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**National Ignition Facility
System Design Requirements
Conventional Facilities
SDR001**

J. Hands

April 9, 1996

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National Ignition Facility
System Design Requirements
Conventional Facilities

SDR001

Revision A
April 9, 1996

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1 . Introduction

NIF Project Control Procedure 6.1 (Preparation and Revision of System Design Requirements; NIF-LLNL-93-251, L-16551-2) establishes the methods and responsibilities for identifying, preparing, approving, and revising the NIF System Design Requirements (SDRs).

SDRs contain verifiable engineering design requirements that flow down from higher level NIF requirements, DOE orders, and other applicable codes, standards and regulations.

1.01. Mission

The National Ignition Facility (NIF) will be a key element in the Department of Energy's Defense Programs aboveground experimental (AGEX) capabilities for maintaining nuclear competence and weapons effects simulation. The primary mission of the NIF Project will be to demonstrate fusion ignition in the laboratory. The most immediate application of the NIF will be to provide nuclear-weapon-related physics data, since many phenomena occurring on the laboratory scale are similar and relevant to those occurring in weapons. The NIF may also provide an important capability for weapons effects simulation. The second purpose for the NIF is to achieve propagating fusion burn and modest energy gain for development as a source of civilian energy, as stated in the NIF Justification of Mission Need which was endorsed by the Secretary of Energy, the DOE's Fusion Policy Advisory Committee, and the National Academy of Sciences Inertial Fusion Review Group.

The following are the potential sites for the NIF:

- Lawrence Livermore National Laboratory,
- Los Alamos National Laboratory,
- Sandia National Laboratory/New Mexico,
- Nevada Test Site,
- North Las Vegas.

1.02. Scope

This System Design Requirements (SDR) document specifies the functions to be performed and the minimum design requirements for the National Ignition Facility (NIF) site infrastructure and conventional facilities. These consist of the physical site and buildings necessary to house the laser, target chamber, target preparation areas, optics support, and ancillary functions.

The site and buildings described in this SDR are generic in nature and are not site-specific. Rather, they are the minimum facilities needed to support the NIF activities. Even though the actual NIF site may contain a mixture of new and existing facilities, this SDR will address all of the requirements as new facilities. There will be some instances such as seismic requirements in which specific criteria have been selected to allow for consistent facility description and cost estimating.

The conventional facilities element of the WBS provides the buildings and site infrastructure for the NIF Project. These buildings house the laser system and the target area as well as the additional facilities necessary to support operation and maintenance activities. These additional facilities include subsystem assembly areas, optics refurbishment facilities, machine shops, target receiving and inspection facilities, office space, and other general-use space necessary to support the project staff during both construction and operation. Site infrastructure must provide electric power, communication, water, sewage, and cooling services for all project facilities. Standard building utilities will be distributed for convenient access to project special equipment areas. These utilities include the standard services plus monitoring systems, environmental control, and safeguards and security systems.

1.02.01. Requirements Hierarchy

There are four levels of design requirements for the NIF project:

- Level 1: Primary Criteria;
- Level 2: Functional Requirements;
- Level 3: System Design Requirements;
- Level 4: Interface Control Documents and other requirements.

Each criteria level is consistent with the requirements of the next higher (lower numbered) level criteria. Level 1 and 2 requirements establish the fundamental performance and design objectives for the NIF project. They flow down to the System Design Requirements documents which comprise the Level 3 requirements. Each requirement within an SDR is traceable to one or more higher level requirements or a requirement in another SDR.

There are five SDRs:

SDR 001	Conventional Facilities	WBS 1.2
SDR 002	Laser System	WBS 1.3, 1.4, 1.6, 1.7, 1.8
SDR 003	Target Area	WBS 1.8
SDR 004	Integrated Computer Controls	WBS 1.5
SDR 005	Optics	WBS 1.6

There are four Subsystem Design Requirements (SSDRs) under SDR001:

SSDR 1.1	Site Improvements	WBS 1.2.1
SSDR 1.2	Laser and Target Area Building (LTAB)	WBS 1.2.2.1
SSDR 1.3	Optics Assembly Building (OAB)	WBS 1.2.2.3
SSDR 1.4	Support Facilities	WBS 1.2.3

1.02.02. Definitions

Parent Req't:

The paragraph number(s) in the Functional Requirements and Primary Criteria from which the requirement in the present document is derived. Requirements may have multiple parents. It is useful to identify the important parents in order to be able to determine what lower requirements are affected by a change at a higher level.

Supporting Document:

A supporting document such as an analysis which may be needed to generate the present requirement from the parent requirement. For example: a staffing study to determine the number of personnel required. Not all requirements have Supporting Documents.

Related Req't:

Other SDRs which either affect the requirement or are affected by the requirement.

Owner:

The project member who is responsible for assuring that the requirement is accurate and for verification that the project satisfies the requirement.

Verification:

How the project will show that the requirement has been met or exceeded.

Applies to:

The types of systems which are primarily affected by the requirement. (Performance; Optics; Mechanical; Electrical; Instrumentation and Control; Reliability, Availability and Maintainability; Environmental Safety and Health; Target Physics; and Other (specify in Comments)).

Shall:

This denotes a requirement that is mandatory and must be met.

Should:

This denotes a non-mandatory recommendation or goal.

1.02.03. Revising SDR

SDRs are controlled by the Level 3 Change Control Board and the NIF Project Manager. The process for changing or revising SDRs is defined by NIF Project Control Procedure 6.1: Preparation and Revision of System Design Requirements (NIF-LLNL-93-251, L-16551-2).

2 .System Definition

The NIF site includes a centrally located experimental facility (LTAB and OAB) and multiple supporting facilities. This Conventional Facility SDR document contains the design requirements for all of these facilities and the site improvements necessary to accommodate them.

The conventional facility subsystem provides

- 1) All site infrastructure, including roadways, parking, and pathways, and
- 2) Utilities to support operations, such as sanitary sewers, storm drains, potable water, cooling water, natural gas and compressed air, and distributed electrical/communication systems.
- 3) Experimental facilities housing target and laser operations and providing areas for diagnostics, a control room, hazardous packaging, decontamination, maintenance, capacitor banks, and tritium recovery. For the purpose of this SDR, the special optics processing facilities are also categorized as experimental facilities.
- 4) Supporting facilities providing sufficient area to accommodate offices, target receiving and inspection, general assembly, electrical/mechanical assembly and fabrication, warehousing, shipping, receiving and inspection, medical facilities, a cafeteria, garage and gas station, fire station, and security and badging.

The SDRs identify space requirements, environmental conditions (temperature, humidity, cleanliness, etc.) lighting, electrical, and other special requirements needed by these areas.

2.01. System Description

NIF is projected to occupy approximately 0.20 sq.-km. A representative layout of the anticipated functional areas is shown below.

The NIF experimental facilities will include the Laser and Target Area Building (LAB) and the Optics Assembly Building (OAB).

In addition to the experimental facilities, the NIF requires site infrastructure and support facilities including:

- Site-wide utilities such as process cooling, electrical power, storm drains, sewers, etc.
- Offices.
- Target receiving and inspection.
- Component and system assembly areas.
- Storage.
- Site services such as medical, fire protection, cafeteria, security, etc.
- Other conventional infrastructure such as roads, parking, walkways, secure perimeter, etc.

SITE PLAN - CONCEPTUAL

29RJF/dam
Fig 5.1-1 (240)

2.02. System Interfaces

The Conventional Facilities will have the following interfaces with the NIF site:

- Electrical power,
- Fire water,
- Potable water,
- Cooling tower water,
- Sanitary sewer,
- Storm drainage,
- Process gas,
- Security systems,
- Emergency systems, and
- Hazardous waste management.

The LTAB will interface with the following special equipment:

Laser (SDR 002)

- Laser Structures (WBS 1.4.3)
- Laser Alignment Systems (WBS 1.7.1)
- Amplifier Power Conditioning (WBS 1.3.4)
- Pockels Cell (WBS 1.3.3)
- Spatial Filters (WBS 1.4.1)
- Final Optics (WBS 1.8.7)
- Beam Diagnostics (WBS 1.7.2)

Target Area (SDR 003)

- Target Area Structures (WBS 1.8.4)
- Target Diagnostics (WBS 1.8.3)
- Environmental Protection Systems (WBS 1.8.5)
- Target Area Auxiliary Systems (WBS 1.8.6)

Integrated Computer Controls Systems (SDR 004)

- Horizontal and vertical mounts for the Target Chamber,
- Optical component mountings,
- Electrical supplies and grounding,
- Capacitor bank power supplies,
- Diagnostics,
- Environmental Protection System.

The OAB will interface with the following special equipment:

Laser (SDR 002)

- Pockels Cell (WBS 1.3.3)
- Spatial Filters (WBS 1.4.1)
- Final Optics (WBS 1.8.7)

Optics (SDR 005)

2.03. Major Subsystems

The Conventional Facilities include:

Site Improvements

- Secure Perimeter
- Roads, Parking and Walkways
- Utilities, Sewage and Drainage

Experimental Facilities

- Laser and Target Area Building (LTAB)
- Optics Assembly Building (OAB)

Support Facilities

- Office Building
- Target Receiving and Inspection Building
- General Assembly Building
- Electro-Mechanical Shop
- Warehouse (General Storage)
- Shipping, Receiving and General Stores
- Medical Facility
- Cafeteria
- Gas Station and Garage
- Fire Station
- Security and Badging

2.03.01. Site Improvements

The site improvements provide for all of the following functions:

- Site grading and landscaping;

- Roads, parking and walkways for NIF facilities;

- NIF-specific mechanical infrastructure:

- sanitary sewage,
  - storm drains,
  - potable water,
  - process cooling water,
  - heating fuel;

- NIF-specific electrical distribution and communication systems:

- high voltage distribution,
  - area substations,
  - telephone system,
  - computer networks for classified and unclassified data,
  - site lighting for roads, parking and pathways.

2.03.01.01. Secure Perimeter

The NIF site will have security features, including a secure perimeter, to meet the requirements for physical protection, protection of vital equipment, and classified equipment and information according to the requirements in this SDR.

Site access/egress will be at two points, both gated and guarded, with one entry/exit being the primary contact with the LTAB facility and containing badging as well as security functions. The other entry/exit is provided for material deliveries.

A significant portion of the NIF site will be considered an open area; visitors to these areas will be required to enter through the badge office where they will be assigned a badge for access.

2.03.01.02. Roads, Parking and Walkways

Site planning principles include separation of vehicular and pedestrian traffic, use of service roads to minimize cross traffic, and separate employee/visitor and service entrances to the site. All roads and service areas should be designed with sufficient turning radii to accommodate the large trucks accessing loading docks and service entrances at each facility.

Designated employee parking lots should be strategically located throughout the site. Location should be based on building occupancy, proximity to the workplace and functional requirements. Each parking lot should have clear access to a pedestrian path system efficiently directing individuals to their work areas. Visitor parking that is separate from employee parking lots will be landscaped with trees and shrubs to complement the architecture, present an appropriate public image to visitors, and provide a pleasing and productive work environment.

Main access roads serving the LTAB and the stores and warehouse buildings should be designed for heavy highway truck loads, such as liquid nitrogen delivery. The balance of the road and traffic system should be designed for standard trucks. The roadway system should include a perimeter road for both security and enhanced traffic flow.

The main employee and visitor parking areas are located near the office building and the technical support facilities. The visitor entrance will be through the security and badging facility where parking and access to the office building and LTAB is provided. The site has parking stalls for 420 vehicles distributed throughout the area. Handicapped, visitor, and government vehicle parking is provided and will be identified.

2.03.01.03. Utilities, Sewage and Drainage

The sewage system will be comprised of gravity service lines to feed to the host site system. No treatment facilities are contemplated as a part of the NIF site.

The site will also include storm drainage. The generic site is considered to have a 1-1/2% fall from one side to the opposite side where connections will be made to the host site system. The storm drainage system provides curb inlets or catch basins along all roadways and for all parking lots. Roof drains will connect to the storm drainage system.

2.03.02. Experimental Facilities

The experimental facilities consist of the Laser and Target Area Building (LTAB), the Optics Assembly Building (OAB), and the Diagnostics Building.

2.03.02.01. Laser and Target Area Building (LTAB)

The LTAB is the major structure of the NIF complex which contains the experimental hardware, control systems, and diagnostics.

The Laser and Target Area Building consists of three main parts: the Laser Building (WBS 1.2.2.1), the Target Area Building (WBS 1.2.2.2), and the Diagnostics Building.

The LTAB will provide a thermally and vibrationally stable environment.

The conventional portions of the LTAB can be categorized as follows:

- Foundation,
- Structure,
- Superstructure,
- Enclosure,
- Interior Finishes, and
- Special Mechanical and Electrical Equipment and Construction.

The primary design requirements on the foundation, structure, and superstructure are to reduce vibration as much as possible and to survive the specified seismic events.

The enclosure will be selected to meet the environmental conditions at the selected site and to provide an aesthetically pleasing appearance for the life of the facility. Exterior walls will withstand the ambient environment, including wind loads.

The interior finishes will provide an aesthetic, functional and safe surrounding for the staff and visitors. Many of the interior walls will be fire rated to meet the fire protection requirements. Some of the walls will have sound transmission requirements.

The building will include clean areas, decontamination and waste processing equipment, HVAC equipment which will provide a thermally-stable and pressure-controlled environment, and material handling equipment including bridge cranes and elevators. Portions of the structure will meet requirements for confinement of ionizing radiation and emissions. The building also has special electrical supply and grounding requirements and requirements related to electromagnetic interference. Vibration isolation will be provided for all motors/generators and transformers rated at more than 100 kVA.

The LTAB will include:

- Fire detection and alarm system,
- Evacuation voice alarm system,
- Telephone and computer networking system, and
- Intrusion detection system.

There will be safety interlocks on:

- Master Oscillator Room,
- Capacitor rooms,
- Laser Bays,
- Target Room,
- Optical Switchyard, and
- any other areas where hazardous laser energy or extremely hazardous electrical energy may be present.

Access control will be provided on the above mentioned areas and the Classified Control Room.

The LTAB will be an "industrial" occupancy as defined in NFPA 101-LSC (Life Safety Code). The Uniform Building Code occupancy classification for the LTAB is primarily Group B (Laboratories -

Testing and Research). Construction will be Type II per NFPA 220.

Because of the high value of the LTAB equipment, the building will incorporate features to limit the total potential fire loss to the monetary limits in the Fire Protection section of this SDR.

2.03.02.01.01. Laser Building

The Laser Building houses the laser system from the capacitors which power the laser to the spatial filter. The capacitors are located in four bays, the laser is located in two bays.

The building also houses the Operations Support Area (which contains the control rooms, the Master Oscillator Room, etc.), mechanical equipment (such as HVAC), and visitor facilities.

2.03.02.01.01.01. Laser Bays

Each Laser Bay houses half of the total number of laser beams, beginning with the Preamplifier Modules and extending to and including the Transport Spatial Filters. The portions of the laser beams prior to the Preamplifier Modules (i.e., the initial portions of the Optical Pulse Generation system) are located in the Master Oscillator Room in the Operations Support Area. The portions of the laser beam after the Transport Spatial Filters are located in the Target Building.

The Laser Bays provide a controlled and stable environment for the laser. The laser requires precise thermal and vibration control and a clean environment.

2.03.02.01.01.02. Capacitor Banks

The laser amplifiers are powered by large capacitors which are located in four banks. Each of the banks is located near the amplifiers to reduce the length of the electrical transmission line between the capacitor and the amplifiers.

The walls of the capacitor banks provide mechanical shielding to contain any projectiles which may be produced should a capacitor explode.

The banks are located on ground level to provide access for removal and replacement of the capacitors.

The capacitor banks are not clean areas.

2.03.02.01.01.03. Operations Support Area

The Operations Support Area contains:

- Control Room
- Classified Control and Data Room
- Master Oscillator Room
- Operations Planning Room
- Computer Room
- LTAB Offices
- Document Library
- Conference Room
- Security System Area
- Technical Maintenance Areas
- Restrooms
- Custodial Room

2.03.02.01.01.04. Visitor Facilities

Areas will be provided to allow visitors to view a Laser Bay, a Switchyard, and the interior of the Target Bay.

2.03.02.01.01.05. Mechanical Equipment

The Laser Building includes the following types of mechanical equipment:

- Elevators for personnel and equipment
- Bridge cranes in the laser bays
- Compressed gas and liquified nitrogen systems
- Cooling water system
- Vacuum systems
- HVAC systems
- Vibration isolation features

2.03.02.01.01.05.01. Mechanical Equipment Bay

The Laser Building HVAC systems will be housed in a mechanical equipment bay which will be vibrationally isolated from the Laser Bay slab.

2.03.02.01.02. Target Area Building

The Target Area Building is divided into the Target Area, and the Switchyard(s). Thermal and vibrational stability are provided in the Switchyards and Target Bay. The Target Area Building is a clean area.

The Target Area Building provides secondary confinement of the ionizing radiation and emissions which are produced by some of the shots.

2.03.02.01.02.01. Target Bay

The Target Bay is housed within the Target Area Building and contains the Target Chamber. The walls and roof of the Target Bay (along with the Target Chamber) provide the primary confinement of prompt and residual radioactivity which are produced by some of the shots. The room also provides personnel access to the components within the room.

The Target Bay requires a thermally- and vibrationally-stable and clean environment.

Because of the potential for air activation during high-yield experiments, the Target Bay HVAC system will be isolated and will generate a negative pressure in the Target Bay prior to and after high yield shots to confine activated air components and allow them to decay prior to release. The exhaust release point must be elevated above the highest point of the building.

The Target Bay is connected to a decontamination area which contains the Environmental Protection Systems which are used to process contaminated material and components.

Discharge water from fire suppression activity in the Target Bay must be collected for treatment and disposal. The Target Bay will serve as the collection reservoir.

2.03.02.01.02.02.Switchyards

The Switchyards contain the mirrors used to route the laser beams to the appropriate ports in the walls of the Target Bay. They also include some of the laser and target diagnostics.

Many of the components in the Switchyards require a thermally- and vibrationally-stable environment.

The Switchyard (Target Area Building) walls and roof must be sufficiently thick to provide adequate shielding against prompt radiation.

The Switchyards are clean areas.

2.03.02.01.03.Target Diagnostics Building

The Target Diagnostics Building contains laboratory space for support of target diagnostics activities such as diagnostic assembly and calibration.

The building houses some of the target diagnostics and is capable of being modified to allow some future diagnostics.

The building also houses a target diagnostics data acquisition area which provides safeguard and security for up to and including SRD data

The basement of the building includes a decontamination area, a hot cell (where radiated components are temporarily stored to allow the radioactivity to decay immediately after extraction from the target chamber and prior to further processing and decontamination), and the Environmental Protection System. This system provides for processing and decontamination of components and effluents. It also includes the effluent monitors.

The Diagnostic Building includes the target receiving and installation area, which is where targets are delivered to the LTAB and processed for installation in the target chamber.

The building also includes staging areas for components and equipment.

The Diagnostic Building includes an elevator for personnel and equipment, a tank farm which includes liquid nitrogen and carbon dioxide and holding tanks for the Environmental Protection System effluents and waste water, and HVAC systems.

The basement of the building will be accessible by standard semi-tractor trailers,

2.03.02.01.04.Environmental Control

The laser, optics, and target have stringent stability requirements. To meet these requirements, the LTAB must provide precise temperature control and an extremely low level of vibration and acoustic noise.

2.03.02.01.05.Clean Areas

The following LTAB areas contain optics which require clean areas:

Laser Bay
Switchyards
Target Bay.

2.03.02.03. Optics Assembly Building

The specific functionality to be included in the Optic Assembly Building (OAB) is TBD.

For reference, the total anticipated NIF need for optic processing functionality is described in the following paragraphs. This description assumes that all this functionality is included in the OAB. This assumption is presently being re-assessed, and the optimum distribution of the total functionality between the OAB and other support facilities is TBD.

The Optics Assembly Building will have adequate Class 100 cleanroom space to assemble the cavity mirrors, transport mirrors, polarizers, spatial filter lens assemblies, Pockels cells, amplifiers, final optics assemblies and interstage and beam transport systems. The Facility must have adequate capacity to clean the ~600 parts/day required to meet the 24 month assembly schedule. Mechanical components will be cleaned to a level of less than .2 particles/cm² greater than 5 microns in size.

Mechanical components will progress from the receiving area, through the cleaning facility to the assembly area. Cleaned optics components will be transported from another facility to the optics assembly building loading dock, and then will progress from the receiving area directly into the assembly area. Cleaned, aligned optical assemblies will be transported to the LTAB for installation into the National Ignition Facility.

The major features of the facility are:

- Loading Dock for receiving components
- Class 10,000 cleanroom for pre-cleaning
- Class 1000 cleanroom for optical and mechanical cleaning systems
- Class 100 cleanroom for assembly of components
- Clean area connecting corridor
- Temperature control to 20°C±0.28°C in the optics assembly building

2.03.03. Support Facilities

Operation of the NIF will require support facilities including:

- Office Building
- Target Receiving and Inspection Building
- General Assembly Building
- Electro-Mechanical Shop
- Warehouse (General Storage)
- Shipping, Receiving and General Stores
- Medical Facility
- Cafeteria
- Gas Station and Garage
- Fire Station
- Security and Badging

2.03.03.01. Office Building

The Office Building provides:

- Offices for permanent technical staff and visiting scientists;
- Conference rooms;
- Library;
- Computer facilities;
- Drafting facilities; and
- Physical Security including Limited-areas and Access Control.

2.03.03.02. Target Receiving and Inspection Building

The Target Receiving and Inspection Building provides:

- Clean areas and inspection laboratories for receiving and inspecting NIF targets;
- Vibration-controlled environment;
- Temperature- and humidity-controlled environment;
- Cryogenic laboratories;
- Central chemical waste system; and
- Limited-area security controls.

This building will process up to (335) tritium targets annually.

2.03.03.03. General Assembly Building

The General Assembly Building will be used for assembly mechanical and electrical components.

It will include:

- Industrial-quality space,
- Material handling equipment for large mechanical structures,
- Assembly welding area, and
- Local exhaust and ventilation systems.

2.03.03.04. Electro-Mechanical Shop

The Electro-Mechanical Shop will include:

- Machine tools for fabricating components,
- Electrical component fabrication and testing area, and
- Local exhaust and ventilation systems.

2.03.03.05. Warehouse (General Storage)

The Warehouse will provide:

- Bulk storage of NIF components, equipment and supplies,
- Loading docks,
- Fork Lift access,
- Roll-up doors, and
- Storage cabinets and shelving.

2.03.03.06. Shipping, Receiving and General Stores

The Shipping, Receiving and General Stores will be used for receipt and shipment of materials, equipment and supplies.

It will provide:

- Storage and distribution.
- Loading docks.
- Fork Lift access.
- Large doors.
- Storage cabinets and shelving.

2.03.03.07. Medical Facility

The Medical Facility will provide the following:

- Medical offices.
- Emergency services.
- Dispensary.
- Decontamination.
- Examination and therapy areas.

It shall be able to handle the following types of conditions:

- radiation contamination,
- basic life-support, and
- minor injuries.

2.03.03.08. Cafeteria

An on-site cafeteria will provide food service, preparation and storage, for staff and visitors.

2.03.03.09. Garage and Gas Station

The Garage and Gas Station will support the NIF vehicles. It will include:

- Garage for routine light maintenance and repair.
- Refueling, and cleaning of plant vehicles and heavy equipment.
- Gasoline, diesel.

2.03.03.10. Fire Station

An on-site fire station will provide primary response to NIF emergencies. The station will have:

- Fire and emergency personnel and equipment.
- Response capabilities for hazardous material incidents.
- Emergency communications both on-site and to off-site agencies.
- Living quarters for on-duty personnel and training facilities.

2.03.03.11. Security and Badging

The NIF site-security will be based in this building. It will be used for:

- Site security administration.
- Badging of personnel.
- Site access control

3. System Design Requirements

This section contains the design requirements which shall be used for all of the NIF facilities conventional facilities.

3.01.Applicability to Site

These requirements have been written for a generic site, such that NIF could be located at any of the five candidate sites with only minor modifications.

As a goal, the project should evaluate the conditions (environmental, soil, etc.) at each of the candidate sites.

Where there is negligible cost increase, the design shall be compatible with as many of the potential sites as possible.

Where compatibility with more than one site results in a significant cost increase, the NIF conventional facilities may be designed for the preferred site (because it represents the most stressing seismic environment). Title II designs shall be for the specific site which is selected.

3.01.01.Updating Requirements after Site Selection

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.

3.02.Design Lifetime

All new permanent construction for NIF shall be designed for at least a 30 year design life.

3.02.01.Ease of Replacement

Systems or portions of systems for which a 30 year design life is impractical shall be designed for ease of replacement, meaning replacement can be accomplished in a timely manner, at reasonable cost, and consistent with facility availability requirements. Replacement includes removal, refurbishment, and reinstallation of original equipment.

3.02.02.Design Life of Existing Facilities

The design life for the modification and use of existing facilities, or the use of existing facilities without modification, shall be evaluated on a case-by-case basis after final site selection.

3.02.03.Facility Survival

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.

3.02.03.01.Performance Class

The LTAB shall be designed and constructed per performance class 2 (PC-2) as defined in DOE-STD-1020-94 (Natural Phenomena Hazards Design and Evaluation Criteria for DOE Facilities) and DOE-STD-1021-93.

Other facilities shall use a graded approach.

3.02.03.02.Probability of Natural Phenomena

The probabilities of occurrence listed in DOE-STD-1020-94 shall be utilized for natural phenomena.

3.02.03.03. Seismic Analysis

Dynamic seismic analysis shall be performed on the primary structures (e.g., the Target Area Building, the Target Bay, and the Laser Building floor).

3.03. Operations

The National Ignition Facility shall be operated in a manner consistent with its role as a national resource.

3.03.01. Personnel

The NIF project shall provide a staffing plan.

Staffing shall be allocated to support all required operations, maintenance, and support functions.

The plan shall address construction, start-up activities, and operations.

The staffing plan shall be used to size personnel facilities such as office space, cafeteria, parking, etc.

3.03.02. Operational Availability

The facility shall be designed for maximum reasonable availability and rapid recovery from unplanned shutdowns.

3.03.02.01. Reliability, Availability and Maintenance

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.

3.03.02.01.01. Reliability

The facility shall have an overall reliability of 99.85%. Reliability is defined as the probability of meeting the minimum requirements of the experiment per no-yield shot.

3.03.02.01.02. Inherent Availability

The facility shall have a shot availability of at least 99.15%. The system is unavailable when it is undergoing unplanned maintenance. Unplanned maintenance includes failure detection and active repair as well as logistic and administrative downtimes.

3.03.02.01.02.01. Spare Equipment

Sufficient spares shall be maintained to satisfy the RAM specifications.

3.03.02.01.02.02. Maintenance Equipment

Suitable maintenance equipment shall be available as necessary to satisfy the RAM requirements.

3.03.02.02 Maintainability

3.03.02.02.1 Maintenance Time Goal

The facility shall have a scheduled maintenance plan that fits within an overall annual plant goal of 69 days. The unplanned maintenance goal is 2.3 days per year. Opportunistic maintenance activities are performed between shots and during other system downtimes.

3.03.02.02.2 Maintainability Features

The facility shall be designed to facilitate efficient maintenance. Surface finishes and coatings shall be selected with maintainability and cleanliness in mind. Features shall be incorporated in the facility to improve maintainability where they are shown to be cost-effective.

3.03.02.03. Annual Shot Rate

The facility shall be available for at least 770 no-yield target shots each year.

3.03.02.04. Increased Shot Rate

As a design goal, the facility should not preclude an increase in availability to 1200 total shots each year.

3.03.02.05. Annual Number of Yield Shots

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

3.03.02.06. Total Annual Yield and Source Term

The NIF shall be capable of performing yield shots with total DT fusion yield of 1200 MJ/year or 4.3×10^{20} neutrons/year. For DT fuel, the monoenergetic neutron energy is 14.1 MeV. The contribution of D-D reactions to this source term can be ignored.

3.03.02.07. Time Between No-yield Shots

The facility shall be capable of maintaining a time between shots of 8 hour for shots with no fusion yield. The facility shall not preclude future upgrade to allow the conduct of experiments with a time between shots of 4 hours for shots with no fusion yield.

3.03.02.08. Laser Shot Accuracy

At least 80% of all laser shots shall meet all experimental requirement specifications (e.g., laser energy, beam balance, and pointing accuracy).

3.03.02.09. Recovery from Abnormal Events

The time required for the Conventional Facilities to recover from any abnormal event shall be less than the maximum times cited below, as a function of the expected yearly frequency of occurrence of the event.

<u>Expected Frequency of Occurrence Per Year, F</u>	<u>Maximum Recovery Time</u>
$F \geq 1$	24 hours
$1 > F > 1E-2$	1 week
$1E-2 > F \geq 5E-4$	3 months

Probabilities listed in DOE-STD-1020-94 shall be used for natural phenomena.

For frequent events, the maximum allowed recovery time may be restricted by availability requirements to be less than that shown in the table above.

3.03.03. Classified Operations

The facility shall be designed to allow both classified (at the SRD level) and unclassified experiments.

3.03.03.01. Changing Between Classification Levels

The facility should allow changing classification levels with minimal impact on operations and cost.

3.03.03.02. 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.

3.03.03.02.01. Establishment of Security Requirements

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.

3.03.03.02.02. Security - Limited Areas

Limited areas will be defined in the NIF Security Procedures.

3.03.03.02.03. Automated Data Processing Security

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.

3.03.03.02.04. Security Plan

The NIF conventional facilities will comply with the NIF Security Procedures.

3.03.03.02.05. Protection of Property and Facilities

The NIF complex shall meet the requirements for physical protection of DOE property and unclassified facilities.

3.04. Environmental Protection and Health Safety

The following orders, notices, and regulations summarize the Environmental Safety and Health requirements for the NIF Conventional Facilities:

151.1	Emergency Management System
420.1	Facility Safety
440.1	Worker Protection for DOE Federal and Contractor Employees
N 441.1	Radiological Protection for DOE Activities
P 450.1	Environment, Safety, and Health Policy for the DOE Complex
451.1	National Environmental Policy Act Compliance Program
5400.1	General Environmental Protection Program
5400.5	Radiation Protection of the Public and the Environment
5820.2A	Radioactive Waste Management
10 CFR 20	Standards for Protection Against Radiation
40 CFR 61 (H)	National Emission Standard for Emissions of Radionuclides Other Than Radon from DOE Facilities
40 CFR 125	Criteria and Standards for National Pollutant Discharge Elimination System
40 CFR 260-262	Hazardous Waste Management System
29 CFR 1910	OSHA - Operation
29 CFR 1926	OSHA - Construction
15 USC 2601-2692	Toxic Substance Control Act
33 USC 1251 et seq.	Clean Water Act
40 USC 6901-6992	Resource Conservation and Recovery Act
42 USC 4321 et seq.	National Environmental Policy Act
42 USC 7401	Clean Air Act

3.04.01. Siting

Siting shall consider the effects of construction and operation on surrounding ecosystems and environmentally sensitive areas.

3.04.02. Waste and Effluents

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).

3.04.02.01. Liquid 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.

3.04.02.01.1 Target Bay Liquid Effluents

Any discharge water within the Target Bay that is potentially contaminated with radioactive substances shall be held until it is tested and confirmed to meet sewerable discharge requirements. This requirement includes water from fire-suppression activity within the Target Bay.

3.04.02.02. Airborne Effluents

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.

3.04.02.02.01. Elevated Exhaust Release Point

The final exhaust release point for the Environmental Protection Systems and any airborne radiological emissions should be elevated above the highest point of the facility for dispersion.

3.04.02.02.02. Monitoring of Exhaust Air

Exhaust air shall be continuously monitored for radioactivity.

3.04.03. Radiation Protection

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.

3.04.03.01. Maximum Credible Yield

The maximum credible DT fusion yield produced by a single shot is 45 MJ, corresponding to 1.6×10^{19} neutrons.

3.04.03.01.01. Waste Handling Area Confinement and Ventilation

The NIF waste handling areas shall comply with the standards of confinement and ventilation requirements specified by DOE Order 5820.2A, Radioactive Waste Management.

3.04.03.01.02. Waste Collection and Processing

The NIF facilities shall be compatible with the operations and equipment required for collection, labeling, packaging, sorting, and shipment of hazardous waste, low-level radioactive waste (LLW), and mixed (LLW and hazardous) waste in accordance with 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.

3.04.03.01.07.01. Negative Pressure Ventilation

The ventilation system for the Switchyards and Target Bay shall operate at negative pressures during and immediately after shots of greater than one megajoule and provide secondary tritium confinement.

3.04.03.02. Radiation Protection of the Public

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.

3.04.03.02.01. Public Exposure to Airborne Radionuclides

Exposure of members of the public from emissions of radionuclides in the ambient air from normal NIF operations shall remain below 10 mrem/y.

3.04.03.02.02. Public Exposure from all Sources

The facility shall 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 NIF radiation at the site boundary to exceed 100 mrem/y.

3.04.03.03. Radiation Protection of NIF Personnel

The NIF personnel radiation protection program shall follow DOE Notice 441.1 Protection for Radiological Activities, and 10 CFR 835, Occupational Radiation Protection.

3.04.03.04. ALARA Principle

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, collected employees, and visitors from both routine and off-normal operations.

3.04.03.05. Radiation Shielding

The target bay shall be the primary barrier for prompt radiation, air activation, and residual radioactivity.

The radiation shielding design shall be more conservative than required by DOE Order 420.1, Facility Safety. As a design goal, the maximum dose to an individual worker shall be limited to one-tenth of the occupational external dose limits specified in 10 CFR 835.

3.04.03.05.01. Concrete Shielding

Concrete shielding shall comply with ACI 301, which provides adequate strength for DBE loads.

3.04.03.06. Radiation Monitoring of Switchyards, Target Bay and Target Chamber

The Switchyards, Target Bay, and Target Chamber shall be monitored to ensure that radiological conditions are safe for personnel entry.

3.04.03.07 Tritium Confinement

The primary confinement of Tritium will be within the Target Experimental System. The Target Bay and decontamination room shall provide secondary confinement for potential leaks from the primary boundary.

3.04.03.08. Compliance with Radiological Safety Requirements

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.

3.04.04. Decontamination and Decommissioning

The NIF shall meet the requirements of DOE Order 420.1 (Facility Safety) and site-specific requirements for decontamination and decommissioning.

Conventional Facilities shall comply with the NIF Decontamination and Decommissioning (D&D) Plan.

3.04.04.01. Target Chamber Cleaning

The NIF facilities shall be compatible with the equipment and operations required to meet the Target Chamber tritium level specifications.

3.04.04.01.01. Target chamber interior decontamination

The facility shall support personnel access to the inside of the target chamber for periodic cleaning necessary to maintain radiological, low-hazard, non-nuclear operations and for inspection and maintenance.

3.04.04.02. Design for Decommissioning

Facilities in which radioactive or other hazardous materials are utilized shall be designed to simplify decontamination and decommissioning and/or increase the potential for reuse. Features and procedures that simplify and facilitate decommissioning shall be identified during the planning and design phase based upon a proposed decommissioning method or conversion to other use.

3.04.05. General Safety**3.04.05.01. Low-Hazard Radiological Facility**

The NIF shall be designed, constructed, and operated as a radiological low-hazard, non-nuclear facility.

3.04.05.02. Life Safety

The NIF shall comply with the requirements for life safety contained in DOE Order 420.1 (Facility Safety).

The code shall be used to establish minimum requirements for life safety such as protection of vertical openings, travel distances, and capacities of means of emergency egress.

3.04.05.02.01. Egress Features

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.

3.04.05.02.02. Laser Safety

The laser safety program shall comply with ANSI Z136.1, Laser Safety, and OSHA requirements. Exposure to hazardous levels of laser light shall be prevented by the use of physical barriers, interlocks, and personnel entry controls in addition to personnel training.

3.04.05.02.03. 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.

3.04.05.02.04. Construction Safety

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.

3.04.05.02.05. Default to Safe State Upon Loss of Power

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.

3.04.05.02.06. Facility Safety Interlocks

The facility shall incorporate features, including safety interlocks, to restrict personnel access to all hazards.

Interlocks shall comply with Supplement 33.48 of the LLNL Health and Safety Manual.

Interlocks shall be dedicated, designed to fail safe and shall activate laser shutters and shut off power to laser systems if access control is violated.

3.04.05.03. Fire Protection Program

The NIF shall meet the design and fire protection requirements of DOE Order 420.1, Facility Safety, and the Uniform Building Code (UBC).

The requirements of the DOE fire protection program shall be documented and incorporated in the plans and specifications for all new facilities and for significant modifications of existing facilities. This includes a documented review by a qualified fire protection engineer of plans, specifications, procedures, and acceptance tests.

3.04.05.03.01. Fire Protection - Structural Members

The structural members of the LTAB (including exterior walls, interior bearing walls, columns, floors, roofs, and supporting elements) shall, as a minimum, meet UBC fire-resistive standards.

3.04.05.03.02. Fire Barriers

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.

3.04.05.03.03. Improved Risk Fire Protection

The NIF shall meet the requirements for an "improved risk" level of fire protection sufficient to attain DOE objectives.

3.04.05.03.04. Automatic Fire Sprinklers

To achieve an "improved risk" level of protection, automatic fire sprinklers shall be installed throughout the complex.

3.04.05.03.05. Ancillary Fire-Protection Systems

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

3.04.05.03.06. Fire Loss (Maximum Allowable)

The maximum possible fire loss (MPFL) shall not exceed \$150 million per fire. When the MPFL exceeds \$150 M, a redundant fire protection system and three-hour fire barriers are required to limit the maximum possible fire loss to \$150 M.

3.04.05.03.07. Fire Loss (Maximum Credible)

The maximum credible fire loss shall not exceed \$50 million. When the possible fire loss exceeds \$50 M, a redundant fire protection system shall be provided that, despite the failure of the fire protection system, will limit the loss to \$50 M.

3.05. 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.

3.05.01. 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.

3.05.02. Low Voltage Protection of Computers

Computers shall be protected with low voltage dropouts requiring manual restart.

3.05.03.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.

3.05.04.Power for Safety and Security Functions

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.

3.05.05.Standby Power for Operations

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.

3.06.Future Modifications and Upgrades**3.06.01.Design and Construction Tradeoffs**

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.

3.06.02.Accommodating Range of Needs

Whenever possible, the design should accommodate the requirements of users with diverse needs.

3.06.03.Potential Upgrade to Direct-drive

Future upgrade to allow direct-drive experiments, shall not be precluded in the baseline NIF design. In order to not preclude this option, the Facility System, in concert with other NIF systems, shall provide a conceptual design for the required beam transport to the target chamber and ensure that this transport can be accomplished by rearranging existing direct-drive components or adding additional components.

3.06.04.Radiation Effects Testing Capability

The NIF should provide the basic capability so as not to preclude radiation effects testing by DNA or DOE, with future upgrade. The design shall not preclude laser irradiation of distributed target arrays with future upgrade.

3.06.05.Future Additional Target Chamber

The design of the Facility shall not preclude the future installation of an additional target chamber, employing all laser beams, for weapons physics and/or radiation effects testing. As a part of the NIF project, the Facilities, in concert with other NIF systems, shall provide a general arrangement layout for the addition of the target chamber. All Facility designs shall be compatible with this design concept. All structural elements shall provide clearance for the identified future laser beam paths. Certain structures, such as building skins or shielding walls, require integrity to fulfill their functions prior to addition of the future target chamber; clearance for future beams is not required through such structures. However, their design shall be adequate that they will meet their requirements after addition of the future target chamber and associated beam clearances.

3.07 General Design Criteria

DOE Order 6430.1A shall be used for general facility design guidelines, where applicable, and where other requirements of this document do not list other requirements.

3.08. Documentation

The Conventional Facilities shall provide the following documents:

- Energy Conservation Plan
- Conventional Facilities Quality Plan

The following documents are required by the Conventional Facilities:

- DOE 1324.5B Records Management Program
- Operational Emergency Base Plan DOE 151.1
- Quantitative Hazards Assessment DOE 151.1
- Emergency Plan DOE 151.1
- Fire Hazards Analysis
- Programmatic Environmental Impact Statement
- Preliminary Safety Analysis Report
- Quality Assurance Plan
- Decontamination and Decommissioning Plan

3.09. Quality Assurance Program

The NIF conventional facilities, including design and construction activities, shall comply with the NIF Project Quality Assurance Program Plan.

3.12. Experimental Facilities

3.12.01.Laser and Target Area Building

The LTAB shall provide an optically-stable and clean environment to allow the system to routinely deliver high power laser beams to a target chamber.

The building shall provide for the following:

- house the laser system;
- house the target area;
- house the control rooms;
- house the diagnostics area;
- provide space and equipment for related operations support including:
  - Mechanical, electronic and laser maintenance areas;
- provide environmental control for the interior including:
  - precise temperature control,
  - controlled humidity,
  - clean areas,
  - low vibration;
- provide environmental protection and safety including:
  - containment and monitoring of radiation,
  - decontamination facilities,
  - hazardous waste processing facilities,
  - control of all emissions;
- provide physical and technical security;
- provide all other necessary services and utilities including:
  - telecommunications systems,
  - electrical utilities;
- provide for visitors.

The LTAB is comprised of a Laser Building, a Target Area Building, and a Diagnostics Building.

The LTAB shall allow the lasers in the Laser Building to enter the Target Area Building and the Target Chamber.

The Target Area Building shall be shielded for confinement of radioactivity.

3.12.01.02.Laser Building

Capable of housing the Laser Building and some of the ancillary subsystems.

3.12.01.02.01.Laser Bays

Capable of housing the Laser Assemblies and some of the transmission lines from the capacitor Bays.

3.12.01.02.02.Capacitor Banks

Capable of providing for capacitors that provide power to the laser amplifiers.

3.12.01.02.03. Operations Support Area

The Operations Support Area shall include:

- Control Room
- Classified Control and Data Room
- Master Oscillator Room
- Operations Planning Room
- Computer Room
- LTAB Offices
- Document Library
- Conference Room
- Security System Area
- Technical Maintenance Areas
- Restrooms
- Custodial Room

3.12.01.03. Target Area Building

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

3.12.01.03.A Diagnostic Removal and Replacement

The facility shall be compatible with the equipment necessary to rapidly remove and replace diagnostics.

3.12.01.03.01. Target Bay

This shall be capable of housing the target chamber, final optics, vacuum piping, and target diagnostics while providing adequate shielding.

3.12.01.03.01.01. Target Bay Cryogenics

The target area support systems shall be capable of target operations with both cryogenic and non cryogenic targets containing fusion fuel.

3.12.01.03.01.01.01. User-supplied Cryostats

Provisions shall be made to accommodate and support experimenter-supplied cryostats for cryogenic targets.

3.12.01.03.02. Switchyards

Switchyards shall be capable of accommodating beam tubes and turning mirrors.

3.12.01.04. Diagnostics Building

The building shall include staging areas for diagnostic and target handling components and equipment.

The basement of the building shall be accessible by standard semi-tractor trailers.

3.12.01.04.01. Diagnostics Operations and Support

The Target Diagnostics Building shall provide laboratory space for support of target diagnostics activities such as diagnostic assembly and calibration.

The building shall accommodate target diagnostics as identified on drawing (TBD) and shall be capable of being modified to allow addition of the LANSA diagnostic in the future.

The building shall also provide a target diagnostics data acquisition area which provides safeguards and security for up to and including SRD data.

3.12.01.04.02. Decontamination Area

The building shall include a decontamination area and a hot cell (where radiated components may be temporarily stored to allow the radioactivity to decay immediately after extraction from the target chamber and prior to further processing and decontamination).

3.12.01.04.03. Environmental Protection System

The building shall house the Environmental Protection System for processing and decontamination of components and effluents.

3.12.01.04.04. Target Receiving and Installation

The Diagnostic Building shall include a target receiving and installation area, where targets may be delivered to the LTAB and processed for installation into the target chamber.

3.12.01.04.05. Tank Farm

The Diagnostics Building shall have an exterior Tank Farm which provides the necessary compressed gases.

The Tank Farm shall also have tanks to collect the liquid effluents from the Decontamination Area and Environmental Protection System.

3.12.01.05. Environmental Control**3.12.01.05.01. Vibration and Acoustic Noise**

The LTAB will house vibration-sensitive special equipment. The structural design of the Laser Bays, Switchyards and Target Bay shall provide means to effectively isolate this equipment to control acoustic noise and vibration within specified displacement and rotation requirements.

Any component located within the laser bay or target building shall be included in assessments of vibration.

3.12.01.05.01.1 Specific LTAB Vibration Constraints

The LTAB vibrations should be maintained below $1 \times 10^{-10} \text{ g}^2/\text{Hz}$ from 1 to 200 Hz at the surface of the foundation to which the critical structures mount.

3.12.01.05.01.2 Foundation Decoupling

The LTAB foundation (to which the vibration-critical special equipment mounts) shall be physically decoupled from the foundations which support the external skin of the building.

3.12.01.05.02. Floor Deflection

Laser Bay and Switchyard floor deflections are critical to maintaining laser alignment. The specifications for allowable deflections shall be provided in the applicable SSDR(s).

3.12.01.05.03. Temperature and Humidity

The Laser Building and Target Area Building interior temperature shall be tightly controlled. Any component located within the laser bay or target building shall be included in assessments of thermal loads.

The Laser Building and Target Area Building interior relative humidity shall be compatible with Laser and Target operations. Target handling areas may have more stringent requirements than apply to the laser and optics.

The Diagnostic Building interior temperature is not critical and shall be controlled per applicable energy conservation standards.

3.12.01.05.03.A Specific LTAB Temperature Constraints

The Laser Bays, Switchyards, and Target Bay shall be maintained at a temperature of $20^\circ\text{C} \pm 0.28^\circ\text{C}$. The Master Oscillator Room shall be maintained at a temperature of (TBD).

3.12.01.06. Clean Areas

The following LTAB locations shall be clean areas:

- Master Oscillator Room
- Laser Bays
- Switchyards
- Target Bay

3.12.01.06.A Specific LTAB Cleanliness Constraints

Clean Area surfaces, finishes, and structures shall be compatible with Class 10,000 cleanliness requirements.

Clean Area HVAC shall be compatible with Class 100,000 cleanliness requirements.

3.12.01.07. Electrical Supply and Grounding Systems

The LTAB electrical supply and grounding systems shall be compatible with the control and data acquisition requirements. The Facilities shall comply with the NIF Grounding Plan, NIF-LLNL-94-211, L-17346-1. All components in the Laser Bay shall be isolated from those in the Target Bay and separately grounded.

3.12.01.08. Mechanical Equipment

The LTAB shall have elevators for transportation of personnel and equipment.

There shall be overhead cranes in each Laser Bay and the Target Bay.

3.12.01.09. Visitor Facilities

The LTAB shall include a Visitor Lobby and provide facilities for visitor viewing of a Laser Bay, a Switchyard, and the interior of the Target Bay.

3.12.02. Optics Assembly Building

(TBD)

3.12.02.01. Internal Environment

The internal temperature shall be maintained at $20^{\circ}\text{C} \pm 0.28^{\circ}\text{C}$.

3.12.02.02. Clean Rooms

The Optics Assembly Building shall have adequate Class 100 cleanroom space for TBD operations. The pre-cleaning area shall be maintained as a Class 10,000 cleanroom; the room housing the automated cleaning systems shall be maintained as a Class 1000 cleanroom; the assembly area shall be a Class 100 cleanroom.

3.12.02.02.01. Cleaning Methods

Because of the negative environmental impact of chlorinated fluorocarbons (CFCs) and VOCs, the Facility shall use an aqueous cleaning system that is environmentally safe and minimizes hazardous waste generation.

3.13. Support Facilities**3.13.02. Office Building**

(TBD)

3.13.03. Target Receiving and Inspection Building

The NIF shall be able to receive, inspect, and handle targets filled with fusion fuel. These targets include cryogenic and/or classified targets. The targets will be from on-site and off-site sources (e.g., General Atomics). The filled targets containing tritium will be transported in Department of Transportation-certified shipping containers. The facility shall be able to handle multiple-target shipments.

NIF shall be able to process sufficient targets to support up to TBD (335) yield shots per year.

3.13.04. General Assembly Building

The NIF Site Requirements specifies that an industrial-type building of approximately 22,000 ft² will be used to assemble large and heavy mechanical and electrical components that do not require a clean room environment. The facility must have the capability to handle these large and heavy assemblies. There is also a requirement to include a provision for assembly welding.

3.13.05. Electrical / Mechanical Shop

NIF requires an area of approximately 12,000 ft² for electrical and mechanical support shops. This area will house the machine tools to be used for repairs, maintenance, and special fabrications required for daily operations for the NIF laser and its auxiliary systems.

3.13.06. Warehouse

Approximately 30,000 ft² of industrial-quality space will be required for bulk storage of NIF components, equipment, and supplies for NIF operations.

3.13.07. Shipping, Receiving, and Central Stores

The site shall be capable of shipping and receiving all components for the NIF as defined in SDDR's.

3.13.08. Medical Facility

This facility shall have the capacity to support all of the personnel at the NIF site. It shall have the capabilities outlined in section 2.03.03.07.

3.13.09. Cafeteria

Shall provide food service per section 2.03.03.08.

3.13.10. Garage and Gas Station

Shall be capable of providing services per section 2.03.03.09

3.13.11. Fire station

Shall be capable of providing services per section 2.03.03.10.

3.13.12. Security and Badging

Shall be capable of providing services per section 2.03.03.11.

4. Applicable Documents

This section lists DOE Orders, codes, and standards considered applicable on October 1, 1993. The applicable portions of these documents apply. Applicable LLNL standards are being considered contingent upon the decision of the final site selection.

4.01. Freezing of Orders

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.

4.02. Compliance with DOE Orders and Federal Regulations

The NIF shall be designed and constructed in full compliance with DOE Orders and federal regulations.

4.02.01. Exceptions to DOE Orders

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.

4.02.02. List of Applicable DOE Orders

This section lists DOE Orders, codes, and standards considered applicable on 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 apply.

DOE 151.1	Emergency Management System
DOE 420.1	Facility Safety
DOE 430.1	Life Cycle Asset Management
DOE 440.1	Worker Protection Management for DOE Federal and Contractor Employees
DOE N 441.1	Radiological Protection for DOE Activities
DOE P 450.1	
DOE 451.1	National Environmental Policy Act Compliance Program
DOE 460.1	Packaging and Transportation Safety
DOE 470.1	Safeguards and Security Program
DOE 471.1	Identification and Protection of Unclassified Controlled Nuclear Information (9/25/95)
DOE 471.2	Information Security Program
DOE M 471.2-1	Manual for Classified Matter Protection and Control (9/26/95)
DOE 1360.2B	Unclassified Computer Security (5/18/92)
DOE 5300.4D	Telecommunications: Protected Distribution Systems (3/4/94)
DOE 5400.1 (Chg. 1)	General Environmental Protection Program (6/29/90)
DOE 5400.5 (Chg. 2)	Radiation Protection of the Public and Environment (1/7/93)
DOE 5632.1C	Protection and Control of Safeguards and Security Interests (7/15/94)
DOE M 5632.1C-1	Manual for Protection and Control of Safeguards and Security Interests
DOE 5637.1	Classified Computer Security Program
DOE M 5639.6A-1	Manual of Security Requirements for the Classified Automated Information System
DOE 5700.6C	Quality Assurance (8/21/91)
DOE 5480.19 (Chg. 1)	Conduct of Operations Requirements for DOE Facilities (5/18/92)
DOE 5820.2A	Radioactive Waste Management (9/26/88)
DOE 5481.1B (Chg. 1)	Safety Analysis and Review System (5/19/87)
	Technical Surveillance Countermeasures Procedural Manual (classified)

4.02.03. Partial List of Applicable Federal Regulations

10 CFR 435	Energy Conservation Voluntary Standards for Commercial and Multi-Family High Risk Residential Buildings
10 CFR 835	Occupational Radiation Protection
10 CFR 20	Standards for Protection Against Radiation
10 CFR 830.110	Nuclear Safety Management, Safety Analysis Report
28 CFR 36	Americans with Disabilities Act
29 CFR 1910	Code of Federal Regulations, Occupational Safety and Health Administration, Department of Labor
29 CFR 1910.7	Definitions and Requirements for a Nationally Recognized Testing Laboratory (NRTL)
40 CFR 61	National Emissions Standards for Hazardous Air Pollutants (NESHAP)
40 CFR 121-130	Federal Water Pollution Control Act
40 CFR 260-272	Resource Conservation and Recovery Act (RCRA)
40 CFR 300-399	Comprehensive Environmental Response, Compensation & Liability Act
40 CFR 1501	National Environmental Policy Act (NEPA)
41 CFR 101-91.6	FPM Regulations, Architectural Barriers Act PL 90-480
Fed-Std-209E	Airborne Particulate Cleanliness Classes in Cleanrooms and Clean Zones
Fed-Std-975	Uniform Federal Accessibility Standards
33 USC 1251	Clean Water Act

Clean Air Act

USC 6901 et seq. Resource Conservation and Recovery Act

4.03. 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 Title I design.

4.03.01. Updating List of Codes and Standards

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.

4.03.02. List of Applicable National Consensus Codes and Standards

ACGIH	Industrial Ventilation Manual
ACI 318	
ANSI C2	National Electrical Safety Code
ANSI C84.1	Electric Power Systems and Equipment -- Voltage Rating (60 Hz)
ANSI N13.1-1969	Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities
ANSI Z136.1	(Laser Safety)
ANSI Z358.1	Standard for Emergency Eyewashes and Showers
ASHRAE 62-1989	Ventilation for Acceptable Indoor Air Quality
ICRP 60 S40	1990 Recommendations of the International Commission on Radiological Protection
IEEE 466	Standard for Emergency and Standby Power Systems (The Orange Book)
IEEE 493	Recommended Practices for Design of Reliable Industrial and Commercial Power Systems
NFPA 110	Emergency and Standby Power Systems
NFPA 101	Life Safety Code
NFPA 70	National Electrical Code
NFPA 72	National Fire Alarm Code
OSHA	(Construction Safety, Laser Safety, Standby Power)
UBC	(Fire Resistive Stds)
	Uniform Plumbing Code

(DOE 1300.2A)

- (1) All DOE facilities, programs, and projects shall use non-government standards (NGSs) in their design, construction, testing, modification, operation, decommissioning, decontamination, and remediation when such standards are adequate and appropriate for the intended application. If there is a conflict of requirements between the NGSs and the requirements or policy of the Department as established in Directives, Rules, Safety Guides, DOE standards, limited standards, or other Departmental policy documents such that the DOE requirements are more conservative or restrictive than the NGSs, then the DOE requirements shall be used;
- (2) Use of any standard in the design, construction, testing, modification, operation, decommissioning, decontamination, and remediation of DOE facilities, programs, or projects shall be documented in appropriate design or safety documents for those activities, such as System Design Descriptions and Safety Analyses Reports;
- (3) Standards should be referenced, in entirety or in part, tailored as appropriate to specific needs. Where parts of standards are referenced in contracts, specifications, or other documents, these documents may include the text from the standards provided that the text is quoted without change. When these documents contain modified requirements from standards, then the modification should be clearly identified. In all cases, the issue date of the standard used should be documented or the specific index of standards to be applied must be specified;

4.04.State and Local (County, City, etc.) Requirements
(site-specific)

4.05.Applicable LLNL Standards
(site-specific)

LLNL Metric Transition Path, Committee on Metrification, October 10, 1992.

Design Safety Standards -- Mechanical Engineering, Rev. 7, Feb. 1993, LM-012.

Health and Safety Manual, March 1989, M-010.

Plant Engineering Drafting Manual.

Facility Standards.

Hazards Control Manual, M010. (same as Health and Safety Manual above?)

Mechanical Engineering Design Practice, M-256.

Mechanical Engineering Policy Procedures Manual.

4.06. Applicable NIF Project Documents

NIF Justification of Mission Need

NIF Draft Preliminary Environmental Impact Statement

National Ignition Facility Functional Requirements and Primary Criteria, Draft, 1/9/96 -- NIF-LLNL-96-011 (L-21166-01).

NIF Site Requirements, Rev. (TBD), (date) -- NIF-LLNL-93-089 (L-16883-1).

NIF Quality Assurance Plan, Rev. (tbd), (date) -- NIF-LLNL-93-044 (L-15959-1).

NIF Draft Preliminary Environmental Impact Statement.

NIF Staffing Plan

NIF Decontamination and Decommissioning Plan.

NIF Conceptual Design Report, May 1994 -- NIF-LLNL-94-113 (L-16973-1).

NIF System Design Requirements, Laser (SDR 002), Rev. 0, March 1994 -- NIF-LLNL-xx-xxx (L-xxxxx-x).

NIF System Design Requirements, Target Area (SDR 003), Rev. 0, March 1994 -- NIF-LLNL-xx-xxx (L-16983-1).

NIF System Design Requirements, Integrated Computer Controls (SDR 004), Rev. 0, March 1994 -- NIF-LLNL-xx-xxx (L-xxxxx-x).

NIF System Design Requirements, Optics (SDR 005), Rev. 0, March 1994 -- NIF-LLNL-xx-xxx (L-xxxxx-x).

4.07. Applicable NIF Drawings

The following NIF Project drawings apply as specified in sections 3.2 to 3.6. The specified revision applies.

TBD [overall optical component layout]

TBD [facility footprint drawing]

5. Acronyms

ACGIH	American Congress of Government and Industrial Hygienists
ACI	American Concrete Institute
ALARA	As Low As Reasonably Achievable
ANSI	American National Standards Institute
APE	Associate Project Engineer
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
CFC	Chlorinated Fluorocarbon
CFR	Code of Federal Regulations
D&D	Decontamination and Decommissioning
DOE	Department of Energy
ES&H	Environmental Safety and Health
FHA	Fire Hazards Analysis
FRPC	Functional Requirements / Primary Criteria
HC	Hazard Category
HVAC	Heating, Ventilation and Air Conditioning
I&C	Instrumentation and Control
ICRP	International Commission on Radiation Protection
IEEE	Institute of Electronic and Electrical Engineers
LLNL	Lawrence Livermore National Laboratory
LN	Liquid Nitrogen
LNG	Liquified Natural Gas
LTAB	Laser and Target Area Building
MPFL	Maximum Permissible Fire Loss
NFPA	National Fire Protection Association
NIF	National Ignition Facility
OAB	Optics Assembly Building
OSHA	Occupational Health and Safety Act
PC	Performance Class
PEIS	Preliminary Environmental Impact Statement
PHA	Preliminary Hazards Analysis
RAM	Reliability, Availability and Maintainability
SAR	Safety Analysis Report
SDR	System Design Requirement(s)
SRD	Secret Restricted Data
SSDR	Subsystem Design Requirement(s)
UBC	Uniform Building Code
USC	United States Code
VOC	Volatile Organic Compound
WBS	Work Breakdown Structure

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