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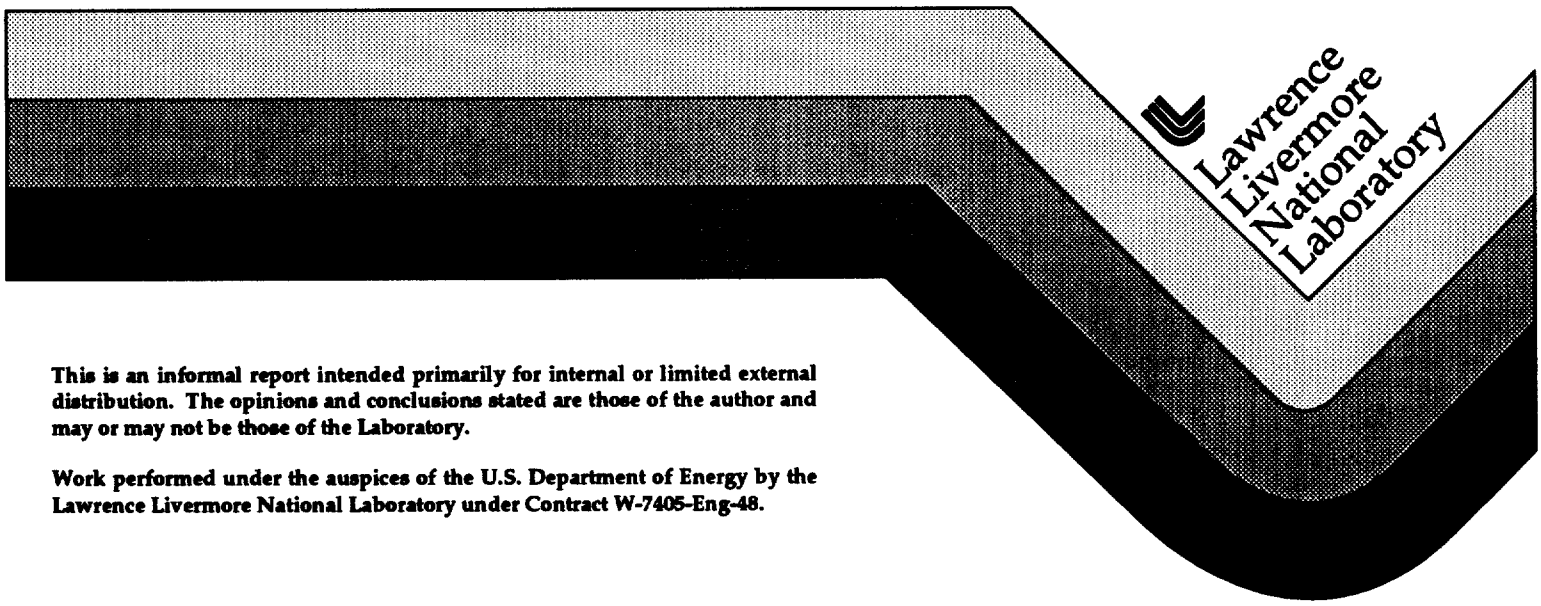
National Ignition Facility SubSystem Design Requirements Laser Auxiliary Subsystem SSDR 1.3.5

S. Mukherji

October 24, 1996



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WBS 1.3.5

National Ignition Facility

Subsystem Design Requirements

Laser Auxiliary Subsystem

SSDR 1.3.5

Revision C
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Table of Contents

1.0 Scope

This system design requirement document establishes the performance, design, development and test requriements for the NIF Laser Auxiliary Systems. The Laser Auxiliary Systems consist of:

a. Gas Cooling System
b. Low conductivity cooling water system
c. Deionized cooling water system
d. Electrical power distribution system

The gas cooling system will be used for cooling the main laser amplifer flashlamps and some smaller quantities will be used for purging Pockels cells and for diode pumps in preamplifier.

The low conductivity cooling water system will be used for cooling the capacitor banks. The deionized cooling water system will be used to cool the multi-pass amplifer in the OPG PAM. Electrical power will be required for the OPG systems, Pockels cells, power conditioning, and amplifier support equipment.

2.0 Applicable Documents

2.1 Applicable NIF Project Documents

National Ignition Facility Functional Requirements and Primary Criteria, Revision 1.4, L-15983-3, February, 1996.

National Ignition Facility System Design Requirements, Laser System SDR002, Revision A, NIF-LLNL-96-228, L-21707-01.

"Proposed Metrication Policy for NIF," memo from R. Sawicki, NIF-LLNL-96-038, L-21248-01, 21 January, 1996.

NIF Grounding Plan, NIF-LLNL-94-211, L-17346-1.

NIF-LLNL-93-044/L-15958-1, National Ignition Facility Quality Assurance Program Plan, November 1993.

2.2 Applicable US Government Orders and Standards

DOE 5400.1 General Environmental Protection Program
DOE-STD-1021-93, Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components

2.3 Applicable National Codes and Standards

ARI: Air Conditioning and Refrigeration Insititute
AMCA: Air Movement and Control Association
ASME: American Society of Mechanical Engineers
ANSI: American National Standards Institute
ASTM: American Society for Testing and Materials
NEC: National Electric Code
NFPA: National Fire Protection Association

2.4 Applicable LLNL Standards

LLNL Committee on Metrification, 10 October 1992, "LLNL Metric Transition Path"
LLNL M-012 Rev 7, Feb 1993, "Design Safety Standards - Mechanical Engineering"
LLNL M-010, March 1989, "Health and Safety manual"
LLNLM010, "Hazards Control Manual"
LLNL, M-256 "Mechanical Engineering Design Practice"
LNL "Mechanical Engineering Policy Procedures Manual"
LLNL Plant Engineering Standards

1 System Definition

This section defines the Laser Auxiliary systems for providing utilities for amplifiers, master oscillator room, preamplifier modules, Pockels cells, and capacitor bank switching. The utilities consist of nitrogen cooling, low conductivity cooling water, deionized cooling water and electrical power.

3.1.1 System Description

Laser auxilary system consists of the following items:

A. Cooling system for cooling the booster and cavity amplifiers and also for diode pumps in Pams and for purging Pockels cells.

B. Low conductivity cooling water for cooling capacitor modules.

C. Deionized cooling water for cooling PAMS.

D. Electrical power distribution
The LAS electrical design requirements are to identify, qnantify, configure, and distribute 120/208 Vac facility power between the branch distribution panel boards and the laser system special equipment loads described below.

1. The OPG system requires "Clean Power" distribution within the MOR.
LTAB area loads include "Utility and Research Power" distribution to the PAM's, PABTS, PEPC, and PAMMA maintenance area, vacuum systems, and I/C racks.

2. Laser Amplifer system requires "Utility Power" distribution for service carts and portable clean rooms associated with amplifier maintenance. Main power for flashlamp drive is supplied by the Power Conditioning Group from a separately derived system.

3. The Power Conditioning system requires "Research Power" to I/C racks within the capacitor bank bays.

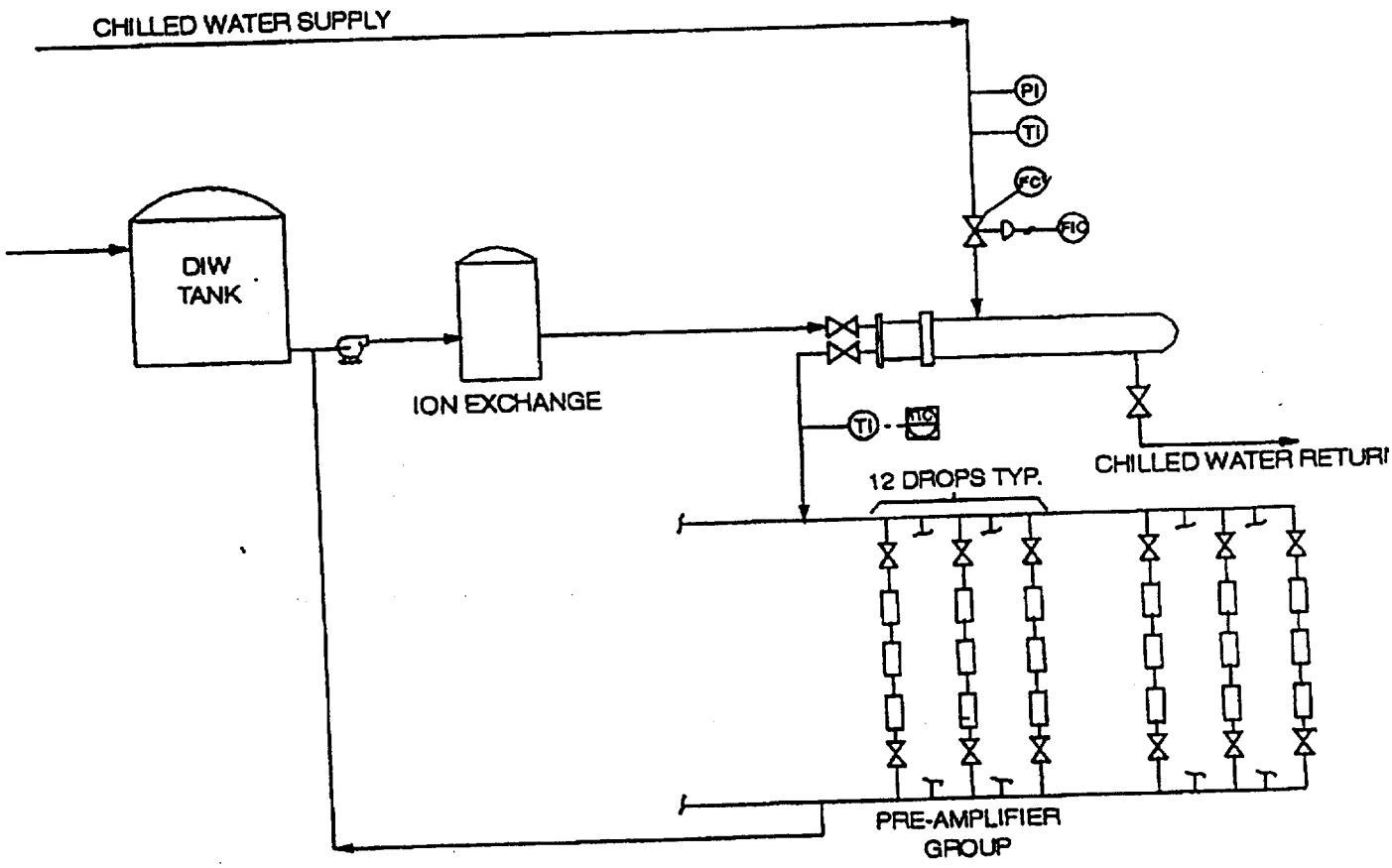
3.1.2 System Functions

- Provide main amplifier cooling gas
- Provide low conductivity water cooling for capacitor banks
- Provide DIW for cooling multipass amplifiers on the preamplifiers
- Provide electrical power for laser special equipment loads

3.1.3 System Diagrams

Diagram for deionized water cooling system is enclosed.

3.1.3.1 Deionized Cooling Water System



3.1.4 System Interfaces
Laser auxiliary systems will support the following laser components:

- 1.3.5 - 1.2.2 Interface with LTAB facility.
- 1.3.5 - 1.3.1 Interface with optical pulse generation system.
- 1.3.5 - 1.3.2 Interface with amplifiers.
- 1.3.5 - 1.3.3 Interface with Pockels cells.
- 1.3.5 - 1.3.4 Interface with amplifier power conditioning system.

3.2 Systems Characteristics and Verification

3.2.1 Performance Characteristics

3.2.1.1 Amplifier Cooling System Requirements

3.2.1.1.01 Separation of flashlamp and slab gassupply
The gassupplied to the amplifier slab cassettes and flashlamp cassettes shall be separate and capable of maintaining independent flow and cleanliness characteristics.

3.2.1.1.02 Bundle cooling flexibility
The cooling system shall meet all requirements with any subset of bundles, up to the full system, operational. undles must be capable of being "deselected" from a given cooling flow cycle using isolating valves.

3.2.1.1.03 Gas Coolant Supply Temperature
The temperature setpoint of the gas to be supplied to the flashlamp cassettes shall be the same as room temperature set point of the Laser Bay.

3.2.1.1.04 Gas Coolant Purity
The gas supplied to the flashlamp cassettes shall be sufficiently pure to ensure that the reflectivity of the reflectors within the amplifier does not degrade prematurely.

3.2.1.1.08 Cleanliness
The gas supplied to pump cavity shall be consistent with maintaining a Class 100 Cleanliness Level.

3.2.1.1.08.1 External surfaces
The external surfaces of the laser auxiliary subsystem within the laser bay should be cleaned to Class 100,000 clean room conditions. If feasible the surface should be designed and constructed for Class 10,000 clean room use and shall be compatible with cleaning by aqueous solution.

3.2.1.4 Vibration Isolation
Vibration isolaton shall be provided for all laser auxiliary systems to maintain 10^{-10} g^2/Hz or less at the base of all laser support structures.

3.2.1.5 Electrical Power Distribution
Provide 120/208 VAC power to laser systems special equipment loads within pulse generation, amplifiers, pockels cells, and power conditioning sub-systems as described in 3.1.1 D.

3.2.1.5.1 Provide Power Conditioning

3.2.1.5.1.1 Control Circulating Ground Currents
Control unwanted circulating ground currents by establishing single point ground(s) within the affected subsystem.

3.2.1.5.1.2 Control Electrical Noise
Control unwanted electrical noise on the distribution system, both common and transverse modes, by appropriate filtering within the affected subsystem.

3.2.1.5.1.3 Control Current Surges
Provide current surge protection on the distribution system within the MOR.

3.2.2 Physical Characteristics

3.2.2.1 General Arrangement

3.2.2.1.2 General Arrangement Drawings
The laser auxiliary subsystem shall conform to the following drawings which specify the general arrangement.

NIF-LTAB, Title I, CFG-201

3.2.3 Reliability, Availability and Maintainability

3.2.3.1 Lifetime
The laser auxiliary subsystem will be designed to operate for 30 years.

.2.3.2 Replaceability
Any portion of the laser auxiliary subsystem which cannot reasonably be designed for 30 year lifetime shall be designed to be replaced or repaired at reasonable cost in a timely manner consistent with the overall availability of the laser auxiliary subsystem as stated in 3.2.3.3 and 3.2.3.5.

Interchangeability of laser auxiliary subsystem components shall be preserved. All components with the same part number shall be interchangeable.

3.2.3.3 Inherent Availability
The laser auxiliary subsystem will be designed to have a shot availability of at least 99.79 %. 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.

3.2.3.4 Reliability
The laser auxiliary subsystem shall have an overall reliability of 99.999%. Reliability is defined as the probability of meeting the minimum requirements of the experiment per no-yield shot as stated in SDR2:3.2.3.4.

3.2.3.5 Maintainability
The laser auxiliary subsystem shall have a scheduled maintenance plan that fits within an overall annual plant goal of 69 days. The unplanned maintenance goal is 14 hours per year. Opportunistic maintenance activities are performed between shots and during other system downtimes.

3.2.3.6 Recovery From abnormal events

The time required for the laser auxiliary subsystem 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.

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

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

3.2.4 Environmental

For nitrogen, LCW, DIW and electrical power no special environment is required. Industry standard enclosures, mecahnical and electrical rooms will be used.

3.3 Design and Construction

Detailed design and specifications will be prepared as construction documents. All equipment and materials will be described in detail in the specifications. Construction will be per design and specifications and per acceptable industry standards. All installed systems will be tested for final acceptance for performance requirements. See applicable section of SDR 002.

3.4 Logistics

No special documentation is required for transportation, maintenance, supply, etc., for systems described above.

3.5 Personnel and Training

Operators will be trained on system operation and maintenance procedures during system testing and acceptance.

4.0 Quality Assurance

Quality assurance will be obtained through design reviews, problem identification and resolution, construction inspection, reviewing construction submittals, and finally during equipment/system testing and acceptance. See applicable section of SDR002.

4.1 Q-Level Assigned

WBS element number	WBS element title	Assigned Q-level			Why not Q-level 3 ?
		1	2	3	
1.3.5.1	Laser Auxiliary Mechanical Systems		√		potential contamination to main amplifiers and damage to blast shields
1.3.5.2	Laser Auxiliary Electrical Systems			√	

6.0 Revision Record

Rev	Date	ECR#	By	Description of/Reason for Change
0	CDR	n/a		
A	6/6/96	n/a	Mukherji	inital Title I issue
B	10/6/96	49	Mukherji	final Title I update, many miscellaneous changes
C	10/24/96	70	Mukherji	add specification for cooling gas purity (3.2.1.1.04)

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