

LLE INSTRUCTION 7700F

SUBJECT: DESIGN AND INTEGRATION OF EQUIPMENT

- ENCLOSURES:**
- (1) Project Budget Request for NEW Project
 - (2) Project Budget Request for EXISTING Project
 - (3) Equipment Qualification Checklist (EQC)
 - (4) Safety Risk Assessment Checklist (SRAC)
 - (5) Failure Mode and Effects Analysis (FMEA)
 - (6) Pre-Operation Safety Inspection Checklist
 - (7) Project Approval Cover Sheet

1. **Purpose:** To establish procedures for initiation, coordination, and administration of LLE-approved projects for new or changed equipment or systems. This instruction includes design review and documentation requirements to ensure that safety, reliability, and all other relevant factors are addressed during the design and qualification process.
2. **Scope:** This policy applies to projects that produce new equipment or significant modifications to existing equipment including beam-generation and control equipment, target handling and positioning equipment, laser diagnostics, target diagnostics, and communication infrastructure. Significant modifications in the context of this instruction include changes that affect the operational characteristics, structural integrity, or safety of a previously qualified piece of equipment. Generally, changes that affect more than one engineering discipline should be classified as significant. For minor changes to a qualified piece of equipment, a full requalification in the context of this instruction is not required as long as the Engineering Division Director approves the change to be minor, the change is approved as part of the normal Project Data Management (PDM) design approval process, and the change is effected using LFORM work authorization procedures (WAP's).

LLE internal projects will generally be proposed and approved as part of the Laboratory's annual budget cycle, but projects may be proposed and considered for approval whenever the circumstances warrant. This policy also applies to projects that originate or are developed externally for use at LLE. The complete process defined here will be tailored to accommodate the characteristics of individual projects.

Each project will have a task identification acronym, budget, System Engineer (SE), Principal Investigator (PI), and Project Assistant (PA).

The overall project process consists of the following phases:

- Budget Approval
- Definition of Requirements
- Safety Risk Assessment & Failure Modes and Effects Analysis
- Design
- Assembly
- Preliminary Qualification
- Installation
- Final Qualification
- Approval and Commissioning

3. Project Initiation, Annual Renewal, and Approval (Internal Projects)

- a. All internal projects will be initiated by submitting a Project Budget Request (PBR) form, Enclosure (1). If the project is not completed within the fiscal year for which it was approved, the PBR must be resubmitted as part of the next year budget process using Enclosure (2).
- b. The Principal Investigator is responsible for submitting new or updated PBR's to their Division Director.
- c. The Division Director will review each PBR in the context of the Laboratory's goals and plans. Requests that are approved at the division level will be included in the draft fiscal year budget package prepared by the Director of the Administrative Division.
- d. The Director of the Administrative Division will notify the PI's and PA's of the status of their project requests as a result of the Fiscal Year Budget Cycle and whenever changes occur. System Engineering and the affected supporting groups, as indicated on the approved PBR, will also be notified.
- e. When a project has been approved, System Engineering will work with the PI/PA and the designated functional groups to complete the definition of the project.
- f. The Administrative Division will maintain a database that tracks the status and budget of each project that has been approved. This database will also capture the project description, completion date, and supporting group effort information included on the PBR form.
- g. System Engineering will actively monitor project status and assist the PI/PA in adhering to the project schedule.

4. Project Initiation and Approval (External Projects)

Projects that originate or are developed externally for use at LLE will result from discussions between LLE and one or more collaborating institutions. When the principals have agreed to pursue a project, the appropriate persons from each institution will cooperate to execute the design and qualification process defined in the remainder of this instruction.

5. Project Completion Procedures

a. Overview

Once a project is approved, a System Engineer will be assigned to the project and a Project Team consisting of the Principal Investigator, Project Assistant, System Engineer, and applicable operations and engineering representatives will be assembled. The System Engineer will facilitate and coordinate the efforts of this team to

- Determine project requirements,
- Generate a Failure Mode and Effects Analysis
- Tailor an Equipment Qualification Checklist (EQC), Enclosure (3),
- Schedule reviews and track corrective actions from reviews, and
- Assemble the final project documentation package for approval.

Project reviews are the primary mechanism for updating interested parties on the status of a project prior to advancing to the next level of development. They include

- Requirements Review (RR),
- Conceptual Design Review (CDR) – Mandatory
- Preliminary Design Review (PDR)
- Final Design Review (FDR) – Mandatory
- Operational Readiness Review (ORR) – Mandatory

The requirements of these reviews are detailed below. As noted above, the CDR, FDR and ORR are mandatory. Exceptions will be made when appropriate (i.e., for simple projects or legacy requalification reviews), where all the relevant information is presented in a single comprehensive review. The need for the other reviews will normally be determined during the initial project definition phase. Each review requires a presentation of an up-to-date Safety Risk Assessment (SRA) and Failure Mode and Effects Analysis (FMEA).

b. Project Definition Phase

- (1) After a project is approved, the System Engineer will meet with the Principal Investigator to determine the project requirements and assist the PI to submit engineering service requests including Electronics and Controls Engineering, Mechanical Engineering, Software Engineering, and Optical Engineering/Manufacturing as required. If a Project Requirements Review is required it will be scheduled. The System Engineer will issue a memorandum of technical requirements that defines the form, fit, and function of the component.
- (2) Once the project requirements are understood, the System Engineer, with input from the Project Team, will complete a requirements document and a tailored Equipment Qualification Checklist (EQC), Enclosure (3). For each item marked as applicable, a scheduled completion date will be assigned.

c. Safety Risk Assessment

- (1) Personnel safety is of paramount importance and will be addressed at every stage of the design and qualification process. An up-to-date Safety Risk Assessment (SRA) and Failure Mode and Effects Analysis (FMEA) must be presented at each design review. The SE will complete these documents in collaboration with the safety officers and project team engineers. The completed safety analysis will be approved by the PI and the Chief Safety Officer or his designate.
- (2) The SRA checklist of Enclosure (4) is used to summarize potential hazards associated with a project, prior to implementing any mitigation strategies.
- (3) The Failure Mode and Effects Analysis spreadsheet of Enclosure (5) provides details about specific risks to personnel and equipment, as well as corresponding mitigation strategies. Each non-zero entry on the SRA must have one or more supporting lines in the FMEA spreadsheet.
- (4) The final design must ensure that all safety risks identified on the FMEA are reduced to “minor or none” or else the project will not be commissioned. The final FMEA will be available when conducting the Operational Readiness Review inspection.

d. Design Phase

Once the project requirements are determined and the applicable engineering service requests are submitted, the design phase will commence. During the CDR a determination will be made whether a PDR is required or the project can proceed directly to an FDR. Normally all design reviews will be presented to the Project Team and other key stakeholders at a meeting. For minor projects it may be determined at the CDR that the FDR could be fulfilled by the approval of the final design using the

Product Data Management (PDM) system. Design review meetings will be scheduled through System Engineering at least one week in advance and all participants will be notified.

(1) Conceptual Design Review (CDR)

- (a) The purpose of the CDR is to ensure that the needs of the project will be met. A comparison of the expected performance of the design to the technical requirements should be presented for evaluation. Differences between the two should be discussed and resolved before the design progresses to the next phase. System integration issues, implementation, and procure/build issues should also be considered.

Multiple concepts may be presented at a CDR. If a favored approach cannot be determined during the CDR, a PDR will be required. At this stage there should be no areas of technical concern that are known “show-stoppers” (i.e., “don’t know how to do it”). Specific deliverables at the CDR include

- A description of the project and its scope
 - Identification of the Project Team
 - Definition of all required functional and technical requirements including control and software requirements
 - A presentation of the conceptual design that meets the need of the project, including CAD models, schematics, flow charts, or optical ray-trace diagrams, as needed, to clearly convey the concepts
 - A tailored EQC and a summary schedule
 - Identification of interface requirements
 - Identification of aims, goals, tolerances, metrics, and test-measurement procedures
 - A Safety Risk Assessment and Failure Mode and Effects Analysis in accordance with Sec. 5.c
 - Identification of project concerns
 - Budget and an itemized budget of procurement costs to project completion
- (b) At the conclusion of the CDR, the key design concepts are fixed, enabling technologies are verified, and the procurement of long-lead materials may be authorized. The System Engineer should publish a memorandum that documents any concerns that must be addressed as part of the follow-on design review. If the CDR was not successful, it must be repeated.

- (c) Upon recommendation by the SE and concurrence of the appropriate Division Director, the Administrative Division Database Administrator may activate the project to allow the procurement of long-lead materials.

(2) Preliminary Design Review (PDR)

- (a) The purpose of the PDR (if required) is to produce a more-advanced design based on the technical requirements approved during the CDR. Specific deliverables at the PDR include
- A design that meets the need of the project
 - An updated EQC and summary schedule
 - Definition of all functional and technical requirements, including software functionality
 - An updated presentation of the design including FEA analysis, optical ghost analysis, 3-D model, solid model, prototype, control system, etc.
 - Comparison of known technical performance capabilities compared to the list of technical and functional requirements such as FEA, ghost analysis, etc.
 - Preliminary bill of materials (BOM's), drawings of the assembly, subassembly, part or electrical or software schematics, and optical configuration
 - Review of interface requirements
 - Updated identification of aims, goals, tolerances, metrics, and test-measurement procedures
 - Review and update of the Safety Risk Assessment and Failure Mode and Effects in accordance with Sec. 5.c
 - Update of project concerns and identification of how each is being addressed
 - Review of how concerns identified in the CDR completion memorandum have been addressed
 - Updated budget and an itemized budget of procurement costs to project completion
- (b) At the conclusion of the PDR the final design concepts are fixed, enabling technologies are proven, a list of all components, materials, and software requirements are complete, and project plans and schedules are firm. Multiple design concepts should not be pursued beyond this stage. The SE should publish a memorandum that documents any action items that must be addressed as part of the final design review.

(3) Final Design Review (FDR)

- (a) The purpose of the FDR is to ensure that the design meets the needs of the project. The expected performance characteristics are better understood and, if necessary, are supported by the completion and testing of a prototype or breadboard. By the time of the FDR, designs should be complete, including detailed and dimensioned 2-D CAD drawings, electrical-circuit schematics, PC layouts, preliminary software, and a BOM including sourcing and cost analysis as applicable. Specific deliverables at the FDR include
- A completed final design
 - Updated comparison of known technical performance capabilities compared to the list of technical and functional requirements
 - Results of modeling and prototype testing
 - Final BOM, drawings of the assembly, subassembly, part or PCB schematics, or optical configurations
 - A list of required spare parts for each assembly or component
 - Assembly, alignment, or other relevant test procedures and results
 - Preliminary, debugged software packages
 - Preventative Maintenance (PM's) items associated with the part, component, or assembly
 - Final concerns list and identification of how each was addressed
 - Review of how concerns identified in the CDR/PDR completion memorandum have been addressed
 - Final update of the Safety Risk Assessment and Failure Mode and Effects in accordance with Sec. 5.c
 - Updated Project Schedule—a proposed schedule to completion
 - Updated Budget—an itemized budget to project completion
- (b) At the conclusion of the FDR the final design is approved and the project schedule and plans are firm. The SE should publish a memorandum that documents any action items that must be addressed prior to the ORR.

e. Assembly Phase

- (1) Component assembly is to be performed by qualified personnel using the approved assembly drawing. If any discrepancies of fit or function of component parts from approved drawings and specifications are identified, the assembly work will be stopped and the discrepancy will be brought to the

attention of the appropriate engineer for resolution. Component parts will be brought into compliance with the drawing or the drawing will be changed as appropriate. Only after the discrepancy is resolved will the assembly be continued.

- (2) After the component is assembled, a fit and function test will be conducted off-line if possible. This includes testing the control system and software to the full extent possible.

f. Preliminary Qualification Phase

- (1) In general, equipment, controls and software are to be qualified by of off-line testing prior to installation. During a design review, management will decide if a safety inspection of a laboratory installation will be required prior to operating new or modified equipment. All relevant items identified in the FMEA must be reviewed prior to first use to verify that the necessary mitigation strategies are implemented and effective.
- (2) In some cases, laboratory test facilities cannot replicate the relevant operational environment and *in-situ* testing (i.e., in the OMEGA facility including on-shot testing) must be performed at various stages of development to demonstrate that a system or subsystem meets design objectives. Prior to conducting a test using the OMEGA facility, a test plan must be developed to define
 - Purpose of test
 - Required operating conditions
 - Personnel involved and responsibilities of each
 - Discussion of relevant FMEA topics and mitigation strategies
 - Safety inspections required prior to executing test procedure
 - Test procedure with sufficient supporting detail so that it can be conducted by the proposed personnel. Qualification tests may involve active participation of the PI, including operation of equipment, following the terms defined in the WAP

Test plans are to be submitted with a WAP (see LFORM) by the relevant Group Leader and will be approved by the Laser Facility Manager. Tests will be scheduled to occur when they are consistent with laboratory objectives. Advance planning is critical to ensure that all laboratory objectives can be met safely and effectively.

g. Installation Phase

- (1) Prior to installation, the PI must verify that all threats identified in the FMEA have been successfully mitigated. Where appropriate, a safety test plan must be developed to demonstrate the effectiveness of each safety feature of the design

(i.e., interlocks, software error trapping, overpressure control, etc.). This test plan is to be included with an installation plan and both must be approved before installation begins.

- (2) The order of execution of the safety inspection and safety test plan will be determined on a case-by-case basis when the installation plan is reviewed. The results of the safety tests are to be published prior to final qualification. Installation and safety tests are to be coordinated using a WAP as specified in the LFORM.
- (3) Equipment will be installed by only qualified personnel approved by the applicable Engineering Group Leader. For any installations in the OMEGA Laser Facility, the installation must be completed using the work authorization procedures (WAP's) of the LFORM.

h. Final Qualification Phase

- (1) After the equipment is installed, an Operational Readiness Review (ORR) will be conducted to verify that the project is complete to the extent mandated by the tailored EQC, Enclosure (3) and the Pre-Operational Safety Inspection Checklist, Enclosure (6). A safety inspection report is required prior to the ORR for any project in which the FMEA identified risk factors requiring mitigation.
- (2) The SE will recommend the appropriate venue for the ORR (meeting or electronic approval). To facilitate the ORR, the System Engineer will prepare a task list of required action items and assign responsibility for each element. Responsible persons will independently complete the task(s) assigned and report the results in writing to the System Engineer who will complete a composite ORR report. Corrective actions noted in the ORR report must be corrected and documented prior to operation of the equipment.
- (3) To support final certification of the project completion, the SE will assemble an ORR approval package consisting of the following (where applicable) for review and approval:
 - Project Budget Request
 - Requirements Document
 - Completed Service Requests
 - Copies of presentation materials and minutes from each design review held
 - Final Safety Risk Assessment Checklist and Failure Mode and Effects Analysis
 - Completed Equipment Qualification Checklist

- Obtain verification from each engineering group that the following are complete: Design assembly drawings, electrical schematics, piping and instrumentation diagrams (P&ID's), BOM, and operating procedures
- Work Authorization Procedure
- Test plans executed during qualification and summary reports thereof
- Operational Readiness Review Report
- Fit and function test results
- Operating Procedures
- Maintenance Requirements and Procedures

These materials will also be assembled into a shared directory or searchable database. To the maximum extent possible, documents listed above will be released into the Product Data Management (PDM) system.

i. Project Commissioning and Approval

- (1) When all requirements have been completed, the SE will attach an approval cover sheet, Enclosure (7), to the project package and obtain the approval of the applicable Division Directors, the Principal Investigator, and the Chief Safety Officer. For all OMEGA Experimental diagnostics/instruments, this certification must be completed at least two weeks prior to its first use unless an exception is obtained from the LLE Director. For all other areas of LLE the certification must be completed before the first use of the equipment.
- (2) Project completion will be reported to the Administrative Division Database Administrator so that it can be removed from the active project list and have an equipment property tag installed.

j. Project tracking

- (1) The SE will maintain the project status on the LLE web page.

6. Responsibilities

a. Principal Investigator (PI)

- (1) Initiate projects by completing a Project Budget request.
- (2) Provide input as to scientific requirements.
- (3) Work with System Engineering and the Project Team to complete definition of the project including the requirements and potential evolutionary applications during the useful life of the equipment.

- (4) Prepare the required service request forms with the assistance of the SE.
- (5) Approve the Safety Risk Assessment Checklist
- (6) Exercise budget authority to control expenses.
- (7) Ensure that the project is completed on schedule to support the experimental program.

b. System Engineer (SE)

- (1) Provide the overall administration of the project through completion.
- (2) Assemble the Project Team and coordinate their efforts.
- (3) Prepare a Requirements Document
- (4) Prepare a tailored Equipment Qualification Checklist.
- (5) Lead the Project Team in preparing for design and requirements reviews.
- (6) Schedule design reviews.
- (7) Publish design review minutes and ensure that all action items are completed.
- (8) Have the project budget activated upon completion of the CDR.
- (9) Assist the PI in the submission of engineering service requests.
- (10) Complete the safety risk assessment and failure mode and effects analysis in collaboration with the safety officers and project team engineers.
- (11) Lead the Project Team in the production of appropriate fit and function, installation, and qualification test plans.
- (12) Lead the Project Team in providing draft operating procedures to the OMEGA Facilities Division.
- (13) Support the ORR by preparing a task list of required review/inspection elements and assign reviewers/inspectors for each element.
- (14) Track and maintain the status of completing EQC requirements.
- (15) Assemble the project completion package and route for approval by the Division Directors and Chief Safety Officer.

c. Project Assistant (PA)

- (1) Assist the PI and SE in completing their responsibilities.

d. Group/Section Leader(s)

- (1) Assign qualified group members, as needed, to serve as Project Team members
- (2) Provide technical support to the PI and SE in fulfilling their responsibilities.
- (3) Assign qualified group members to review and approve all new installation and operating procedures.

- (4) Support installation and qualification of project deliverables.
 - (5) Support training of operations personnel.
 - (6) Assign qualified group members to participate in design reviews.
- e. **Laser Facility Manager**
- (1) Administer the formulation of and approve operational procedures for OMEGA equipment projects.
 - (2) Participate in design reviews and Operational Readiness Reviews as appropriate.
- f. **Engineering Group Members**
- (1) Serve as members of the Project Team as appropriate.
 - (2) Complete the design, assembly, installation, and testing of equipment as appropriate.
 - (3) Verify that equipment is built to and installed per plan.
 - (4) Prepare for and present their portion of design reviews as appropriate.
- g. **Safety Officers**
- (1) Provide input and review of the Safety Risk Analysis Checklist.
 - (2) Participate in safety inspections of installed equipment.
 - (3) Participate in design reviews as appropriate.
- h. **Engineering Division Director**
- (1) Review and approve proposed projects as appropriate.
 - (2) Provide overall direction of the design, assembly, and integration of projects.
 - (3) Approve the completion of projects.
 - (4) Approve minor changes to previously qualified equipment that are exempted from the requirements of this instruction.
- i. **OMEGA Facility Director**
- (1) Review and approve proposed projects as appropriate.
 - (2) Participate in design reviews and Operational Readiness Reviews as appropriate.
 - (3) Approve operational procedures for OMEGA equipment projects.
 - (4) Ensure the completion of operational training for OMEGA equipment projects.
 - (5) Approve the completion of projects.

j. Experimental Division Director

- (1) Review and approve proposed projects as appropriate.
- (2) Approve the completion of projects as appropriate.

k. Administrative Division Director

- (1) Administer the formulation of the fiscal year budget, including projects.
- (2) Via the Administrative Division Database Administrator
 - (a) administer the project financial database and provide periodic project reports.
 - (b) authorize activation of a project for purchases after completion of a CDR
 - (c) assign property tags at the completion of projects as appropriate

7. Approval

R. L. McCrory
Director, Laboratory for Laser Energetics

FY08 Project Budget Request
for
NEW Project

Proposed Task ID:	
Project Title:	
Principal Investigator:	
Project Coordinator:	

Describe this project:

Desired Completion Date: (Month / Year)

Justification for project and completion date:

Indicate Functional Groups expected to contribute:

Mech. Eng. Elect & Controls Eng. OMAN SDG Optical Eng.

(Service requests must be prepared after project approval and prior to CDR. The PI will work with System Engineering and functional group leaders to estimate the required effort and establish dates for the CDR, FDR, and other reviews.)

Fabricated Equipment Budget—List materials required.

Nomenclature	# Units	Unit Cost	Cost
			\$0
			\$0
			\$0
Total Budget			\$0

Project Budget Request
for
EXISTING **Project**

Proposed Task ID:	
Project Title:	
Principal Investigator:	
Project Coordinator:	

Describe this project:

Describe the progress made in previous years. Discuss any problems or limitations.

Describe the remaining work.

Desired Completion Date: (Month/Year)

Justification for project and completion date:

Indicate Functional Groups expected to contribute: (N.A. if project has completed CDR)

Mech. Eng. Elect & Controls Eng. OMAN SDG Optical Eng.

(Service requests must be prepared after project approval and prior to CDR. The PI will work with System Engineering and functional group leaders to estimate the required effort and establish dates for the CDR, FDR, and other reviews.)

Fabricated Equipment Budget—List materials required.

Nomenclature	# Units	Unit Cost	Cost
			\$0
			\$0
			\$0
Total Budget			\$0

Equipment Qualification Checklist (EQC)

Title: _____ **Project TASKID:** _____
PI: _____ **PA** _____
PSE: _____ **Requested by:** _____
External Org.: _____

To be tailored during by the Project System Engineer (PSE) during Conceptual Design,
 Mark Req'd column blanks as Y or N:

Item	Req'd Y or N	Sched. Comp. Date	Actual Completion Signature/Date
Project Definition			
Requirements document	Y		
Draft shop service requests	Y		
Tailor EQC	Y		
Conceptual Design Review (CDR)			
CDR	Y		
Complete Safety Risk Assessment Checklist	Y		
CDR minutes published	Y		
CDR Action Items resolved			
Prepare Software Request			
Preliminary Design Review (PDR)			
PDR			
Update Safety Risk Assessment Checklist			
PDR minutes published			
PDR Action Items resolved			
Software/Control Requirements Review (CRR)			
CRR minutes published			
CRR Action Items resolved			
Final Design Review (FDR)			
FDR	Y		
LLEINST 9800 Computer Identification Data Sheet initiated			
Update Safety Risk Assessment Checklist	Y		
FDR minutes published	Y		
Physical envelope/space claim cleared			

Title: _____ **Project TASKID:** _____

Item	Req'd Y or N	Sched. Comp. Date	Actual Completion Signature/Date
Fit and Qualification Test plans published			
Draft Installation and Operating Procedures published			
SRF updates defined			
FDR Action Items resolved			
Fit and Qualification Test plans published			
Installation/Operational Readiness Review (ORR)			
Work Authorization Procedure prepared, including approved installation procedures	Y		
Crew orientation conducted	Y		
Equipment installation	Y		
Pre-Operation Safety inspection completed	Y		
LLEINST 9800 Computer Identification Data Sheet completed			
Fit and Function tests complete			
Qualification tests complete			
Operating procedures approved and published	Y		
SRF changes approved and installed			
Initial operator training conducted	Y		
Required Executive software updates implemented			
ORR	Y		
ORR Action Items resolved	Y		

Safety Risk Assessment Checklist

Project TASKID _____

Item	Associated Risk *		Line #'s of related entries in FMEA spreadsheet
	None (= 0)	Some ** (> 0)	
Mechanical			
Elevated Weight			
Vacuum/Pressure Vessel			
Operator Access (weight, size, reach)			
Personnel Hazard (head, trip, moving parts, noise, ...)			
Other Structural/Loading			
Hot/Cold Surfaces			
Rigging (installation, normal use)			
Alternate Configurations			
Chemical			
Fuel or Oxidizer			
Asphyxiant			
Toxic Material			
Reactive/Corrosive			
Beryllium			
Electrical			
High Voltage			
Unprotected Leads			
Overheating			
Stored Energy			
Lasers			
Eye Hazard – During Operation			
Eye Hazard – Alignment Only			
Open Focus Spot			
Ionizing Radiation			
Radioactive Liquid			
Radioactive Solid			
Radioactive Gas			
Loose Surface Radioactivity			
Can Become Activated			

* Risk is rated prior to applying mitigation strategies. All entries having some (non-zero) associated risk must have a corresponding entry in the Failure Mode and Effects Analysis (FMEA) spreadsheet

** Numbers 0 to 2 are per FMEA: 0 = none, 1 = minor or marginal, 2 = critical or catastrophic

Submitted By _____
System Engineer

Approved By _____
Principal Investigator

Approved By _____
Chief Safety Officer

Table 1: Failure Mode and Effects Analysis (FMEA)

System or Subsystem	Hazard Category ¹	Failure Mode ²	Causes	Effects	Consequence before Mitigation ^{3, 4}	Probability of Occurrence before Mitigation ⁵	Mitigation	Consequence After Mitigation	Probability of Occurrence After Mitigation
Enter the system in which the failure may occur.		List the failure mode.	Describe the cause. Use multiple rows for multiple causes.	Describe the effect(s) on the system in which the failure occurs.	Rate the severity of hazard before mitigation efforts are made.	Estimate the likelihood of the failure occurring before mitigation efforts are made.	Describe the step(s) necessary for mitigating the likelihood of the failure occurring.	Rate the severity of hazard after mitigation efforts have taken place.	Estimate the likelihood of the failure occurring after mitigation efforts have taken place.
Project or Equipment Name:									

¹ Hazard Category: **Personnel, Equipment, Other**

² Failure Mode: Brief statement of the hazard

³ Personnel Hazard Level definitions: **Catastrophic** = May cause death. **Critical** = May cause severe injury. **Marginal** = May cause minor injury. **Minor** = Not serious enough to cause injury. **None** = No hazard for personnel.

⁴ Equipment Hazard Level definitions: **Catastrophic** = May cause > 1 day lost shot time. **Critical** = May cause < 1 day lost shot time. **Marginal** = May cause ~1 hour of lost shot time. **Minor** = May cause delay < 0.5 hour of lost shot time. **None** = No risk of lost shot time. Note: For non-shot related equipment, assess hazard level based on programmatic impact (cost, man-hours, delay, etc).

⁵ Likelihood of Occurrence definitions: **Probable** = Expected to happen in the life of the project. **Infrequent** = Could happen in the life of the project. Controls have significant limitations or uncertainties. **Remote** = May happen in the life of the project, but not expected. Controls have minor limitations or uncertainties. **Improbable** = Extremely remote possibility that failure will occur in the life of the project. Proven controls are in place.

Pre-Operation Safety Inspection Checklist

To be completed during equipment inspection and included in the Installation/Operations Readiness Review (ORR) package.

Project ID _____

Item	Risk*	OK	Comment/Mitigation
Mechanical			
Moving Components			
Elevated Weight			
Compressed Gas			
Liquid Under Pressure			
Stored Gravitational Energy			
Stored Spring Energy			
Stored or Trapped Gas Pressure			
Sharp Edges			
Head Hazard			
Trip Hazard			
Noise			
Hot/Cold Surfaces			
Reach/Access			
Will Not Support Incidental Loads			
Maintenance Access – Rigging			
Alternate Configurations			
Equipment Labeled			
Review Lockout Devices/Method			
Chemical			
Fuel or Oxidizer			
Asphyxiant			
Toxic Material			
Reactive/Corrosive			
Appropriate Labels			
Appropriate Storage			
MSDS			
Beryllium			
Electrical			
High Voltage			
Unprotected Leads			
Overheating			
Electrical Lockout			
Cabling Labeled			
Grounding			
Review Lockout Devices/Method			

Item	Risk*	OK	Comment/Mitigation
Lasers			
Eye Hazard – During Operation			
Eye Hazard – Alignment Only			
Open Focus Spot			
Ionizing Radiation			
Radioactive Liquid			
Radioactive Solid			
Radioactive Gas			
Loose Surface Radioactivity			
Can Become Activated			
LockOut – Zero Energy State			
Review Lockout Devices/Method			

*Insert the risk level (0, 1, or 2) from the Final Safety Risk Assessment Checklist as appropriate

Completed by (as applicable):

 Mechanical Safety Officer/Date

 Chemical Safety Officer/Date

 Electrical Officer/Date

 Laser Safety Officer/Date

 Radiation Officer/Date

 Laser Safety Officer/Date

Reviewed by:

 LLE Safety Officer/Date

Project Approval Cover Sheet

Project Title _____ **Project TASKID** _____

Approvals:

OMEGA Facility Director _____ **Date** _____

Engineering Division Director _____ **Date** _____

Experimental Division Director _____ **Date** _____

LLE Safety Officer _____ **Date** _____

- System Engineering: Check if Approval is provisional due to draft operating procedures that require collection of operational data to finalize.

Provisional approval expires _____; thereafter, approved operational procedures are required.