3.2 Other Government Regulations

- 10 CFR 835 -Occupational Radiation Protection
- 10 CFR 20 - Standards for Protection Against Radiation
- 29 CFR 1910 - Occupational Safety and Health Act (OSHA) - Operation
- 29 CFR 1926 - Occupational Safety and Health Act (OSHA) - Construction
- 40 CFR 125 - Criteria and Standards for NPDES (National Pollutant Discharge 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. - NEPA (National Environmental Policy Act)
- 40 USC 6901–6992 - Resource Conservation and Recovery Act (RCRA)
- 15 USC 2601–2692 - Toxic Substance Control Act

10.3.3 National Consensus Standards

The NIF Project shall comply with the following national consensus standards, as noted elsewhere in this document:

- ACI 301 - 1996, Specifications for Structural Concrete for Buildings
- ANSI C2 - 1993, National Electric Code
- ANSI C84.1 - 1989, Electrical Power Systems and Equipment—Voltage Rating (60 HZ)
- ANSI Z136.1 - 1993, Laser Safety

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- ANSI/RIA R15.06 - 1992, Industrial Robots and Robot System—Safety Requirements
- DOE-STD-1020-94, Natural Phenomena Hazards Design and Evaluation Criteria for DOE Facilities
- DOE-STD-1021-93, Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, & Components.
- IEEE 493 1990, IEEE Recommended Practice for the Design of Industrial and Commercial Power Systems
- All NFPA Codes
- NFPA 70 1996, National Electric Code
- NFPA 72 1993, National Fire Alarm Code
- NFPA 101 1994, Code for safety to Life from Fire in Buildings and Structures
- ANSI/NFPA 110-1993, Standard for Emergency and Standby Power Systems
- Uniform Building Code (UBC) 1994

Orders, standards, and codes listed as mandatory in DOE Orders are not necessarily referenced in this list.

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

AA	Aluminum Association
AASHTO	American Association of State Highway Officials
ABMA	American Boiler Manufacturers Association
ACI	American Concrete Institute
ACGIH	American Council of Government Industrial Hygienists
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AMCA	Air Movement and Control Association
ANSI	American National Standards Institute
APA	American Plywood Association
ARI	Air Conditioning and Refrigeration Institute
ARMA	Asphalt Roofing Manufacturers Association
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating & Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
BHMA	Builders Hardware Manufacturers Association

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CISCA	Ceiling and Interior Systems Contractors Association
CGA	Compressed Gas Association
CMAA	Crane Manufacturers Association of America
CRSI	Concrete Reinforcing Steel Institute
EPRI	Electric Power Research Institute
FM	Factory Mutual Engineering and Research
GA	Gypsum Association
ICBO	International Council of Building Officials (Uniform Building Code)
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society of North America
ISA	Instrument Society of America
NAPHCC	National Association of Plumbing, Heating, & Cooling Contractors
NCMA	National Concrete Masonry Association
NEC	National Electric Code (NFPA)
NEMA	National Electrical Manufacturers Association
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Technology
NFPA	National Fire Protection Standards
RFCI	Resilient Floor Covering Institute
SDI	Steel Deck Institute
SDI	Steel Door Institute
SMACNA	Sheet Metal & Air Conditioning Contractors National Association
SSPC	Steel Structures Painting Council
STI	Steel Tank Institute
SWI	Steel Window Institute
TCA	Tile Council of America
TIMA	Thermal Insulation Manufacturers Association
UL	Underwriters Laboratories

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11.0 Revision Record

Rev	Date	ECR #	BCP#	Description of/Reason for Change
1.3	3/94	n/a	n/a	CDR release
1.4	4/1/96	n/a	96-004	Directed changes in DOE Orders and Federal Regulations. Miscellaneous changes throughout document
1.4	4/1/96	n/a	96-005	Functionality Changes to the NIF Baseline. Changes include the addition of: optic assembly capability, beam smoothing, flashlamp cooling, 4x2 amplifiers, not-to-preclude direct drive, not-to-preclude radiation effects testing, and laser spot size.
1.4	4/1/96	n/a	96-006	Engineering Option Studies: increased shot rate and full implementation of direct drive.
1.5	12/18/96	80, 81	97-001 97-002	Title I Update of Functional Requirements/Primary Criteria. Changes to incorporate results of Title I design and design review, update of DOE Orders and standards, and miscellaneous changes
1.6	2/13/97	96	97-003	Typographical changes and minor wording changes to reflect completion of ROD and final incorporation of Necessary and Sufficient Standards
1.7	6/30/05	N/A	05-001	Changes to reflect the NIF specific Work Smart Standards as the applicable standards for future construction and operations. Removes specific reference to DOE Safeguards and Security (S&S) orders to reflect current practice of compliance with LLNL accepted S&S Orders. Retains the 1996 necessary and sufficient standards for historical record as the code of record for Title I design.
1.8	9/25/06	XX	06-002	Changes Section 10.3 such that all operations and construction activities occurring subsequent to this revision will be in accordance with the LLNL Work Smart Standard (WSS) set. All design activities which have not completed the preliminary design process will be conducted in accordance with the LLNL WSS set.

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