Calculating Project Contingency Using Cost Risk Analysis in Aspen Capital Cost Estimator™

Monte Carlo Risk Analysis for Capital Projects

aspentech | Jump Start Guide

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Cost Risk Analysis

Risk analysis is an essential component of CAPEX estimation in engineering projects, providing a structured approach to account for uncertainties and potential cost overruns. By identifying and quantifying risks associated with design, procurement, construction and market conditions, risk analysis ensures that the contingency included in a CAPEX estimate is both realistic and sufficient to address project uncertainties. This not only improves the accuracy of the estimate but also instills confidence in stakeholders regarding budget feasibility and risk preparedness.

Estimating Project Contingency in ACCE

A robust risk analysis process involves assessing probabilities and impacts of various risk factors, such as material price fluctuations, schedule delays or unforeseen technical challenges. Through methodologies such as Monte Carlo, engineers can account for these uncertainties and generate probabilistic outcomes, identifying a range of potential contingency values and project costs. This data-driven approach allows teams to allocate a contingency amount that balances the need for cost control with the capacity to absorb potential risks, ensuring the project stays within the estimated budget.

Aspen Capital Cost Estimator (ACCE) provides an integrated methodology to run Monte Carlo risk analyses for your capital project. This integration provides a competitive advantage by facilitating better decision-making while leveraging the same information available in the capital cost estimate without the need for manual data transfer. This enables project teams to proactively address uncertainties while maintaining focus on the accuracy of the estimate scope.

Ultimately, this alignment of risk management with cost estimation leads to more predictable and successful project outcomes.

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Perform a Risk Analysis in ACCE

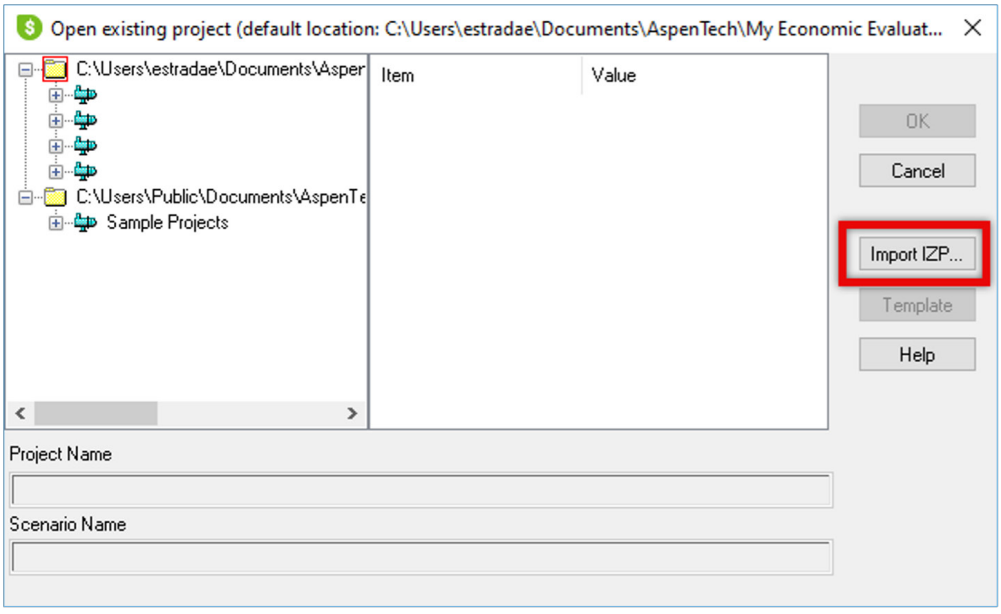
ACCE's Risk Analysis allows you to identify and quantify key risks associated to your project estimated cost and provides a probabilistic result that allows you to add an appropriate amount of contingency to the estimate and assure the project will not overrun its budget.

Overview

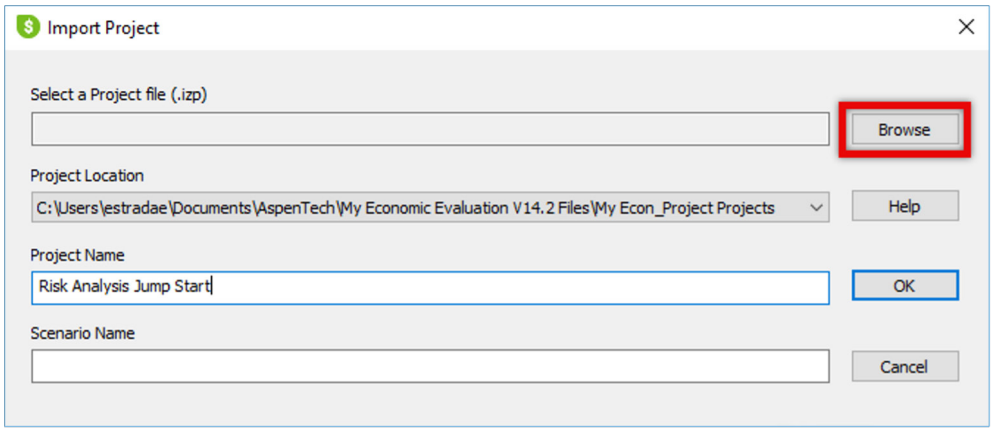
In this guide, you will review the steps to create a cost risk analysis in ACCE to calculate the contingency required for a gas plant project that has already been estimated in ACCE.

Task 1 – Open the Starter File and Evaluate the Project

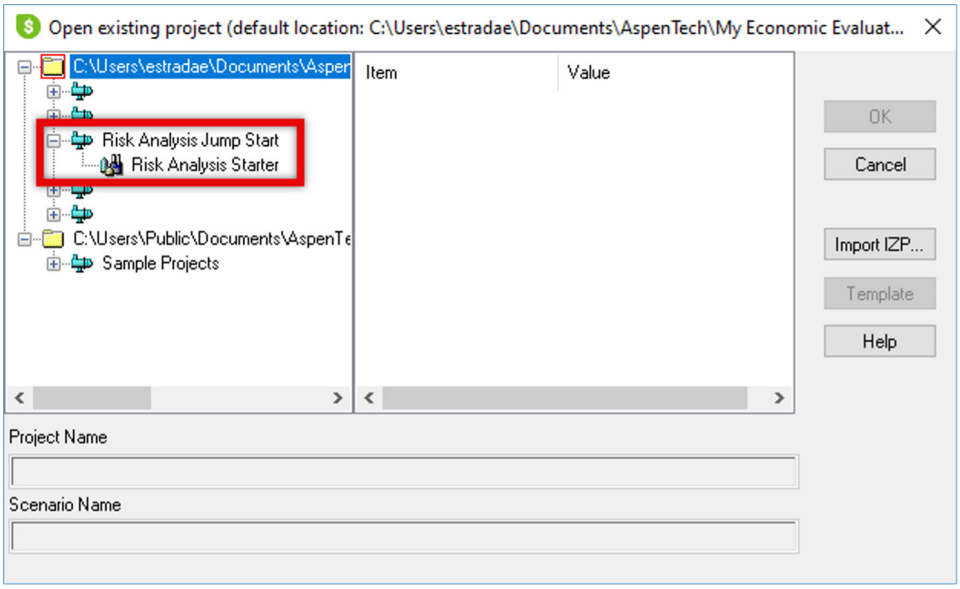
1. Save the attached **IZP** file Risk Analysis Starter.izp on your PC desktop for easier finding.
   Note: The attached IZP file is compatible with V12.0 and later versions of ACCE.
2. Launch Aspen Capital Cost Estimator.
3. Click on File | Open. A window showing all your existing projects will show up.
4. Click on the Import IZP... button.



5. Enter the Project Name, "**Risk Analysis Jump Start**," then click on the **Browse** button.



6. Locate the starter file **Risk Analysis Starter.izp** you placed on the desktop and click **Open**.
7. Hit **OK** to continue. A message confirming the IZP file was successfully imported will appear. Click **OK** to close it.
8. Once done, the imported project will be available in the list and ready to use. Double-click on the **Risk Analysis Starter** project to launch it.



9. Take a quick look at the project's contents in the Project View tab. Note there are two report groups and four areas that contain different types of components, including equipment items, steel structures, pipe segments and even a building.

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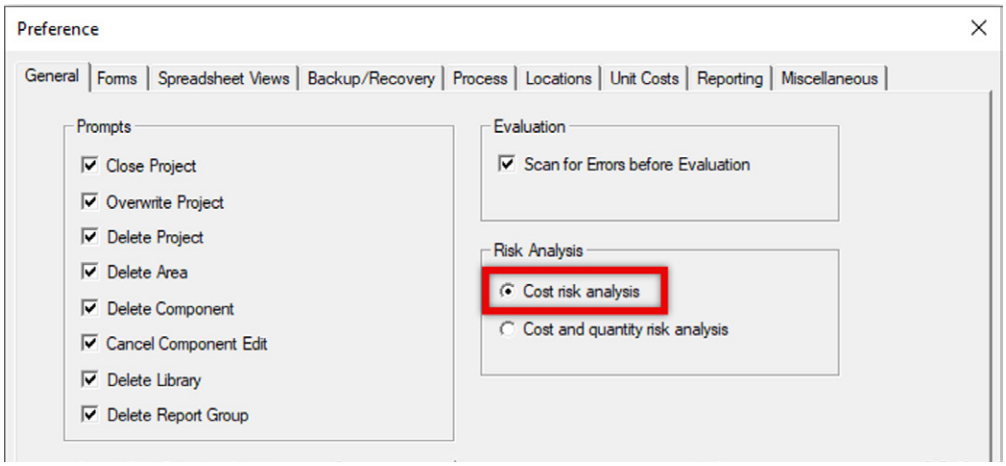
10. Evaluate the project by clicking on the  icon or clicking **Run | Evaluate Project**. If any report window or other window opens upon completing the evaluation, close it.

Task 2 – Configure a Cost Risk Analysis

11. Go to **Tools** | **Options** | **Preferences** | **General** and make sure the **Cost risk analysis** mode is selected. Click **OK** when done.



Note: ACCE allows users to include or exclude quantities in the analysis; users should decide at the start whether to include them or not. If the **Cost and quantity risk analysis** option is chosen, you can follow the same methodology in this guide, but additional information will be required to control the possible quantity ranges in the project.

12. Click on **Run | Risk Analysis | Create** Input File. ACCE will create and open an Excel file that will be used for the Monte Carlo analysis.
13. Review the Base Estimate tab in Excel. This contains the current totals of the key direct and indirect costs of the project.
14. Switch to the User Input – Ranges tab in the appearing Excel file.

In this spreadsheet, you can change the Min % and Max % cells in orange to control the expected cost ranges for each separate account.

Additionally, you can use the Include/Exclude column to choose which accounts should be considered or ignored for this analysis.

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Note: In the Cost Element column, the current analysis will allow you to set values for material costs, manhours, wage rates and indirect costs. When you run a cost and quantity risk analysis, the quantities for equipment, piping, civil, etc. will also appear in this column.

15. Enter the following Material Cost range limits to control the minimum and maximum price of each account.

Account	Cost Element	Min %	Max %
Equipment	Material Cost	-3%	45%
Piping	Material Cost	-2%	35%
Civil	Material Cost	0%	30%
Steel	Material Cost	0%	30%
Instruments	Material Cost	-2%	60%
Electrical	Material Cost	0%	40%

Note: These % values denote how likely it is for the estimated value to underrun or overrun. For example, the first row indicates the final equipment material has 3% chance of underrunning, but it's 45% likely that the final cost is higher than the estimated cost.

The values used in this guide are for demonstration purposes only.

16. Enter the following Manhours range limits to adjust the possible effort for each account.

Account	Cost Element	Min %	Max %
Equipment	Manhours	0%	20%
Piping	Manhours	-5%	30%
Civil	Manhours	0%	15%
Steel	Manhours	0%	15%
Instruments	Manhours	-5%	30%
Electrical	Manhours	0%	15%

17. Enter the following indirect cost range limits.

Account	Cost Element	Min %	Max %
Field office	Material Cost	-3%	45%
Construction indirects	Material Cost	-2%	35%
Engineering and home office	Material Cost	0%	30%
Other project indirects	Material Cost	0%	30%

18. Switch to the **User Input – Correlations** tab in Excel and review the Correlation matrix.

Note: In this first task, you will not run a correlated analysis, so at this moment the matrix should show only 1.0 in the diagonal and 0.0 below said diagonal. By default, the cost risk analysis does not use this matrix, which is a good starting point when these correlations are not known.

19. **Save** the Excel file and close it.

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Task 3 – Calculate Project Contingency

20. Back in the ACCE window, click on **Run | Risk Analysis | Run Analysis.**
21. The Excel spreadsheet will open once again, but this time a new tab, **RESULTS**, will appear. Go to the **RESULTS** tab.

This report will first show the calculated Project Contingency Based on Probability of Non-Exceedance, ranging from P05 to P95.

14	**Base Estimate:**	**10,123,252** DOLLARS USD **BASE ESTIMATE**	
15			
16	**Project Contingency Based on Probability of Non-Exceedance**		
17	**P Value**	**Contingency Amount (DOLLARS USD)**	**Contingency %**
18	P05	466,387	4.61
19	P10	555,166	5.48
20	P15	622,816	6.15
21	P20	677,414	6.69
22	P25	726,990	7.18
23	P30	770,738	7.61
24	P35	813,915	8.04
25	P40	855,696	8.45
26	P45	899,126	8.88
27	P50	942,491	9.31
28	P55	986,793	9.75
29	P60	1,033,596	10.21
30	P65	1,080,756	10.68
31	P70	1,133,854	11.20
32	P75	1,190,890	11.76
33	P80	1,253,908	12.39
34	P85	1,326,738	13.11
35	P90	1,423,337	14.06
36	P95	1,555,510	15.37

Note: The numbers shown in the image above may vary based on the ACCE version you're using, since the estimate results depend on ACCE's cost basis.

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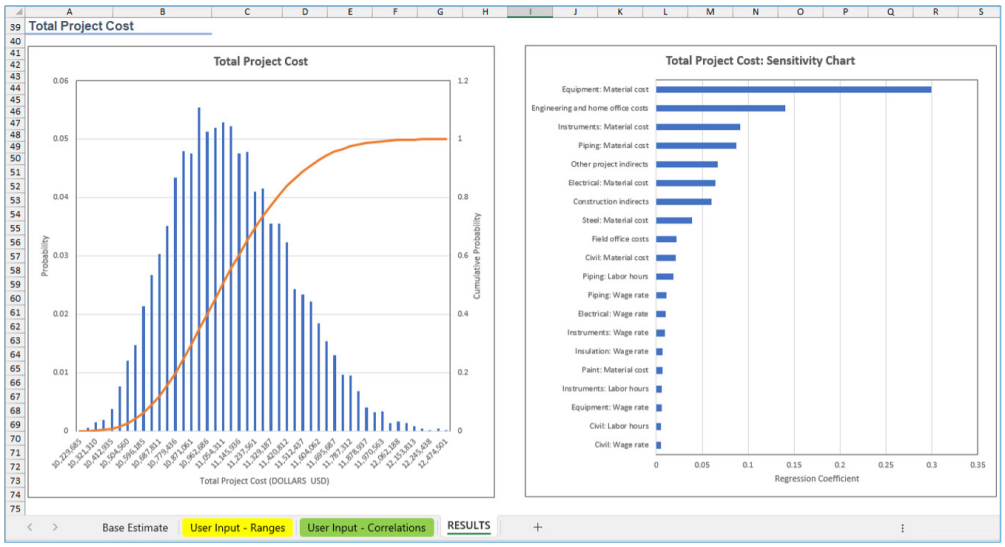
As the probability increases, the contingency increases as well. For example, P70 means the estimate has a 70% chance of underrunning and a 30% chance of overrunning.

The **RESULTS** tab also shows histograms (S-curves and funnel charts) that can be used to track the cumulative impact of risks, as well as to identify the accounts with the highest risk.



Based on these results, users can pick an appropriate contingency % for the project and enter it back in ACCE, under Project Basis View | Contingency and Misc. Project Costs.

Standard Basis Input File - IP

Name	Units	Item 1
CONTINGENCY AND MISC. PROJECT COSTS		
CONTINGENCIES AND FEE		
Contingency	PERCENT	
ROYALTY AND MISC CHARGES		
Royalty, special charge Item 1	USD	0
Royalty, special charge Item 2	USD	0
Royalty, special charge Item 3	USD	0
Royalty, special charge Item 4	USD	0

Note: The contingency value specified in this field only controls the project's direct costs, such as material, wage rates and labor. This means that the ACCE reports that display the contingency value will often show an overall lesser % value, because indirect costs contingencies (such as shipping) are not controlled through this field.

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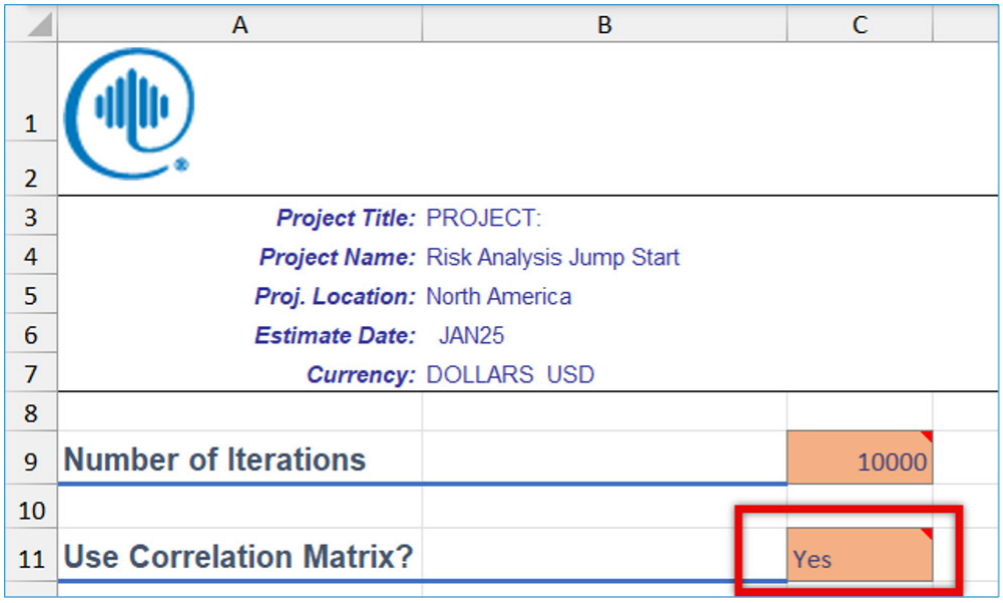
Task 4 – Run a Correlated Analysis

22. In the Excel report, switch to the **User Input – Correlations** tab.
23. Enter a value of 0.8 on cells **L23** (Piping Manhours – Instrumentation Manhours) and **Y34** (Insulation Wage rate – Paint Wage rate).

This value indicates the correlation between each account pair, so if one of them changes, the other one is likely to be affected. Values in the matrix can go from -1.0 to 1.0. Negative values denote an inverse relation between the accounts, and a positive value indicates a direct relation.

In this example, the value on L23 indicates there is a high correlation between piping and instrumentation labor, since most instruments are mounted into pipes and an overrun in piping can overrun the instrumentation manhours. Y34 also indicates a high correlation between paint and insulation wage rates, since both activities will be done by the same group in this project.

24. Enter a value of 0.6 on cell **C12** (Piping & Equipment material cost).
25. Return to the **User Input – Ranges** tab and use the dropdown button on cell **C11** (Use Correlation Matrix?) to set the value to **Yes**.



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26. **Save** the Excel file and close it.
27. Back in ACCE, click on **Run | Risk Analysis | Run Analysis.**
28. The Excel spreadsheet will open. Once again, go to the **RESULTS** tab and review the new contingency values.

14	**Base Estimate:**	**10,123,252** DOLLARS USD **BASE ESTI**	
15			
16	**Project Contingency Based on Probability of Non-Exceedance**		
17	**P Value**	**Contingency Amount (DOLLARS USD)**	**Contingency %**
18	P05	424,386	4.19
19	P10	514,925	5.09
20	P15	584,576	5.77
21	P20	644,096	6.36
22	P25	694,255	6.86
23	P30	742,270	7.33
24	P35	789,019	7.79
25	P40	836,609	8.26
26	P45	883,133	8.72
27	P50	930,414	9.19
28	P55	979,977	9.68
29	P60	1,030,641	10.18
30	P65	1,085,358	10.72
31	P70	1,146,108	11.32
32	P75	1,212,401	11.98
33	P80	1,284,969	12.69
34	P85	1,365,820	13.49
35	P90	1,469,962	14.52
36	P95	1,620,235	16.01

Notice in this example the contingency range between P05 and P90 has increased, since a direct correlation was entered for two accounts that heavily impact the total cost of the project.

Once again, users can pick an appropriate contingency % based on these new results and enter it back in ACCE, under **Project BasisView | Contingency and Misc. Project Costs**.

29. **Save** the Excel file and **close** it.
30. **Save** the project file in ACCE.

Conclusion

A probabilistic risk analysis is essential for determining accurate contingency values to mitigate capital cost project risks. The traditional approach is often iterative, time-consuming and requires manual data transfer between separate estimation and risk analysis tools.

Aspen Capital Cost Estimator streamlines this workflow by integrating estimation and risk analysis within a single platform. By capturing estimate results directly and enabling the creation of reusable risk analysis spreadsheets across iterations and even different projects, ACCE eliminates the need for manual data handling, accelerates risk assessments and ensures more effective contingency calculations for successful project execution.

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About Aspen Technology

Aspen Technology, now part of Emerson, is a global software leader helping industries at the forefront of the world's dual challenge meet the increasing demand for resources from a rapidly growing population in a profitable and sustainable manner. AspenTech solutions address complex environments where it is critical to optimize the asset design, operation and maintenance lifecycle Through our unique combination of deep domain expertise and innovation, customers in asset-intensive industries can run their assets safer, greener, longer and faster to improve their operational excellence.

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