

RISK MANAGEMENT PLAN

for
The Linac Coherent Light Source
Ultrafast Science Instruments (LUSI) Project

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LUSI Project – Risk Management Plan

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Table of Contents

1.0	INTRODUCTION.....	1
1.1	PURPOSE	1
1.2	PROJECT SUMMARY	1
1.2.1	<i>System Description</i>	1
1.2.2	<i>Acquisition Strategy</i>	2
1.2.3	<i>Project Management Approach</i>	3
2.0	RISK MANAGEMENT APPROACH	3
2.1	GENERAL APPROACH AND STATUS	3
2.2	RISK MANAGEMENT STRATEGY	3
2.3	ORGANIZATION.....	5
3.0	RISK ASSESSMENT.....	7
3.1	PROCESS.....	7
3.1.1	<i>Tracking and Closeout</i>	7
	APPENDIX A - METHODOLOGY FOR COMPUTING RISK-BASED CONTINGENCY	8
	APPENDIX B - TABLES & FIGURES.....	11
	APPENDIX C - LIST OF ACRONYMS	12

1.0 INTRODUCTION

1.1 PURPOSE

As stated in DOE Manual 413.3-1, the purpose/objective of a Risk Management Plan (RMP) is to assist management in focusing on and adequately implementing a sound risk management strategy. This RMP presents the process for carrying out proactive risk management as part of the overall management of the Stanford Linear Accelerator Center's LINAC Coherent Light Source Ultrafast Science Instruments (LUSI) project. It is intended to be utilized as a management tool to evaluate and mitigate potential events that may adversely affect the success of the project.

1.2 PROJECT SUMMARY

The LUSI project is a Major Item of Equipment (MIE) consisting of the design, acquisition, assembly, and installation of three x-ray instruments That will complement the initial instrument provided by the LINAC Coherent Light Source (LCLS) construction project. The LCLS, which was tied for third in near term priorities for the Office of Science as described in the *“Facilities for the Future of Science: A Twenty-Year Outlook” dated November 10, 2003*, will serve as a research and development center for XFEL physics in the hard x-ray regime and as a scientific user facility for the application of XFEL radiation to experimental science.

The LUSI project's complement of x-ray instruments, coupled with the LCLS's initial instrument, which is directed towards atomic physics, will provide the tools to exploit the unique scientific capability of this new facility. LUSI plans to build these instruments and beam delivery systems over a period of six fiscal years (2007 – 2012). One of the three instruments will be optimized for hard x-ray studies of ultrafast dynamics at the atomic level, addressing basic problems in chemistry and materials science. The second instrument will concentrate on hard x-ray coherent imaging of nano-particles and large biomolecules. The beam delivery systems are aimed at the use of soft x-rays to study magnetic structures and surface chemistry and the study of equilibrium dynamics on the nanometer scale using hard x-rays.

1.2.1 System Description

A brief description of LUSI's instruments is as follows:

X-ray Pump Probe Diffraction Instrument

The X-Ray Pump Probe Diffraction instrument will predominantly use a fast optical laser to generate transient states of matter, and the hard x-ray pulses from the LCLS to probe the structural dynamics initiated by the laser excitation. The laser pump will have the ability to conduct precise optical manipulations, in order to create the desired excited states. An ultrafast laser pulse excites a brief change in the positions of the atoms in the sample. This change is studied using diffraction of the LCLS x-ray pulse, which follows the laser pulse after a precise time delay. LUSI will provide the x-ray spectrometer and two-dimensional detector as well as x-ray diagnostics and experimental controls to record the x-ray scattering patterns.

Coherent X-ray Imaging Instrument

In combination with the LCLS, coherent x-ray imaging can potentially provide a new horizon of imaging nanoscale materials and large single macromolecules at or near atomic resolution in three dimensions. Resolution in these experiments would not depend on sample quality in the same way as in conventional crystallography, but would be a function of radiation intensity, pulse duration, wavelength, and the extent of ionization and sample movement during the exposures. The full peak brightness of the LCLS is fully exploited when imaging biological materials such as viruses and single macromolecules. The penetration depth of hard x-rays in combination with the coherent nature of the radiation will permit detailed 3D study of large, non-periodic structures, and provide capabilities that will go beyond conventional scanning probe microscopy, electron microscopy or x-ray crystallography.

LUSI will provide the necessary x-ray optics to prepare the beam, the sample environment and diagnostics to characterize the x-ray sample interaction and the necessary controls and diagnostics. The two-dimensional detector that is required will be provided by others.

X-ray Photon Correlation Spectroscopy Beam Delivery System

The unprecedented brilliance and narrow pulse duration of the LCLS provides a unique opportunity to observe dynamical changes of large groups of atoms in condensed matter systems over a wide range of time scales using X-ray Photon Correlation Spectroscopy (XPCS). In contrast to the study of stimulated dynamics (pump-probe), the XPCS technique studies equilibrium fluctuations excited by the thermal energy of the sample. Images of the speckle scattering pattern are taken with various time delays between images, and the change in the speckle pattern as a function of time delay is used to study the sample dynamics.

LUSI will only provide the beam delivery system which consists of an offset monochromator to permit the use of this instrument in parallel with other experiments using radiation in the far experimental hall. The delivery system will also allow for the installation of a device for generating two separated x-ray pulses from one LCLS pulse with precise time delay between them that is adjustable over a wide range. In addition LUSI will provide a two dimensional detector purposely built for XPCS as well as minimal diagnostics and controls to permit the integration of outside users equipment into the LCLS experimental control system.

1.2.2 Acquisition Strategy

The plan for executing this project is addressed in the *LUSI Project Execution Plan* (PEP). When the project is completed its instruments will join the one other instrument at the LCLS facility, and all will be available to the user community.

The LUSI project scope consists of the design, acquisition, assembly and installation of three instruments in the LCLS Experimental Halls. All instruments will be based on

straightforward implementation of proven designs that have benefited from research and development (R&D) experience gained throughout the community.

Most equipment will be procured using normal SLAC standards and specifications and will be tested prior to acceptance. Some specialized equipment such as detectors and optical components will have added quality assurance (QA) and inspection requirements that will be specified as part of the procurement process. No R&D effort is required to successfully implement these instruments and beam delivery systems, but during the life of the project, technological developments that would enhance the performance of the instruments will be sought out and applied.

1.2.3 Project Management Approach

The LUSI project will be managed following the project management concepts defined in DOE Order 413.3, *Program and Project Management for the Acquisition of Capital Assets*. Risks likely to be encountered during the execution of the project will be detailed in this plan and managed using a tailored approach in accordance with the methodology identified in the above order.

2.0 RISK MANAGEMENT APPROACH

2.1 GENERAL APPROACH AND STATUS

The instrument designs and components are mostly similar to those already developed for other like instruments throughout the community and most technical equipment will be ordered from commercial vendors. Given the comprehension of the design and the fact that the parameter requirements proposed are considered achievable within current technical capabilities, the overall risk of the LUSI project is considered low. None-the-less the project will be challenging and will face risks in achieving its goals.

2.2 RISK MANAGEMENT STRATEGY

Risk is a measure of the inability to achieve overall project objectives within defined cost, schedule, and technical/scope constraints and has two components: (1) the probability of failing to achieve a particular outcome, and (2) the consequences/impacts of failing to achieve that outcome. All elements of the project were examined by the Integrated Project Team (IPT) to identify potential areas of risk uncertainty.

For each potential risk event identified, an assessment is conducted by determining (a) the potential consequence (*Marginal, Significant, or Critical*) of the occurrence of the identified event/issue and (b) the likelihood (*Unlikely, Likely, or Very Likely*) of the occurrence of the event/issue. Definitions of the categories for consequence and likelihood are given in Tables 1 and 2. Using the consequence and likelihood assessments, risks are categorized as shown in Table 3.

All areas of consideration are evaluated by the IPT, and subject matter experts participate as necessary. Mitigation management strategies are considered, evaluated, and selected on a graded approach, based on risk assessment results.

The LUSI PPEP, instrument parameters list, QA plan, hazard assessment, cost estimates, and schedule have and are all being prepared with an awareness of potential risks. The initial risk assessment process for the LUSI project has been totally integrated with the process for setting the project cost contingency. Contingency estimates were developed at the lowest level of the work breakdown structure (WBS) using a risk-based contingency approach. This approach is described in Appendix A.

Type of Risk	Consequence		
	Marginal	Significant	Critical
Cost: Impact on project contingency	<\$100k	\$100– 500k	>\$500k
Schedule: Impact on instrument schedule float	None	Impacts Level 1-3 milestones defined in PPEP	Impacts instrument early finish date
Technical: Impact on performance	Minor degradation (performance falls below upper end of goal; see instrument parameter list)	Significant degradation (performance falls below mid-range goal; see instrument parameter list)	An instrument's CD-4 will not be met (essential performance parameter not met)

Table 1. Risk Consequence categories

Category	Definition
Very likely	Risk is likely to occur with a probability greater than or equal to 90%.
Likely	Risk is likely to occur with a probability greater than or equal to 50%.
Unlikely	There is less than 50% chance that this event will occur.

Table 2. Risk likelihood categories

Likelihood of Occurrence	Consequence		
	Marginal	Significant	Critical
Very likely	Medium	High	High

Likely	Low	Medium	High
Unlikely	Low	Low	Medium

Table 3. Risk categorization matrix

2.3 ORGANIZATION

The LUSI Project Director has overall responsibility for implementing the RMP during the design, construction and testing phases of the project. The Risk Management Coordinator is the overall coordinator of the project's Risk Management Program. He/she is responsible for:

- Maintenance of the RMP
- Maintaining the Risk Management Database
- Briefing the Project Director on the status of the project's risk
- Tracking efforts to reduce risk levels
- Provide risk management training
- Facilitate risk assessments
- Prepare risk briefings, reports and documentation for project reviews

Figure 1 portrays the LUSI project's organization up to the Federal Project Director.

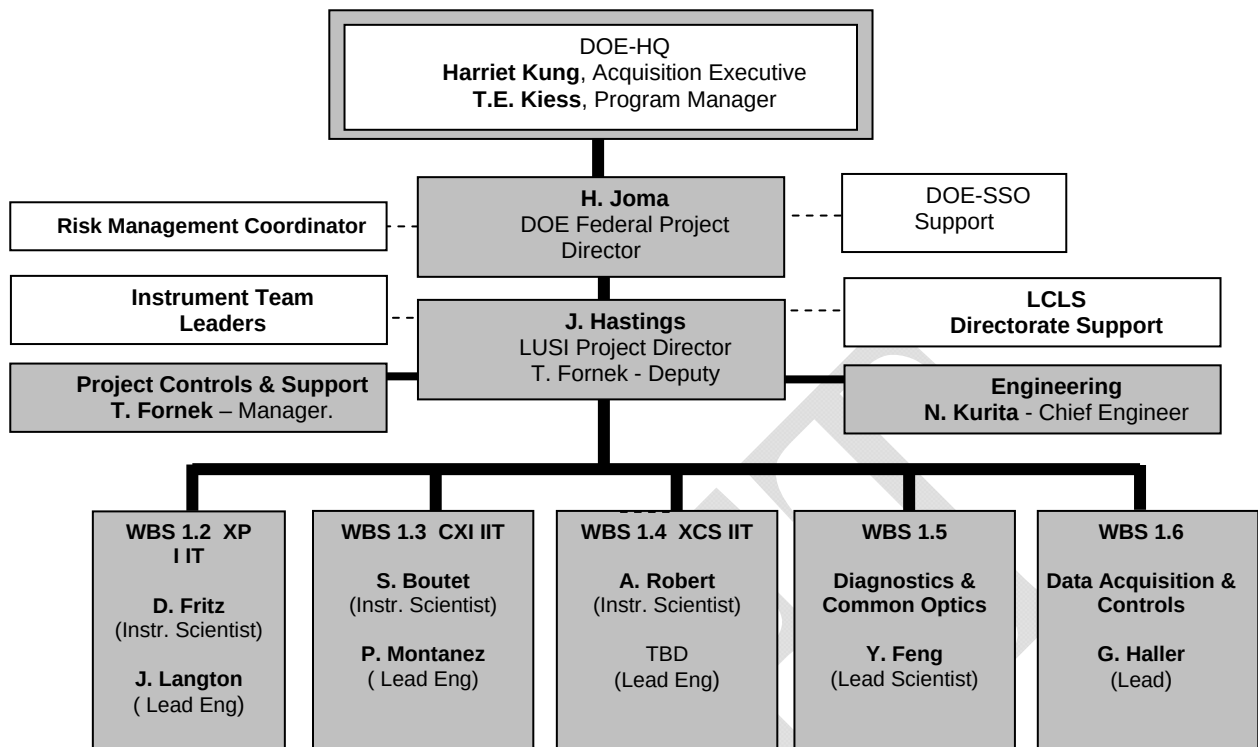


Figure 1 – LUSI Project Organizational Structure

The LUSI ~~project~~ management is responsible for complying with the DOE risk management policy and for structuring an efficient and useful risk management approach.

The LUSI ~~Control Account Managers project-management~~ is responsible for implementing risk management tasks per this Plan. These responsibilities include:

- Review and recommend to the Risk Management Coordinator changes on the overall risk management approach based on lessons learned.
- Quarterly, update the project risk assessments made during the project's initial phase. During project execution, monthly updates will be conducted.
- Review and be prepared to justify the risk assessments made and the risk mitigation plans proposed.
- Report risk to the Project Director and Risk Management Coordinator.
- Ensure that risk is a consideration at each program review.

3.0 RISK ASSESSMENT

3.1 PROCESS

Risk identification is the first step, and an iterative one, in the assessment process. This involved reviewing the LUSI project to determine those events that would prevent the project from achieving its goals. Results of specific risk assessments that were conducted for each of the identified project areas of consideration are provided in the LUSI Risk Registry. The risk issue, project element, likely causes, and an analysis of the impact and likelihood are provided for each risk item. The mitigation strategy, responsible individual or group, and expected closeout date complete the assessment.

During the initial stages of the project, quarterly evaluation of the RiskRegistry, risk assessment items will be updated or closed out, and additional risk items will be included as needed. Also, the risk assessment will contain more quantitative information as the project becomes more mature. This will include estimates of the potential cost associated with specific cost risk items, potential schedule impacts in terms of duration for schedule risk items, cost of implementing the proposed strategy, and the residual risk. During project execution, monthly risk evaluation will be necessary.

3.1.1 Tracking and Closeout

Each risk mitigation strategy that has been developed for effective risk management has been assigned to a responsible individual(s) or group, and a closeout date has been identified. **The Control Account Managers will be responsible for monitoring the risks in their area of responsibility and for informing the Risk Management Coordinator of any changes that impact the Risk Assessment.** The Risk Management Coordinator will track these items to completion. Initially the risk assessment items will be reevaluated by the LUSI project management on a quarterly basis and during project execution a monthly evaluation will be preformed.

APPENDIX A - METHODOLOGY FOR COMPUTING RISK-BASED CONTINGENCY

The proposed budget for the LUSI project includes contingency which is calculated by summing the contribution from each WBS element. The contributions are developed at the lowest level of the WBS and are based on an assessment of the technical, cost, and schedule risk combined with a weighting factor that reflects the type of cost (labor or material).

The base cost estimate is the expected cost of completing an activity. Contingency is not included in the base cost.

Cost contingency is defined to be the amount of additional funds, above and beyond the base cost, required to ensure the project's success. These additional funds are used only for omissions and unexpected difficulties.

Although contingency is summarized on a sub-system basis, this is only a procedure to determine the risk-based cost that contributes to the total project contingency. Contingency is held entirely by project management and not by individual work-package managers. The procedure for allocating and using contingency funds is addressed in the LUSI PPEP.

The procedure used to estimate the required cost contingency begins with a comparison of the conceptual state (technical, cost, or schedule) of the system being considered with the descriptions shown in Table A-1 (Risk Factors) and Table A-2 (Risk Weighting Factors). These factors have been set in a matrix, Table A-3 (Risk Factor Matrix) where the technical person is required to identify the risk factor for the technical, cost and schedule characteristic of the sub-system and then the appropriate weighting factors. Once these have been selected by the cognizant technical person, management calculates the contingency rate using an algorithm that combines the calculated risk (factor x weight) from each state. This yields the contingency percentage for this element of the project. The contingency contribution is determined by multiplying the base cost by the calculated contingency percentage.

TECHNICAL	COST	SCHEDULE	RISK FACTOR
Existing design & off-the-shelf hardware	Off-the-shelf or catalog item		1
Minor modifications to an existing design	Vendor quote from established drawings	No schedule impact on any other item	2
Extensive modifications to an existing design	Vendor quote with some design sketches		3
New design, nothing exotic	In-house estimate based on previous similar experience	Delays completion of non-critical path subsystem item	4
New design, different from established designs or existing technology	In-house estimate for item with minimal experience but related to existing capabilities		6
New design, requires some R&D, but does not advance the state of the art	In-house estimate for item with minimal experience and minimal in-house capability	Delays completion of critical path subsystem item	8
New design, development of new technology that advances the state of the art	Top-down estimate from analogous programs		10
New design, way beyond the current state of the art	Engineering judgment		15

Table A-1 Technical, Cost and Schedule Risk Factors

TECHNICAL	COST	SCHEDULE	RISK WEIGHT
	Material cost OR labor rate	Same for all	1
Design OR manufacturing	Material cost AND labor rate		2
Design AND manufacturing			4

Table A-2 Technical, Cost and Schedule Risk Weighting Factors

WBS #

DESCRIPTION:

	RISK FACTOR (<i>x</i> only one)	X	RISK WEIGHT (<i>x</i> only one)	X
TECHNICAL	Existing design & off-the-shelf hardware			
	Minor modifications to an existing design			
	Extensive modifications to an existing design			
	New design, nothing exotic		Design <u>or</u> manufacturing	
	New design, different from established designs or existing technology		Design <u>&</u> manufacturing	
	New design, requires some R&D, but does not advance the state of the art			
	New design, development of new technology that advances the state of the art			
	New design, way beyond the state of the art.			
COST	Off-the-shelf or catalog item			
	Vendor quote from established drawings			
	Vendor quote with some design sketches			
	In-house estimate based on previous similar experience		Material cost <u>or</u> labor rate	
	In-house estimate for item with minimal experience but related to existing capabilities		Material cost <u>&</u> labor rate	
	In-house estimate for item with minimal experience & minimal in-house capability			
	Top-down estimate from analogous programs			
	Engineering judgement			
SCHEDULE	No schedule impact on any other item		Same for all	
	Delays completion of noncritical path subsystem item		Same for all	
	Delays completion of critical path subsystem item		Same for all	

Table A-3 Risk Factor Matrix

APPENDIX B - TABLES & FIGURES

LIST OF TABLES

TABLE 1. RISK CONSEQUENCE CATEGORIES	4
TABLE 2. RISK LIKELIHOOD CATEGORIES	4
TABLE 3. RISK CATEGORIZATION MATRIX.....	5
TABLE A-1 TECHNICAL, COST AND SCHEDULE RISK FACTORS.....	9
TABLE A-2 TECHNICAL, COST AND SCHEDULE RISK WEIGHTING FACTORS	9
TABLE A-3 RISK FACTOR MATRIX	10

LIST OF FIGURES

FIGURE 1 – LUSI PROJECT ORGANIZATIONAL STRUCTURE	6
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APPENDIX C - LIST OF ACRONYMS

CD	Critical Decision
DOE	Department of Energy
ES&H	Environment, Safety, and Health
ETC	Estimate-to-Complete
FY	Fiscal Year
IPT	Integrated Project Team
LCLS	Linac Coherent Light Source
LUSI	Linac Coherent Light Source Ultrafast Science Instruments
PPEP	Preliminary Project Execution Plan
QA	Quality Assurance
R&D	Research and Development
RMP	Risk Management Plan
SLAC	Stanford Linear Accelerator Center
SSO	Stanford Site Office (DOE)
WBS	Work Breakdown Structure
XFEL	X-ray Free Electron Laser
XCS	X-ray Photon Correlation Spectroscopy