# TABLE OF CONTENTS, Volume II

1. **INTRODUCTION** ........................................................................................................ 3
   1.1. Purpose and Scope .................................................................................................. 3
   1.2. Applicable Documents .......................................................................................... 4
   1.3. Definitions and Abbreviations .............................................................................. 4

2. **DELIVERABLES** ...................................................................................................... 6

3. **PREPARING RISK MANAGEMENT PLAN (RMP)** .................................................. 7
   3.1. Introduction ........................................................................................................... 7
   3.2. Risk Management Approach .............................................................................. 7
       3.2.1. Risk Management Objectives ........................................................................ 7
       3.2.2. Project Success Factors ................................................................................ 8
       3.2.3. Risk Management Methodology ..................................................................... 8
   3.3. Risk Management Strategy Process Description ................................................. 10
       3.3.1. Risk Identification strategy ............................................................................ 10
       3.3.2. Risk Impact Assessment and Categorization .................................................. 11
       3.3.3. Risk Response Plan ....................................................................................... 14
       3.3.4. Risk Reporting .............................................................................................. 16
       3.3.5. Risk Monitoring and Review ........................................................................... 16
       3.3.6. Unforeseen Risk Process Description ............................................................ 17

4. **EXHIBITS** ............................................................................................................... 18
   Exhibit II.1. Sample Project Risk Register ................................................................... 19
   Exhibit II.2. Sample Risk Statement Form and Delphi Technique ............................... 20
   Exhibit II.3. Sample Fault Tree Analysis .................................................................... 21
   Exhibit II.4. Sample Risk Breakdown ........................................................................ 22
   Exhibit II.5. Sample Risk Management Schedule ....................................................... 23
   Exhibit II.6. PertMaster and Monte Carlo Risk Simulation .......................................... 24
   Exhibit II.7. Sample Risk Report’s Table of Content .................................................. 28
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1. INTRODUCTION

1.1. Purpose and Scope

The United States Department of Veterans Affairs (VA) is the second largest government department in the country and, as well, the most comprehensive system of assistance for veterans. Construction projects undertaken by VA are complex and costly. They are typically threatened by different types of risks that may end up having impacts on some of the projects objectives. In order to identify and respond to those risks, the Architect/Engineer (A/E) for each project shall develop and maintain a comprehensive Risk Management Plan (RMP).

This document is intended to provide guidance to the Architect/Engineer (A/E) in the development of a Risk Management Plan (RMP) during the design phase of Medical Center Major New Facilities, Additions and Renovations projects by the United States Veterans Affairs (VA). The VA oversees complex projects throughout the country which require careful planning and execution during the evolution of the projects.

The purpose of the Risk Management Plan (RMP) is to identify, analyze, manage and control all risks that could have adverse impact to VA’s project budget and schedule throughout all the phases of the project’s life cycle. It also provides a useful road map that can be used by the A/E and the project team to assist them in completing the project successfully.

The RMP is intended to be a dynamic tool for risk project control, developed by the A/E (qualified risk expert) with input from all parties involved including the Office of Construction and Facilities Management (CFM) Project Manager, the Department of Veterans Affairs Medical Center (VAMC) Director and Facility Engineer, Veterans' Integrated Service Network (VISN) Capital Asset Manager, VA CAMPS Office, the Office of Strategic Management and Contracting Officer and Peer Reviewers. The RMP may be used as a reference by the Construction staff as it also encompasses risk analysis in the procurement, construction and activation phases.

*This document is solely intended as a guide, it is not intended to dictate means and methods. The A/E is responsible to develop the means and methods and correlate with the VA requirements, as part of PG 18-15*
1.2. Applicable Documents

The A/E shall apply the following set of documents to develop the Risk Management Plan (RMP).

<table>
<thead>
<tr>
<th>Document Title</th>
<th>Document Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Architectural and Engineering CPM Schedules. Section 01 32 16.01</td>
<td><a href="http://www.cfm.va.gov/till/spec/">http://www.cfm.va.gov/till/spec/</a></td>
</tr>
</tbody>
</table>

Table - 1: Applicable documents for preparation of RMP

1.3. Definitions and Abbreviations

A/E: Architect and Engineer. Person and/or entity in charge of the design phase of construction projects.

Delphi Technique: It is a technique that consists of answering questionnaires in two or more rounds where experts are asked about important project risks. Then, the answers are circulated among them for discussion and review, with the final purpose to obtain one accurate answer; each expert is kept anonymous.

Primary Risk: Risks that have major impact on the objectives of the project.

Project Risk Register (PRR): It is a tool used in project risk assessment which helps to identify, analyze and manage risks.

Residual Risk: Risks that once they have been mitigated remain there. This type of risk does not represent high level of danger to the project objectives.
Risk:
Risk is the combination of likelihood of any uncertain event or condition occurring and the consequences of the occurrence. The occurrence of these events or conditions might cause harm and/or loss to the project. However, it is important to keep in mind that not all risks adversely impact projects.

Risk Assessment:
It is the process that involves the usage of available information to determine the probability that identified events may occur and the level of consequence in the case of occurrence.

Risk Breakdown Structure (RBS):
This method consists of first of all, identify major risk categories, and then start breaking down them into more detailed ones.

Risk Identification:
It is the process which helps to determine what, how, and why unusual events may occur.

RMP:
Risk Management Plan.

Secondary Risks:
Risks that arise right after a risk response plan has been implemented.

VA:
US. Department of Veterans Affair.
2. DELIVERABLES

According to VA PG 18-15, multiple submissions of the Risk Management Plan are required over a period of time that evolves throughout the project. The below table captures the phases and the level of detail in which the A/E shall submit the Project Risk Management Plan and Analysis for the VA review and comment:

<table>
<thead>
<tr>
<th>Design Phase</th>
<th>RMP Deliverable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-design</td>
<td>• Project Risk Analysis (Preliminary Risk Management Plan).</td>
</tr>
<tr>
<td></td>
<td>• Recommendations for addressing major risks.</td>
</tr>
<tr>
<td></td>
<td>• Type of software, methodology and format that the A/E will use in order</td>
</tr>
<tr>
<td></td>
<td>to be approved by VA.</td>
</tr>
<tr>
<td>Schematic Design (SD1)</td>
<td>• Schedule Risk Analysis based on CPM for detailed design and project schedule.</td>
</tr>
<tr>
<td>Schematic Design (SD2)</td>
<td>• Updated Schedule Risk Analysis along with the Risk Management Plan.</td>
</tr>
<tr>
<td>Design Development (DD1)</td>
<td>• Updated Schedule Risk Analysis along with the Risk Management Plan and mitigation actions.</td>
</tr>
<tr>
<td>Design Development (DD2)</td>
<td>• Updated Schedule Risk Analysis with increased detail in new risks and mitigation plan.</td>
</tr>
<tr>
<td>Construction Documents (CD1)</td>
<td>• Updated Schedule Risk Analysis identifying new risks and mitigation actions, particularly in construction areas.</td>
</tr>
</tbody>
</table>

*Table – 2: Required Deliverables*
3. PREPARING RISK MANAGEMENT PLAN (RMP)

Based on a thorough review of the project scope, stakeholders’ requirements, and project constraints project environment, the A/E shall prepare the RMP. The RMP document shall include the following:

3.1. Introduction

In this section the A/E shall introduce the RMP, provide brief definition of key risk management terminology, summarize the purpose and scope of the document, and state the pertinent VA medical center project.

3.2. Risk Management Approach

In this section the A/E shall introduce the approach that he/she will use to develop the RMP. The A/E shall at least explain the following:

3.2.1. Risk Management Objectives

The A/E shall list the objectives (from the top level) of the project's risk Management process. For example, some objectives could be:

- Accomplish all the minimum Medical Facilities standards of VA's Architectural Design Manual for (1) New Hospital; (2) Replacement Hospitals; (3) Ambulatory Care; (4) Clinical Additions; (5) Energy Centers; and (6) Outpatients Clinics issued on May 2006.
- Maximize the probability of achieving successfully the project’s objectives within the planned approved budget.
- Maximize the probability of completing the whole project within time frame stated in the project specifications.
- Identify and assess project risks that threaten the progression of the project, as well as, the adverse impact that these could bring up throughout the life cycle of the project.
- Generate risk mitigation plans as the basis for determining the budget needed to cover such plans, as well as, the allocation of these resources throughout the project life cycle.
- Communicate to all stakeholders (CFM Project Manager, VAMC Director and Facility Engineers, VISN Capital Asset Manager, VHA Camps Office, peer reviewers, Commissioning Agent, and other stakeholders) involved in the project the identified risks, as well as the responsibility roles of all of them.
● Define the cost estimate for risk contingency plans in order to determine the project maximum cost reserve.

3.2.2. Project Success Factors

The A/E shall list and describe project success factors which help all stakeholders to understand those meaningful elements that need to be accomplished in the process. Those factors need to be related to the fact of identifying the best approach for reducing risks to acceptable levels. The A/E shall recognize and list all general success factors such as (The A/E should refer, but not limited, to these factors):

● The A/E shall recognize the Risk Management process as a valuable discipline which provides positive and potential effects on project objectives, project stakeholders and team members.

● The A/E shall convey to all stakeholders and team members involved in the project the importance of having an open and honest communication among all of them. Overt and honest communication will increase effectiveness of the Risk Management Plan in terms of decision-making and plan implementation.

● The A/E shall convey to all stakeholders and team members the importance of establishing the final scope of work that does not require many changes after Schematic Design 2 (SD2).

● The A/E shall convey to all stakeholders and team members the importance of completing the final budget and schedule by Schematic design 2 (SD2) phase, and as well, all the risks that may impact accomplishing these two objectives.

3.2.3. Risk Management Methodology

The A/E shall define the methodology to be used to identify and manage such events (risks) that threaten accomplishing the goals of the project; one of the methodologies usually used out there in the industry is Monte Carlo risk simulation, which could be an optional tool for A/E to be implemented in the development of the RMP. Furthermore, the A/E shall establish the components of the process to be used when developing the RMP. The A/E shall at least include the following components within the process:

● Establish the project’s objectives and stakeholders’ responsibilities.

● Identify as many risks as possible.

● Analyze and assess risks (Optional method is Monte Carlo simulation).

● Evaluate the best response action to risks.

● Develop risk contingency plans.

● Report Risks.

● Review and monitor risk.

● Assess unforeseen risks.
3.2.3.1. Roles and Responsibilities

List and describe the risk management responsibilities delegated throughout the project organization. The A/E shall develop a table that contains risk activity and responsibility which includes at least the following elements (See Table 2 as a reference):

<table>
<thead>
<tr>
<th>Risk Activity</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk Identification</td>
<td>All project stakeholders</td>
</tr>
<tr>
<td>Risk Assessment</td>
<td>All project stakeholders</td>
</tr>
<tr>
<td>Risk Response</td>
<td>Risk Project Manager, A/E (recommend) and VA (approval)</td>
</tr>
<tr>
<td>Risk Contingency Plans</td>
<td>Risk Project Manager, A/E (recommend) and VA (approval)</td>
</tr>
<tr>
<td>Risk Reporting</td>
<td>Risk Project Manager and all stakeholders (feedback)</td>
</tr>
<tr>
<td>Risk Monitoring and Review</td>
<td>All project stakeholders</td>
</tr>
</tbody>
</table>

**Table - 3: Risk Management Responsibilities (Reference example)**

An effective Risk Management is contingent on comprehensive contribution from stakeholders involved in a project. Any experience, comment, thought, or concern that is gathered would help to ensure that risk occurrence is swiftly and effectively addressed. It is important that those involved in the project are committed to provide as much information as possible in order to develop a credible RPM. The best strategy for engaging stakeholders to communicate any existing and possible risk in a project is by assigning risk management responsibilities. This practice encourage each person involved in the project to be more effective and moreover to picture the overall scope of the Risk Management Plan (RMP).

3.2.3.2. Risk Identification Tools

List and describe each of the risk identification tools to be implemented to develop the RMP. For instance, such tools could be: (the selected tool is up to the project manager’s criteria).

- Brainstorming.
- Interviews.
- Risk Statement Form. (See Exhibit 2)
- Fault tree analysis. (See Exhibit 3)
- The Delphi technique. (See Exhibit 2)

A good strategy when sitting down with the risk team for identifying risks is to perform a Risk Breakdown Structure. This Approach strategy is very useful to categorize risks
since it presents different levels and scenarios of the project where adverse events can occur. (See Exhibit 4 as a reference)

3.2.3.3. Risk Management Schedule

Develop a Risk Management Schedule with milestones, taking as a reference the Integrated Master Schedule. The Risk management schedule should include activities such as reviews, meetings, assessment milestones, and other significant events that are included in the Risk Management plan development.

The A/E shall refer to “Architectural and Engineering CPM schedules; Section 01 32 16.01. Numeral 1.13 Project design schedule risk analysis/mitigation plan” in order to conduct the Risk Schedule. (See Exhibit 5 as a reference)

3.3. Risk Management Strategy Process Description

In this section the A/E shall describe the process to be used for addressing risks from the identification stage to the monitoring and reviewing stage. It is important to highlight that this process takes place throughout the whole project’s life cycle. The A/E shall at least present the following stages:

3.3.1. Risk Identification strategy

The A/E shall identify as many risks as possible throughout the project’s life cycle. Using the selected identification tool from Section 3.2.3.2, identify as many risks as possible, being careful to distinguish authentic risk (e.g. primary and secondary risks) from non-risk or risk with no adverse impact to the project (e.g. residual risks).

Describe how the identification process is managed, for example who is responsible for this task, how this task is planned to be addressed, and when it is planned to be performed. Be clear and concise.

Some of those possible risks that the A/E may deal with are presented below: (The A/E should refer, but not limited, to this list)

- Change of scope of work
- Failure to involve stakeholders early in the process.
- Lack of communication between stakeholders.
- Lack of work flow control (Implementation of detailed Schedule).
- Design may be inadequate.
- Architect/Engineer (A/E) staffing may be inadequate.
- Acquisition of permits.
• Long lead/Critical Equipment and Material.
• New Government Regulations.
• Low bids that become difficult to execute.
• Contractor’s bid withdrawal.
• Termination of contract due to contractor’s default.
• World Market.
• Environmental issues.
• Programming issues.

The A/E shall record the person and/or entity that identified the risk, as well as, the date (trigger date) when the risk may occur in the instance where corrective measure/plans have not been implemented to respond to such risks.

The A/E shall develop a single comprehensive Project Risk Register (PRR), see exhibit 1, that can be regularly updated throughout the project’s life cycle and activation phase where all the information shall be documented.

The register shall include recommendations of response for the identified risks as well. Refer to exhibit 1 for more detailed information about how the A/E should document all identified project risks in the Project Risk Register (PRR). The VA requires performing the Project Risk Register (PRR) as per “The Network Analysis Schedule specifications.” Section 01 32 16.01.

3.3.2. Risk Impact Assessment and Categorization

The A/E shall select the appropriate analysis method to address risks and he/she shall justify the selection of such method.

There are two different analysis methods to assess the risks. The first method is known as Qualitative Analysis which assesses and evaluates characteristics of identified risks and prioritizes them based on agreed-upon standards. Quantitative Analysis is the other method, which consist of providing a numerical estimate of the overall consequence of adverse events on the project’s objectives.

3.3.2.1. Qualitative Risk Analysis

If Qualitative Risk Analysis is the selected method, The A/E shall follow the steps presented below in order to implement this method.

Step 1 - Probability of Risk Occurrence

For each identified risk, assess and categorize the risk event in terms of probability of occurrence. The A/E shall collect all the comments and input from all stakeholders and then use table 4 to determine the probability level. The A/E shall ensure to document all
the information obtained from this categorization in the Project Risk Register (PRR). This step shall be performed periodically throughout the project’s life cycle once new risks are identified, in order to update the Project Risk Register (PRR) and therefore enhance the risk analysis.

<table>
<thead>
<tr>
<th>Probability Level</th>
<th>Probability</th>
<th>Probability of occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Very High</td>
<td>&gt;75%</td>
</tr>
<tr>
<td>3</td>
<td>High</td>
<td>&gt;50%</td>
</tr>
<tr>
<td>2</td>
<td>Moderate</td>
<td>&gt;25%</td>
</tr>
<tr>
<td>1</td>
<td>Low</td>
<td>&gt;1%</td>
</tr>
</tbody>
</table>

*Table - 4: Probability of Risk Occurrence classification.*

*Activities with probability of occurrence less than 1% can be neglected.*

The A/E shall ensure that all stakeholders will provide constructive inputs to obtain accurate results. Refer to exhibit 1 for more detailed information about how the A/E should assess project risks under this step.

**Step 2 - Consequence of Risk Occurrence**

Once risks are classified by probability of occurrence, the second step is to assess and classify identified risks in terms of the level of consequences on the project in case of risk occurring. Use Table 4 to perform such categorization. This classification also determines the area of impact of where risk will occur. The A/E shall accommodate each risk into the different categories and then determine the level of consequence. This information shall be documented in the Project Risk Register (PRR).

The A/E shall ensure that all stakeholders will provide constructive inputs to obtain accurate results. Refer to exhibit 1 for more detailed information about how the A/E should assess VA project risks under this step.

After determining the probability and consequence level for each identified risks, they need to be ranked in such a way that those with high level of occurrence and greater consequences must be prioritized in the “Risk Response Plan.”
### Table 5: Consequence of Risk Occurrence classification

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Consequence level</th>
<th>Consequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>The consequence of a risk event will directly impact the project’s budget.</td>
<td>4 3 2 1</td>
<td>Very High High Moderate Low</td>
</tr>
<tr>
<td>Scope</td>
<td>The consequences of a risk event will affect the final product of the project and/or a single phase.</td>
<td>4 3 2 1</td>
<td>Very High High Moderate Low</td>
</tr>
<tr>
<td>Schedule</td>
<td>When a risk event delays the completion date of a project and/or a single activity, concurrently, it is increasing the cost and may result in a reduction of scope and quality of the project.</td>
<td>4 3 2 1</td>
<td>Very High High Moderate Low</td>
</tr>
<tr>
<td>Quality</td>
<td>Frequently, this impact category is overlooked because it is in here where most of mitigation plans are implemented.</td>
<td>4 3 2 1</td>
<td>Very High High Moderate Low</td>
</tr>
</tbody>
</table>

**Step 3 - Risk Ranking**

Prioritize identified risks based on the results obtained from the previous numerals (2.3.2.1.2. and 2.3.2.1.3.). The following ranking scale table (See table 5) can be used as a guideline to assess risk response plan priorities. The A/E shall document the results of this risk ranking in the Schedule Risks Register. Refer to exhibit 1 for more detailed information about how the A/E should assess project risks under this step.

**Table 6: Ranking scale (Probability level Vs. Consequence level)**
● High: Risk that represents a high level of damage to the project objective. A rapid risk response plan is required to reduce high level risks either to medium or low level (Consider to implement new method or change the scope of the project).

● Medium: The risk is moderate; however, it can be dangerous to some elements of the project (Consider alternative methods).

● Low: it represents a minimal hazard to the project (Does not need rapid response but it does need to be monitored)

3.3.2.2. Quantitative Risk Analysis

If Quantitative Risk Analysis is the selected method, The A/E shall incorporate Monte Carlo risk simulation methodologies such as PertMaster¹ (See Exhibit 6 for detailed information about how this software is used). These tools help to estimate the project risks when all risks are considered simultaneously. In order to implement this method the A/E shall pursue, but not limited, the following activities:

● Analyzing and picturing very well all projects objectives, a good way to do that activity is by sorting objective by project schedule or cost estimate.

● Identifying all risk on individual project elements such as schedule or line-item costs.

● Including general risks that have broader consequence on the overall project.

● Applying quantitative tools to determine the overall impact of the risks on the project’s objectives.

The A/E shall apply Quantitative Risk Analysis during the design of large complex projects in order to validate the durations of the design activities. The probability of accomplishing the scope of work within the planned durations should be at least 50% or better, preferably at 70% level. The A/E shall perform such analysis at the VA’s discretion.

3.3.3. Risk Response Plan

The A/E shall recommend VA to select the best risk response action to be taken in order to proceed with generating risk contingency plans. This recommendation is made based on the ranking given to the risks.

The A/E is also responsible to provide recommendations to VA for possible risk contingency plans that help VA to determine the best set of action that correctly address risks.

¹ This methodology example is solely intended as a reference, it is not intended to dictate means and methods. The A/E is responsible to develop the means and methods and correlate with the VA requirements, as part of PG 18-15
3.3.3.1. Risk Response Action

Select the appropriate response for each identified risk. The probability and consequences of risk occurring will be the basis for deciding which action should be taken to address the risk.

The A/E shall document these actions in the Project Risk Register (PRR) in order to be presented to VA (Refer to Exhibit 1 for more detailed information about how the A/E should document these responses). The following actions are the four basics ways to manage a risk:

- **Avoid:** Change in the objectives and scope of the projects may result in avoiding the risk. This type of response need to be notified to VA.
- **Transfer:** Shift the responsibility of the risk to a third party. This action does not eliminate the risk.
- **Mitigate:** If the risk cannot be avoided, mitigation plans need to be implemented to reduce the probability and/or consequences of the risk.
- **Accept:** When risk cannot be avoided and mitigated, and acceptance is the only response, the A/E shall include a risk estimating cost into the project’s budget and shall update the project’s schedule in order to provide the VA with an order of magnitude of the risk’s impact. If the risk is accepted, a written note must be submitted stating the acceptance of the risk.

3.3.3.2. Risk Contingency Measure/Plan Process

List and explain how contingency measures/plans will be managed in order to determine the set of actions which will increase the probabilities of successfully achieving the project’s scope. Such measures/plans need to be documented in the Project Risk Register and then presented to VA for approval (Refer to Exhibit 1 for more detailed information about how the A/E should document these contingency measures/plans). It is recommended to concentrate, at least, on the following factors.

- Communicate to all members involved in the project all the identified risks, the area of the project that is/will be affected, their risk’s root, and their impact to project objectives.
- Identify risk owner and assigned responsibilities. Risk owners should be aware of what is expected from them.
- Agree upon what risk response action (avoid, transfer, mitigate, and accept the risk) will be taken to address the risk.
- Specify the time of when agreed-upon responses will be executed.
- Estimate the resources, costs, and duration of each response plan. This estimation has to be approved by the project manager and owner, and it is the risk owner's commitment to accomplish it.
● Implement risk response plans.
● Track and review risk response plans. It is responsibility of every Stakeholder involved in the project to oversee response plans in order to verify on how effective the results are; otherwise, actions need to be taken. Response activities should be documented and reviewed periodically.

All contingency measures/plans are to be reviewed and updated throughout the project life cycle if necessary; furthermore, the A/E need to publish and distribute them to all those directly involved in the execution of the project. These plans need to come along with a contingency plan schedule, as well with a contingency resources estimating plan.

The latter means that the A/E shall estimate and document all resources, such as money, equipment and labor that are needed for the execution of the contingency plan. If this estimation incurs in extra cost, the VA will be informed and the cost will be included in the budget of the project.

3.3.4. Risk Reporting

The A/E shall describe what format reports are planned to be used, to whom they are submitted and the frequency. The A/E shall document this information in the Project Risk Register (PRR) as well. Reports must contain every action that is taking to address the occurrence of a risk. The A/E shall include into the reports at least the following information (See Exhibit 7 for more detailed information of common risk reporting format):

● Dates of action.
● Corrective actions.
● Change requests.
● Updates to risk plans.
● The effectiveness of risk mitigations activities.
● Identification checklist.
● Detailed Risk Register and so on.

These reports must be submitted in every deliverable and also in each design review to the VA for progress review (Refer to required deliverable in section 2.). All reports must be archived for future projects.

3.3.5. Risk Monitoring and Review

The A/E shall update the Project Risk Register in a monthly basis and be ready to discuss it with the VA during monthly meetings in order to implement corrective actions, identify additional risks, update the Risk list, and review change requests.
3.3.6. Unforeseen Risk Process Description

Every unforeseen risk must be immediately notified to the project manager and stakeholders. The person or individual who identified the risk will assess the situation. If necessary the A/E shall notify VA in order to implement risk response plans to address such situations. This issue must be documented in case of the occurrence in the Project Risk Register (PRR).
4. EXHIBITS

Exhibit II.1. Sample Project Risk Register
Exhibit II.2. Sample Risk Statement Form and Delphi Technique
Exhibit II.3. Sample Fault Tree Analysis
Exhibit II.4. Sample Risk Breakdown
Exhibit II.5. Sample Risk Management Schedule
Exhibit II.6. PertMaster and Monte Carlo Risk Simulation
Exhibit II.7. Sample Risk Report’s Table of Content
## EXHIBIT II.1

### Risk Identification

<table>
<thead>
<tr>
<th>Risk Number</th>
<th>Name of Risk</th>
<th>Description of Risk Source</th>
<th>Type of Risk Identification</th>
<th>Triggering Event</th>
<th>Frequency of Occurrence</th>
<th>Probability of Occurrence</th>
<th>Risk Impact</th>
<th>Risk Management Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF-01</td>
<td>Change in Budget</td>
<td>The actual project budget is likely to be different from the negotiated budget due to unforeseen costs during construction.</td>
<td>Cost Escalation Schedule (CES)</td>
<td>Change in Budget</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Contingency Plan</td>
</tr>
<tr>
<td>RF-02</td>
<td>Schedule Delay</td>
<td>There may be delays in the project schedule due to unforeseen circumstances such as weather, supplier delays, or labor shortages.</td>
<td>Time Escalation Schedule (TES)</td>
<td>Schedule Delay</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>Contingency Plan</td>
</tr>
<tr>
<td>RF-03</td>
<td>Quality Issues</td>
<td>There is a risk of quality issues arising from the construction process, which could lead to delays and increased costs.</td>
<td>Quality Assurance System (QAS)</td>
<td>Quality Issues</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
<td>Risk Mitigation Plan</td>
</tr>
<tr>
<td>RF-04</td>
<td>Material Shortage</td>
<td>The project may experience material shortages due to supply chain disruptions or unforeseen demand.</td>
<td>Material Supply Schedule (MSS)</td>
<td>Material Shortage</td>
<td>Low</td>
<td>High</td>
<td>High</td>
<td>Risk Mitigation Plan</td>
</tr>
<tr>
<td>RF-05</td>
<td>Safety Incidents</td>
<td>There is a risk of safety incidents occurring on the project, which could lead to delays and increased costs.</td>
<td>Safety Management System (SMS)</td>
<td>Safety Incidents</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>Risk Mitigation Plan</td>
</tr>
</tbody>
</table>

### Risk Assessment

<table>
<thead>
<tr>
<th>Risk Number</th>
<th>Risk Impact</th>
<th>Risk Probability</th>
<th>Risk Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF-01</td>
<td>High</td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td>RF-02</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>RF-03</td>
<td>High</td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td>RF-04</td>
<td>Low</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>RF-05</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
</tr>
</tbody>
</table>

### Risk Response Plan

- **Contingency Plan**: Contingency plans are developed for each identified risk to mitigate potential impacts. These plans include alternative strategies, resource allocation, and communication plans.
- **Risk Mitigation Plan**: Mitigation strategies are implemented to reduce the probability or impact of identified risks. This includes actions such as diversifying suppliers, improving communication, and increasing training for project personnel.

### Risk Monitoring and Control

- Regular reviews of the project status and risk management plan are conducted to ensure that risks are effectively managed and that contingency plans are in place.
- Risk registers are maintained to track the status of identified risks and ensure that appropriate actions are taken.

### Legend

- **Risk Impact**: High, Medium, Low
- **Risk Probability**: High, Medium, Low
- **Risk Score**: Medium

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**Note**: This exhibit provides an overview of the risks associated with the project and outlines the strategies in place to manage these risks. Regular reviews and updates to the risk management plan are necessary to ensure effective risk management throughout the project lifecycle.
The following is a sample risk statement form to be used for identifying risks. This form may be customized and enhanced while implementing the Risk Management Plan process.

<table>
<thead>
<tr>
<th>Risk Identification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of person doing assessment:</td>
</tr>
<tr>
<td>Date:</td>
</tr>
<tr>
<td>Activity / Procedure being assessed:</td>
</tr>
<tr>
<td>Description of why risk occurs:</td>
</tr>
<tr>
<td>Type of risk</td>
</tr>
<tr>
<td>Who is at risk?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Risk Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Who is responsible for the risk:</td>
</tr>
<tr>
<td>Probability of occurrence:</td>
</tr>
<tr>
<td>Consequence of occurrence:</td>
</tr>
<tr>
<td>Area of Impact in the:</td>
</tr>
<tr>
<td>Duration of Risk in case of occurring:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Risk Response Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Action to be taken in case of occurring:</td>
</tr>
<tr>
<td>Possible Response plan:</td>
</tr>
<tr>
<td>Estimated response plan cost:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Risk Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Status of risk:</td>
</tr>
<tr>
<td>Signature of Assessor:</td>
</tr>
</tbody>
</table>
SAMPLE FAULT TREE ANALYSIS

- Schedule
  - Change Scope of Work
    - Congress realizes the need of modifying the size of the project
      - Demand growth in the area
        - Less demand than expected
  - Economic crisis
    - World bankruptcy
  - Local Crisis
  - Long Lead/Critical Equipment and Material
  - Project Control
    - Project Manager Failure
    - Lack of work flow control
      - Implementing scheduling and risk software in the project
  - Supplier Failure
    - High demand
  - Conflict of interest
  - Failure to involve stakeholders early in the project
    - Contract Delivery Method (DBB)

- Or
- And
### VA Risk Management Plan Schedule

<table>
<thead>
<tr>
<th>Activity ID</th>
<th>Activity Name</th>
<th>Start Date</th>
<th>Finish Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1000</td>
<td>Start Development of RMP</td>
<td>22-Jul-11</td>
<td>19-Aug-11</td>
</tr>
<tr>
<td>A1010</td>
<td>Risk Identification Performed by all Project Stakeholders</td>
<td>21-Jul-11</td>
<td>27-Jul-11</td>
</tr>
<tr>
<td>A1020</td>
<td>Risk Assessment Performed by all Project Stakeholders</td>
<td>21-Jul-11</td>
<td>27-Jul-11</td>
</tr>
<tr>
<td>A1030</td>
<td>Risk Contingency Plans Proposed by A/E</td>
<td>28-Jul-11</td>
<td>03-Aug-11</td>
</tr>
<tr>
<td>A1040</td>
<td>VA Review and Comment on Proposed Risk Contingency Plans</td>
<td>04-Aug-11</td>
<td>12-Aug-11</td>
</tr>
<tr>
<td>A1050</td>
<td>VA Review and Comment on Proposed Risk Response</td>
<td>04-Aug-11</td>
<td>12-Aug-11</td>
</tr>
<tr>
<td>A1060</td>
<td>VA Review and Comment on Proposed Risk Reporting</td>
<td>04-Aug-11</td>
<td>15-Aug-11</td>
</tr>
<tr>
<td>A1070</td>
<td>Meeting for All Project Stakeholders to Review and Comment on Risk Reporting</td>
<td>0</td>
<td>19-Aug-11</td>
</tr>
<tr>
<td>A1080</td>
<td>Risk Monitoring and Review Throughout Duration of Project</td>
<td>0</td>
<td>19-Aug-11</td>
</tr>
<tr>
<td>A1090</td>
<td>End Development of RMP</td>
<td>19-Aug-11</td>
<td>19-Aug-11</td>
</tr>
</tbody>
</table>
PERTMASTER AND MONTE CARLO RISK SIMULATION

PertMaster is a Risk Management software that uses Monte Carlo risk simulation methodology. This methodology requires some knowledge of probability and statistics but provides a software based on probabilistic approach to risk including some very useful features. This software provides a wide range of duration distributions for various impact ranges, with more flexibility and power than more simple probabilistic methods that typically use three point probability assessments. PertMaster basically looks at each task that has a distribution and sets its duration to a value between the minimum and maximum. When triangular distribution (See figure 1 below) is to be used, PertMaster sets the duration to the most likely more often than any other value. The least possible value to occur is considered an extreme value; i.e. the minimum and maximum duration. Once the impact ranges are established, the software runs repeated calculation iterations using each of the duration estimates, until the range of completion dates narrows and additional iterations do not show additional spread and the normal distribution of dates is reasonably well established. Discrete and discontinuous risk events can be incorporated and used in the simulation as well as running statistical modeling of uncertainty in durations. Once the analysis is complete the first thing it has to be done is look at the change of finishing by a certain date.

Results from the use of PertMaster include the probability of achieving various completion dates, which can be used to help the client choose the right confidence level for the selected project duration (see figure 2 below, as an example of how PertMaster provides these results), as well as the budget cost (See figure 3 below).

The use of PertMaster is particularly useful in conceptual and feasibility scheduling when durations are even less certain; and often, it is found that Contractor’s planned completion dates fall within a very low range of probability, usually due to lack of Risk Management planning. This means that it is very important for Risk Management to use simulation methodologies that require very good schedule techniques, with appropriate logic and accurate estimated durations. Furthermore, when a subcontractor or trade contractor is known not to be a strong performer, PertMaster allows specific trades to be isolated and risk analysis can be run at a different rate or profile on just those trades, allowing customized risk analysis. This is very useful in Design-Bid-Build work where there is a tendency to accept low bids which include historically weak trade contractor performance.

Some of the other features that can be yielded from the use of PertMaster are complex metrics that cannot easily be extracted from a schedule by other means, like the Criticality Index (Figure 4 below), which identifies the times that an individual activity
shows up on different Critical Paths (strictly the percentage of iterations that the activity appears on the Critical Path). This provides for better monitoring ability since these are the activities that are going to be more likely to delay the project. Sensitivity Analyses, correlating activity duration and project duration, produce “Tornado” charts (Figure 5 below), listing the major obstacles to completing the project.

![Duration Uncertainty](image1)

**Figure 1.** Triangular distribution or three 3 point analysis can be set for duration and cost.

![Entire Plan : Finish Date](image2)

**Figure 2.** Finish date histogram. The bars on the graph represent how often during the analysis the plan finish on certain date or between a certain date range.

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Figure 3. Finish date histogram. The bars on the graph represent how often during the analysis the plan finish on certain budget cost or between a certain cost range.

Figure 4. Criticality Index: the percentage of iterations each activity was critical.

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3 Emerald Associates, Project Risk Analysis (with Primavera), AACE Toronto Section, October 2, 2008.
Figure 5. "Risk Tornado (Statistics and controls hidden) ranking the risks by their impact on the project completion date."
**SAMPLE OF RISK REPORT’S TABLE OF CONTENT**

**Table of Content**

**Executive Summary** - Briefly summarize the main report; include items such as report purpose, VA background, scope of the project, methodology, risk assumptions, and mitigation recommendations. The summary must be short and concise.

1. **Purpose** - In this Section needs to be presented, but not limited, the purpose of the report, as well as project’s general description that includes name of the project, location, elements related to cost and schedule

2. **Project Scope** - In this Section needs to be presented, but not limited, project technical scope such as estimates, budget costs, design phase main elements, construction main elements, and schedule as developed and presented by. In addition, based on VA requirements and the established RMP, stipulate the dates when the reports will be submitted, as well as the person or entity to whom it will be submitted.

3. **Methodology** - In this Section needs to be explained the methodology that was implemented during the process, for example, list of risk team members and responsibilities, methodology implemented to identify risks, type of analysis performed (Qualitative and/or Quantitative), and description of the implemented software if used. Refer, but not limited, to the RMP.

4. **Key Assumptions** - in this section all key assumption needs to be presented in order to help ensure that project leadership and other stakeholders understand the steps, limitations, logics and any decision made in the risk analysis.

5. **Risk Analysis Results** - in this Section needs to be presented the results in narrative as well as any table, chart and figures obtained from the risk analysis (i.e. Risk Register, Criticality Index, Tornado Charts, Finish Date and cost Histograms and so on).

6. **Observation and Recommendations** - In this section needs to be presented all the major findings and/or observations captured from the analysis results. This will come along with key recommendations and corrective actions that my assist in mitigating the risk in order to achieve the project’s objectives.