

## Guidelines for Risk Analysis

- What** These guidelines serve as reference information for use understanding and building Risk Analyses.
- Why** Using these guidelines to create Risk Analyses to mitigate and plan cost and schedule risks during the course of the project.

### 1 Glossary of Terms and Acronyms

BL - Baseline  
CA – Control Account  
CAM – Control Account Manager  
CL – Confidence Level  
CTC - Chargeable Task Code  
DOE – U.S. Department of Energy  
DTI – Desk Top Instruction  
EV – Earned Value  
EVMS - Earned Value Management System  
P6 – Primavera P6 Scheduling Software  
PCS – Project Controls Specialist  
PM – Project Manager  
PMP – Project Management Plan  
PRA – Primavera Risk Analysis  
RBS – Risk Breakdown Structure  
RRB – Risk Review Board  
WAD – Work Authorization Document  
WBS – Work Breakdown Structure  
WP – Work Package

Primavera Risk Analysis (PRA) - Primavera Risk Analysis uses advanced Monte Carlo-based cost and schedule analytics to provide full-lifecycle risk management through the following types of risk models: estimate uncertainty, task existence, probabilistic branching, fixed-cost uncertainty, variable-cost uncertainty, resource uncertainty, conditional branching, and weather modeling. In addition, users can conduct risk analyses at both the project and portfolio level, making strategic decisions about project selection through portfolio models as well as traditional project-level risk analysis against individual or linked schedules.

Risk Review Board (RRB) – Members of the project team who meet periodically to discuss, analyze, and update all Open or Proposed risks which are relevant to the project. This time is comprised of high and low level management, control account managers (CAMs), project controls specialists (PCS), and all relevant parties.

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.

Work Package (WP) – Commonly defined as “a task or set of tasks performed within a control account”. However, this term is often confusing due to its use in various tools. For example, in Cobra, a WP, and its ID refers to a P6 Task and its “Activity ID”. This usage is acceptable in Cobra because in EVMS terms a WP is any level of activity below the Control Account. However, in P6, a WP is sometimes referred to as an element of the Work Breakdown Structure (WBS). Throughout this document, WP, Task, and Activity are interchangeable, synonymous terms and do not refer to a particular level of the WBS.

## 2 Intent of Desk Top Instruction (DTI)

The intent of this DTI is to provide guidance and clarification regarding the Risk Analysis tools, as well as the outputs from the Monte Carlo analysis. Risks can be initiated by anybody working on the project, however the risks are owned by the CAM. The CAM is responsible for facilitating the risk, determining the cost and schedule impacts, providing all backup and documentation, and updating the risk register. The risk manager is responsible for collecting the risk data along with a summary schedule and, using PRA, perform a Monte Carlo analysis to determine the overall risk impacts. Also see Fermilab-Risk-Management-Procedure DocDB #PPP-doc-65.

## 3 Risk Register:

### 3.1 Navigating the Risk Register

The Fermilab Risk Register is located here: <https://fermipoint.fnal.gov/collaboration/PM-Tools/Pages/Risk-Register.aspx>



## Risk Register

Fermilab Risk Management Procedure for Projects	<p>This is the Lab-wide web-based Risk Register for Fermilab projects.</p> <p><a href="#">Enter a new risk in the Risk Register</a></p> <ul style="list-style-type: none"><li>• Use "Add New Risk" in the left side menu</li></ul> <p><a href="#">Browse existing risks</a></p> <ul style="list-style-type: none"><li>• Use links in the left side menu to browse risks by Project / WBS, cost impact, schedule impact, owner or topic in the Risk Breakdown Structure (RBS)</li></ul> <p><a href="#">Update data for existing risks</a></p> <ul style="list-style-type: none"><li>• In any of the risk browsing views, click the edit icon (to the left of the risk) or the risk title followed by the edit button</li></ul> <p><a href="#">Check the risk identification coverage</a></p> <ul style="list-style-type: none"><li>• At the end of the risk identification process, it is suggested that you consult the "Risk Breakdown Structure" checklist (left side menu) to see if there are additional areas of risk that need to be considered</li></ul> <hr/> <p><a href="#">For comments, feedback, or in case of problems</a></p> <ul style="list-style-type: none"><li>• <a href="#">Lucas Taylor</a>, Fermilab Risk Manager</li></ul>
Risk Breakdown Structure	
Fermilab Enterprise Risk Register [external]	
<b>Risk Register</b>	
Open risks - by rank	
Open risks - by RBS	
All risks	
All risks - by WBS	
All risks - by Owner	
Top Cost Impacts	
Top Schedule Impacts	
Add new risk	
Risks with missing probability or impact values	
Operations risks	

➤ The headings are sortable.



## Risk Register

The screenshot shows the Risk Register interface. On the left is a sidebar with navigation options: 'Fermilab Risk Management Procedure for Projects', 'Risk Breakdown Structure', 'Fermilab Enterprise Risk Register [external]', 'Risk Register', 'Open risks - by rank', 'Open risks - by RBS', and 'All risks'. The main area displays a table with columns: 'Edit', 'Risk Type', 'RI-ID', 'Title', 'Probability', and 'Cost Impact'. A dropdown menu is open over the 'RI-ID' column, showing options: 'A on Top', 'Z on Top', 'Clear Filters from RI-ID', 'Show Filter Choices', and 'Close'. The table rows include project identifiers and counts, such as 'Project:ID plu... tions (34)', 'Project:ID plu... ilities -- Operations (21)', 'Project:ID plu... )', 'Project:ID plu... ct 402 (42)', and 'Project:ID plu... e 1 -- Project 401 (93)'.

Open risks – by rank: Risks with an Open status are sorted by High, Medium, Low, or Negligible. These rankings are based on a combination of probability, cost, and schedule impact.

### Risk Impacts

		Low	Medium	High
	Technical	Slightly sub-standard	Moderately sub-standard	Very sub-standard or KPP in jeopardy
	Cost	(0.1 - 1) M\$	(1 - 10) M\$	> 10 M\$
	Schedule	< 6 Months	(6-12) Months	> 12 Months
<b>Risk Probability</b>	<b>V. High</b>	64 - 100%		
	<b>High</b>	39 - 64%		
	<b>Medium</b>	21 - 39%		
	<b>Low</b>	9 - 21%		
	<b>V. Low</b>	0 - 9%		

Open risks – by RBS: All Open risks grouped by their Risk Breakdown Structure (RBS), which is broken down into 3 main categories; External, Management, and Technical, all of which have their own sub-categories. Each risk shall have an RBS assigned when it is created.

All Risks: All risks are listed here, first by subproject then WBS, regardless of their status.

All Risks – by WBS: Click the filter icon and select the WBS to view risks related only to that WBS.

All Risks – by Owner: Click the filter icon and select the subproject to view risks related only to that subproject. The information is sorted by the Owner (CAM) of the risk.

Top Cost Impacts: Click the filter icon and select the subproject to view risks related only to that subproject. The information is grouped by Risk Status and is sortable by Cost Impact.

Top Schedule Impacts: Click the filter icon and select the subproject to view risks related only to that subproject. The information is grouped by Risk Status and is sortable by Schedule Impact.

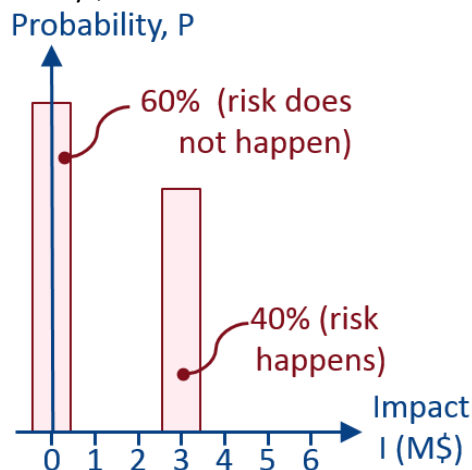
Add New Risk: Clicking on this will bring you to the online Risk Register form with numerous fields that can be filled out. Details on how to fill this form out will be covered later in this DTI.

Risks with missing probability or impact value: Risks grouped by subproject which do not contain a probability or impact value.

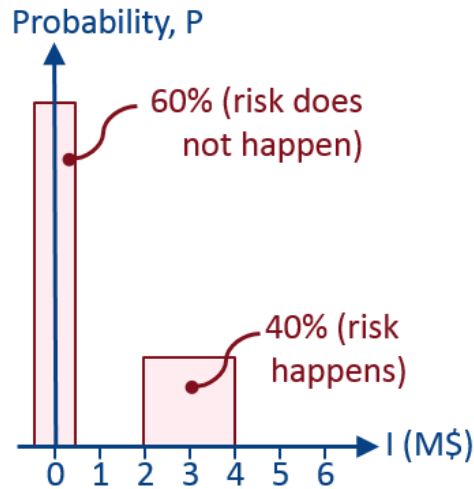
### 3.2 Adding a new Risk

It is highly recommended when filling out a risk for the first time that all fields are filled out.

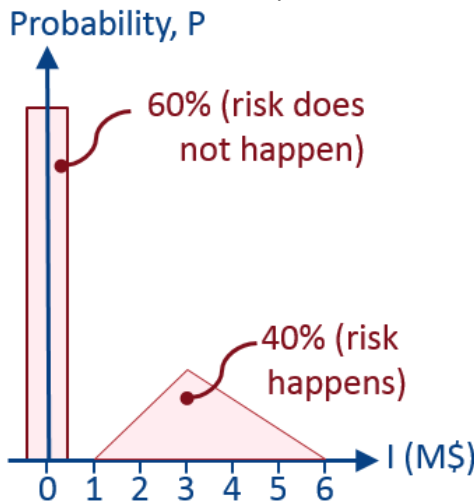
- RI-ID is the Risk ID, which should be filled out by the Risk administrator on the project. It must be unique for every risk. The naming convention should be along the lines of:
  - RT/O-(project #)-(subproject)-xxx
    - For example, a risk which is a Threat on the Cryogenics subproject for Project 131-LBNF:
      - RT-131-CR-001
    - If the risk was an opportunity, the Risk ID would be:
      - RO-131-CR-001
- Risk Status:
  - Proposed
    - Use this for new risks that have not been accepted by management. Risks that are proposed are not included in the risk analysis
  - Open
    - Once a risk has been accepted by management then select Open status. A risk with Open status will be included in the risk analysis
- Cost & Schedule Impacts:
  - 1 Point – Single Point
    - If this is selected it means that if the risk occurs the impact will be exactly what is specified in the impact field, ie. if the cost impact is \$300k and the risk occurs it will be exactly \$300k



- 2 Point – Flat or Uniform
  - If this is selected you must select a lower and upper limit for the impact, ie. a schedule impact that has a uniform range between 1 month and 6 months.

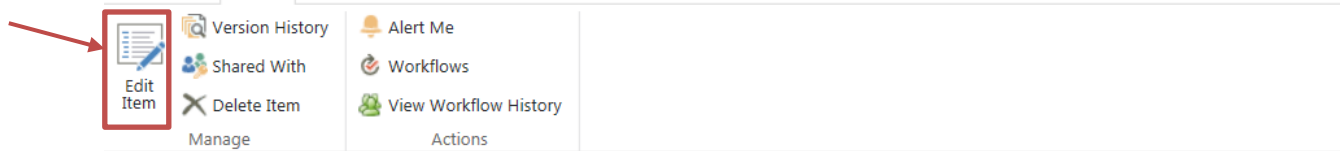


- 3 Point – Triangular
  - This involves a Min, Max, and Most likely, ie. a cost impact ranging between \$0 and \$500k with a most likely of \$100k



- Impacted Activities is a field which refers to the Summary Schedule activity and should be filled out by the Risk administrator with help from the CAMs
- Link to More Details: in this field create a link to docdb where the backup information is stored such as the risk form and supporting documentation
- The Change Log field is the only required field when adding or modifying a risk in the register. When creating a new risk the Change Log field should state "New Risk Added". When modifying a risk, enter the changes made to the risk in this field.

### 3.3 Modifying Existing Risks



Fermilab Risk Management Procedure for Projects	RI-ID	RT-131-CR-106
Risk Breakdown Structure	Project	<a href="#">LBNF / DUNE</a>
Fermilab Enterprise Risk Register [external]	Title	Efficiency of delivering materials and working underground is underestimated.

Open the risk then click on the Edit Item button. Once changes are made, update the Change Log field describing what changes were made.

## 4 Risk Form

The Risk Form is used for supplemental information which cannot be entered into the online Risk Register due to text box limitations. This form should be stored on docdb and linked using the risk register.

Graphics, charts, and tables should be pasted into this form. There are fields in the form for in-depth and detailed analysis with no limit on how much text can be entered.

This form should only be used if it is not possible to fit all the information into the online Risk Register.

## 5 Primavera Risk Analysis:

### 5.1 Creating a Summary Schedule

- The Summary Schedule should be a very high level look at the entire project where key tasks are created which illustrate the core activities needed to complete the project.
- Costs are not loaded into the Summary Schedule, only dates and activities with correct logic.
- All CD milestones should be entered into the Summary Schedule with correct logic.
- The Summary Schedule critical path should reflect the correct critical path of the project.
- The risk activities in the schedule should be 0d duration activities
- The summary schedule will be run through a Monte Carlo analysis in PRA

**Baseline or Working Schedule Activities:**

131.01.02.03 Cryogenics Infrastructure		3203d	01-Oct-15 A	21-Apr-28
131.01.02.03.01 Cryostat		2903d	01-Oct-15 A	26-Feb-27
131.01.02.03.01.01 Cryostat Design		904d	01-Oct-15 A	10-May-19
131.01.02.03.01.02 Cryostat Construction		2381d	30-Oct-17	26-Feb-27
131.01.02.03.01.02.00 Cryostat & Steel Structure Milestones		1666d	01-Jun-18	23-Dec-24
131.01.02.03.01.02.01 Cryostat #1 Construction		1852d	30-Oct-17	20-Mar-25
131.01.02.03.01.02.01.01 Steel Support Structure #1		1004d	13-Feb-19	13-Feb-23
131123.01.01.560	Fabricate Steel Frame Assemblies #1	250d	13-Feb-19	11-Feb-20
131123.01.01.562	Deliver Steel Frame Components to SURF #1	60d	12-Feb-20	05-May-20
131123.01.01.636MS	T4 MS - Readiness Check for Steel Frame #1 Installation	0d	05-May-20	
131123.01.01.634	Installation Readiness Review - Steel Frame Installation Contract	10d	06-May-20	19-May-20
131123.01.01.568	Steel Frame Build #1	125d	01-Jul-20	30-Dec-20
131123.01.01.662	Construct Bridge between Steel Structure Frame & Rock #1	40d	30-Oct-20	30-Dec-20
131123.01.01.704	Fabricate and Install Mezzanine #1	20d	04-Jan-21	01-Feb-21
131123.01.01.576	Steel Frame Close TCO (Temporary Construction Opening) #1	40d	13-Dec-22	13-Feb-23
131.01.02.03.01.02.01.02 Membrane Cryostat #1		1852d	30-Oct-17	20-Mar-25
131123.01.01.582	Preparation of Safety Documentation - Cryostat #1	1044d	30-Oct-17	29-Dec-21
131123.01.01.564	Fabricate Cryostat Components #1	250d	13-Feb-19	11-Feb-20
131123.01.01.566	Deliver Cryostat Components #1	60d	12-Feb-20	05-May-20
131123.01.01.638	Installation Readiness Review - Membrane Cryostat Installation Contract #1	10d	06-May-20	19-May-20
131123.01.01.572	Assemble Cryostat #1	250d	04-Jan-21	29-Dec-21
131123.01.01.602MS	T4 MS - Agreement with LAr Safety Panel on Expedite Process #1	0d		04-Jan-21*
131123.01.01.580	Testing Prior to Filling (Safety) #1	40d	14-Feb-23	10-Apr-23
131123.01.01.584	Completion of Safety Documentation #1	40d	11-Apr-23	06-Jun-23
131123.01.01.774	Safety Approval for Filling #1	10d	07-Jun-23	20-Jun-23
131123.01.01.586MS	T4 MS - Approval for Filling (Safety) #1	0d		20-Jun-23
131123.01.01.592	Approval for Operations (Safety) #1	20d	22-Mar-24	18-Apr-24
131123.01.01.660	Operation Readiness Clearance Review - After filling #1	230d	19-Apr-24	20-Mar-25

**Summary Schedule Activities:**

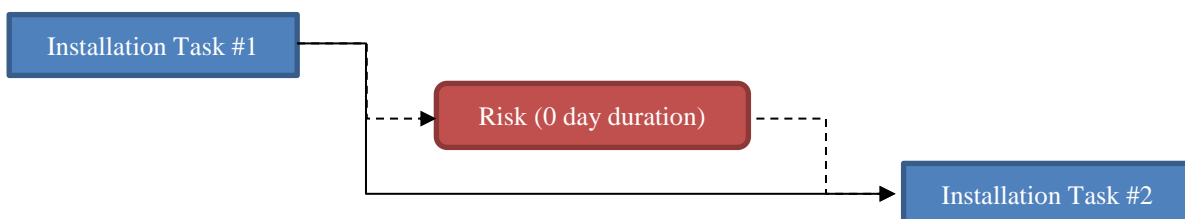
PRA-131-v-latest 2015-11-12 08:42 CST -- LBNF / DUNE Summary Schedule -- V-latest		3872d	01-Oct-15	07-Mar-31
PRA-131-v-latest.00 Milestones		3872d	01-Oct-15	07-Mar-31
PRA-131-v-latest.01 Project Management (Project Office Costs)		2869d	02-Oct-15	12-Mar-27
PRA-131-v-latest.02 Far Site		3348d	02-Oct-15	08-Feb-29
PRA-131-v-latest.02.01 1st 10kt Facility & Detector		2276d	02-Oct-15	25-Oct-24
PRA-131-v-latest.02.01.01 1st 10kt Conventional Construction		1307d	02-Oct-15	16-Dec-20
PRA-131-v-latest.02.01.02 1st 10kt Cryo Infrastructure		2177d	02-Oct-15	06-Jun-24
A2210	1st 10kt Cryostat Structure	91d	01-Jul-20	06-Nov-20

The Baseline or Working schedule activities should be summarized into 1 or 2 tasks in the summary schedule, based on the WBS.

The Risks from the register should be loaded into the Summary Schedule then linked to the schedule tasks. Once they are linked, update the online Risk Register with the successor activity under the Impacted Activities field.

PRA-131-v-latest 2015-11-12 08:42 CST -- LBNF / DUNE Summary Schedule -- V-latest		3872d	01-Oct-15	07-Mar-31
PRA-131-v-latest.00 Milestones		3872d	01-Oct-15	07-Mar-31
PRA-131-v-latest.01 Project Management (Project Office Costs)		2869d	02-Oct-15	12-Mar-27
PRA-131-v-latest.02 Far Site		3348d	02-Oct-15	08-Feb-29
PRA-131-v-latest.03 Near Site		2726d	02-Oct-15	17-Aug-26
PRA-131-v-latest.04 Risk Contingency		2910d	02-Oct-15	11-May-27
PRA-131-v-latest.04.01 LBNF Project Office		2055d	01-Sep-16	08-Nov-24
PRA-131-v-latest.04.02 Beamline		1678d	03-Oct-17	12-Jun-24
PRA-131-v-latest.04.03 Near Detector		1645d	24-Apr-18	08-Nov-24
PRA-131-v-latest.04.05 Far Detector		2058d	02-Oct-15	15-Dec-23
PRA-131-v-latest.04.06 Conventional Facilities		1609d	01-Sep-16	06-Feb-23
PRA-131-v-latest.04.07 Cryo Facilities		1720d	01-Jul-20	11-May-27
PRA-131-v-latest.04.08 DUNE Project Office		0d	29-May-19	29-May-19

The Risks should be linked with a FS relationship as illustrated below:



The Risk and predecessor activity should both be driving the successor task:

Project ID	Driving	WBS	Activity ID	Activity Name	Relations	Lag	Start	Finish
PRA-131-v-	<input type="checkbox"/>	PRA-131-v-l	A1350	Cryo Design and Prototype	FS	0d	02-Oct-15	22-Aug-19
PRA-131-v-	<input type="checkbox"/>	PRA-131-v-l	A1370	1st 10kt Facility Excavation, Drifts, Cryo Cavern	FS	0d	09-Nov-18	03-Jan-20
PRA-131-v-	<input checked="" type="checkbox"/>	PRA-131-v-l	A1380	1st 10kt Facility UGI 4850L	SS	125d	06-Jan-20	16-Dec-20
PRA-131-v-	<input checked="" type="checkbox"/>	PRA-131-v-l	CFFS-4850L-204	RISK -- Rock Falls Impact the Cryostat	FS	0d	01-Jul-20	01-Jul-20
PRA-131-v-	<input checked="" type="checkbox"/>	PRA-131-v-l	CR-100	RISK -- Fermilab has insufficient labor for specialized cryoge	FS	0d	01-Jul-20	01-Jul-20
PRA-131-v-	<input checked="" type="checkbox"/>	PRA-131-v-l	CR-106	RISK -- Efficiency of delivering materials and working underg	FS	0d	01-Jul-20	01-Jul-20
PRA-131-v-	<input checked="" type="checkbox"/>	PRA-131-v-l	CR-109	RISK -- Purification System for Cryostat	FS	0d	01-Jul-20	01-Jul-20
PRA-131-v-	<input checked="" type="checkbox"/>	PRA-131-v-l	CR-112	RISK -- Oxygen deficiency hazard (ODH) incident occurs	FS	0d	01-Jul-20	01-Jul-20
PRA-131-v-	<input checked="" type="checkbox"/>	PRA-131-v-l	CR-113	RISK -- Delay in Interface Agreement with Non-DOE partners	FS	0d	01-Jul-20	01-Jul-20

### 5.2 Importing the Summary Schedule

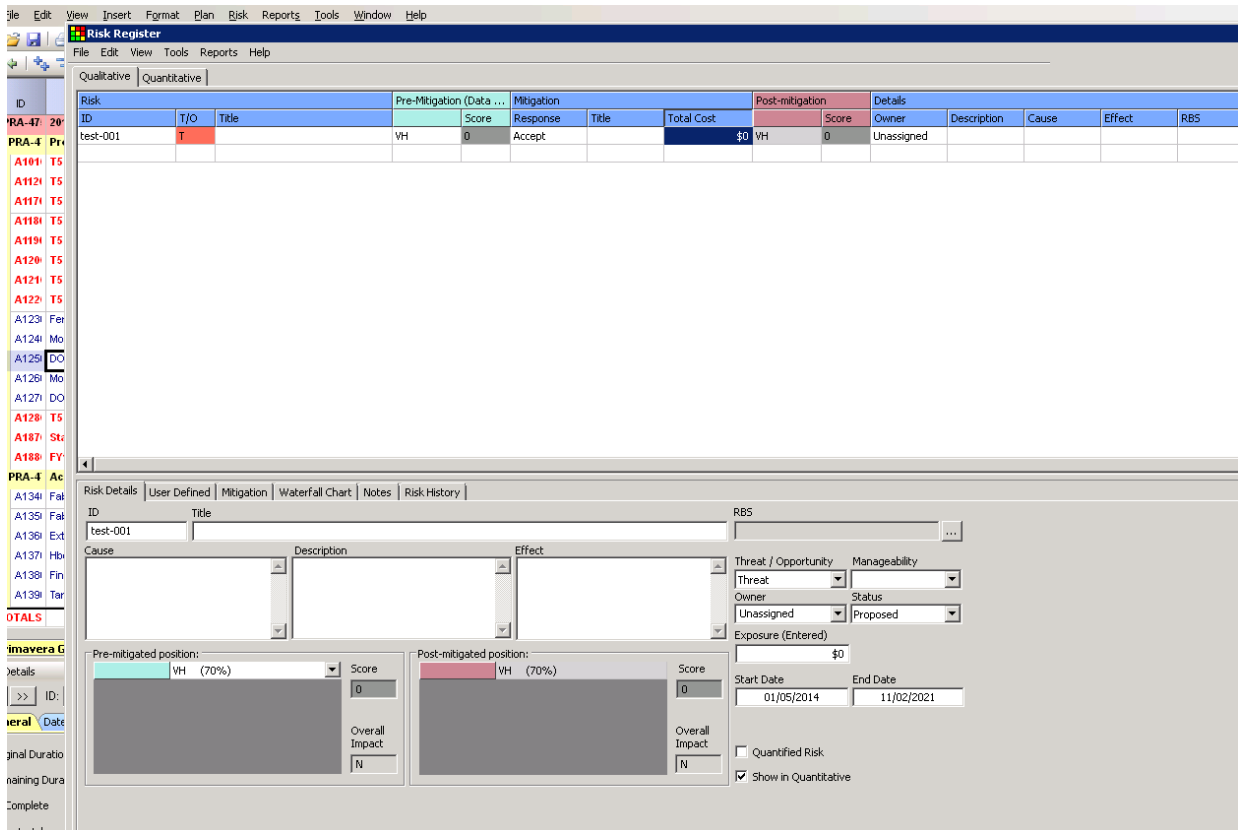
Open PRA → File → Primavera → Open Primavera P6 Project → Enter P6 log-in Info → Select the Summary Schedule to import → Press OK (no need to adjust the options) → Save the File

### 5.3 Creating a Risk Register in PRA and Linking the Risks

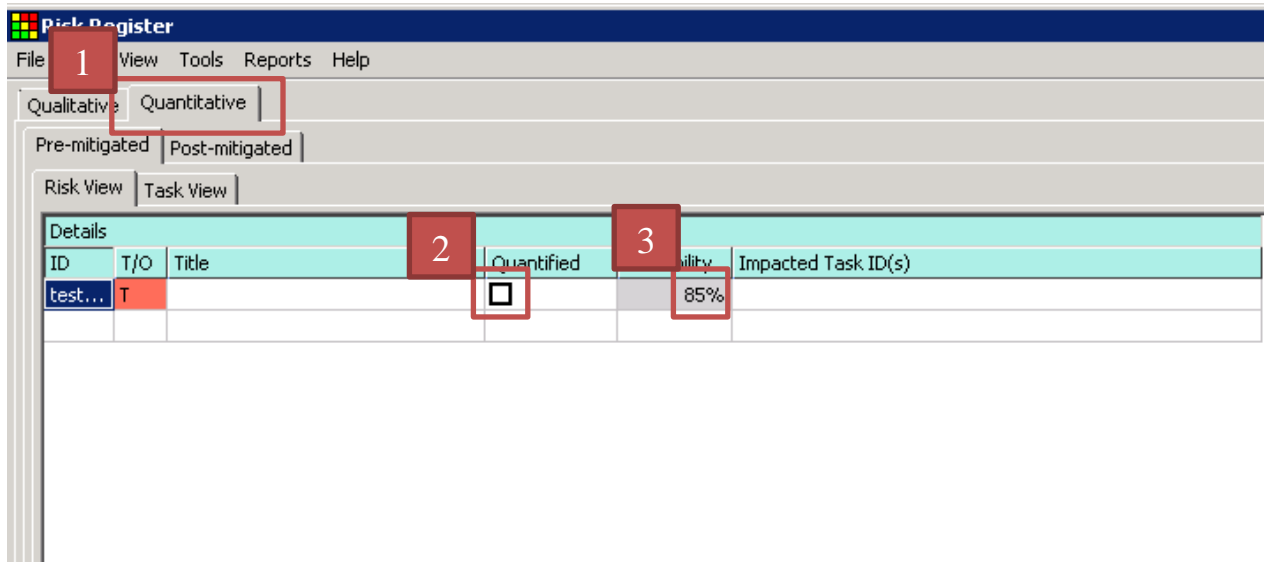
Menu Bar → Risk → Risk Register.

- Under Qualitative enter the risk ID, then choose if it is a threat or opportunity. The title field is not required here, as the risks with their names exist in the summary schedule.
- With each risk entered, change the status of the risk to Open, as Proposed will be the default setting.
- Once all the risks are entered, press File → Export Risk Register As → Save the register. This register can be used for any schedule that is imported from P6, as long as the imported schedule has the same Project ID.





Once all the risks are entered, click under the Quantitative heading, click the checkbox under Quantified, then enter the Probability for each risk.



On the right hand side of the window there is the summary schedule. Select the risk, then click on the Risk activity in the summary schedule. Once the risk activity is selected populate the cost and schedule impacts at the bottom of the window using information from the Risk Register. Schedule impact is in working days and cost impact is in dollars. Leave the Correlate boxes checked.

The screenshot shows the Risk Register application with three numbered callouts:

- 1:** Points to the 'test-01' row in the 'Details' table.
- 2:** Points to the 'RT-475-SOL-148' risk item in the tree view on the right.
- 3:** Points to the 'Impacts for Risk test-01' table at the bottom.

ID	T/O	Title	Quantified	Probability	Impacted Task ID(s)
test-01	T		<input checked="" type="checkbox"/>	85%	RT-475-SOL-148

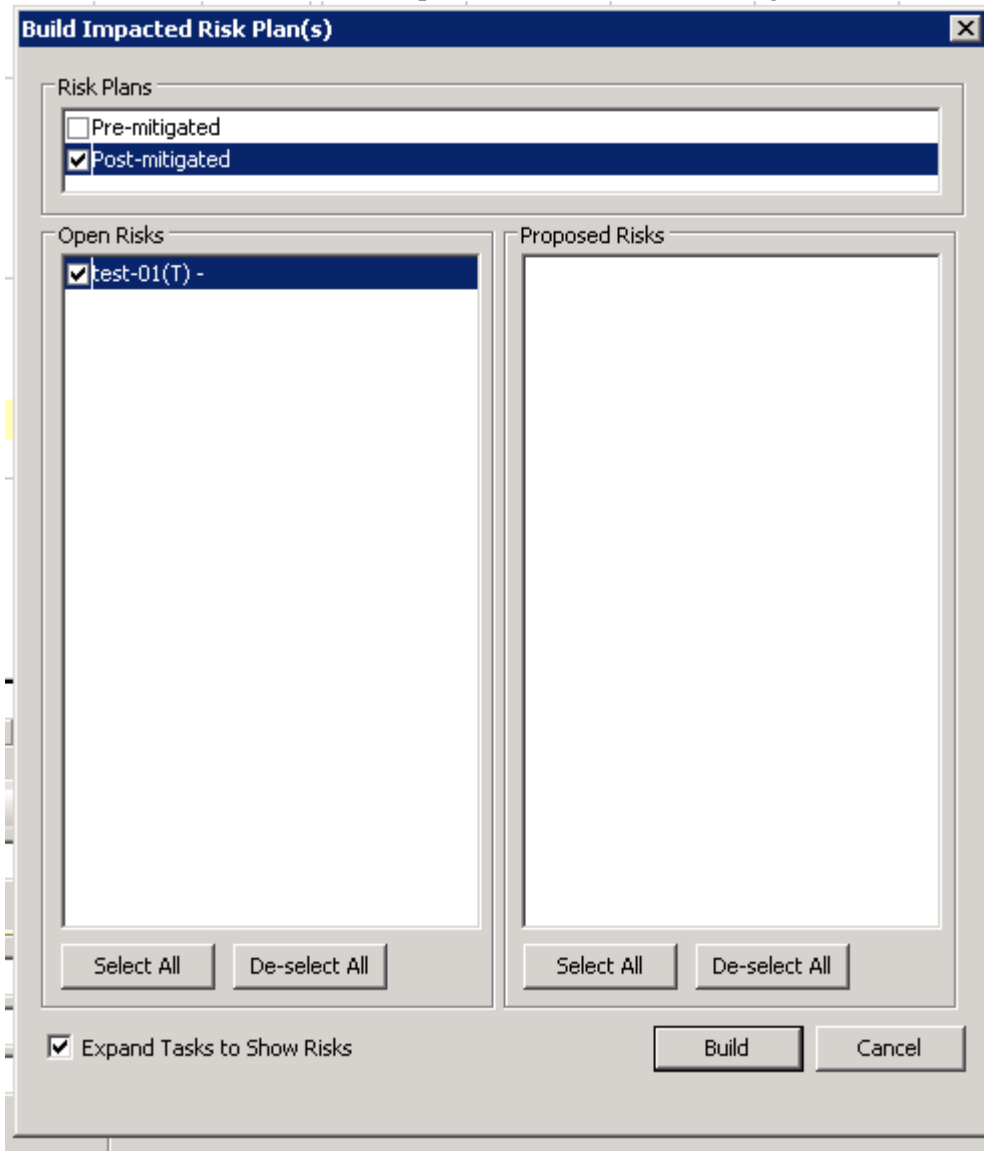
Task ID		Description	Schedule			Cost			Correlate		
Task ID	Description	Shape	Min	Likely	Max	Shape	Min	Likely	Max	Impact Ranges	Event existence
RT-475-...	RISK -- Production S...	Triangle	15	40	50	Uniform	\$1,000		\$50,000	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

➤ File → Save Register and Plan

## 5.4 Running the Analysis

Risk → Build Impacted Risk Plan.

Ensure all the risks are under the Open column and are Post-Mitigated

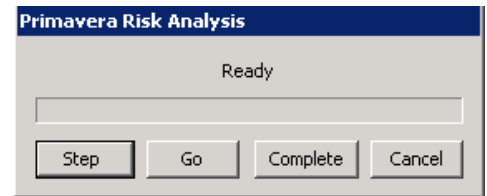
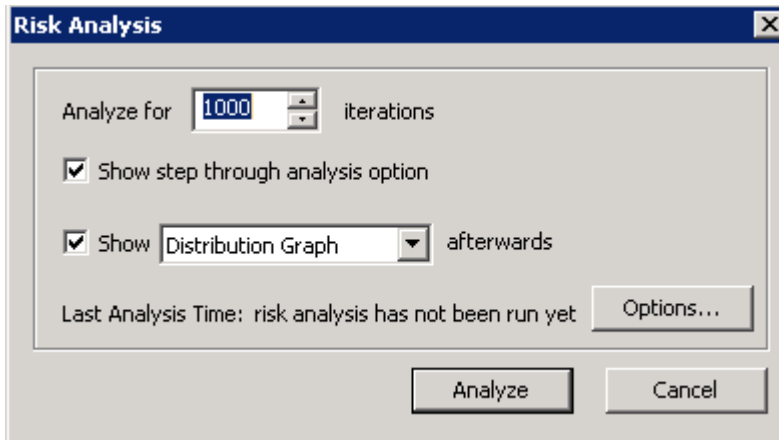


➤ Press Build

Risk → Run Risk Analysis

Choose how many iterations you would like to run for the analysis.

By selecting Show Step Through Analysis Option it will bring up a dialog box where you can step through each iteration, choose to see each iteration, or complete the analysis. It is not necessary to have this check box clicked.

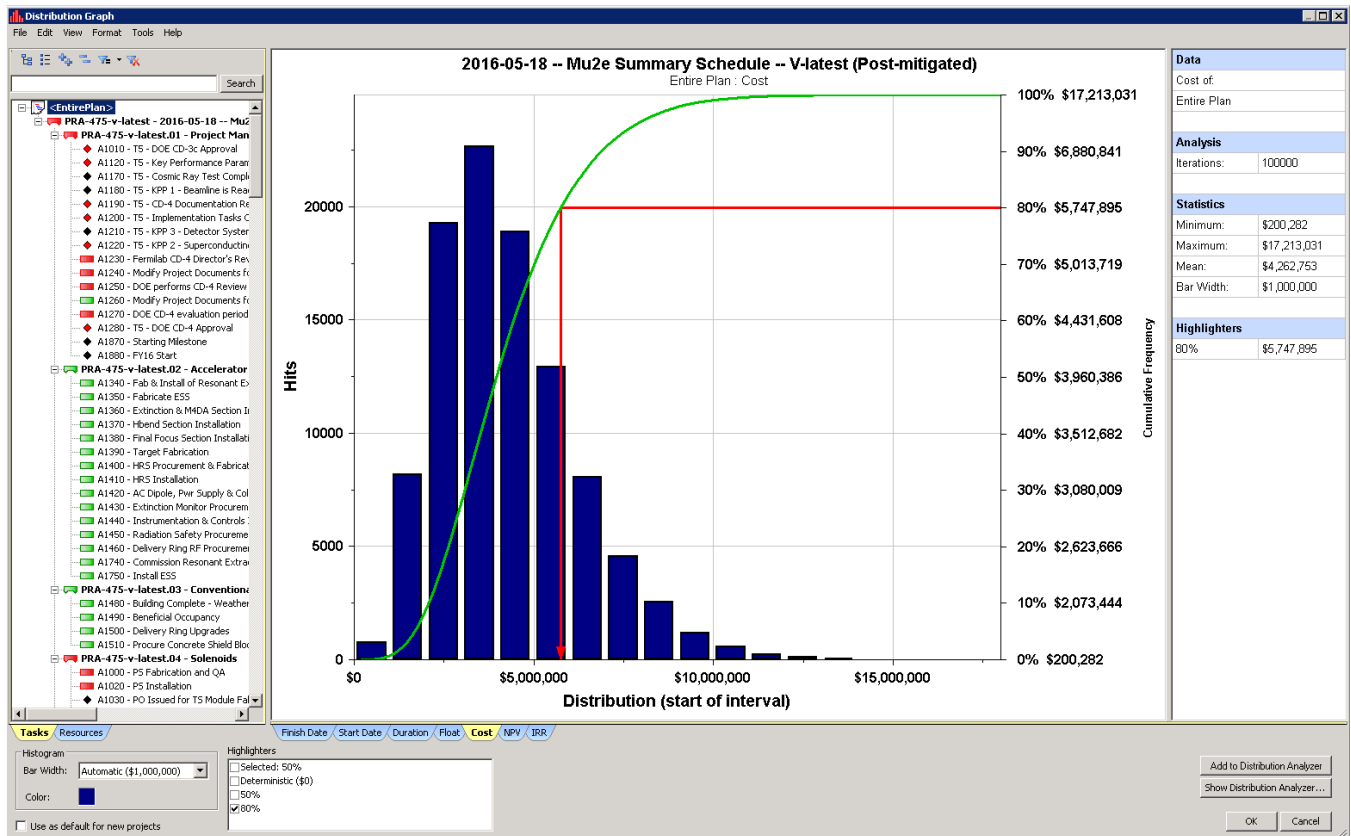


Complete the analysis by pressing Analyze or Complete. If the check box for Show is clicked, a graph will show up once the Monte Carlo analysis is complete. If it is unclicked the graphs will still be created and can be viewed by going to Reports in the menu bar.

## 5.5 Understanding the Output

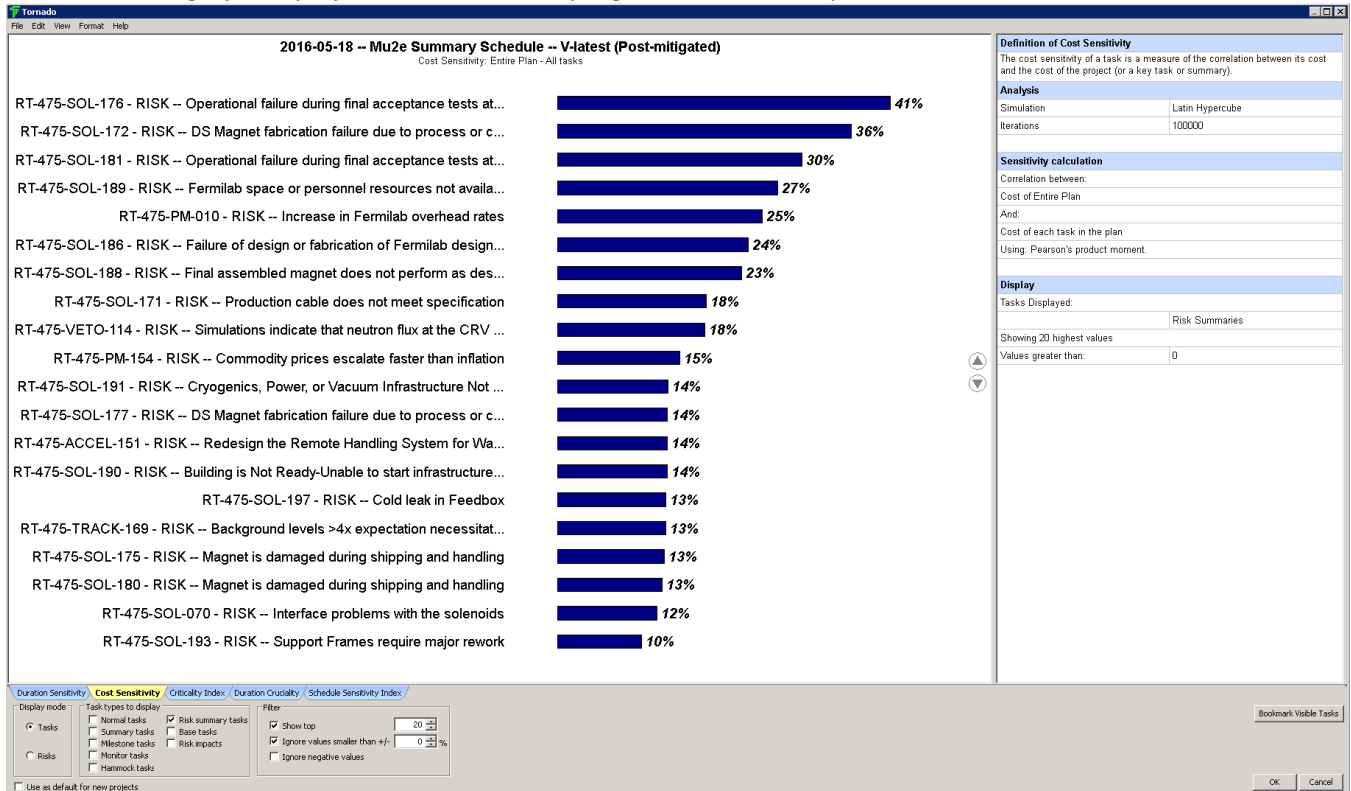
### Distribution Graph:

- The graph's appearance is fully customizable – the colors, highlight markers, background, etc. can all be modified
- The percentages on the right hand Y axis are the Confidence Level (CL). Typically, projects use a 90% CL, however this can be changed depending on the Project Management Plan. At a CL of 80% this means that 80% of the risks will occur. Based on the graph below, at 80% this means the overall risk impact will be \$5.7m. At a CL of 100% this means that all risks will occur, which would only happen if risk management no longer managed the project. In this extremely unlikely scenario, all risks occur and the cost impact is \$17.2m. Similarly, there is also a schedule impact that can be determined from the Monte Carlo analysis which uses the same metrics as the cost analysis.



Tornado Graph:

- This graph displays the risks sorted by highest to lowest impact.



## Document Revision History

Date	Version	Author	Description
6/7/2016	0.0	Mohammed Elrafih	Developed DTI