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LLNL-AM-401097

Engineering Project Management Manual

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February 7, 2008

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This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

Engineering Project Management Manual

Revision History

Date	Authors	Comments
October 2007	Tom Anklam	Revision 0: This manual was created from the former *Engineering Policies and Procedures Manual* Section 5, which had been massively revised and rewritten in June 2006. The authors of that work were Chris Adams, Joel Bowers, Diane Chinn, Beth Dzenitis, Mark Franks, Jim Gansemer, Jeff Hockman, Allen House, Monya Lane, Tom Moore, Mark Sueksdorf, Anita Zenger.
February 2008	See Oct. 2007 Comments	Document registered in the Information Management System to obtain an LLNL number.

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1.0 Introduction

A *project* is a unique work effort undertaken to create a defined product, service, or result within a defined budget and with defined beginning and end dates. Project management is often called the business of getting things done.

The directorate promotes the successful management of projects using processes and tools that are chosen by using a risk-based, tailored approach, consistent with contractual requirements and best commercial practices. The purpose of this manual is to convey the directorate's expectations for high competency in key areas of project management.

This document provides guidance for implementing the Engineering Directorate policy on project management (Policy 5.2) and does not create new requirements beyond those defined in that policy.

1.1 Applicability

Applicability of the Engineering policy on project management is defined in Policy 1 of the *Engineering Policy Manual:* Engineering Policy Applicability and Authorizations for Exceptions and Deviations.

This guidance document is to be used by employees of the directorate to manage projects for Lawrence Livermore National Laboratory (LLNL) and for customers of LLNL, in the absence of more-specific guidance from programs or sponsors.

Projects vary in scale, risk and complexity. Sound management can and should be applied in a tailored approach to every project led or supported by the directorate—regardless of the nature of the endeavor. The principles, processes, tools, and techniques described and referenced herein are thus applicable (in a graded manner) to construction, manufacturing and production, modeling, prototype, software, research, and development projects.

Directorate employees can be engaged in three types of projects:

First, **projects less than 20 million dollars for which the directorate has program or execution accountability**. This includes projects executed on behalf of other Laboratory directorates, Work for Others (WFO), Cooperative Research and Development Agreements (CRADAs), Laboratory Directed Research and Development (LDRD) projects, and Technology Base ("TechBase") endeavors. For these types of projects, directorate employees serve as project managers, principal investigators, and team members. Often, the principal investigator and project manager are one and the same. As such, they typically have authority to establish the management processes for their projects in accordance with this manual.

Second, **projects for which the directorate has execution accountability and is designated to comply with DOE Order 413.3**—*Project Management for the Acquisition of Capital Assets.* These projects of 20 million dollars or more may be wholly managed under the guidance of directorate personnel or as parts of collaborative efforts with other

directorates or institutions. Directorate personnel may serve as project managers, principal investigators and/or team members. The management practices required for this type of project are fully outlined in DOE O 413.3.

Third, **projects for which the directorate does not have program or execution accountability**, that is, for which the directorate is providing a service by managing the project (or a key system, subsystem, or element thereof) for another Laboratory program directorate through the assignment of matrixed directorate personnel. Directorate employees often occupy key and/or influential positions in such projects, and it is expected they will be strong advocates for diligently employing project management principles within those projects. Where programmatic directorates, sponsors, or other customers require specialized project management processes, directorate management will assure that such processes are consistent with the directorate's minimum acceptable standards for project management and the directorate's commitment to the quality of deliverables, safety, and customer satisfaction.

1.2 Glossary of Terms

Many of these definitions are taken almost verbatim from *A Guide to the Project Management Body of Knowledge* (PMBOK® Guide), Third Edition, or *Project Management for the Acquisition of Capital Assets,* DOE M 413.3-1.

earned-value management (EVM)	A management methodology for progress. Performance is measured by determining the budgeted cost of work performed integrating scope, schedule, and resources, and for objectively measuring project performance (i.e., earned value) and comparing it to the actual cost of work performed (i.e., actual cost). Progress is measured by comparing the earned value to the planned value.
element	Term often used to refer to a phase or type of project management activity.
principal investigator	Person given the responsibility of leading the research or development of a project.
PMI	Project Management Institute. An organization providing training, certification, and professional standards for project managers.
PMO	Project Management Office. The PMO is a virtual office that coordinates project management support to the directorate through the service of project management consultants.
project management consultant	Directorate employee who is assigned to the Project Management Office, is experienced in project management, and is selected to provide guidance and direction to the directorate and its customers.

work breakdown structure (WBS) A product-oriented grouping of project elements that organizes and defines the total scope of the project. The WBS is a multilevel framework that organizes and graphically displays elements representing work to be accomplished in logical relationships. Each descending level represents an increasingly detailed definition of a project component. Project components may be products or services. It is the structure and code that integrates and relates all project work (technical, schedule, and cost) and is used throughout the life cycle of a project to identify and track specific work scopes

2.0 Project Management Roles and Responsibilities

This section outlines the roles and responsibilities of the directorate and personnel associated with project management activities.

2.1 Directorate Chief Engineers

Chief Engineers are responsible for

- Maintaining directorate project management policies and applying best industry and government practices, standards, and tools
- Being the point of contact for the Project Management Office (PMO)
- Directing the activities of the PMO
- Ensuring that directorate-funded projects (for example, LDRD, TechBase, and work for others) are implementing earned-value management (EVM) as defined in Appendix E
- Ensuring adequate "staffing" of the PMO
- Reporting PMO activity to the AD
- Determining appropriate dissemination of lessons learned when obtained from project closeout reviews
- Providing the directorate's Assurance Office with information on lessons learned, to be used for independent Assurance Office assessments and reports on project management

2.2 Directorate Project Management Office (PMO)

The PMO is a virtual office composed of directorate personnel (*project management consultants*) who are appointed by their respective Division Leaders and who have demonstrated project management experience and a willingness to assist directorate management in the implementation of sound project management principles. The PMO home page is located at http://www-eng-r.llnl.gov/project_mgmt/proj_mgmt.html.

Members of the PMO are responsible to

- Serve as project management consultants for directorate personnel assigned to LDRDs, TechBase, Strategic Initiatives, and/or programmatic projects

- Provide project management subject matter expertise to other Laboratory directorates as requested
- Provide quality assurance on implementing project management policy
- Translate external orders and standards into directorate project management policy and procedures
- Employ lessons learned to advance project management performance within the directorate
- Maintain this document to ensure that the latest project management principles are included
- Recommend and/or conduct project management training for directorate personnel and attend to the quality of this training
- Assemble and maintain a set of exemplary templates for project documentation and reviews, readily accessible as reference material for directorate personnel
- Maintain a web site to provide expedient project management information to directorate personnel

2.3 Project Management Consultants

Project management (PM) consultants are experienced directorate project manager volunteers who are nominated by their Division Leaders to provide expertise and mentoring, based on demand and availability. A list of current PM consultants is located at http://www-eng-r.llnl.gov/project_mgmt/consult.html.

Examples of consultant functions include

- **Direct Project Consulting**—Informal project mentoring performed through interviews and team discussions to help the project manager initiate, plan, execute, control, or close out a project. Consultants can identify areas for improvement, recommend best practices, and share relevant lessons learned.
- **Reviews**—Informal or formal presentations given by the project leader to a group of PM consultants. The consultants follow the project review protocol as described in Section 4.4. A PM consultant would chair the review.
- **Project Leadership**—Programs are often looking for a project manager to team up with the technical leader. The PMO will publish a consultant list for the programs to use when they contact directorate division management for critical project support.

2.4 Division Leaders

Division Leaders will use a graded approach to determine how the Project Management policy will be applied within their divisions.

Division Leaders are responsible for

- Identifying project managers within their division
- Identifying projects within their division

- Setting expectations for project managers within their division
- Assuring that project managers in their division are in compliance with these policies
- Assessing a project manager's performance
- Prioritizing project management training for their employees
- Planning and conducting project reviews—including project initiation, status, and closeout—in accordance with "Project Management Reviews," Section 3.5
- Appointing PMO project management consultants from within their division

2.5 Assurance Manager

The Assurance Manager reports to the directorate's AD to assure that the directorate implements the Project Management Policy (5.2).

The Assurance Manager is responsible for providing PM assessments of the implementation of project management as described in the policy, upon request from directorate senior management (Division Leaders and above).

2.6 Project Sponsor, Customer, and Stakeholders

The *sponsor* is the funding organization that authorizes and directs the project manager to perform the project on its behalf. The sponsor may be an LLNL programmatic entity, an external organization, or directorate management. Responsibility for project performance, safety, schedule, and budget is delegated by the sponsor to the project manager.

The *customer* is defined as a representative of the sponsor, not necessarily having financial authority, who serves as the routine contact for the project. The customer is the end user of the product or service of the project and typically has authority to establish project requirements.

Stakeholders are individuals and organizations actively involved in the project or whose interests may be positively or negatively affected by the project execution.

2.7 Project Manager

The project manager is the directorate employee responsible for the planning, execution, control, and closeout of the project for the sponsor.

Alternate titles of employees with the same functional responsibilities as project managers are

- TechBase and LDRD principal investigators
- Project engineers, subsystem managers
- Institutional operations program managers

The project manager is responsible for

- Planning the project, including a risk-based, tailored application of project management principles, processes, tools, and techniques
- Understanding and responding to sponsor, customer, and stakeholder expectations
- Establishing communication requirements with stakeholders
- Day-to-day execution of the project plan, including leading the project team, reporting status and progress, and performing all work in strict compliance with all LLNL and DOE requirements for ISM, ES&H, and security
- Implementing and executing project controls
- Where applicable, providing project management discipline and tools to a sponsor who, in turn, executes the project with assistance from the directorate
- Closing out the project at completion

2.8 Project Team Members

The project manager often assembles the project team, with input from the sponsor and directorate management. The team may consist of individuals from within the directorate or from outside organizations—such as other functional directorates, programmatic directorates, consultants, industrial partners, other DOE laboratories, subcontractors, or vendors—who contribute to one or more project processes. Institutional support services such as Hazards Control, Technical Information Department, Plant Engineering, Health Services, the Environmental Protection Department, and Safeguards and Security may also contribute to project execution on an as-needed basis.

Each project team member is responsible for

- Safety and security
- Quality
- Understanding and executing the project plan
- Appropriately exercising project controls
- Notifying the project manager of deviations from the project plan

3.0 Project Management Practices

Section 3.0 lays out directorate project management practices that form the basis for the procedures located in Section 4.0.

3.1 Project Proposals

A project proposal

- Requests resources for a project from a sponsor
- Establishes clear expectations for the sponsor and stakeholders prior to the start of a project

- Assures a sponsor that a project is appropriately planned for successful completion
- Encourages the project manager preparing the proposal to take ownership of a proposal, making sure that the scope, budget, and schedule of the project are practicable
- Identifies and requires acceptance of relationships and responsibilities, for example, management committing to supplying required resources, including a project manager who is committed to executing the plan as proposed

Proposals are to be self-consistent in scope, cost, and schedule, and they are to provide a level of detail commensurate with the level of risk of the project. In the absence of a program-defined management review process, proposals are to be reviewed at the appropriate risk authorization level through a directorate project management review as defined in Section 3.5.

Unless otherwise directed by the sponsor, proposals should contain the following minimum set of elements:

- Problem definition
- Objectives
- Problem solution path
- Project plan
- Budget
- Schedule
- Deliverables
- Required resources
- Closeout strategy
- Follow-on activities

3.2 The Risk-Based, Tailored Approach

As stated in the Engineering Project Management Policy, directorate project managers shall apply *tailored* (also known as "graded") project management processes to manage project risks. Tailoring means applying the appropriate level of detail, rigor, and discipline that is based on the project risk.

Project managers are expected to assess the project risks necessary to manage stakeholder expectations and to assure the accomplishment of project objectives through the tailored application of project planning and controls. The extent of this effort is determined by the need to thoroughly identify, characterize, and manage failure modes at the level of risk tolerance approved by project stakeholders. The output of this assessment is a Risk Authorization Level (RAL) and the determination of required project controls. Project managers are expected to obtain concurrence on their risk assessment from their line management. Someone at the management level associated with the RAL (self, supervisor, Division Leader) is expected to review the project plan.

The alternative to risk management is crisis management, which involves rapid and ofttimes minimal planning, intensively uses resources, and is by nature prone to error. The directorate considers crisis management avoidable in most projects and usually a poor choice in business practices. In special circumstances—such as national security, disaster responses, or other rapidly evolving circumstances—directorate management may choose to deliberately accept the inherently lower efficiency and higher probability of failure of the crisis management approach. These cases are rare allowances to an otherwise unacceptable business model.

3.3 Required Elements of a Project Plan

The directorate requires that project plans be developed for projects under its control. Project managers matrixed to other LLNL directorates shall develop project plans as a routine practice unless otherwise directed by the sponsoring organization.

A project plan consists of a minimum set of required elements. The level of rigor for each of the required project plan elements is to be tailored to the risk and complexity of the project and defined and accepted by agreement with directorate management.

The minimum set of elements required of directorate project plans consists of

- Statement of work (ensures scope alignment with stakeholder expectations)
- Work breakdown structure
- Resource requirements
- Execution plan (schedule, spend rate, earned value reporting structure, etc.)
- Risk management plan
- Definition of the review process
- Project completion or closeout plan
- Project management review schedule

3.4 Earned-Value Management

It is Engineering Directorate practice to employ the principles of earned-value management (EVM) at a level of rigor commensurate with the project scope, schedule, cost, and risk to assure that the stakeholders are capable of assessing project performance. For details, see Section 4.3.

A baseline will be established as part of the project plan, prior to execution. Subsequent changes to the baseline (otherwise known as “rebaselining”) are acceptable, with approval of the sponsor, under circumstances such as

- Significant changes in scope, schedule, budget imposed by the sponsor
- New information, discovery, or breakthrough alters the scope of the project
- A significant opportunity arises during the project that can benefit the sponsor

A rebaseline often requires a new schedule, budget, and earned value metrics for the remaining work. A rebaseline is typically not justified if the project is behind or ahead of

schedule or under or over budget. Instead, these circumstances are managed and tracked as variances.

3.5 Project Management Reviews

It is Engineering Directorate practice that projects undergo project management reviews based on the level of project risk during the planning phase and at appropriate stages of the project. At project initiation, the project sponsor and directorate management will establish the scope and frequency of project management reviews for the duration of the project. The project manager and key stakeholders will determine appropriate times for reviews. The protocols and criteria for developing and holding project management reviews are described in Section 4.4.

3.6 Project Closeout

It is Engineering Directorate practice to do a formal closeout for all projects. A project is ready for closeout when the sponsor accepts the project deliverable.

The purpose of closeout is to

- Assemble, archive, and, where applicable, transfer to the responsible organization whatever key documentation was generated during the project
- Assess the project for lessons learned and best practices that could be instrumental in improving the success of subsequent projects
- Return facilities and equipment to their intended final state for other users, where applicable

The formality of closeout varies widely with project risk. For example, the highly prescribed and formalized closeout process for DOE line-item capital acquisition projects is mandated by Order 413.3. Project managers should, at a minimum, preserve essential project documentation and determine the level of lessons-learned review required by program management, the sponsor, or line management.

4.0 Project Management Procedures

These 4.0 sections cover the processes or procedures to be used by directorate employees in implementing policies, describing how to carry them out in practice.

4.1 Procedure for Writing Project Proposals

The primary goal of a project proposal is to convince the sponsor that a project has value and can be completed successfully on schedule and within budget. The proposal is evaluated on how well it responds to the basic questions of what, how, when, and how much.

Proposals should be concise, informative, and structured to demonstrate a logical approach. The knowledge level of readers should be assessed and accounted for in writing the proposal. All aspects of the project should be presented, including alternative approaches.

A proposal should include three sections: Motivation, Approach, and Plans. It is useful to provide an executive summary at the beginning of the proposal to summarize the project and expected results. Appendices should be included with supporting details, for example, calculations, schedules, figures, and references.

The remainder of Section 4.1 describes the items that should be addressed in a proposal. To provide sufficient information for the reviewer, each question should be addressed.

4.1.1 Motivation

Define the problem to be solved and the benefits of solving the problem. Address three sets of questions.

- **Problem Definition**
  - What needs are being addressed?
  - What problem is being solved?
- **Background Information**
  - What previous work has been directed at this problem?
  - Is there related work in progress?
  - Why is this work timely—why can it be solved now?
- **Expected Gains**
  - What is the compelling reason to do this work?
  - What will be the return or payoff in solving this problem?

4.1.2 Approach

Describe how the project will solve the problem. Address three sets of questions.

- **Problem Solution**
  - What is the approach?
  - Why will it work?
  - What are alternative solutions, if any, and why is this solution best?
- **Project Plan**
  - What is the final product?
  - What are the assumptions built into the project baseline?
  - What are the milestones?
  - What is the timetable?
  - How will the project close out?
- **Resources**
  - Who will be performing the work—what are their qualifications?

- What resources are required, for example, personnel, facilities, and equipment?
- What is the budget and expected spending rate?

4.1.3 Plans

Use this section to describe the future after completing the project. Re-emphasize the long-term benefits of completing the project. Address two sets of questions.

- **Benefits of the Project**
  - Who will benefit from the deliverables?
  - How will the deliverables help the readers of this proposal?
- **Follow-on Activities**
  - Is future funding needed? If so, from whom?
  - How will future customers or users be identified?

4.2 Risk-Management Planning Procedure

Risk management addresses the uncertain outcome of future events and the development of strategies to deal with these uncertainties to increase the odds of favorable outcomes. The risk-based tailored approach manages uncertainties (or "failure modes") by prudently investing project resources in mitigation, transfer, and avoidance strategies. The extent of this effort can range from informal brainstorming to an elaborate failure mode and effect analysis (FMEA). Risk-management planning is at the heart of the tailored approach.

Tailoring the formality and depth of the risk assessment itself can be facilitated by considering one or more indicators that are often associated with high-risk projects, such as

- Any rapidly assembled activity that involves major or unique procurements, hardware deliverables, or field operations
- Technology development redefining the state of the art
- Complex or rapidly changing technical interfaces
- Hazards that require engineered controls
- A project sponsored by a demanding, influential client who could consequently respond with unwelcome political or public-image reactions
- Deliverables that have national implications and that are developed outside of any established QA process
- Teaming with an outside organization with questionable reliability or with whom LLNL has a difficult relationship
- Security or environmental constraints

Procedure Steps

Use the interactive web-based tool at http://hattori.llnl.gov:8080/risk-assessment/ to calculate risk levels, determine the level of authorization needed, and tailor the controls for a project. The basic procedure is summarized in the flow chart shown in Figure 1.

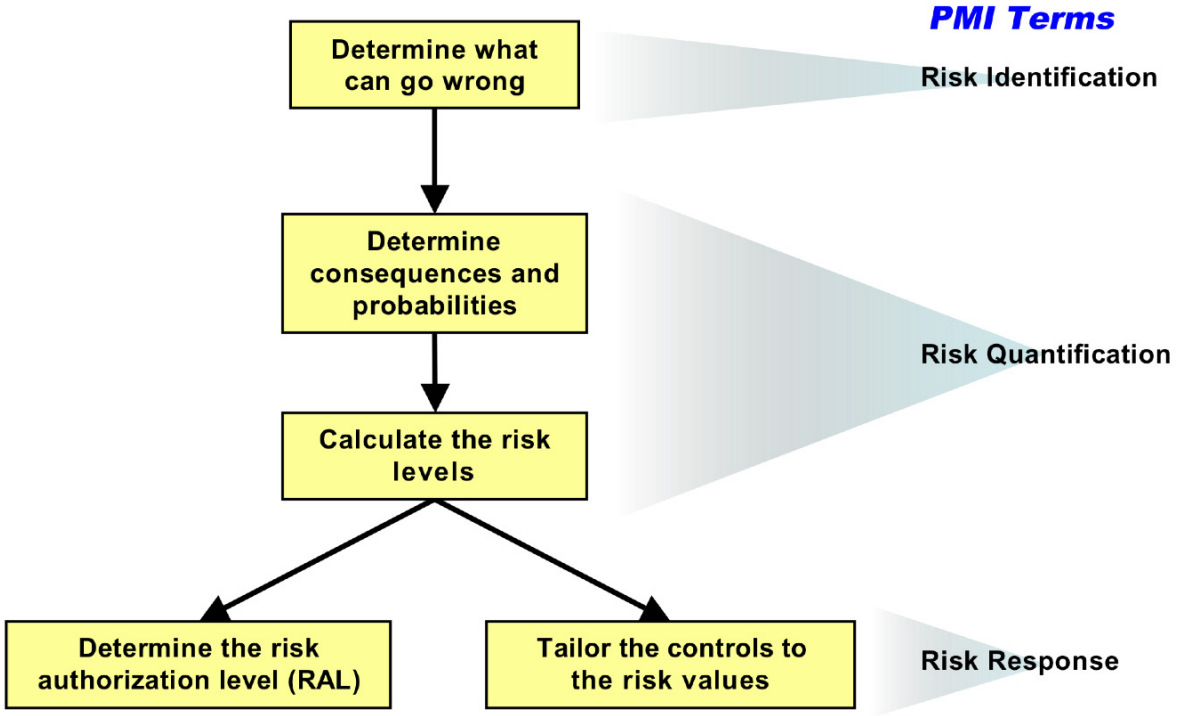


Figure 1. Path for Determining the Appropriate Level of Project Controls and Oversight

For descriptions of levels of consequence and probability for seven risk areas and for determining the levels of project controls to use, see Appendix I.

4.3 Earned-Value Management

Earned-value management (EVM) provides a real-time look at the cost and schedule performance of a project. Earned value is equivalent to "progress"—value is earned as activities are accomplished, and there is a direct relationship between "percent complete" and earned value. Assessing earned value, or progress, against your planned activities allows you as the project manager to understand and track the health of your project. An early understanding of areas that need a small course correction enables the project manager to take appropriate actions. It is unlikely that small deviations from the plan will resolve themselves without intervention of the project manager and, if not addressed, these problems can grow to such an extent that the project is no longer able to recover. Likewise, identification of areas performing better than expected may provide people or money that can be redirected to attack problem areas.

Directorate Project Management Office consultants are available at http://www-eng-r.llnl.gov/project_mgmt/consult.html to provide assistance in developing and instituting an earned-value system.

Projects subject to DOE Order 413.3 will require an extensive earned-value management system that meets ANSI/EIA 748-A, *Earned Value Management Systems* standards. Details

of this system are not addressed in this document but can be found at http://www-r.llnl.gov/evms/Pdffiles/FinalLPMS.pdf.

4.3.1 Three Primary Functions

An earned-value system

- Provides a uniform unit of measure across disciplines or expense types to assess project progress. The traditional units of measure used are dollars or work hours.
- Provides a consistent method for analyzing project progress and performance
- Provides a basis for assessing a project's cost and schedule performance by comparing the cost budgeted (recall that a budget has a time or schedule component to it) or planned for an activity or procurement with the actual cost of accomplishing that activity

4.3.2 Establishing a Basic Earned-Value System

Follow these five steps to establish a basic earned-value system.

1. Establish the work breakdown structure (WBS) to divide the project into manageable portions known as WBS elements.

   Many times in small projects, this is intuitive and not documented. Several minutes of effort can result in an "outline" of a small project's deliverables that will serve this purpose.
2. Identify the activities for each WBS element that, when completed, represent the accomplishment of the WBS element.

   Again, this is usually intuitive in small projects; take 30 minutes to write it down.
3. Allocate costs—dollars or work hours—appropriately to each activity.

   This establishes the "value" that will be "earned" as the tasks are completed.
4. Schedule each activity over time.

   Consider dependencies: people, equipment, or purchased components, and the availability of each. These variables will likely constrain the start and finish of an activity. Identify tasks that must be completed prior to beginning a following task, and schedule accordingly.
5. To establish the budget, tabulate and graph the distribution of the task costs over the scheduled time for execution of the task. A sample is presented in Figure 5, Appendix E.3.
   - Consider showing the monthly budget and the cumulative budget. The monthly plan is typically a somewhat "normal" distribution with less planned expense at the beginning and end than in the middle of the project.
   - The cumulative plan, when graphed, will typically be an S-shaped curve. This is the plan or "spending profile" that serves as the baseline against which project performance is measured.

4.3.3 Determining and Communicating Project Status or Health

Communicate the health and status of the project with these four steps.

1. Update the completion status of each activity.
   - This is reported either monthly or quarterly, depending on the characteristics of a particular project.
   - A predefined performance measure—a rule to assess percent complete—will make this an objective rather than subjective task.
2. Enter the actual cost associated with each activity.

   This can be determined by working with a resource analyst.
3. Apply the earned-value calculations found in Appendix E to derive cost and schedule performance metrics over the past reporting period and cumulative project performance to date.
4. Analyze the data, and write the performance report.
   - Include the updated graph.
   - Assess both cost and schedule performance.
   - Develop and list potential corrective actions to be implemented to bring performance back on plan.

There is a cost associated with establishing and maintaining an earned-value system. The depth of earned value rigor that the directorate requires varies with the characteristics of each project. Use Appendix I or the online tool at http://hattori.llnl.gov:8080/risk-assessment/ to determine the initial requirements for a specific project, remembering that the designated approver of each project may provide relief from specific requirements.

Directorate Project Management Office consultants are available at http://www-eng-r.llnl.gov/project_mgmt/consult.html to provide assistance in developing and instituting an earned-value system.

4.4 Project Management Review Procedure

4.4.1 Overview

The purpose of a project management review is to

- Assess progress at initiation and regularly thereafter to maximize the likelihood of fulfilling contractual commitments for performance, schedule, and cost deliverables
- Give advanced warning of the character of potential problems so that management attention can facilitate resolution
- Provide advance warning and engage management's help on typical project pitfalls such as scope creep, early consumption of contingencies, technical issues, task percent-completion status versus plan, new or moving milestones, systems integration issues, ill-defined acceptance criteria, manpower issues, closeout issues, and documentation issues

- Provide assurance that the appropriate level of project management and systems engineering discipline has been applied to permit the directorate and/or its customers to optimally plan and control execution of a project and thereby increase the likelihood of project success
- Increase the likelihood of project success by allowing for prompt resolution of resource issues
- Provide support and encouragement to principal investigators, project engineers, and managers in the execution of their assignments
- Provide a forum for identifying and capturing lessons learned

This procedure provides criteria for periodic directorate management reviews of hardware, software, and analytical projects led or executed primarily by directorate personnel. The purpose of this procedure is to standardize the project management review process throughout the directorate. Management reviews are distinguishable from design reviews (as described in Policy 5.1 of the *Engineering Policy Manual* and in the *Engineering Directorate Design Review Manual*), which focus on evaluation of technical approaches.

For programmatic and TechBase work, the process is to be implemented within, and by, each division office. Project management reviews of LDRD projects will be implemented primarily by the DAD for Science and Technology.

The review chairperson will help plan the review, chair the review, and track documentation and action-item closure. Review teams will be appointed as needed. The depth of project reviews should reflect the detail described in the associated project plan.

4.4.2 Project Management Review Definitions

4.4.2.1 Project Initiation Review

The introductory review or project initiation will be held at the start of a project and is critical in assuring proper initial planning and application of project management processes tailored to the complexity of the project. It is necessarily more detailed than the comparatively brief follow-on status reviews, which are periodically held to assess progress and are to be attended by personnel familiar with the objectives (deliverables) and technical approach of the project. The duration and depth of the project initiation review is dependent on the risk level and complexity of the project and on the initial conditions such as the definition of deliverables and extent of preexisting design.

4.4.2.2 Project Status Review

Project status reviews will be held periodically during the project initiation and execution phases as defined in the associated project plan. The scope of the project status review is dependent on the risk level and complexity of the project.

4.4.2.3 Project Closeout Review

The project closeout review will be held by the project manager at or near the end of the project closeout process.

The purpose of this review is to finalize stakeholder and user acceptance of the project and to validate the adequacy and quality of the deliverables (for example, through review of acceptance test data). At the closeout review, the team should also confirm the adequacy of project documentation, resolve any remaining action items, finalize plans for decommissioning of project-related equipment, and discuss lessons learned. The duration of the project closeout review is dependent on the risk level and complexity of the project. The closeout review is not intended to serve as an operational readiness or prestart review for subsequent activities.

The project manager will

- Include the project team and the key stakeholders in the lessons-learned exercise.
- Conduct closeout review after the execution phase of the project, to get the most effective input from people.
- Set ground rules and timelines for discussion.
- If possible, recruit a lessons learned facilitator who is not closely connected to the project and who would run the lessons-learned segment of the review. (If not possible, the project manager will act as facilitator who carries out the remaining activities of this list.)
- Concentrate on obtaining information in four general areas:
  - What went well?
  - What didn't go well or had unintended consequences?
  - If you had it all to do over again, what would you do differently?
  - What recommendations would you make to others doing similar projects?
- Focus on behaviors or tactics that were successful or problematic, rather than on people who were successful or problematic.
- Guard against a bias towards negative or positive comments.
- Ask prompting questions to get balanced input.
- Accept input after the session from individuals who prefer to remain anonymous.
- Provide the project manager with a complete, unedited listing of input from the lessons-learned exercise.
- Document lessons learned in a positive way that promotes their use as best practices.

4.4.2.4 Review Format

Templates will be established by the Chief Engineer and maintained by the PMO. Suggested templates can be downloaded from the web location given in Appendix H.

Suggested content for project management reviews are given in Table 1. The specific order of the topics, suitable for the complexity of the project, is left to the discretion of the project manager and Division Leader. The nature of each topic section will depend on the type of review, i.e., initiation, status, or closeout.

For most projects, material should be limited to the quantities specified in Table 1, except for the project initiation review, where two or three viewgraphs are permitted for the headings of

"Project Concept and Overview," "Performance Requirements," and "Project Scope." In addition, at the initial review, it is expected that additional time will be spent discussing the technical approaches and challenges. At the project closeout review, additional time will be spent addressing outstanding items, such as lessons learned, deliverables validation, and facility decommissioning.

4.4.3 Project Review Procedure

1. Project team prepares review materials (Table 1) based on project status (Initiation, Status, Closeout).
2. Project manager selects review chairperson.
3. Chairperson sets review date and location.
4. Chief Engineer, in consultation with directorate management, selects review committee.
5. Chairperson notifies all participants.
6. Chairperson or project manager submits review package to reviewers (well in advance if possible).
7. Chairperson holds review.
8. Chairperson submits to project manager the action items from review in a timely manner.
9. Chairperson tracks and closes action items.
10. Project manager archives review materials and action items.

Table 1. Typical Elements of a Project Review Presentation

Section	Description
Project Concept and Overview	Describe the nature of the project and the motivation/justification for conducting the work.
SOW/Project Scope	• Provide a statement of the purpose and goals of the project or research. Who is the customer; what is the principal deliverable; what is the total multiyear budget; and what percentage of the project is currently estimated to have been completed? • Describe the high-level technical approach, architecture, and design assumptions, emphasizing any deviations from prior reviews.
Performance Requirements	Describe key requirements emphasizing any deviations from the prior reviews.
Work Breakdown Structure (WBS)	• Include a high-level (level 1 or 2) work breakdown structure (WBS). • The WBS may be functionally oriented, end-item (system) oriented, or a mix thereof. • The WBS may be displayed as a hierarchical chart or as an indented list.
Project Organization	• Show relationships of key project members and stakeholders. • Show relationships to external resources and collaborators.

Section	Description
Schedule	• Display overall project schedule in Gantt format, rolled up to appropriate level of detail. • Include status date bar, task completion indicators, critical path, and milestone markers. • Explain variances.
Deliverables	• Indicate intermediate and final deliverables (with the schedule agreed upon with the customer and current estimate for delivery, if different). • Also, indicate which deliverables have already been met, starting with the beginning of the current fiscal year.
Milestones	• Provide a chart of the status of all project milestones planned and reached since project inception. • Milestones must emphasize the completion of tangible products and should include all key deliverables. For each milestone, indicate description, originally scheduled or baseline due date, revised due date, and completion status. • Explain any deviations from a prior period review, such as addition of new milestones, deleted milestone(s), modified or rebaselined milestone(s), or significant slippage in anticipated milestone completion date(s).
Budget	• Budget information should be provided on a graded basis. • For smaller projects, provide a summary chart showing total project baseline budget, costs to date, and total projected project cost. • For medium and large projects, include a monthly expenditure plan keyed to the WBS, and indicate monthly actual (accrued) costs and variances. Earned-value reporting systems should include monthly cost and schedule performance metrics and indices as described in "Earned Value Performance Measurement Definitions." • If contingency is included, indicate allocation strategy at the introductory review, and identify contingency usage at all subsequent status reviews. The Contingency Utilization Index (CUI) [remaining contingency ($)/remaining PV($)] % over time should be included to demonstrate the contingency usage and trending. • Include a discussion of recovery plans for significant variance conditions. • Include a discussion of project staffing baseline, emphasizing any deviations from the preceding review.
Resources	Staffing and/or procurement plan/status
Key Activities	Include a discussion of significant project activities during the prior reporting period (typically one month) and key future activities planned for the upcoming reporting period.
Risk Management Plan	• Identify key issues or risk factors related to project performance, cost, and budget, and briefly describe the mitigation plan. • For large projects, describe risk triggers and the status of any that have occurred.
System Engineering/ Interface Control	• List key interfaces, and decsribe how they are to be controlled and documented. • Indicate any interface issues.
Integrated Safety Management	Show required safety activities, such as IWS creation, and how safety activities are specifically budgeted.

Section	Description
Change Control Process	Describe the change control process to be used for the project.
Project Closeout	• Describe the proposed closeout plan or current status. • For LDRD projects nearing completion, describe the exit plan for project closeout and securing follow-on work.

4.4.4 Project Management Review Attendees

Typically, attendance at project management reviews includes the following:

- Project engineer-presenter
- Key project personnel
- Key stakeholders
- Cognizant Division Leader or center director
- Review team, including chairperson

4.4.5 Review Team Deliverables

The review team will give an accept "(Y)es or (N)o or (N/A) Not Applicable" rating on the project management evaluation categories that are summarized on review check lists, which can be downloaded from the link provided in "Project Review Forms," Appendix H. Depending on the RAL of the project and the execution status, some categories may or may not apply. Some key review elements are

- Project scope
- Identification of system requirements
- WBS
- Project organization
- Project schedule
- Definition of deliverables
- Milestones
- Budget tracking and reporting
- Definition of resources
- Key activities
- Risk management plan
- Interfaces definition and implementation
- ISM planning and execution
- Change control
- Closeout plan

Following the review, the review team will submit their action items and comments to the review chairperson who will in turn compile the action items and summarize them. The

chairperson will track disposition of action items and summarize their resolution for the review team (with assistance from the project leader) at the subsequent project review(s).

4.4.6 Project Management Review Team Checklists and Forms

Review team members are encouraged to use project management review checklists to track thoroughness of review presentations (see the link in Appendix H). Review chairpersons should tailor the checklist to suit their organization or the projects being reviewed.

4.5 Project Reporting

The project manager's responsibility to the project sponsor and to the overall viability of the project is to make recurring project status reports to assess project progress. These regularly scheduled reports have three purposes:

1. Track and provide a review of actual project accomplishments against project plans.
2. Provide a basis to update project plans as tasks are completed, and change plans for remaining work as required.
3. Give the project team insight into the overall progress of the project to allow the team and management to take corrective actions when project performance varies significantly from the baseline plan.

The frequency, content, and depth of material in the report will vary according to the complexity and associated risk of the project. In general, project status reports are made on a monthly basis; however, exceptions occur as allowed by the project sponsor or as instituted by the project manager. Most often, a project status meeting is held in which key members of the project team are called together to review and comment on the report before issuance.

A project status report should address certain essential elements. The report should include an evaluation of planned deliverables with regard to scope, budget, and schedule. Figure 2 provides an example of a type of report or chart addressing all of these elements. Called a "Quad Format" project summary chart, it is the type required for LDRD projects. The content of any project status report produced by directorate project managers should include the following elements:

- **Overall project or executive summary—**Frequently this assessment takes the form of a table or chart showing the status of the project, whether it is on track, experiencing some recoverable difficulties, or in serious trouble that could prevent the project from meeting its baseline goals. A common method is to report against scope, budget, and schedule, using earned value metrics.
- **Project performance**—In this portion of the report, provide project performance progress over the reporting period. Most frequently, earned-value metrics are reported. Provide an explanation of variances against planned progress. Often, along with the monthly performance metrics, cumulative metrics are illustrated in graphical form.

- **Schedule and accomplishments**—Use this section to highlight specific project accomplishments or milestones that were or were not met during the reporting period. Provide descriptive comments.
- **Controls**—This part of the report should address any issues, concerns, or corrective actions that have arisen or were implemented during the reporting period. The status of changes to project risks can also be given in this section.
- **Project definition or overview**—This is provided as a reminder to readers of what the scope of the project is, over what period it is expected to be completed, and the authorized budget, as well as any unique or special characteristics of the project.

The above list is not exhaustive; other components may be included at the discretion of the project manager or sponsor. Additional information to be reported could include

- Work or activities expected or planned in the next reporting period
- A discussion of outside influences or occurrences that may alter the course of the project
- A written summary of work completed, along with underlying issues and concerns pertinent to the project

ENGINEERING @ LLNL "You got to be careful if you don't know where you're going, because you might not get there." - Yogi Berra

Division Leader's Summary Project Update: ROCSS

Date: April 30, 2001

SV/CV Lights	WBS Level 1.21 Aircraft Integration	WBS Level 1.22 HEAF Integration	WBS Level 1.3 Seedant Evaluation	WBS Level 1.4 Sensor Suite	WBS Level 1.5 HEAF Support
<5% 5–10% >10%	S C	S C	S C	S C	S C

Overview

Customer: Boeing Corporation

Concept: ROCSS is a project that will produce the equipment, personnel, and procedures needed to provide lethality assessments of National Missile Defense (NMD) intercepts. NMD target is "seeded" with an IR-active chemical that is vented to space in a lethal intercept, and detected by remote airborne sensors.

Scope: Develop and model candidate seedants, develop integrated sensor suite, perform sub-scale tests at HEAF, package and integrate system on HALO aircraft

Schedule (Start to Finish): February 2000 - April 2001

Principal Deliverables:

1. **REPORT:** Prioritized list of candidate seedant materials, based on physics modeling, for subsequent verification testing at HEAF
2. **REPORT:** Intermediate and final results of a 12 shot test campaign using sensor suite at HEAF, with at least one seedant material
3. **CAPABILITY:** Packaged sensor suite with specific performance characteristics, operators, ground support ready for flight testing on HALO aircraft

Project Budget/Schedule

BAC=$2363K | EAC=$2563K | % Complete=91% | Scheduled Completion Date= 4/30/2001

Cumulative (to Date) Performance Measures

EV	AC	PV	CV	SV%	CPI	SPI
$2153K	$2342K	$2363K	"-8%"	"-9%	0.93	0.91

Key Near Term Milestones

green dates: achieved or advanced red dates: delayed

Milestone	Baseline Schedule	Current Schedule	%	Comments
HEAF Test Campaign Complete	February 20, 2001	March 15, 2001	100	Seedant detected on 8 shots
ES&H permits complete	March 28, 2001	May 31, 2001	90	OSP, ASD, IWS in review. NEPA CADEX approved.
Sensor Suite ready for flight	March 20, 2001	May 31, 2001	75	All sensors ready, software and hardware ready, but flight racks are in fabrication.
Management prestart review	April 2, 2001	May 25, 2001	0	
Integration flight test complete	April 15, 2001	June 15, 2001	0	

Project Management Issues, Concerns, Corrective Actions

WBS 1.21 Aircraft integration

Sponsor imposed delays in placing interface contract with Aeromet, delayed completion of integration tasks. A day for day slip in the schedule resulted in a 200k shortfall between EV and PV on the scheduled completion date of April 30. Sponsor approved $200k in additional funding with an extended target completion date of June 30, 2001. CV is due to keeping the small team together at a critical mass. CV slightly lower than SV because some team members were able to work part time on other projects during the delay. Aeromet contract was placed, and we are fully engaged in flight integration activities that will culminate in a June test campaign. Additional $200k funding and a baseline schedule delay for 2 months will correct the shortfall. Sponsor has approved this baseline change.

Performance Measure Trends

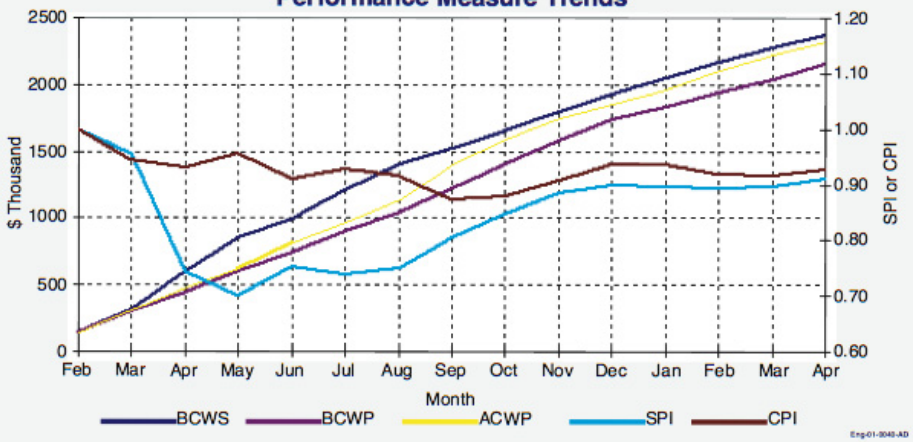


Figure 2. Completed Example of a "Quad Format" Project Summary Chart

4.6 Project Closeout Procedures

During the closeout phase of the project, it is important to archive project information and data, mitigate hazards that may remain, and capture important lessons learned. If there is a possibility that the project will be restarted or the equipment reused, then any issues associated with the restart should be documented.

4.6.1 Documentation Archive and Transferal

A *project archive* refers to the systematic storing of project articles (for example, project charter, working documents, and scale models) at the close of the project. Historical project documents can provide information for future projects, for ongoing project product support, and for answering questions about the project. (See the LLNL Records Management Policy at http://www-r.llnl.gov/bsd/records/policy.html and the LLNL Records Retention Schedule at http://www-r.llnl.gov/bsd/records/retention/retention.html.)

Depending on the type of project, the documentation transferred from the project organization to the operating organization might include

- Environmental and safety documentation
- Design basis documents
- Drawings and specifications, including as-built documents
- Configuration management documents
- Equipment and operating manuals
- Acceptance test results

It is important to properly disposition any classified documents or data generated by the project. The project budget should include the proper ownership transferal or destruction, as applicable, of classified documents in accordance with established procedures.

4.6.2 Hazard Mitigation

After projects are closed out, project staff find new assignments, and their knowledge of the hazards associated with the project can be lost. Topics to be addressed include:

- **Contaminated Equipment.** Cleanup of contaminated equipment should be included in the project plan and budgeted for.
- **Hazardous Chemicals.** Unused chemicals should be dispositioned in accordance with established procedures.
- **Hazardous Equipment.** Equipment like high-voltage power supplies, pneumatic systems, and hydraulic systems must be left in a safe state. Administrative locks can be used to disconnect power and other energy sources. An FPOC or other appropriate person can hold the keys. **Note:** LOTO locks are not used in this situation; they are only used to protect people who are working on equipment.
- **Explosives.** All explosives must be dispositioned.

- **Housekeeping.** The process of cleaning up facilities generally identifies potentially hazardous equipment and materials that might otherwise be overlooked. When this is done after the fact by workers unfamiliar with the project, hazards can be overlooked. This has resulted, for example, in contaminated parts being sent to DUS. Project equipment and facilities must be cleaned up and junk discarded under the direct supervision of knowledgeable project personnel.

The *ES&H Manual* and Hazards Control consultants are good sources of guidance for how to deal with specific hazards.

4.6.3 Lessons Learned

The lessons-learned process really starts when objectives are established in a project proposal. If the objectives were met, the closeout process sets out to reinforce sound practices and highlight innovative ones; if the goals aren't met, then it tries to discover what went wrong. Lessons learned is knowledge derived from experience to promote the recurrence of desirable outcomes or preclude the recurrence of undesirable outcomes.

Whether it is called a closeout, a lessons-learned, or a postmortem review, it is the first step in the success of all future projects. The review often addresses both positive and negative experiences. The closeout meeting should be based on not only acknowledging mistakes and correcting them but also on acknowledging successes and rewarding them. Reasons for the success of particular methods, systems, and procedures can lead to implementation of similar practices across the Laboratory. Only by learning the lessons of each project—positive *and* negative—can an organization improve on the culture of its project management methodology.

Lessons learned are to be sent to a Chief Engineer, who will determine appropriate dissemination.

Appendix A. Applicable DOE Standards

DOE O 413.3,"Program and Project Management for the Acquisition of Capital Assets."

DOE M 413.3-1," Project Management for the Acquisition of Capital Assets," approved March 28, 2003.

"DOE Program and Project Management Manual" (in preparation at the time of this writing)

DOE O 430.1, "Life Cycle Asset Management."

Appendix B. Applicable Industrial Standards (Guidance)

American National Standards Institute (ANSI), *A Guide to the Project Management Body of Knowledge (PMBOK Guide)*, ANSI/PMI 99-001-2000.

Institute of Electrical and Electronics Engineers (IEEE), *IEEE Std 1490™-2003 Adoption of PMI Standard: A Guide to the Project Management Body of Knowledge -Description*.

American National Standards Institute (ANSI) and Electronic Industries Alliance (EIA), *Earned Value Management Systems,* ANSI/EIA-748-1998.

Appendix C. References

For access to project management references, visit the Project Management tab on the Inside Engineering web site at http://www-eng-r.llnl.gov/project_mgmt/proj_mgmt.html.

Engineering Policy Manual (most recent version), Lawrence Livermore National Laboratory, Policy 5.2, Project Management.

Engineering Directorate Quality Assurance Plan.

Earned Value, Clear and Simple (1999), Tammo T. Wilkens, Los Angeles County Metropolitan Transportation Authority, April 1.

Appendix D. Introduction to Project Management Principles

D.1 Definition of a Project

A project is defined as a temporary endeavor undertaken to create a unique product or service. While the product or service (that is, the deliverable) may endure, the project has a definite beginning and end, the end being reached when the project's objectives are achieved or the project is terminated. Ongoing or repetitive operations are not projects.

D.2 Definition of Project Management

Project management is knowledge, skills, tools, and techniques applied to project activities to meet or exceed customer and stakeholder needs and expectations for a project.

D.3 Project Phases

Projects are unique undertakings and may involve considerable budget, personnel, and equipment for complex projects and fewer of those resources for simpler endeavors. Whether complex or straightforward, all projects may naturally be subdivided into discrete phases wherein certain skills and disciplines are emphasized and specific tasks are required. While each project is unique in its deliverables, the major phases of all projects are very similar. Projects tend to transition from concept to definition, from definition to execution, and from execution to operations or project completion.

Projects quite often need to be thought of in phases to provide better management control and appropriate links to the ongoing operations of the performing organization. Collectively, the project phases are known as the project *lifecycle*. The lifecycle of a typical DOE Order 413.3 line-item construction project is illustrated in Figure 3. Each project phase is marked by the completion of one or more deliverables.

A *deliverable* is a tangible, verifiable work product (that is, hardware, software, analysis) such as a feasibility study, a detail design, a working prototype, or the end product itself. The deliverables, and hence the phases, are part of a generally sequential logic designed to ensure proper definition of the project's product. The phase sequence defined by most project management lifecycles generally involves some form of technology transfer or handoff, such as requirements to design, construction to operations, or design to manufacturing. Deliverables from the preceding phase are usually approved before work starts on the next phase. The conclusion of a project phase is generally marked by a verification review of key deliverables and project performance to determine whether the project should continue into

its next phase and to detect and correct errors in a cost-effective manner as the project moves forward.

The lifecycle of a typical project as illustrated in Figure 3 identifies the major phases of a project and ties specific funding sources to those phases. Funding for specific phases may come from operating or program funds, project engineering and design (PED), other project costs (OPC) or line-item construction dollars. Figure 3 also introduces the concept of *critical decisions* (CD). Based on preconceptual planning, a CD-0 approves the mission need and grants permission to move to the conceptual design phase of the project. CD-1 approves the preliminary baseline range and allows the project team to enter the design phase. CD-2 approves the performance baseline, which establishes the scope, schedule, and budget of the project. CD-3 approval allows the start of execution, and CD-4 allows the start of operations or project closeout.

Smaller projects like TechBase, LDRD, or strategic initiatives (SI) that may be worked on or led by directorate personnel have decision points over the project life cycle akin to critical decisions as described above. Critical decisions on these projects occur at the regular progress reviews presented to directorate management whereby the status of the project is presented and decisions may be made as to whether to continue or terminate the project, based on performance.

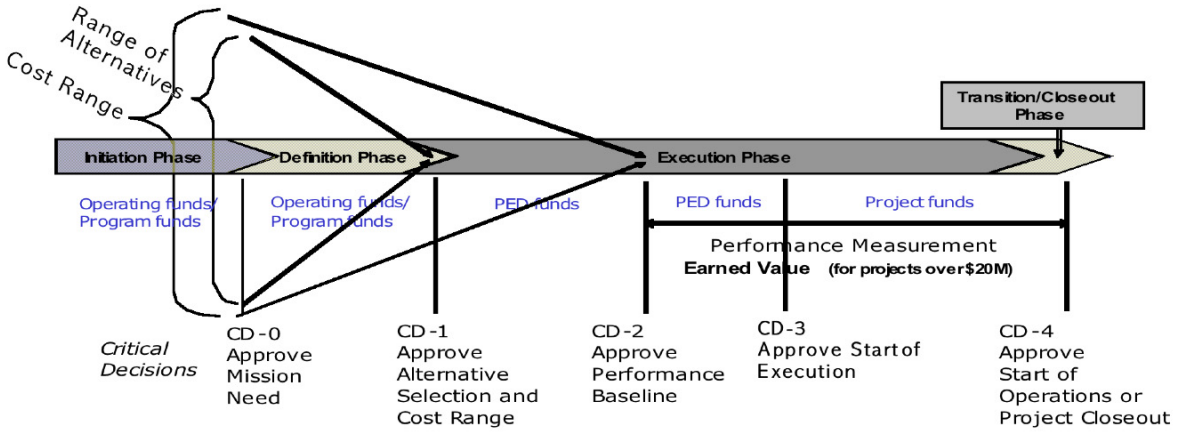


Figure 3. Lifecycle of a Typical Project

The National Nuclear Security Administration (NNSA) and the Department of Defense (DoD) cooperate in the development, production, and maintenance of nuclear weapons. In general, NNSA is responsible for designing, developing, producing, updating, and dismantling nuclear warheads, nuclear weapon trainers, and ancillary equipment, while the DoD is responsible for designing, developing, and producing, and dismantling the weapon delivery system. Directorate personnel may be assigned to support this mission in matrix assignments to the LLNL Defense and Nuclear Technologies Directorate (D&NT). Those personnel supporting D&NT may need to familiarize themselves with the use of the term *phase* as specifically defined and applied to the nuclear weapon development process. Figure 4 illustrates phases 1 through 7 as applied to the development of nuclear weapons.

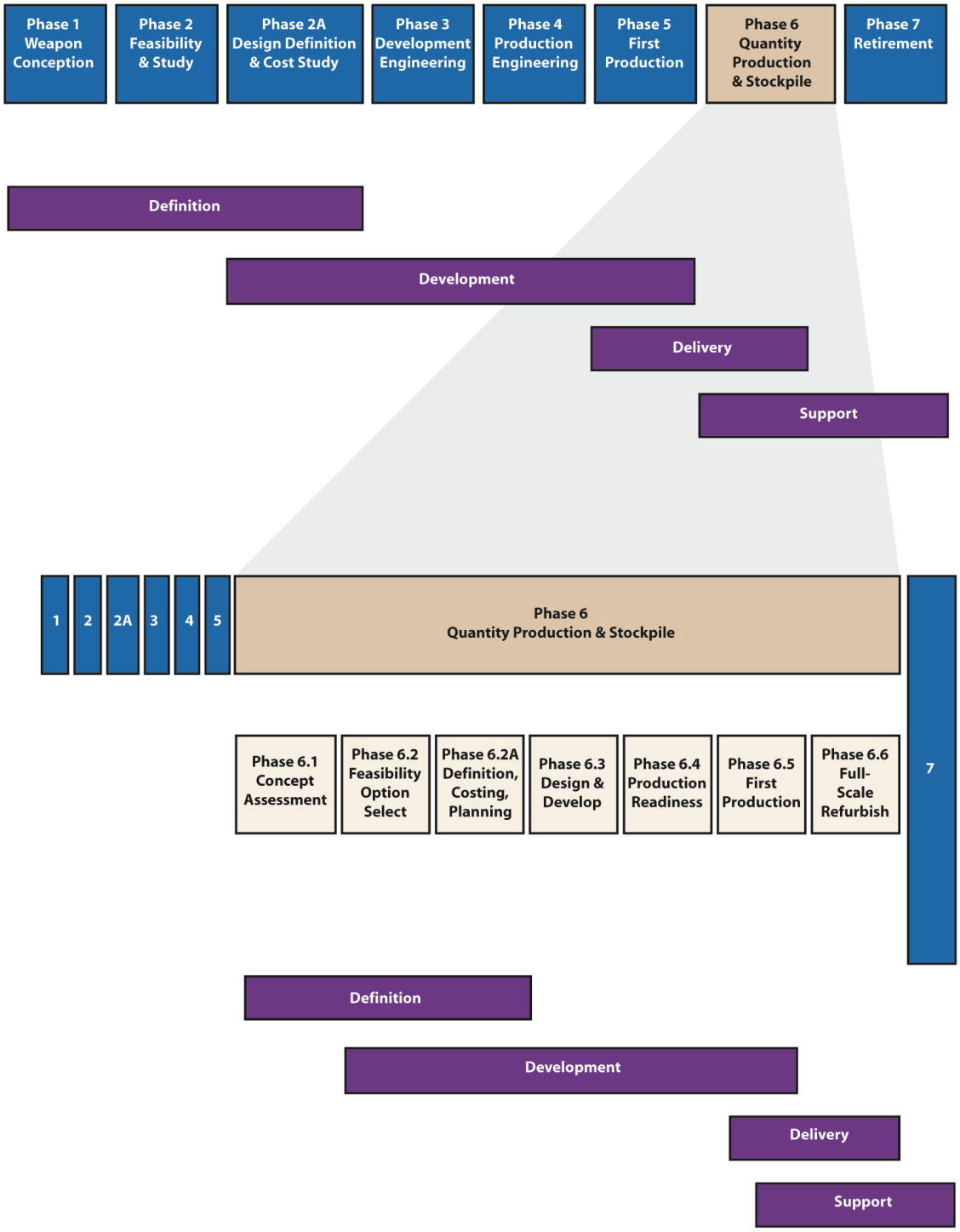


Figure 4. Seven Phases Used by the DOE NNSA for Defining a Nuclear Weapon's Acquisition Life Cycle

D.4 Project Management Knowledge Areas

Project management knowledge and practice can be described in terms of its component processes. These processes have been standardized by PMI and organized into nine knowledge areas described below.

D.4.1 Integration Management

Project integration management is the subset of project management that includes the processes required to ensure that the various elements of a project are properly coordinated.

- **Project Plan Development—**Take the results of other planning processes and put them into a consistent, coherent document.
- **Project Plan Execution—**Carry out the project plan by performing the activities included therein.
- **Overall Change Control—**Coordinate changes across the entire project.

D.4.2 Scope Management

Project scope management is the subset of project management that includes the process required to ensure that the project includes all work required and only the work required to complete the project successfully.

- **Initiation**—Commit the organization to begin the next phase of the project.
- **Scope Planning**—Develop a written scope document as the basis for future project decisions.
- **Scope Definition**—Subdivide the major project deliverables into smaller, more manageable components.
- **Scope Verification**—Formalize acceptance of the project scope.
- **Scope Change Control**—Control changes to project scope.

D.4.3 Time Management

Project time management is the subset of project management that includes the process required to ensure timely completion of the project:

- **Activity Definition**—Identify the specific activities that must be performed to produce the various project deliverables.
- **Activity Sequencing**—Identify and document interactivity dependencies.
- **Activity Duration Estimating**—Estimate the number of work periods needed to complete individual activities.
- **Schedule Development**—Analyze activity sequence, activity duration, and resource requirements to create the project schedule.

D.4.4 Cost Management

Project cost management is the subset of project management that includes the processes required to ensure project completion within the approved budget.

- **Resource Planning**—Determine what resources (people, equipment, materials) and what quantities of each should be used to perform project activities.
- **Cost Estimating**—Develop an approximation (estimate) of individual work items.
- **Cost Control**—Control changes to the project budget.

D.4.5 Quality Management

Project quality management is the subset of project management that includes the processes required to ensure that the project will satisfy the needs for which it was undertaken.

- **Quality Planning**—Identify which quality standards are relevant to the project, and determine how to satisfy them.
- **Quality Assurance**—Evaluate overall project performance on a regular basis to provide confidence that the project will satisfy relevant quality standards.
- **Quality Control**—monitor specific project results to determine whether they comply with relevant quality standards, and identify ways to eliminate causes of unsatisfactory performance.

D.4.6 Human Resource Management

Project human resource management is the subset of project management that includes the processes required to make the most effective use of the people involved with the project.

- **Organization Planning**—Identify, document, and assign the project roles, responsibilities, and reporting relationships.
- **Staff Acquisition**—Get the needed human resources assigned to and working on the project.
- **Team Development**—Develop individual and group skills to enhance project performance.

D.4.7 Communications Management

Project communications management is the subset of project management that includes the processes required to ensure timely and appropriate generation, collection, dissemination, storage, and ultimate disposition of project information.

- **Communications Planning**—Determine the information and communication needs of the stakeholders: who needs what information, when will they need it, and how will it be distributed.
- **Information Distribution**—Make the information available to project stakeholders in a timely manner.
- **Performance Reporting**—Collect and disseminate performance information, including status reporting, progress measurement, and forecasting.

- **Administrative Closure**—Generate, gather, and disseminate information to formalize phase or project completion.

D.4.8 Risk Management

Project risk management is the subset of project management that includes the processes concerned with identifying, analyzing, and responding to project risk.

- **Risk Identification**—Determine which risks are likely to affect the project, and document the characteristics of each.
- **Risk Quantification**—Evaluate risks and risk interactions to assess the range of possible project outcomes.
- **Risk Response Development**—Define strategies for acceptance, transferal, mitigation, or avoidance of threats.

D.4.9 Procurement Management

Project procurement management is the subset of project management that includes the processes required to acquire goods and services from outside the performing organization.

- **Procurement Planning**—Determine what to procure and when.
- **Solicitation**—Obtain quotes, bids, offers, or proposals as appropriate.
- **Source Selection**—Choose from potential sellers.
- **Contract Administration**—Manage the relationship with the seller.
- **Contract Closeout**—Complete and settle the contract, including resolution of any open items.

Appendix E. Earned-Value Measurement Definitions, Examples, and Resources

Earned-value analysis is a method of measuring project performance. The method compares the amount of work planned to the amount of work actually completed. The results determine whether costs and schedules are on target. For each budgeted WBS element, planned and actual costs and earned value are determined monthly:

- **Actual Costs (AC)**—The total of all costs incurred to perform work completed in a given period. Formerly called Actual Cost of Work Performed (ACWP).
- **Earned Value (EV)**—The total of all cost estimates for the activities actually completed in a given period. Formerly called Budgeted Cost of Work Performed (BCWP).
- **Planned Value (PV)**—The total of all cost estimates for activities scheduled to be completed in a given period. Formerly called Budgeted Cost of Work Scheduled (BCWS).

E.1 Earned Value Formulae

- Cost Variance (CV) = EV – AC
- Schedule Variance (SV) = EV – PV
- Cost Performance Index (CPI) = EV/AC
- Schedule Performance Index (SPI) = EV/PV

E.2 Project Total Cost Terminology

Budget at Completion (BAC)	The approved (typically by customer) baseline total budget for a project or WBS element thereof. Sum of the cumulative PV; does not include contingency.
Estimate at Completion (EAC)	Project management's current (periodic) estimate of cost for a project or WBS element thereof. The sum of actual accrued (booked) costs [sometimes referred to as CTD or Cost to Date] plus obligations (liens) plus estimated costs to complete.
EAC by Trend	EAC with calculated cost to complete based on CPI. EAC by Trend = AC + (BAC – EV)/CPI.
ETC	Estimate to Completion is the expected additional cost needed to complete the project or a portion of the project. ETC is calculated with BAC – EV, (BAC – EV)/CPI, or (BAC – EV)/(CPI × SPI).

Other Project Costs (OPC)	All other project costs not included in TEC [see *Total Estimated Costs (TEC)*], such as supporting research and development, preauthorization costs, or plant support costs.
Total Estimated Costs (TEC)	All engineering design costs and construction costs, including project management, construction management inspection, and contingency.
Total Project Cost (TPC)	TPC = TEC + OPC. All costs specific to a project incurred through startup, but prior to operations.
Variance at Completion (VAC)	Comparison of BAC with latest EAC. VAC = BAC – EAC.

E.3 Earned-Value Sample

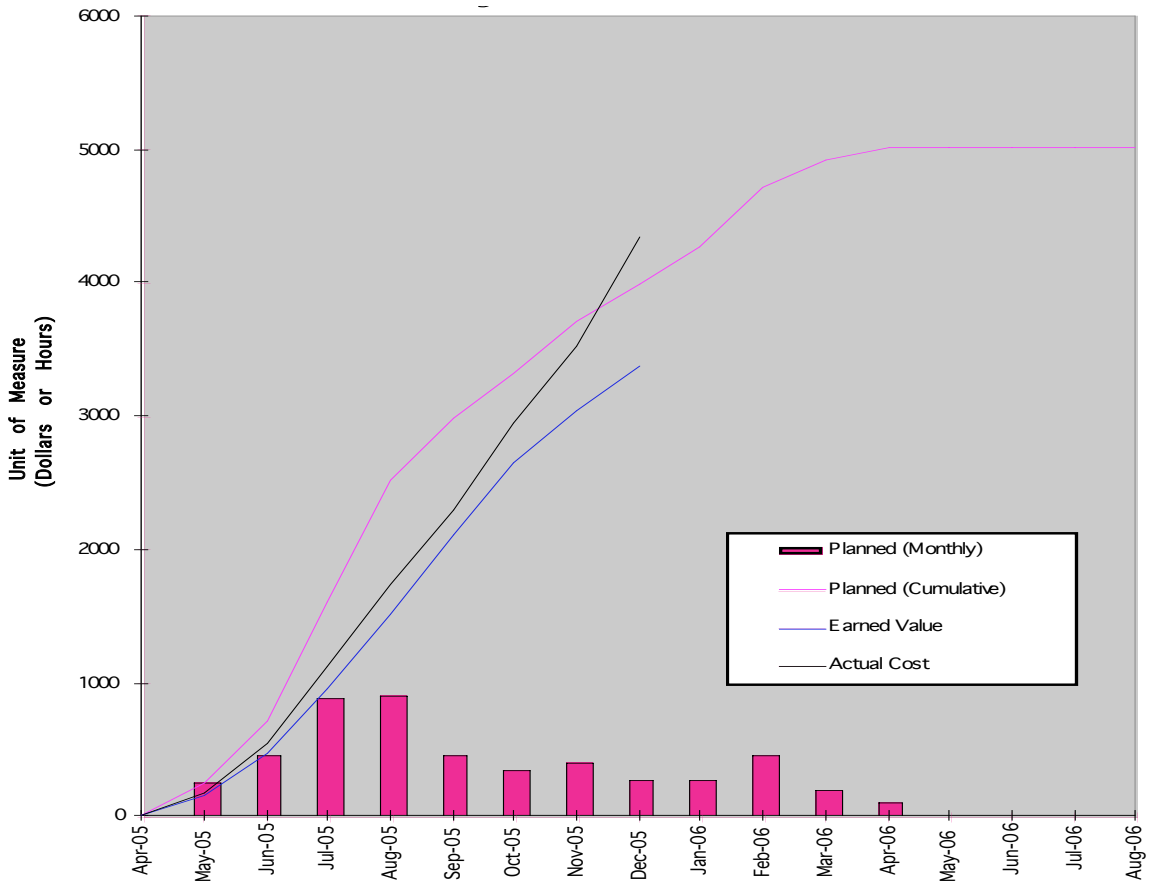


Figure 5. Typical Example of an EVM Graph

In Figure 5, the monthly spending plan is shown as "Planned (Monthly)" and graphed as bars across the bottom. The cumulative spending profile is shown as "Planned (Cumulative)" and displays a somewhat S-shaped curve. The earned value is shown as "Earned Value" and is cumulative to the data date, or date of assessment, which in this case is December 2005. The

actual cost to accomplish the tasks as of the assessment date is shown as "Actual Cost" and is typically derived from LLNL's accounting system.

Planned Value (PV)	Earned Value (EV)	Actual Cost (AC)	Cost Variance (CV)	Schedule Variance (SV)	Cost Performance Index (CPI)	Schedule Performance Index (SPI)
4000	3200	4200	–1000	-800	0.76	0.8

Table 2. Values Associated with Figure 5 at the End of December Data Date

Analysis Based on Figure 5 Data

SV is negative; therefore, the project is behind schedule. The obvious question is how far behind schedule. An extended horizontal line through the current Earned Value point intersects the PV curve at the Oct 05 column, two months earlier than the assessment date. The project is two months behind.

CV is negative; therefore, the project is overspent. The obvious question is how much the project will overspend if the current trend continues. Using the EAC by Trend calculation, the question can be answered. Assuming BAC = 5000,

$$4200 + \frac{5000 - 3200}{0.75} = 6600 \text{ units}$$

Appendix F. Alignment with the Project Management Institute (PMI)

Wherever practicable, the directorate requires that its employees conduct project management activities in alignment with the fundamental principles, processes, tools, and techniques standardized by the Project Management Institute (PMI, at http://www.pmi.org) and as described in PMI's *Guide to the Project Management Body of Knowledge* (PMBOK).

The PMI PMBOK is an internationally recognized standard (ANSI/PMI 99-001-2000, IEEE 1490-1998) that reflects consensus developed over decades through the work of public, private, and academic organizations around the basic skill set for project mangers. Engineering encourages use of the PMBOK as guidance for all project team members.

Engineering supports certification by PMI of its career-track project managers as Project Management Professionals (PMPs). The PMI PMP Certification Program is ISO-9001 certified.

Appendix G. Project Management Training and Certification

The directorate provides appropriate instructional support to assist project managers in developing and maintaining competencies to successfully execute their work assignments. Training should be commensurate with the scope, schedule, cost, and risk elements of a project to ensure that a project manager is capable of successfully delivering the project.

Training standards are intended to meet or exceed the requirements of DOE, regulatory agencies, and standards established by industry or professional organizations.

The directorate's project management curriculum can be viewed at http://www-eng-r.llnl.gov/project_mgmt/eng_pm_trn_reqs.html.

Appendix H. Project Review Forms

Download the following sample forms as Word files from http://www-eng-r.llnl.gov/project_mgmt/eng_pm_forms.html.

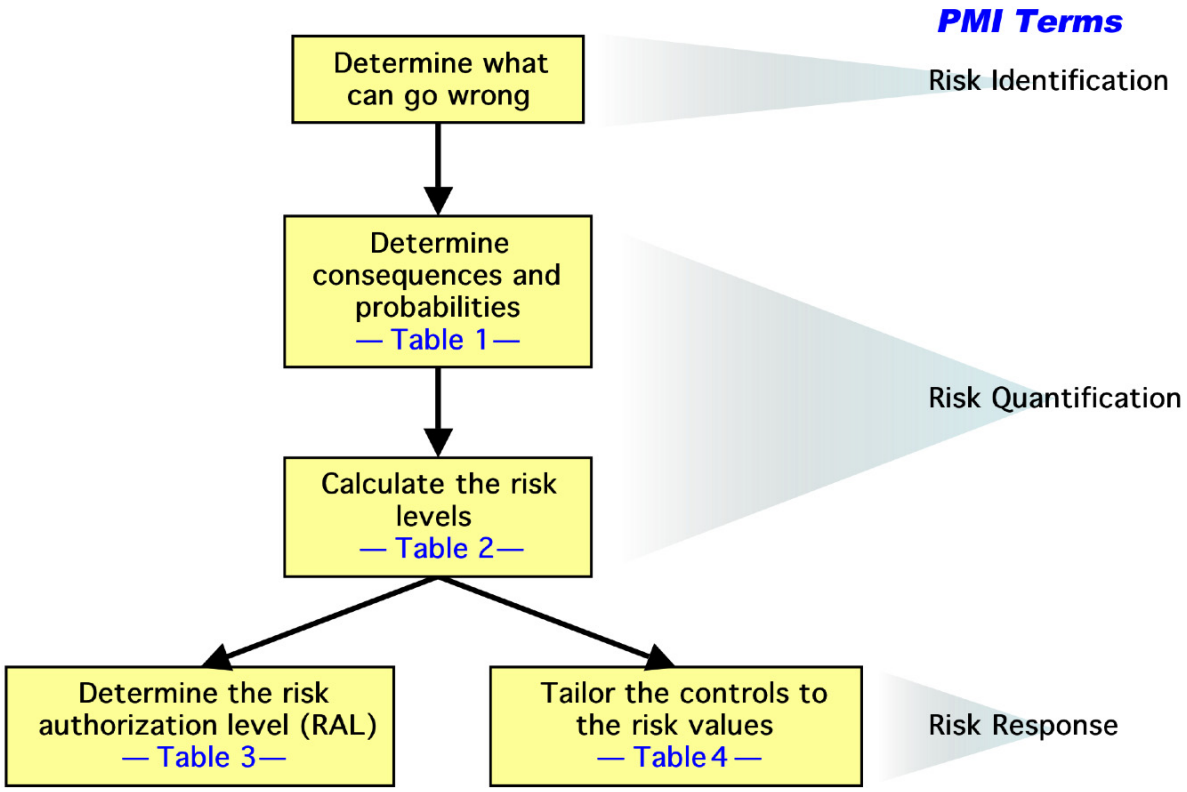
- Project Initiation Review Checklist
- Project Status Review Checklist
- Project Closeout Review Checklist
- Project Review Action Items Checklist
- [Others may be added in time.]

Appendix I. Risk-Management Planning Procedure Details

I.1 Procedure Steps

This appendix can be used in lieu of the interactive web-based tool. You can use the interactive web-based tool at http://hattori.llnl.gov:8080/risk-assessment/ to calculate risk levels, determine the level of authorization needed, and tailor the controls for a project. The basic procedure is summarized in the flow chart shown in the figure that follows.

Note: A suggested worksheet to use for recording and displaying the results of following this procedure can be found in Section I.3.



Path for Determining the Appropriate Level of Project Controls and Oversight

1. **What can go wrong?** Determine possible failure modes associated with each of the following risk areas, where applicable:
   - Scope
   - Schedule

- Budget
- Political and public trust
- Health and safety
- Security
- Environment

2. Down-select possible failure modes to credible failure modes.
3. **How likely is it that something can go wrong, and how bad could it be?** For each risk area (failure mode), use Table 1 to determine the level of consequence and probability, using qualitative identifiers from Negligible to High for consequences and Unlikely to Very Likely for probabilities.
4. **How risky is it?** Using Table 2, combine probability and consequence levels you obtained from Table 1 for each risk area to determine the risk value of Negligible to High.
   - **What is the oversight level needed?** Using Table 3, determine the RAL based on the risk values obtained from Table 2 in step 4. The RAL is driven by the highest value of risk in any of the seven risk areas.
   - **What should be done to ensure success?** Use the risk values obtained from Table 2 to find the resulting control or "Tool" level for each risk area in Table 4. An explanation of each control level for each risk area is listed just after Table 4.

Table 1. Levels of Consequence and Probability for Seven Risk Areas

(Table 1a)

Risk Area	Consequence Descriptors	Consequence of Failure	Probability Descriptors	Probability of Failure
Scope	• Failure to meet some requirements results in the shutdown of a major program • Failure to meet scope objectives result in project failure • Replanning is not effective	**High**	• Requires breakthrough technology • Crisis mode, no significant planning possible • New design way beyond the state of the art • Highly speculative, characterized as "Best Effort" • Construction or manufacturing requires world-class expertise, equipment, or procedures • Enormous complexity or interface issues • Scope is poorly defined	**Very Likely**
	• Failure to meet some requirements results in a major impact on major program • Failure to meet scope objectives results in significant reduction of project value • Replanning may be effective	**Medium**	• Advances state of the art technology • New, difficult design or experiment within the state of the art. • Extensive modifications ot an existing design or practice. • Construction or manufacturing requires advanced expertise, equipment, or procedures • Scope is loosely defined	**Likely**
	• Failure to meet some requirements results has limited impact on the program but has high visibility • Failure to meet scope objectives results in significant reduction of project value • Replanning can be effective	**Low**	• Integration of off the shelf components • New, relatively simple design or development effort • Minor modification to an existing design or procedure. • Construction or manufacturing requires common expertise, equipment, or procedures • Scope is well defined, interfaces are simple	**Unlikely**
	Failure has negligible impact on the program or sponsor	**Negligible**	• Nearly identical to recent successful project. • Procurement of mass-produced, off the shelf, market driven components or services. • Scope is clearly defined, well understood, and agreed between sponsor and provider.	**Very Unlikely**

(Table 1b)

Risk Area	Consequence Descriptors	Consequence of Failure	Probability Descriptors	Probability of Failure
Schedule	• Major potential impact (project failure, program deliverable) • Major schedule impact of greater than 25% delay • No delay is tolerable – even a minor delay results in project failure. • On critical path of a higher level project activity.	**High**	• Extremely aggressive schedule • More unknowns than knowns • No precedent for schedule basis • Limited expertise available • Low confidence estimate (> ±50% uncertainty) • No schedule contingency • Relatively short duration with no realistic recovery time • Critical path not well-understood	**Very Likely**
	• Significant potential impact (missed deliverables) • Moderate schedule impact of between 15% and 25% delay • Near critical path of a higher level project activity	**Medium**	• Difficult, but achievable • More knowns than unknowns • Some experience on similar activities, not at expert level • Medium confidence estimate (±25% uncertainty) • Some schedule contingency options • Critical path understood, but multiple near-critical paths in parallel	**Likely**
	• Minor schedule impact of between 5% and 15% delay • Possible workarounds	**Low**	• Similar to other recent work • Expertise available with a strong track record of on-time performance. • Few unknowns • High confidence estimate (±10% uncertainty) • Some schedule contingency options	**Unlikely**
	• Negligible schedule impact of less than 5% delay • No impact on a higher level project activity	**Negligible**	• Historical data, high confidence estimate • Long total duration that allows for work-around options • Large amount of contingency	**Very Unlikely**

(Table 1c)

Risk Area	Consequence Descriptors	Consequence of Failure	Probability Descriptors	Probability of Failure
Budget	• Major potential loss (>$20M) • Loss of greater than 25% of budget • Potential for ≥$20K overrun on any WFO project ($20K WFO overruns are reported to the UC Board of Regents)	**High**	• Optimistic assumptions, low confidence estimate • Estimates not peer-reviewed • No contingency • In house estimate for area with low experience • Cost estimate based on incomplete scope information	**Very Likely**
	Significant impact ($250K to $20M)	**Medium**	• Vendor quote from conceptual sketches • In house estimate for area with minimal direct experience, but related to other similar work • Top-down estimate from analogous projects	**Likely**
	Minor economic impact (up to 10% of budget; $20–$250K)	**Low**	• Vendor quote from finished drawings • In house estimate for area with high familiarity • Bottom-up estimates with peer review	**Unlikely**
	Low dollar loss	**Negligible**	• Historical data adjusted for quantities and escalation over time. • Commercial off the shelf items with firm quotations	**Very Unlikely**

(Table 1d)

Risk Area	Consequence Descriptors	Consequence of Failure	Probability Descriptors	Probability of Failure
Political and Public	• Major loss of public confidence (National news coverage), attention of Congress • Cancellation of project • Shutdown of facility	**High**	• Project takes place in the public domain • Public participation with project • High priority or high visibility • Complex, multpartner project	**Very Likely**
	Criticism from DOE HQ, LSO, City of Livermore, or Alameda County	**Medium**	• Team has limited experience dealing with public and/or political groups • Media exposure to significant program milestones • Public input on decision making or funding	**Likely**
	Interdepartmental or directorate interface issues	**Low**	• Limited media exposure or public interest • Project manager and team are experienced in dealing with public and/or political groups	**Unlikely**
	Negligible concern	**Negligible**	Pubic unlikely to have an exposure to project under any scenario.	**Very Unlikely**

(Table 1e)

Risk Area	Consequence Descriptors	Consequence of Failure	Probability Descriptors	Probability of Failure
Health and Safety	• Failure results in violation of OSHA or EPA regulations • Significant hazard to employees and public (death)	**High**	• Unconventional or unprecedented operation • Personnel with no prior experience in this activity • Requires development and implementation of new H&S policies or procedures • Likely to occur several times during the project lifecycle • New administrative safety controls	**Very Likely**
	Failure results in a • Reportable occurrence • Potential serious injuries • Lost work time	**Medium**	• Team has personnel with limited experience in this activity • New IWS • Existing operational procedures being applied to project with significantly higher consequences • Requires significant modifications to existing H&S policies or procedures • Could be expected to occur once during the project lifecycle • Mature administrative safety controls	**Likely**
	• Minor injury potential • First aid category • No lost work time	**Low**	• Requires incremental change to existing policies or procedures • Existing IWS • Not expected to occur during the project lifecycle • LLNL-engineered safety controls	**Unlikely**
	No health and safety consequences	**Negligible**	• High confidence in ability to execute tasks according to established and proven procedures • No health and safety issues identified • Commercially engineered safety controls	**Very Unlikely**

(Table 1f)

Risk Area	Consequence Descriptors	Consequence of Failure	Probability Descriptors	Probability of Failure
Security	• National security is compromised • Loss or theft of Category I or II SNM or National Security Information • Loss or theft of Controlled Electronic Media • Violation of DoE orders • Failure results in a Category A security infraction	**High**	• Unconventional or unprecedented operation • Untested security controls • Personnel with no prior experience in this activity • Requires development and implementation of new security policies or procedures • Combined with one of the above descriptors—access to highly classified information, large number of documents, CREM, and outside interactions	**Very Likely**
	• Failure results in a Category B security infraction • Violation of DOE Orders • Loss or theft of Category III or IV SNM or classified information	**Medium**	• Existing operational proecedures being applied to project with significantly higher security concerns • Requires significant modifications to existing security policies or procedures • Team has limited experience in this activity • New security procedures • Combined with one of the above descriptors—classified information, modest number of documents, CREM, and outside interactions	**Likely**
	• Minor violation of Laboratory policy • Failure results in a Category C security infraction • Loss of UCNI or Business Sensitive information	**Low**	• Requires incremental change to existing policies or procedures • Confidence in ability to execute tasks according to established and proven procedures • Combined with one of the above descriptors—limited access to classified information, small number of documents, CREM, and outside interactions	**Unlikely**
	OUO classified or SUI information involved.	**Negligible**	• High confidence in ability to execute tasks according to established and proven procedures • No security issues identified • Project has no exposure to classified information	**Very Unlikely**

(Table 1g)

Risk Area	Consequence Descriptors	Consequence of Failure	Probability Descriptors	Probability of Failure
Environment	• Violation of EPA or other environmental regulations • Release of radioactive, toxic, or other prohibited substances off-site • Requires major clean-up activity regardless of location of contamination	**High**	• Unconventional or unprecedented hazard • Untested industrial safety or engineered controls • Personnel with no prior experience in this activity • Requires development and implementation of new hazards control policies or procedures	**Very Likely**
	• Reportable occurrence • Release of radioactive, toxic, or other prohibited substances restricted to on-site areas outside of immediate work area. • Requires minimal cleanup	**Medium**	• Controls previously applied to projects with significantly smaller environmental risk • Significant changes to existing procedures • New IWS	**Likely**
	• Minor impact or contamination • Requires no or minimal clean-up • No reportable impact to inside of facility	**Low**	• Requires incremental change to existing policies or procedures • Controls previously applied to project with similar environmental safety concerns • Environmental safety issues limited in scope and impact	**Unlikely**
	Negligible impact	**Negligible**	• High confidence in ability to execute tasks according to established and proven procedures • No environmental safety issues identified • Existing IWS or WAL-A	**Very Unlikely**

Table 2. Determine the Risk Value for Risk Areas

Consequence				
High	Low	Moderate	**High**	**High**
Medium	Negligible	Low	Moderate	**High**
Low	Negligible	Negligible	Low	Moderate
Negligible	Negligible	Negligible	Negligible	Low
	Very Unlikely	**Unlikely**	**Likely**	**Very Likely**

Probability

Table 3. Determine the Risk Authorization Level Based on Overall Risk Value

Level of Risk	Scope	Schedule	Budget	Political and Public Trust	Health and Safety	Security	Environment
High							
Moderate							
Low							
Negligible							

RAL A	**Self-authorized by project manager**	**RAL B**	**Line manager concurrence required**	**RAL C**	**Division management concurrence required**

I.2 Using a Matrix to Determine Activities Based on Level of Risk

Tailored project plan, control, and communication tools result in an effective and efficient means to maximize the success rate of a project. In addition, these tools make communication with sponsors, LLNL managers, and project team members consistent and professional. Appropriately tailored project management tools, as defined by Engineering, can be identified by assessing the various characteristics of a project, using Table 4. **Note: A zero (0) value = Not Applicable.**

	TOOL 1	TOOL 2	TOOL 3	TOOL 4	TOOL 5	TOOL 6	TOOL 7	TOOL 8	TOOL 9	TOOL 10	TOOL 11	TOOL 12	TOOL 13
Project Category													
Risk Level	**Rigor Level**	**Rigor Level**	**Rigor Level**	**Rigor Level**	**Rigor Level**	**Rigor Level**	**Rigor Level**	**Rigor Level**	**Rigor Level**	**Rigor Level**	**Rigor Level**	**Rigor Level**	**Rigor Level**

The Layout of Table 4

Table 4 is laid out as follows:

- The PROJECT CATEGORY, i.e., Budget, Schedule, and so forth divides Table 4 into seven sections. Each section needs to be considered when determining the level of rigor to which project management tools are suggested.
- Risk Levels are listed directly below the PROJECT CATEGORY cell.
- The top row of Table 4 shows the project management planning, control or communication TOOLS that may be used for a project. At the intersection of TOOLS and RISK LEVEL is the numerical level of rigor suggested to satisfy project planning and control requirements.

Table 4 addresses PROJECT RISK areas to determine rigor levels of the various TOOLS:

1. Select the appropriate RISK LEVEL, as determined in Tables 1, 2, and 3, beneath each PROJECT CATEGORY.
2. Record the level (1, 2, 3, etc.) found at the intersection of the selected RISK LEVEL and each of the TOOLS. These levels have been uniquely specified for each PROJECT CATEGORY and RISK LEVEL.
3. When completed, the seven segments may define differing levels of rigor for each of the planning, control, or communication TOOLS. The highest level (largest number) for each TOOL is the suggested level of detail and rigor to be implemented for the project. A short narrative describing the various levels of rigor for each tool follows Table 4.

Table 4. Determine the Level of Project Controls to Use

	SOW	WBS	Requirements Document	Project Org Document	Schedule	Budget	Risk Plan	System Eng. or Interface Plan	Change Control	ISM	Security	Reporting	Earned Value Management
Scope Risk													
Negligible	1	1	1	1	1	1	1	1	1	1	1	1	1
Low	1	2	1	1	1	1	2	1	2	1	1	1	1
Moderate	2	2	2	2	2	2	2	2	2	1	1	1	1
High	3	3	3	2	2	2	3	2	2	1	1	2	1
Schedule Risk													
Negligible	1	1	1	1	1	1	2	1	1	1	1	1	1
Low	1	1	1	1	2	1	2	1	1	1	1	1	2
Moderate	2	2	2	2	2	2	2	2	2	1	1	2	2
High	2	3	3	3	3	3	3	3	2	1	1	2	3
Budget Risk													
Negligible	1	1	1	1	1	1	1	1	1	1	1	1	1
Low	1	2	2	1	2	2	2	1	1	1	1	2	2
Moderate	1	2	2	1	2	2	2	2	2	1	1	2	2
High	3	3	3	3	3	3	3	2	2	1	1	3	3
Public or Political Perception Risk													
Negligible	1	1	1	1	1	1	1	1	1	1	1	1	1
Low	2	2	2	2	2	1	2	1	2	1	1	2	2
Moderate	3	3	3	3	2	2	3	2	2	1	1	3	3
High	3	3	3	3	3	2	3	3	2	1	1	3	3

	SOW	WBS	Requirements Document	Project Org Document	Schedule	Budget	Risk Plan	System Eng. or Interface Plan	Change Control	ISM	Security	Reporting	Earned Value Management
Health and Safety Risk													
Negligible	1	1	1	1	1	1	1	1	1	1	0	1	0
Low	2	1	1	1	1	1	2	1	2	1	0	1	0
Moderate	2	2	2	2	2	1	2	2	2	1	0	2	0
High	3	2	2	3	2	2	3	3	2	1	0	2	0
Safeguards and Security Risk													
Negligible	1	1	1	1	1	1	1	1	1	0	1	1	0
Low	2	1	1	1	1	1	2	1	1	0	1	1	0
Moderate	2	2	2	2	2	1	2	2	2	0	1	2	0
High	3	2	2	3	2	2	3	2	2	0	1	2	1
Environmental Risk													
Negligible	1	1	1	1	1	1	1	1	1	0	0	1	0
Low	2	1	1	1	1	1	2	1	1	0	0	1	0
Moderate	2	2	2	2	2	1	2	2	1	0	0	2	0
High	3	2	2	3	2	2	3	2	2	0	0	2	0

[Note: A zero (0) value = Not Applicable]

I.3 Project Control Risk-Level Descriptions

Note: DOE Order 413.3 may establish additional or alternative requirements for the highest level of each control.

SOW

1 A brief, deliverable-focused (scope and schedule) SOW is required.

2 A detailed deliverable-focused (scope and schedule) SOW is required.

3 Deliverable-focused with additional detail on methods of accomplishment for high-risk drivers.

WBS

1 Project deliverable plus one level of breakdown

2 Project deliverable plus two levels of breakdown

3 Project deliverable plus three levels of breakdown

Requirements Document

1 Brief narrative description

2 Detailed table of quantitative performance requirements with no flow-down

3 Detailed flow-down of requirements to the subsystem and component level

Project Organization Document

1 A team roster that identifies key personnel is required.

2 A personnel organization chart (organizational breakdown structure—OBS) is required. Key personnel and their roles must be defined.

3 A responsibility assignment matrix (RAM) that correlates the OBS with the WBS is required.

Schedule

1 Major tasks (2 per fiscal quarter) and their start and finish dates are identified.

2 Tasks are defined; dependency logic is used; milestones are established.

3 Tasks are defined; dependency logic is used; milestones are established; resources are loaded and leveled.

Budget

1 Funds are allocated to major tasks/milestones (2 per fiscal quarter).

2 Funds are allocated to major tasks or milestones as labor and procurements. A monthly spend profile is created.

3 Funds are allocated to control accounts as specified in the WBS. A monthly spend profile is created. May require a formal cost accounting plan and cost accounting manager(s).

Risk Plan

1 A list of risks is required; your Division Leader may direct you to develop responses to specific risks from your list.

2 A list of risks and a qualitative assessment is required; your Division Leader may direct you to develop responses to specific risks from your list. Your Division Leader may direct you to assign funds to cover specific uncertainties from your list, should they arise.

3 A list of risks and a quantitative assessment is required; response strategies are required for the highest-rated risks. An actively managed list, or "risk register" is required and needs to be presented at any project review. Funding to mitigate the highest-rated risks is to be identified and held separately from other project funds. An actively managed list, or "contingency register" is required and needs to be presented at any project review.

System Engineering/Interface Control

1 Informal documentation retained by the RI/PI/PM meets this level of requirement.

2 Interfaces and system requirements are actively managed with formal documents.

3 Interfaces and system requirements are actively managed through a change-control process. May be complex enough to merit a "System Engineer" position in the project organization.

Change Control

1 Informal documentation of the configuration must be maintained by the PI/RI or their designee.

2 A formal system shall be used for change control. The Engineering Records Center or a formal product data structure are examples of acceptable systems.

ISM

1 An assessment must be done to determine that LLNL policy/requirements will be met. If assessment determines that LLNL policy/requirements will NOT be met the project will provide the time, funding, and leadership to obtain the necessary resources to become compliant with LLNL policy/requirements or obtain the necessary waivers. Elements of this will likely show up in the risk plan.
See http://www-r.llnl.gov/es_and_h/ism/isms.html for guidance.

Security

1 An assessment must be done to determine that LLNL policy/requirements will be met. If the assessment determines that LLNL policy/requirements will NOT be met, the project will provide the time, funding, and leadership to obtain the necessary resources to become compliant with LLNL policy/requirements or obtain the necessary waivers. Elements of this will likely show up in the risk plan.
See http://www-r.llnl.gov/securityprogram/issm/assessment/ for guidance.

Reporting Requirements

1 An informal report communicating financial, schedule, and high- and lowlights is required.

2 A formal report communicating financial, schedule, highlights, and issues is required.

3 A formal written report and oral presentation communicating financial, schedule, risk status, contingency, highlights, and issues is required.

Earned-Value Management

1 Quarterly (or weekly for projects of extremely short duration and high visibility) earned value is required. Two tasks or milestones per quarter are required to be identified and then assessed for the report.

(A PowerPoint version of the Earned Value Management (EVM) Quarterly Review Template is located at http://www-eng-r.llnl.gov/project_mgmt/pdf/EVP_template.ppt, and an Earned Value Management (EVM) Reporting Guidelines presentation on its use is located at http://www-eng-r.llnl.gov/rd_res/pdf/EVM_rpt_guidelines.ppt on the Inside Engineering web site.) These examples have a performance metric standard of 25% earned when the activity is started and remaining at 75% earned when the activity is completed. This may or may not be appropriate for all projects.

2 Same quarterly assessment of tasks and/or milestones as Level 1. Formal completion criteria (what does “finished” look like) and performance measures (how will you assess progress) are required prior to starting work.

3 *Monthly* assessment of tasks and/or milestones. Formal completion criteria (what does “finished” look like) and performance measures (how will you assess progress) are required prior to starting work.

I.4 Suggested Worksheet

Risk Assessment Output Worksheet

Risk Area	Consequence Level	Probability Level	Risk Level	RAL	Control Descriptions
Scope					
Schedule					
Budget					
Political and Public Trust					
Health and Safety					
Security					
Environment					