LIFE

CYCLE

ASSET

MANAGEMENT

Good Practice Guide
GPG-FM-007

Risk Analysis and Management

March 1996

Department of Energy
Office of Field Management
Office of Project and Fixed Asset Management

ATTACHMENTS

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1. INTRODUCTION

Risk analysis should be used throughout a project to identify significant risk factors and to formulate management and/or mitigation plans. It should not be conducted separately from or in addition to other risk-based analyses traditionally employed during project development, such as those used to determine pure technical risk or to establish cost and schedule contingencies. Instead, project risk analysis should be considered an ongoing, integrated process that addresses the risk associated with each elements of the project. The results of the risk analyses should be used to do the following:

- delegate authority for critical decisions,
- decide between technical alternatives,
- establish funding contingency (cost),
- establish schedule contingency,
- select procurement strategies,
- determine project performance measures, and
- select appropriate status and performance reports.

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2. PRINCIPLES AND PROCESSES

2.1 Project Risk Management Planning

One of the earliest actions in the risk analysis process should be to determine at which points (if any) in the project life cycle risk analyses are appropriate. Reviews, revisions, or updates should be performed at least once during each project phase (i.e., conceptual, execution, and acceptance), preferably at the beginning of the phase (see *Project Management Overview*, GPG-FM-001). A risk analysis should be performed if conditions warrant (i.e., a major risk is realized, the potential of a high-risk item is eliminated, the potential for new risks is identified, etc.). When subsequent reviews, revisions, or updates are performed, the information on project scope and performance should be provided to the risk analysis team.

For large projects, initial risk analyses are typically undertaken when a valid mission need has been identified and work has begun on preconceptual activities or when a project will advance state-of-the-art technology or apply existing technology in a new way. For small projects (low dollar value and complexity), an initial risk analysis may not be warranted or feasible until the project conceptual phase. The complexity and size of the project are the key factors in determining when the initial risk analysis should be performed, how often it should be reviewed and/or updated during the project, which elements will be reviewed and to what depth, and the extent of external participation.

Once project risks have been identified, they should be graded as low, medium, or high, and a management or mitigation strategy selected accordingly. (See section 2.5 below.) The Department of Energy (DOE) encourages the use of the graded approach to select tools and techniques that are commensurate with the dollar value, complexity, visibility, and risk of a project. Sound project management principles and practices are sufficient to manage and mitigate low and most medium risks; however, project risk management planning is recommended for high risks and for some medium risks. Project risk management planning documents the risk identification, mitigation strategy, hold points and expected closure dates, and management activities and responsibilities. If the risk factor for any project risk is high, specific risk management planning should be integrated with the ongoing management and execution planning (see *Project Execution and Engineering Management Planning*, GPG-FM-010).

The results of the initial risk analysis should be considered when developing schedule and cost contingency. An appropriate time value should be added to the project master schedule milestones to mitigate each project risk that could affect completion of the project or project milestone within the desired schedule. An appropriate dollar value

should be estimated to mitigate each project risk that would affect the ability to complete the project within the planned funds.

Attachment 2 lists project activities that might contribute to risk and recommends management and mitigation strategies.

It may not be possible to develop a management or mitigation strategy for every high-risk factor. It may be more cost effective to concentrate management attention on the mitigation of medium risks that can be controlled, accept some high risk, and document the basis for that decision. If the risk analysis process reveals no high-risk areas, a rigorous management plan is not warranted.

The time and money spent analyzing risks and determining risk management and mitigation strategies should be considered from a cost-to-benefit perspective. Managing or mitigating a risk should cost far less than realizing the risk itself would cost. The following are some examples of risk mitigation strategies.

- Specific design features/redundancies to control the risk.
- Prototype testing.
- Alternative/value engineering studies.
- Formal design reviews.
- Analytical modeling.
- Operating adjustments.
- Life accelerating testing.
- Functional testing.
- Expert design review and redesign.
- Financial incentives to vendors/contractors.
- Strategic milestone selection.
- Hold points.

- Additional resources.
- Selective use of contingency.
- Overtime/multiple shifts.
- Selection of project controls to appropriate level.

In addition to the development of a risk management strategy, the results of the risk analysis are also used by the project manager to develop performance objectives and measures and specify status report formats. When risk management planning is completed, the project team should implement the plan and periodically evaluate performance against performance measures and objectives to ensure that risks are mitigated.

The Project Management System Process Flow Diagram (see *Project Management Overview,* GPG-FM-001) illustrates the flow of DOE project management requirements, how the project risk analysis supports these requirements, and approximate timing for performing the project risk analysis. The Project Risk Analysis Flow Chart, Attachment 1, illustrates the steps in a project risk analysis and the resulting documentation.

2.2 Project Team Participation in Risk Analysis

The DOE project manager is responsible for performing the risk analysis, documenting the results, and determining the appropriate application of plans and controls based on the results of the risk analysis. However, the entire project team should participate in the risk analysis process. The project team should agree on the selected risk management approach; if they cannot agree, however, the project manager is ultimately responsible for determining appropriate application of plans and controls. For more information on selecting project team members, see *Project/Program Relationships,* GPG-FM-014.

In most cases, it is advisable to include contractor representatives in the risk analysis because the contractor is generally responsible for executing most of the management and mitigation strategies. This is especially true for management and operating contractors. Contractor representatives might include the contractor project manager, an engineering manager, and a construction manager. Depending on the dollar value and complexity of the project, other contractor representatives might be involved.

Program managers are encouraged to participate in the risk analysis, particularly if the project has a high dollar value, is complex, or has high risk potential. This participation ensures that project risk and program or mission risks are considered together and that the project manager and the program manager can plan supporting mitigation strategies.

2.3 Risk Analysis Meeting

If the dollar value or complexity of the project is low, a formal meeting may not be required to perform a risk analysis. Generally, however, risk analysis is performed in a meeting where participants discuss the project scope, risks, and assumptions and brainstorm management or mitigation strategies. Prior to the risk analysis meeting, the project manager should provide the risk analysis participants with all available project information.

Screening questions should be used to identify risks and categories of risks. Departmental elements may choose to develop a standard screening checklist for efficiency. Typically, positive responses to screening questions would indicate a risk potential that would be further evaluated by the team. Attachment 3 is a sample list of risk categories and risk screening questions.

2.4 Project Planning Documentation

The risk analysis process should be fully documented. Project planning documentation should reflect the selection of performance objectives and measures, status report formats, the risk analysis, and a project risk management plan, if one is required. Project planning documentation should also include judgments used in performing the risk analysis (e.g., assumptions, defaults, and uncertainties).

2.5 Quantification of Risks

Risks are quantified (i.e., graded as low, medium, or high) based on the results of the risk analysis meeting and the definition of project scope, schedule, and cost. Each risk and its corresponding assumptions should be recorded on a risk identification and analysis form.

Any method chosen for grading risk should be *qualitative* as well as *quantitative*. Though formulas and modeling techniques are useful tools for organizing and assessing risks, they do not substitute for the professional judgment and experience of the project manager and other project team members. Some suggested ways to grade risk are included as Attachment 5.

A sound methodology for determining whether a risk is low, medium, or high is to combine information about its probability of occurrence (P) and the consequence of the realized risk (C), as described below.

The probability of occurrence is considered for the duration of the project. However, if probability of occurrence is higher in some project phases than others, the probability of occurrence should be used in the current or next immediate project phase, and the probability of occurrence for the risk should be updated in a subsequent risk analysis. The probability is expressed as a decimal between 0 and 1, where 0 is no probability of occurrence and 1 is 100% probability of occurrence. Record the probability of occurrence (P) on the risk identification and analysis form with any other assumptions or basis used for determining the probability.

The consequence of realized risk is best determined using a consequence table, which permits the team to define the cost and schedule thresholds at which the consequences of realized risk will result in one of the following outcomes:

- no consequence to cost and schedule,
- small reduction in desired cost and schedule results,
- some reduction in desired cost and schedule results,
- significant degradation in desired cost and schedule results, or
- project cost and schedule goals cannot be achieved.

The evaluation should quantify consequences in terms of dollars and schedule time units (days, weeks, months). A sample consequence table is included as Attachment 6. The consequence of a realized risk (C) should be recorded on the risk identification and analysis form (see Attachment 7) with any other assumptions or bases used for determining the consequences.

One of the three following methodologies should be used to combine the probability of occurrence (P) and the consequence of the realized risk (C).

1. Determine the risk factor (RF). This approach yields the most conservative risk grading result; that is, it produces the highest number of risk factors that result in high risks. To use this method, the following formula is applied:

Risk Factor (RF) = (P + C) - (P x C)

where:

High risk = RF greater than 0.7
Medium risk = RF between 0.7 and 0.3
Low risk = RF less than 0.3

A risk factor chart, which indicates the conservatism of using this methodology, is included as Attachment 8.

2. Use a risk grading plotting chart. This is a less conservative methodology. The chart is included as Attachment 5.

3. Use a purely subjective methodology. The team can evaluate the project, determine the risks, and assign a grade based purely on experience and judgment. This methodology may best be used for low dollar value and less complex projects.

Other methodologies can be employed to quantify risk. Whatever method is used, documentation of the chosen methodology is highly recommended. Documentation creates a record for future use in the event that a later review, revision, or update is performed by a new team.

3. MEASURING FOR RESULTS

No required format has been established for documenting risk analysis or the project risk management plan. Sample formats, which the project manager can tailor to individual projects, are included as attachments to this Guide.

- Project Risk Analysis Flow Chart, Attachment 1
- Suggested Risk Management and Mitigation Strategies, Attachment 2
- Project Risk Categories and Screening Questions, Attachment 3
- Sample Project Risk Management Plan Outline, Attachment 4
- Risk Grading Plotting Chart, Attachment 5
- Risk Consequence Table, Attachment 6
- Project Risk Identification and Analysis Form, Attachment 7
- Risk Factor Chart, Attachment 8

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4. SUGGESTED READING

- *Project Management Overview*, GPG-FM-001
- *Project Execution and Engineering Management Planning*, GPG-FM-010
- *Contingency Analysis*

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5. DEFINITIONS

For a complete listing of the definitions for major terms used in this Guide, see the Consolidated Glossary.

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6. ASSISTANCE

Questions concerning this Guide may be referred to the Office of Field Management in Washington, D.C., (202) 586-4041.

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7. RELATED TRAINING

For in-depth discussions on the topics covered in this Guide, see Attachment 9 for course synopsis and scheduled offerings.

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8. EXAMPLES

See the attachments.

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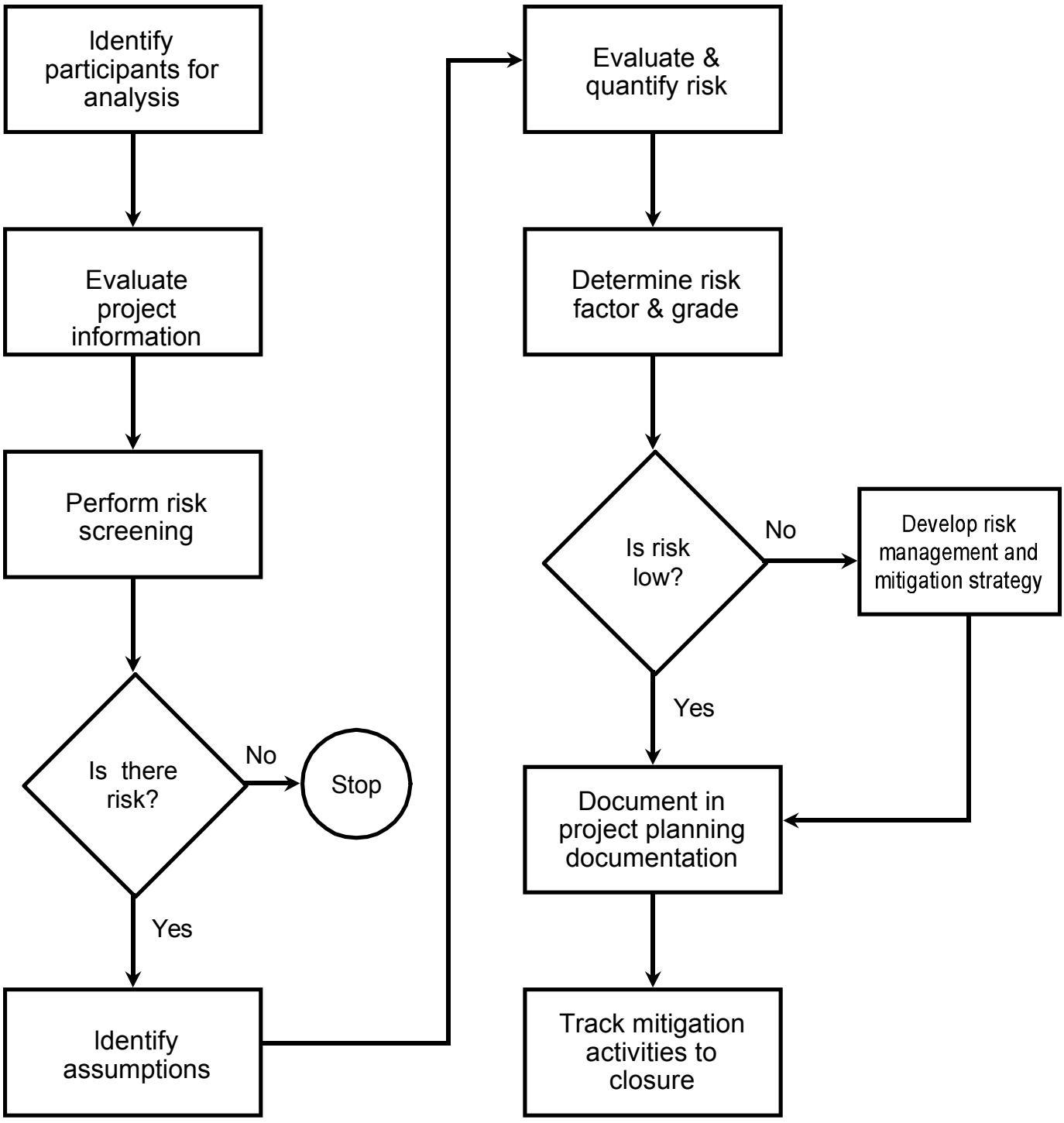
Project Risk Analysis Flowchart



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ATTACHMENT 2
SUGGESTED RISK MANAGEMENT AND MITIGATION STRATEGIES

The following guidelines can be used as examples to develop management and mitigation strategies.

PROJECT ACTIVITY CONTRIBUTING TO RISK	MANAGEMENT AND MITIGATION STRATEGIES
High or medium risks with low probability or low consequence where the team feels no special mitigation is required (e.g., not cost effective)	- Accept risk and document basis
Testing will not provide sufficient information to verify design criteria	- Formal Design Review
Functional testing cannot be performed	- Formal Design Review
Use of new technology or new application of existing technology	- Formal Design Review - Prototype Testing - Value Engineering
Technology has been modernized such that a like equipment replacement is not feasible	- Functional Testing of equipment - Analytical modeling - Operating adjustments - Formal Design Review
Unusually complex design	- Formal Design Review - Value Engineering - Functional testing of systems
New design basis accident or other unreviewed safety question introduced.	- Formal Design Review
Significant personnel contamination potential	- Formal Design Review
Code used as the design criteria for safety class structure, system and component	- Formal Design Review
Project schedule uncertainties or restraints that may impact project milestones and/or completion date	- Additional resources - Overtime - Subcontracting work to others - Financial incentives to vendors/subcontractors - Multiple shifts
Facility outage required for project implementation	- Integrated program and project schedule with additional milestones

PROJECT ACTIVITY CONTRIBUTING TO RISK	MANAGEMENT AND MITIGATION STRATEGIES
Radiation release potential	- Expert Design Review - Formal Design Review
Only one qualified, reliable vendor	- Sole Source Justification
Significant long-term environmental impacts	- Expert Design Review - Formal Design Review
Potential project cost uncertainty and project cost overruns	- Selective use of contingency - Consideration of alternative - Value Engineering

ATTACHMENT 3
PROJECT RISK CATEGORIES AND SCREENING QUESTIONS (Sample)

	YES	NO
A. TECHNOLOGY		
1. New technology?		
2. Unknown or unclear technology?		
3. New application of existing technology?		
4. Modernized/advanced technology in existing application?		
B. TIME		
1. Project schedule uncertainties or restraints that may impact project completion or milestone dates?		
2. Long lead procurement items that may affect critical path or milestone completion?		
C. CONTRACTOR CAPABILITIES		
1. Potential unavailable qualified vendors or contractors?		
D. INTERFACES		
1. Significant transportation or infrastructure impacts?		
2. Multiple project interface?		
3. Significant interface with operational facility?		
E. SAFETY		
1. Criticality potential?		
2. Significant contamination potential?		
3. New design basis accidents or other unreviewed safety questions?		
4. Hazardous material involved?		

	YES	NO
F. ENVIRONMENTAL		
1. Environmental assessment or environmental impact statement required?		
2. Potential for releases or additional releases?		
3. Undefined disposal methods?		
4. Any Environmental Permits or licenses required (RCRA, NEPA, CAA, CWA, etc.)		
G. REGULATORY INVOLVEMENT		
1. Is EPA involved in any project decisions?		
2. Are state regulators involved in any project decisions?		
3. Is the Defense Nuclear Safety Board involved in any project decisions?		
4. Is the Nuclear Regulatory Commission involved in any project decisions?		
H. POLITICAL VISIBILITY		
I. NUMBER OF KEY PARTICIPANTS		
1. Will there be more than one primary contractor performing work?		
J. COMPLEXITY		
1. Undefined or unclear functional requirements?		
2. Undefined or unclear design criteria?		
3. Complex design features?		
4. Difficult to functional test?		
5. Existing or as-built conditions documented?		
K. LABOR SKILLS, AVAILABILITY, PRODUCTIVITY		
1. Adequate and timely resources available?		

	YES	NO
2. Specialty resources required?		
3. Is a rapid labor build-up required?		
4. Will labor be exposed to environmental extremes (heat, cold, etc.)?		
5. Will any project work be performed in a radiologically controlled zone?		
L. NUMBER OF LOCATIONS/SITE ACCESS/SITE OWNERSHIP		
1. Will project work be performed in more than one physical location (areas, sites, buildings, etc.)?		
2. Does DOE own the site?		
3. Are infrastructure improvements required?		
M. FUNDING/COST SHARING		
1. Is project duration greater than 2 years?		
2. Are other Federal agencies or States providing project funds?		
3. Are other governments (countries) providing project funding?		
N. MAGNITUDE/TYPE OF CONTAMINATION		
1. Is hazardous or low-level waste present?		
2. Is high-level or mixed waste present?		
3. Has waste present been characterized?		
O. QUALITY REQUIREMENTS		
1. Is precision work required?		
2. Is rework expected due to nature of project tolerances?		
3. Does NQA1 apply?		
P. PUBLIC INVOLVEMENT		

	YES	NO
1. Will the Citizens Advisory Board be involved in making project decisions?		
2. Will the Citizens Advisory Board be involved in establishing priorities?		
3. Will other intervenor organizations (Sierra Club, Green Peace, etc.) take interest in the project?		
Q. OTHER		

ATTACHMENT 4
SAMPLE PROJECT RISKS MANAGEMENT
PLAN OUTLINE

The following is a sample outline for a project risk management plan. The information provided in italics is for informational/instructional purposes.

1. DISTRIBUTION LIST

The distribution list is placed outside the project risk management plan document so that a revision to the distribution list does not necessitate a revision to the plan.

2. APPROVAL SIGNATURE

_____ _____
Project Manager *Date*

3. SUMMARY OF REVISIONS

For each revision, identify the revision letter or number, revision date, and list those sections that were revised with sufficient detail to identify the change.

4. PROJECT SUMMARY

Provide a brief summary of project phase, scope, schedule, and cost objectives.

5. ASSUMPTIONS

List all assumptions or bases used to determine, define, and analyze risks.

6. RISK MANAGEMENT AND MITIGATION STRATEGIES

List each high risk or risk that the team felt should be managed or mitigated. For each risk, provide the name of the person responsible for managing or mitigating the risk, the

management or mitigation strategy, hold points, and expected closure dates.

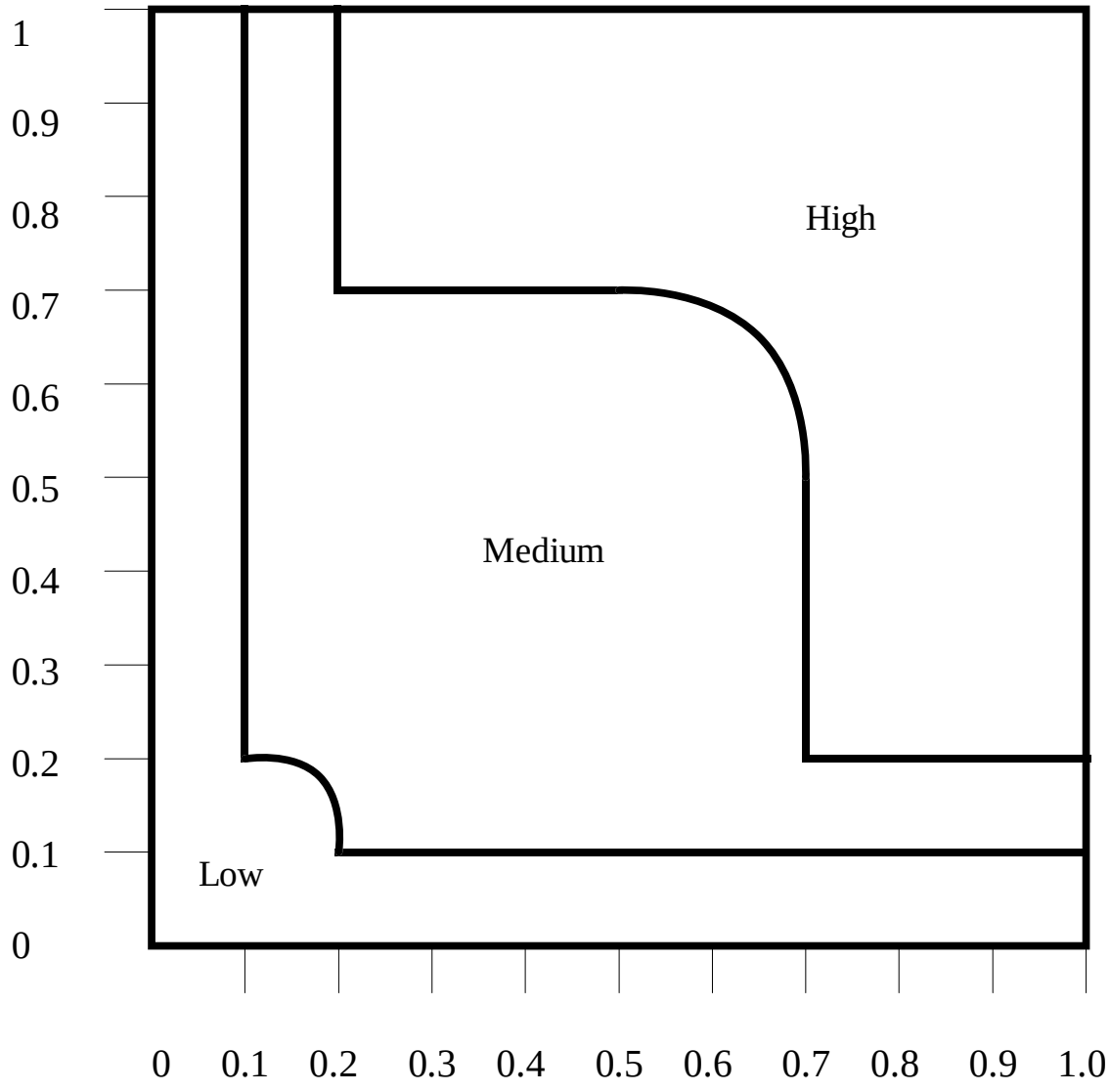
7. ATTACHMENTS

Attach the Risk Consequence Table, Risk Identification and Analysis Form, Risk Categories and Screening Questions, and other information, as appropriate.

8. REFERENCES

Reference or attach all project documents used as bases for the risk analysis (i.e., Functional Design Criteria, Procurement Specifications, Design Change Package). Also include any references used in developing management and mitigation strategies.

Attachment 5
Risk Grade Plotting Chart



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ATTACHMENT 6
RISK CONSEQUENCE TABLE (Sample)

Consequence of Realized Risk	Consequence of Occurrence	Cost Thresholds	Schedule Thresholds
0.1	Minimal or no cost and schedule consequences unimportant	(1)	(2)
0.3	Small reduction in desired cost and schedule results	(1)	(2)
0.5	Some reduction in desired cost and schedule results	(1)	(2)
0.7	Significant degradation in desired cost and schedule results	(1)	(2)
0.9	Desired cost and schedule goals cannot be achieved	(1)	(2)

(1) For each consequence of realized risk, assign a dollar value.

(2) For each consequence of realized risk, assign a time duration.

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ATTACHMENT 7
PROJECT RISK IDENTIFICATION AND ANALYSIS FORM

IDENTIFIED PROJECT RISK	P	C	RF	RISK CATEGORY
ASSUMPTIONS/BASIS				
IDENTIFIED PROJECT RISK	P	C	RF	RISK CATEGORY
ASSUMPTIONS/BASIS				

Legend:

1. P = Probability of occurrence
2. C = Consequence of occurrence
3. RF = Risk factor
4. RISK CATEGORY = High, Medium, or Low

Attachment 8
Risk Factor Chart