National Ignition Facility Risk Management Plan

February 1997

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NIF Risk Management Plan

February 1997

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1.0 Introduction

The NIF Risk Management Plan has been prepared in accordance with the DOE Life Cycle Asset Management Good Practice Guide to support Critical Decision 3 of the NIF Project. The objectives of the plan are to: 1) identify the risks to the completion of the Project in terms of meeting technical and regulatory requirements, cost, and schedule, 2) assess the risks in terms of likelihood of occurrence and their impact potential relative to technical performance, ES&H (environment, safety and health), costs, and schedule, and 3) address each identified risk in terms of suitable risk mitigation measures.

The documents that form the basis for this risk assessment are as follows:

1. Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management (DOE, 1996a) and Record of Decision (DOE, 1996b),
2. Preliminary Hazards Analysis (Brereton, 1993),
3. Fire Hazards Analysis (Jensen, 1997),
4. Preliminary Safety Analysis Report (LLNL, 1996a),
5. Reliability, Availability and Maintainability Report,
6. Radiation Protection Evaluation,
7. Primary Criteria and Functional Requirements (LLNL, 1996b),
8. Project Execution Plan (DOE, 1996c),
9. Schedule Risk Assessment,
10. Construction Safety Program (LLNL, 1997),
11. Title I Design Media,
12. Congressional Data Sheet.

The process used in developing this plan was to form a Risk Assessment team of knowledgeable project personnel. This included: Assurances Manager, Systems Integration Manager, Project Control Manager, a Risk Management consultant, Deputy Associate Project Engineer for Activation and Start-up (Co-chairperson), and Lead Engineer for Safety Analysis (Co-chairperson). They were familiar with the risk basis documents and developed a list of the key risk elements. A methodology for assigning likelihoods, consequences, and risks was developed. Risk elements were then reviewed, and likelihoods, consequences, and risks were assigned. Risk mitigation measures were then developed. Comments were obtained, resolved and incorporated, and this document presents the results of the assessment.

2.0 Background of the NIF Project

The National Ignition Facility Justification of Mission Need approved by the Secretary of Energy defines the specific mission of the NIF Project. The most immediate application of the NIF will be to provide nuclear weapon-related physics data since many high-energy-density physics phenomena that will occur during NIF experiments are relevant and similar to those occurring in nuclear weapons. With a comprehensive test ban, the NIF will also provide an important capability for weapons-effects simulations. Under the cessation of underground nuclear testing, the NIF, along with numerical simulations and other above ground experimental facilities, will provide the critical data that will allow the United States to maintain its technical capabilities in nuclear weapons. As a secondary objective specified by the National Energy Strategy, the NIF will advance our understanding of inertial confinement fusion and help to assess its potential as an energy source. Achieving fusion ignition in the NIF will advance both defense and energy objectives. In affirming the Project's Critical Decision 2, Approval of New Start, the Secretary of Energy verified the mission need and emphasized that the NIF has the potential to contribute significantly to the following DOE mission areas:

2.1 Stockpile Stewardship and Management

In the absence of underground nuclear tests, the NIF will be a critical tool for the DOE science-based Stockpile Stewardship and Management Program. It will help to maintain the continued reliability and effectiveness of the stockpile by creating experimental conditions that approach certain aspects of nuclear-weapons physics. In particular, the NIF's experimental capability will allow nuclear-weapons scientists to assess stockpile problems, verify computational tools, test for nuclear-weapons effects, and increase their understanding of weapons physics.

2.2 Inertial Fusion Energy

The NIF will represent the scientific culmination of this fusion research. In inertial confinement fusion, laser beams or particle beams are focused on spherical targets containing fusion fuel, a mixture of deuterium and tritium, causing them to implode, creating the high temperatures and pressures necessary for these targets to burn. With the NIF, scientists plan to achieve ignition (self-heating of the fuel) and energy gain (more fusion energy produced than laser energy deposited) in the laboratory for the first time.

2.3 Science, Technology, and Other Applications

The NIF will attract world-class scientists and engineers to work on science of national importance. The ability to prove experimental conditions similar to those at the center of the Sun and the stars would accelerate progress in basic sciences, such as stellar physics and cosmology. In addition, as the world's largest precision optical instrument, the Project would spur industrial capabilities, technologies, and commercial applications.

3.0 Technical, ES&H, Cost and Schedule Basis for Risk Assessment

This section provides a summary of the sources of the baseline used to measure risk against. The technical, cost, and schedule baselines are contained in the Project Execution Plan (DOE, 1996c) which was approved by the Assistant Secretary for Defense Programs. As baseline changes are approved, the Project Execution Plan is updated. The ES&H baseline is carried in the Final PEIS for Stockpile Stewardship and Management (DOE, 1996a) (mitigation measures in the Mitigation Action Plan), the NIF Preliminary Safety Analysis Report (LLNL, 1996a), and the Quality Assurance Program Plan (LLNL, 1996c). These documents are listed with their full titles in the reference section (Section 6) of this plan.

4.0 Risk Identification

The risk elements identified by the assessment team are listed in Table 1 and summarized below. The table provides the likelihood or probability of occurrence of each element; the technical, ES&H, cost, and schedule impacts; and an estimate of the bounding risk. The items are listed and briefly discussed here. Risk elements that the team agreed presented negligible risks were prescreened and removed from further discussion (e.g., minor worker injuries during construction).

1. Risk of not getting the requested Congressional authorization and appropriation is possible for any Strategic Initiative due to the magnitude of the budget and the schedule over which it occurs. In FY1996 and FY1997, Congress provided the requested appropriations for NIF. Timely congressional support at the requested amount is essential to maintain the project baseline cost and schedule.
2. Risk of delay in obtaining environmental permits that constrain the start of construction. The Record of Decision (a level 0 milestone) completing the NEPA determination was received on December 19, 1996. This was 3 months later than the baseline schedule. Environmental permit applications were submitted immediately after the ROD.
3. Opposition groups have indicated their intent to file a law suit against the PEIS on Stockpile Stewardship and Management. The impact of a successful legal challenge would depend on the wording of any injunction or other legal decision. For example, an injunction to cease design and construction would have a major impact on the Project with significant delay and penalties amounting to many millions of dollars. On the other hand, if work is allowed to continue during litigation, only minor impacts may occur.

4. Risk of delay in DOE Critical Decision 3 (a level 0 milestone), approval of construction start, would be a critical schedule constraint. Its delay would affect the entire project schedule and cost.
5. Risk of the Title II design schedule not supporting the critical path construction schedule for conventional facilities and special equipment. This requires definition and control of interfaces.
6. Risk of not getting the technology results on schedule to support NIF design and procurement. Since the design packages are being completed in FY1997/1998, the supporting technology data are essential.
7. Risk that optics facilitization and pilot production will not provide adequate basis for NIF optics procurements. This could impact the cost, schedule, and technical performance of the facility.
8. Risk of failure of the limited optics vendor base to produce all of the optics required to meet NIF schedules, cost, and specifications. NIF will require a large number of unique optics and this production may present a challenge to vendors.
9. Risk of procured materials or special equipment (non-optics) not being delivered on time, or not meeting specifications. NIF materials and equipment sometimes have unique characteristics or specifications. It is possible that some items may not meet specifications upon delivery, or in order to meet specifications, they may not be delivered on time.
10. Risk of conventional facility critical path construction falling behind schedule due to labor difficulties, contractual problems, supplier problems, etc. This would have schedule impacts. There may be additional cost impacts as well, from increased labor or supply costs.
11. Risk of interference between any of conventional facility construction, special equipment installation, and initial operation. These are interleaved activities occurring in the same time frame in the same space.
12. Risk of lost-time injuries occurring during construction. Statistics indicate that worker injuries will occur during the construction period. Most of these will be relatively minor, but there may be several more significant injuries resulting in lost work time that may also occur. Such occurrences might have minor schedule impacts. This class of injury is not as severe as that identified in item 13 below.
13. Risk of significant injury or fatal accident during NIF construction could impact the cost and schedule of the Project in a significant way while investigation and reviews are ongoing.
14. Risk of regulation or permit violation during construction. This primarily includes OSHA regulations, but there is also the possibility of violating DOE requirements (such as not reporting an incident in time), or violating the Storm Water Pollution Prevention Plan (SWPPP). Violations could result in small schedule slips and associated costs, or fines. Injuries could occur if violations

exist. Such injuries are generally expected to be minor, but more significant injuries could also result.

15. Risk of severe natural phenomena occurring during construction. This would include earthquakes or severe weather (rainfall/flooding, temperatures, high winds). This could result in damage to the partially constructed facility or injuries. A delay in schedule would likely result.
16. Risk of delay in completing the Operational Readiness Review (ORR) for the first laser bundle and handing it over to the program. Activation and integrated testing would take place before the ORR. After the ORR, the first bundle would be handed over to the Program to operate.
17. Risk of shortfalls in the ICF Program resources to operate the NIF first bundle and to activate the laser clusters in terms of funding, manpower, etc. This should be minimized as Nova operations phase-out while NIF is activating.
18. Risk of performance shortfall in the NIF special equipment systems that affect the ability to achieve technical requirements. Impact of lessons learned from the first laser bundle should reduce this risk.
19. Risk of a change in the regulatory agency. It is expected that DOE facilities will be externally regulated at some point in the future. This may occur within the next 10 years. The Nuclear Regulatory Commission (NRC), or other regulatory body, would become involved, and it is expected that this would result in some delays as the new agency becomes familiar with the new facilities that it will be regulating.
20. Risk of delays in the Acquisition Executive approving Critical Decision 4 marking completion of the project.

5.0 Risk Assessment and Mitigation Measures

The sections to follow describe the methodology that the Risk Assessment team developed to evaluate and rank the risks identified for the NIF Project. The results of the risk ranking are described, and risk mitigation measures are discussed.

5.1 Risk Assessment Methodology

This section provides the methodology used for the relative risk assessment performed as part of this Risk Management Plan. The approach taken was to assign qualitative descriptors to risk element consequences and likelihoods. The risk element consequences and likelihoods were combined using a risk matrix to obtain an assessment of the relative risk presented by each element. The development of the risk matrix is the main subject of this section.

A 3x3 risk matrix has been utilized here, with consequences on the vertical axis and likelihood on the horizontal axis. In order to determine the relative risk presented by each of the 9 blocks of the risk matrix, numerical values were assigned to the likelihood and consequence axes. The product of the numerical values of likelihood and consequence gives a numerical measure of the relative risk for each block. The numerical values for risk were binned into risk ranges, allowing the relative risk of each of the 9 blocks of the matrix to be known. Each NIF risk element can be placed into a block on the matrix based on its associated likelihood and consequence. The relative risk category of the block where the risk element is placed provides the risk category for that risk element.

The basis for the numerical values for likelihoods and consequences used in establishing the risk matrix is given below. This is followed by the approach used for binning the blocks of the matrix into risk ranges. The risk matrix is provided at the end of this section.

Likelihood Categories

The likelihood of occurrence has been estimated in an order of magnitude fashion. The least likely category (A) includes risk elements that will probably not occur during the life of the project, or that are extremely unlikely. This category has been assigned a numerical value of 1. The most likely category (C) would include risk elements that may be expected to occur during the life of the project. A numerical value of 100 was assigned to this category. The intermediate likelihood category (B) includes risk elements that are unlikely to occur during the life of the project. This category has a numerical value of 10 assigned to it. The likelihood categories are summarized below:

- A: Probably will not occur / extremely unlikely (value = 1)
- B: Unlikely that it will occur (value = 10)
- C: Probably will occur (value = 100).

Consequence Categories

Risk elements are broken down into four general types of impacts: technical, ES&H, cost, and schedule. Guidelines used in placing risk elements into a consequence category are provided below for each of the four general types of impacts. These are also order of magnitude estimates, and each category is approximately an order of magnitude different in impact from the adjacent category (ies). To the extent feasible, an attempt was made to have the consequence levels represent approximately equivalent consequences for the four types of impacts. The consequence levels cover the range of potential impacts anticipated for NIF. As with the likelihoods, consequences were placed in three categories, identified as A, B, and C. Category A represents lower impacts, Category B represents intermediate impacts, and Category C represents higher impacts. The various categories for each type of impact are described below.

Technical

- A: Minor results required for final design or procurement are not available; or, the facility, once operating, will not perform exactly as planned, and will be unable to provide some minor pieces of technical information (i.e., “it would be nice to know” type of information) (value = 1)
- B: More significant results for final design or procurement are not available; or, the facility, once operating, will not perform as well as planned and will not be able to provide certain types or ranges of information originally hoped for (“important to know” type of information); the facility will still be capable of providing some valuable information (value = 10)
- C: Critical results required for final design or procurement are not available; or, the facility may not be operable, or if operable, will only be capable of providing very limited new information (value = 100).

ES&H

- A: Lost-time injuries or minor offsite impacts (value = 1)
- B: Significant disabling injuries, single death, or major offsite impacts (value = 10)
- C: Multiple deaths or equivalent offsite impacts (value = 100).

Cost

- A: Less than 10 M\$ lost (value = 1)
- B: Between 10 and 100 M\$ lost (value = 10)
- C: More than 100 M\$ lost (value = 100).

Schedule

- A: Few days to few months (value = 1)
B: Few months to few years (value = 10)
C: Many years delay (value = 100).

Relative Risk Matrix and Relative Risk Levels

The numerical values assigned to each consequence and likelihood category can be combined as a product to give risk values for each block of the risk matrix. The risk values corresponding to the likelihood and consequence scales established above are provided on Figure 1.

For the purpose of categorizing risks according to their relative importance, the blocks on the matrix were grouped into three relative risk levels. The highest level (Level III) corresponds to a combined risk measure greater than 1,000; the second category (Level II) corresponds to a risk measure greater than 100 up to and including 1,000; and the third and lowest risk category (Category I) corresponds to a risk measure of 100 or less.

100	1,000	10,000	C (100)
10	100	1,000	B (10)
1	10	100	A (1)
A (1)	B (10)	C (100)	Consequence Category
Likelihood Category			

	Level I Relative Risk (≤ 100)
	Level II Relative Risk ($> 100, \leq 1,000$)
	Level III Relative Risk ($> 1,000$)

The blocks on the matrix were grouped into these risk levels based on the following. It would be reasonable to place a risk element that will probably occur during the life of the Project, and which would result in the lowest level of consequence (e.g. lost-time injuries, small schedule slip, or low cost impact) in the lowest relative risk level. The numerical value on the block of the matrix associated with an element with a Category C likelihood (highest likelihood) and a Category A consequence (lowest consequence) is 100. Thus, the lowest relative risk level (Level I) would include all blocks on the matrix with numerical values up to and including 100. Any element with a risk value less than or equal to the risk associated with a Category A consequence occurring during the Project lifetime (i.e., Category C likelihood) would fall into this risk range. The next highest level of relative risk, Level II, would include elements presenting 10 times greater risk than Level I risk elements. Level III relative risk would include elements presenting 10 times greater risk than the Level II category, and 100 times greater risk than the Level I risk category. These groupings are reflected on the matrix.

5.2 Risk Assessment Results

Table 1 provides a summary of the 20 identified risk elements and their consequences if they occurred (e.g., CD 3 being late will delay project completion by the same amount and involve a cost penalty averaging \$5M per month). The table gives the relative likelihood of occurrence and the consequence of occurrence for each type of impact (i.e., technical, ES&H, cost, and schedule). A bounding relative risk level is provided for each element. If an element could result in multiple types of impacts, then the risk of each type of impact was reviewed separately. The highest risk associated with any element is listed in the table. The risk assigned was representative of the cumulative risk associated with a given risk element over the life of the Project. Justification for assignment of likelihoods and consequences is provided in Appendix A.

As shown in Table 1, most risk elements fall into the Level I (lowest) relative risk category. There are no elements presenting a Level III relative risk. There are several, however, that present a Level II relative risk. These higher risk elements are discussed in greater detail in the following paragraphs:

1. *Risk of not getting Congressional required budget authorization and appropriation.* This element presents a cost and schedule risk. The cost risk is relatively higher compared to many of the other elements. If the required budget is not obtained, the Project would be delayed with associated cost penalties. It is conceivable, that in the worst case, several years delay could occur. This would result in severe cost impacts. To mitigate this risk full Project funding has been proposed for FY98. Full funding will be proposed each year until the Project's completion. Additionally, both the Project and DOE are striving to maintain

- NIF as a high priority item with Stockpile Stewardship decision-makers. These actions should minimize the likelihood of not receiving the full budget.
3. *Risk of a successful legal challenge of the PEIS on Stockpile Stewardship and Management.* This element presents a cost and schedule risk. Adversaries have indicated their intent to file suit against the Department of Energy on the PEIS. It is possible that this action will have no effect on the NIF schedule. On the other hand, it is also possible that the courts will order all or some NIF activities to cease until litigation is completed. This could result in a lengthy delay with significant cost impacts. In addition, there would be cost impacts associated with the legal defense of NIF. The Project, LLNL counsel, and the DOE are currently working on a defense strategy. The result is that this element presents a relatively higher cost risk than most of the other elements. To mitigate this risk, the Project and the DOE extensively reviewed the PEIS and the NIF PSA (Project Specific Analysis) during their development to ensure that all NEPA requirements were met. Attention was given to any weaknesses identified early on, and these areas were strengthened/ improved. Both the DOE and the Project have confidence that the PEIS can withstand a legal challenge. In addition, DOE and Project personnel have been briefed on how to manage inquiries by litigants. Responses to litigants are planned and well prepared.
 7. *Risk that optics facilitization and pilot production (OF/PP) will not provide adequate basis for NIF optics procurement.* This risk element presents a technical, cost, and schedule risk. The technical risk is relatively higher than the other risk elements. This activity was initiated because of the technical risk associated with the optics. Thus, in and of itself, it presents a risk mitigation action. If OF/PP does not provide sufficient information, or provides unexpected information, there could be a direct impact on the technical performance of the final NIF optics, and possibly cost and schedule impacts as the Project determines how to best act upon the information they have. To minimize this risk, the Project has identified key contacts for each vendor type. These individuals maintain regular contact with the vendors, monitoring progress, providing guidance, and helping address issues. There are also lead technical people in the Program, who are responsible for development activities in these areas. The OF/PP is taking place relatively early in the schedule, making it easier to manage unexpected occurrences without impacting the overall Project schedule. Detailed optics procurement plans have been developed as well as production contingency for key optics.
 13. *Risk of significant injury or fatal accident during NIF construction.* This risk element presents a relatively higher ES&H risk than other risk elements. There is also a cost and schedule risk associated with this element, but the ES&H component dominates. In a conventional construction project the size of NIF, statistics indicate that more than one death would be expected to occur during the activity. If a death were to occur, it is expected that all activity at the site would cease until the incident was fully investigated and the cause of the accident fully understood. To mitigate this risk, the Project has adopted a

“Zero Accident” policy. The Project is planning to, and expects to, perform better than general industry. A Construction Safety Program has been developed and has been distributed with the construction bid packages. Conventional facilities and Special Equipment will also develop specific construction safety plans for their areas. To supplement this, there are the laboratory safety programs and DOE safety requirements. Workers will be well trained. The ES&H team will be available for support, and there will be dedicated safety officers at the site. With all of these additional measures, it is unlikely that a severe injury or death will occur during NIF construction.

5.3 Risk Mitigation Measures and Implementation

Risk mitigation measures can function in two ways: they can either reduce the likelihood of the risk element, or they can reduce the consequences of the risk element. The first type is preventive. Preventive mitigation measures are pro-active measures that assure the risk element does not occur. They work on the causes of why a certain element might occur, and focus on making it less likely for a certain cause to actually take place. The second type of risk mitigation measure attempts to alleviate the consequences of a risk element, once it has occurred. This type focuses on ways of managing the consequence, or provides an alternate pathway to follow if the risk element does occur (i.e., “Plan B”). Measures that have already taken place qualify as risk mitigation measures, if they have had an impact on reducing the likelihood of the risk element. Ongoing activities can also be included as mitigation measures (preventive type).

Risk mitigation measures have been developed for all of the identified risk elements. These are listed in Table 1. The mitigation measures range from detailed planning and scheduling of construction and equipment installation activities to the development of contingency plans (e.g., use of multi-shift, off-shift strategy, and overtime). The main mitigation action is the clear definition of organization responsibility. This is done in the form of formal plans, such as the Construction Management Implementation Plan which defines a single authority during the period when construction, special equipment installation, and start-up or ongoing operations occur simultaneously. That single authority establishes priorities, coordinates the organization at the construction site, and provides the method to resolve interference and conflicts.

Several of the risk elements have already been identified as higher risk areas, and consequently have become project thrust areas. This is true of optics facilitization and pilot production, where key contacts have been identified for each vendor type, and it is their responsibility to maintain regular interactions with the vendors, to monitor progress, and to address issues. In addition, the Program has lead technical people responsible for development activities in these areas. Activation and Start-up has also become a Project thrust area. Many individuals are involved with the activation activity, and they are all working towards the successful start-up of the first bundle. (A bundle is a grouping of 8 individual laser beams. Bundle 31, for example, in Laser

Bay 2, will be the first bundle activated by the Project and handed over to the Program. This will take place in approximately mid FY01.)

Construction bid packages contain detailed specifications and other information, such as the Construction Safety Program. When the contract is awarded, the contractor is bound to adhere to the details of the bid package. Further, the Construction Manager has developed a plan to ensure that commitments are made (e.g., regular safety meetings, training, verification of qualifications), and the NIF Assurances office will oversee and audit the Construction Manager.

The Project also routinely performs audits of the Architectural Engineering firm and the NIF design teams to ensure that Project commitments are being met. Non-conformances and improvement items are documented in a written report. These are tracked by the NIF Assurances Office until closure.

The identified risk mitigation measures currently appear to be adequate, and have reduced the risk of NIF risk elements to acceptable levels.

6.0 References

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- LLNL (1997), Construction Safety Program for the National Ignition Facility, UCRL-ID-125990, Lawrence Livermore National Laboratory, January 1997.

Table 1. Likelihood, consequences, and relative risk of NIF Risk Elements and associated mitigation measures.

Likelihood	Consequences				Bounding Relative Risk	Identified risk element	Planned mitigation measures
	Tech	ES&H	Cost	Schedule			
B			C	B	II	1. Risk of not getting Congressional required budget authorization and appropriation.	<ul style="list-style-type: none">• Maintaining high priority of NIF with Stockpile Stewardship decision-makers• Proposed full Project funding
A			B	A	I	2. Risk of delay in obtaining environmental permits that constrain the start of construction.	<ul style="list-style-type: none">• Permits submitted to regulatory agencies• Permits well prepared by experienced preparers and internally reviewed• Follow-up with regulatory agencies
B			C	B	II	3. Risk of a successful legal challenge on the PEIS on Stockpile Stewardship and Management.	<ul style="list-style-type: none">• PEIS reviewed and revised by DOE GC and DOE EH to fully satisfy NEPA, weaknesses fortified• NEPA reviewed by GC/EH with Secretary on two occasions prior to ROD• Planned response to inquiries by potential litigants• Litigation defense strategy to be developed if sued
A			A	A	I	4. Risk of delay in DOE Critical Decision 3, approval of construction start.	<ul style="list-style-type: none">• ROD published• Action memo prepared• Delegation to ASDP• ASDP kept well informed• Construction plan in place• Permits submitted• Published documents for DOE to make decision, e.g., PSAR approved, PEP approved• Bids complete for first construction packages• All supporting documentation completed
A			B	B	I	5. Risk of Title II design schedule not supporting the critical path construction schedule for conventional facilities and special equipment.	<ul style="list-style-type: none">• Focused special equipment interface definition• Detailed Title I and II design plans• Overtime and multiple shift• Acceleration of Title II S.E. design impacting construction
B	B		B	B	I	6. Risk of not getting technology results on schedule to support NIF design and procurement.	<ul style="list-style-type: none">• Integrated NIF project/program• Redistribution of budgets to meet priorities• Milestone definition and monitoring• QA Plan
B	C		B	B	II	7. Risk that optics facilitization and pilot production will not provide adequate basis for NIF optics procurements.	<ul style="list-style-type: none">• Aggressive vendor interaction• Production contingency for key optics• Detailed optics procurement plan• <u>Early</u> facilitization and pilot optics
B	B		B	B	I	8. Risk of failure of the limited optics vendor base to produce all of the optics required to meeting NIF schedules, cost, and specifications.	<ul style="list-style-type: none">• Optics facilitization• Pilot production• Production contingency for key optics• Early optics production
B	B		A	A	I	9. Risk of procured materials or special equipment (non-optics) not being delivered on time or not meeting specifications.	<ul style="list-style-type: none">• Vendor surveys• Prequalified bidders• Requirement specifications• ICDs• Best-value procurement selection method
B			B	A	I	10. Risk of conventional facilities critical path construction falling behind schedule due to labor difficulties, contractual problems, supplier problems, etc.	<ul style="list-style-type: none">• Detailed schedule and plans• Multiple shifts/overtime• CM coordination and tracking• Incentives to contractors• Project Labor Agreement• Alternate Dispute Resolution process• Owner Controlled Insurance policy
B			B	B	I	11. Risk of interference between any of conventional facilities construction, special equipment installation, and initial operations.	<ul style="list-style-type: none">• Integrated schedule planning• Contingency planning• Daily coordination meetings• Overtime, multiple shifts• QA Plan• CM single authority on priority, interference resolution, etc.• Risk reduction planning (e.g., use of off-shift)• Incentives to contractors• Construction Management Implementation Plan

Table 1. Continued.

Likelihood	Consequences				Bounding Relative Risk	Identified risk element	Planned mitigation measures
	Tech	ES&H	Cost	Schedule			
C		A	A	A	I	12. Risk of lost-time injuries occurring during construction.	<ul style="list-style-type: none">• Conventional Facilities and Safety Equipment Construction Safety Program and Plans• Training• Zero accident policy• DOE safety requirements <ul style="list-style-type: none">• ES&H team• Construction safety officers, construction inspectors• Job hazards analysis
B*		C	B	B	II	13. Risk of significant injury or fatal accident during NIF construction.	<ul style="list-style-type: none">• Construction safety program• Conventional facilities and special equipment construction safety plans• Zero accident policy• Laboratory safety programs• Training <ul style="list-style-type: none">• DOE safety requirements• ES&H team• Construction safety officers, construction inspectors• Job hazards analysis
B		B	B	A	I	14. Risk of regulation or permit violation during construction.	<ul style="list-style-type: none">• Construction Safety Program• Conventional facilities and special equipment construction safety plans• Zero injury techniques• ES&H team <ul style="list-style-type: none">• Construction safety officers, construction inspectors• Designated responsible individual for implementing SWPPP
B		B	B	A	I	15. Risk of severe natural phenomena occurring during construction.	<ul style="list-style-type: none">• Emergency Plan• Training• Mitigation Action Plan <ul style="list-style-type: none">• Quality levels• Tie downs (for seismic, wind, flooding)
B			B	B	I	16. Risk of delay in completing the Operational Readiness Review for the first laser bundle (BU31), and handing it over to the Program.	<ul style="list-style-type: none">• Project/ program focus• ORR plan prepared• Training <ul style="list-style-type: none">• QA Plan• ES&H Plans for key documents (e.g., FSAR, permits, etc.)
B			B	B	I	17. Risk of shortfalls in the ICF Program resources to operate the NIF first bundle and to activate the subsequent laser clusters.	<ul style="list-style-type: none">• High priority of Stockpile Stewardship Program in DP/ commitment of LLNL Laboratory Director• High priority of NIF operation• Phasing of Nova shutdown and NIF activation <ul style="list-style-type: none">• Level of funding may be reduced but balance would be maintained to support the ICF program
B	B to C		B to C	B to C	I to II	18. Risk of performance shortfall in the NIF special equipment systems that affect the ability to achieve technical requirements.	<ul style="list-style-type: none">• Off-line laboratory (e.g., AMPLAB) results• Beamlet results• QA Plan including quality levels <ul style="list-style-type: none">• Technology development/ prototyping results• Lessons learned from first laser bundle• Formal design reviews
C			A	A	I	19. Risk of a change in the regulatory agency (DOE to NRC or other).	<ul style="list-style-type: none">• Actively following discussions on the subject• If regulatory agency changes, will discuss requirements with them immediately, and develop a plan
A			A	A	I	20. Risk of delays in the Acquisition Executive approving Critical Decision 4.	<ul style="list-style-type: none">• Majority of project already turned over by CD4• Experience basis of ~3 years of operation prior to CD4 <ul style="list-style-type: none">• AE kept informed about NIF

*Based on zero CM injury safety program.

APPENDIX A

Justification of Consequences and Likelihoods used in Relative Risk Assessment

1. Risk of not getting Congressional required budget authorization and appropriation.

Cost Consequence:	C	Estimated 60 \$M/year (5 \$M/month) for several years - > 100 \$M from schedule slippage
Schedule Consequence:	B	Could ultimately result in a few years slippage
Likelihood:	B	High priority item within Stockpile Stewardship
Cost Relative Risk:	II	
Schedule Relative Risk:	I	
Bounding Relative Risk:	II	(Cost risk is bounding)

2. Risk of delay in obtaining environmental permits that constrain the start of construction.

Cost Consequence:	B	Estimated 10–100 \$M from schedule slippage
Schedule Consequence:	A	Few months delay estimated
Likelihood:	A	Experienced preparers, permits well prepared
Cost Relative Risk:	I	
Schedule Relative Risk:	I	
Bounding Relative Risk:	I	

3. Risk of a successful legal challenge of the PEIS on Stockpile Stewardship and Management.

Cost Consequence:	C	Costs due to delays could be significant, some costs for effort spent on defending NIF
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Schedule Consequence:	B	Delays range from days to many months, to possibly years
Likelihood:	B	Law suit has been filed; unclear if adversaries will succeed in delaying the Project
Cost Relative Risk:	II	
Schedule Relative Risk:	I	
Bounding Relative Risk:	II	(Cost risk is bounding)
- 4. Risk of delay in DOE Critical Decision 3, approval of construction start.**
Cost Consequence:	A	< 10 \$M due to schedule slippage
Schedule Consequence:	A	Extensive delay not expected (less than a month or so)
Likelihood:	A	NIF high priority item, new Secretary has expressed support of Stockpile Stewardship, pre-construction required actions completed or on schedule
Cost Relative Risk:	I	
Schedule Relative Risk:	I	
Bounding Relative Risk:	I	
- 5. Risk of the Title II design schedule not supporting the critical path construction schedule for conventional facilities and special equipment.**
Cost Consequence:	B	Probably between 10 and 100 \$M due to schedule slippage
Schedule Consequence:	B	Delay could be many months
Likelihood:	A	Dedicated staff, Project well planned
Cost Relative Risk:	I	
Schedule Relative Risk:	I	
Bounding Relative Risk:	I	
- 6. Risk of not getting technology results on schedule to support NIF design and procurement.**
Technical Consequence:	B	Facility may not perform as well as planned

Cost Consequence:	B	~ 10–100 \$M due to schedule delays if wait to obtain information
Schedule Consequence:	B	May delay many months to maybe a year or so, if wait to obtain appropriate information
Likelihood:	B	New technology
Technical Relative Risk:	I	
Cost Relative Risk:	I	
Schedule Relative Risk:	I	
Bounding Relative Risk:	I	
- 7. Risk that optics facilitization and pilot production will not provide adequate basis for NIF optics procurements.**
Technical Consequence:	C	Critical information from OF / PP required for optics procurement
Cost Consequence:	B	~ 10–100 \$M due to schedule delays
Schedule Consequence:	B	Delay many months to maybe a year or so, if wait to obtain appropriate basis
Likelihood:	B	New technology, large scale, vendors not experienced at producing NIF optics
Technical Relative Risk:	II	
Cost Relative Risk:	I	
Schedule Relative Risk:	I	
Bounding Relative Risk:	II	(Technical risk is bounding)
- 8. Risk of failure of the limited optics vendor base to produce all of the optics meeting NIF schedules, costs, and specifications.**
Technical Consequence:	B	Facility will not perform as well as planned if optics do not meet specs
Cost Consequence:	B	~ 10–100 \$M due to schedule delays
Schedule Consequence:	B	Possibly many months to a year or so
Likelihood:	B	New technology
Technical Relative Risk:	I	
Cost Relative Risk:	I	
Schedule Relative Risk:	I	
Bounding Relative Risk:	I	

9. Risk of procured materials or special equipment (non-optics) not being delivered on time, or not meeting specifications.

Technical Consequence:	B	Facility may not perform as well as planned
Cost Consequence:	A	~< 10 \$M due to schedule slippage
Schedule Consequence:	A	Possibly few months delay to upgrade, replace, etc.
Likelihood:	B	Many unique aspects of NIF equipment
Cost Relative Risk:	I	
Schedule Relative Risk:	I	
Bounding Relative Risk:	I	

10. Risk of conventional facilities critical path construction falling behind schedule due to labor difficulties, contractual problems, supplier problems etc.

Cost Consequence:	B	>~ 10 \$M due to schedule, possibly additional labor/supply costs
Schedule Consequence:	A	Up to a few months delay possible
Likelihood:	B	Labor situation appears stable, CM planning
Cost Relative Risk:	I	
Schedule Relative Risk:	I	
Bounding Relative Risk:	I	

11. Risk of interference between any of conventional facilities construction, special equipment installation, and initial operations.

Cost Consequence:	B	~ 10- 100 \$M due to schedule delays
Schedule Consequence:	B	Could result in many months of delays (construct/install in series, rather than parallel)
Likelihood:	B	Schedule planning to minimize conflict
Cost Relative Risk:	I	
Schedule Relative Risk:	I	
Bounding Relative Risk:	I	

12. Risk of lost-time injuries occurring during construction.

ES&H Consequence:	A	Lost-time injuries
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Cost Consequence:	A	Minor cost impacts
Schedule Consequence:	A	Minor schedule impact, if investigation needed
Likelihood:	C	Expected during a construction project of this size
Cost Relative Risk:	I	
Schedule Relative Risk:	I	
Bounding Relative Risk	I	

13. Risk of significant injury or fatal accident during NIF construction.

ES&H Consequence:	C	Conventional construction projects of this magnitude would typically have more than one death occurring during the activity
Cost Consequence:	B	Possibly 10–100 \$M due to schedule slippage
Schedule Consequence:	B	Expect delays of many months to investigate accident
Likelihood:	B	Expected on projects of this magnitude, but actively working to reduce likelihood (e.g., Construction Safety Program)
ES&H Relative Risk:	II	
Cost Relative Risk:	I	
Schedule Relative Risk:	I	
Bounding Relative Risk:	II	(ES&H risk is bounding)

14. Risk of regulation or permit violation during construction.

ES&H Consequence:	B	Expected to be minor, but could have serious injuries/ death
Cost Consequence:	A	Possibly < ~10 due to schedule slippage, fines
Schedule Consequence:	A	Minor delays to investigate violation
Likelihood:	B	Large project
ES&H Relative Risk:	I	
Cost Relative Risk:	I	
Schedule Relative Risk:	I	
Bounding Relative Risk:	I	

15. Risk of severe natural phenomena occurring during construction.

ES&H Consequence:	B	Could result in severe injury; small spills may occur, minor worker injuries would be more typical
Cost Consequence:	B	10–100 \$M from schedule slippage, may have to repair some parts of the facility that were already constructed
Schedule Consequence:	A	Maybe up to a few months to recover at most
Likelihood:	B	Severe earthquake (e.g., like Loma Prieta) infrequent, weather extremes infrequent
Cost Relative Risk:	I	
Schedule Relative Risk:	I	
Bounding Relative Risk:	I	

16. Risk of delay in completing the Operational Readiness Review for the first laser bundle, and handing it over to the Program.

Cost Consequence:	B	~ 10–100 \$M due to schedule delays
Schedule Consequence:	B	Could result in many months of delays
Likelihood:	B	Early planning for ORR
Cost Relative Risk:	I	
Schedule Relative Risk:	I	
Bounding Relative Risk:	I	

17. Risk of shortfalls in the ICF Program resources to operate the NIF first bundle and activate the laser clusters.

Cost Consequence:	B	~ 10–100 \$M due to schedule delays
Schedule Consequence:	B	Could result in many months of delays until ICF program works it into their budget
Likelihood:	B	Future budgets uncertain, but NIF has high priority, Nova operations decreasing
Cost Relative Risk:	I	
Schedule Relative Risk:	I	
Bounding Relative Risk:	I	

18. Risk of performance shortfall in the NIF special equipment systems that affect the ability to achieve technical requirements.

Technical Consequence:	B to C	May only achieve limited to very limited results from operating NIF
Cost Consequence:	B to C	potentially very high, if expend > 1.2 \$B and facility doesn't perform, plus possible additional costs to retrofit
Schedule Consequence:	B to C	Could be many years to redesign and install
Likelihood:	B	New technology, but some experience with beamlet and first NIF bundle
Technical Relative Risk:	I to II	
Cost Relative Risk:	I to II	
Schedule Relative Risk:	I to II	
Bounding Relative Risk:	I to II	

19. Risk of a change in the regulatory agency (DOE to NRC or other).

Cost Consequence:	A	~< 10 \$M due to schedule delays
Schedule Consequence	A	Possibly as much as a few months delay
Likelihood	C	Discussions are underway
Cost Relative Risk:	I	
Schedule Relative Risk:	I	
Bounding Relative Risk	I	

20. Risk of delays in the Acquisition Executive approving Critical Decision 4.

Cost Consequence:	A	~< 10 \$M due to schedule slippage
Schedule Consequence:	A	Possibly few months delay
Likelihood:	A	Most of Project already handed over to Program
Cost Relative Risk:	I	
Schedule Relative Risk:	I	
Bounding Relative Risk:	I	

In cases where the different types of consequences lead to different Relative Risk values, the highest Relative Risk value is noted in Table 1.