Oversight Procedure 40 - Risk and Contingency Review

1.0 PURPOSE

The purpose of this Oversight Procedure (OP) is to describe the review procedures and reporting requirements that the Federal Transit Administration (FTA) expects from the Project Management Oversight Contractor (PMOC) during the review of project risks and, when available, the project sponsor's plan for mitigating and managing project risks.

This OP describes the procedure for a PMOC risk review, including guidelines for schedule and cost risk assessment.

While this OP focuses on Capital Investment Grant (CIG) projects, which have specific requirements by law, it also applies to all capital projects. FTA will issue Implementation Plans (IPs) to clarify the specific reviews and expected deliverables based on the project types.

2.0 BACKGROUND

The reliability of the project sponsor's Project Management Plan (PMP), scope, cost estimate, and schedule over the course of the project life is extremely important, not only for the success of the individual project, but also for the professional credibility of the transit industry including FTA. Professional risk management provides the basis for improving the reliability of project delivery through the successful development and implementation of a project-specific Risk and Contingency Management Plan (RCMP).

3.0 OBJECTIVES

The PMOC's review of project risk and risk mitigation plans requires an evaluation of project scope, project sponsor's cost estimate, and project sponsor's schedule with special focus on elements of uncertainty associated with the project sponsor's project implementation plan and project conditions. Additionally, the evaluation would encompass the management of risks and contingencies.

During a Risk and Contingency Review, the PMOC must review the project sponsor's RCMP so that the PMOC can:

- Evaluate, explore, and analyze uncertainties and risks as they pertain to the core assumptions included within the current project scope, cost estimate, and schedule;
- Establish an appropriate qualitative and quantitative risk-informed assessment of ranges of forecasted cost and schedules;
- Consider risk mitigation options and alternatives, including the use of cost and schedule contingencies;
- Describe and evaluate the management and analytical methods used; and
- Prepare a report with independent recommendations for adjustment to scope, cost, schedule, and risk and contingency management.

FTA may request that the PMOC complete a Risk and Contingency Review at various points in the project lifecycle; at a minimum, prior to entering an engineering phase and prior to grant award. This review is applicable to projects using any of the various forms of Project Delivery Method (PDM). Examples of alternative PDMs in transportation construction include Design-Build (DB), Design-Bid-Build (DBB), Construction Manager (CM)/General Contractor (GC), Construction Manager at Risk (CMAR), Public-Private Partnership (P3), and Design-Build-Finance-Operate and Maintain (DBFOM).

The PMOC's review under this OP is a critical input to FTA's decision regarding project advancement and funding. The independent review confirms that the project sponsor has established appropriate budgets, schedule, and mitigation steps based on the risks that may be present.

4.0 REFERENCES

The PMOC shall become familiar with the following references to Federal legislation, regulation, and guidance before reviewing the project sponsor's work. These are the principal references, but this list is not exhaustive:

4.1 Oversight Procedures

- OP 01: Administrative Conditions and Requirements
- OP 20: Project Management Plan Review
- OP 32C: Project Scope Review
- OP 33: Capital Cost Estimate Review
- OP 34: Project Schedule Review
- OP 39: Review of Third-Party Agreements for Major Capital Projects

Additional OPs may apply as directed by FTA.

4.2 Guidance

- FTA Standard Cost Category (SCC) workbooks:
  - New Starts SCC Workbook
  - Small Starts SCC Workbook
  - Core Capacity SCC Workbook

5.0 REVIEW OF PROJECT SPONSOR'S SUBMITTALS AND PROJECT STATUS

The PMOC evaluation of the project status is a necessary first step in the detailed risk review, as it establishes the basis of the review. The Risk and Contingency Review require the PMOC to obtain and study project documents like those listed in Appendix B.

The completeness and accuracy of the risk review are highly dependent on the completeness and accuracy of the project sponsor documents and the PMOC's project status evaluation. The project status evaluation typically requires assessment of:

- The project sponsor's PMP;
- The project scope, cost, and schedule; and

- Other project elements that may be included at the discretion of FTA, based on FTA concerns or PMOC recommendations.

The project sponsor's submittal, including the core documents as described below and their supporting data, shall provide the detailed basis and assumptions for the development of project scope, cost, and schedule. A thorough examination of the project sponsor's core documents enables the PMOC to establish the project baseline and perform the risk review. The core documents and their supporting data shall include, but not be limited to:

- The project sponsor's RCMP, including:
  - Risk register;
  - Risk assessments;
  - Established contingency levels; and
  - Policies for contingency management and other supporting documents;
- Project core documents with adequate detail to support the PMOC's baseline assessment, including:
  - Project sponsor's PMP;
  - PDMs;
  - Design documentation;
  - Constructability review, if available;
  - Project schedule and basis of project schedule;
  - Cost estimate;
  - Basis of the cost estimate;
  - SCC workbooks (see References section);
  - Project-specific organization and staffing plans;
  - Third-party agreements and their status;
  - Real Estate Acquisition and Management Plan (RAMP);
  - Value engineering; and
  - Inflation and market studies.

If it is found that the sponsor's document submittal is insufficient for a thorough, accurate, and informative risk review, the PMOC shall inform FTA.

6.0 SCOPE OF WORK

6.1 Risk Review Overview

The risk review process occurs in several sequential steps:

1. Establish Project Baseline (stripped of contingency and unmitigated)
2. Risk Identification Review
3. Schedule Risk Assessment
4. Cost Risk Assessment
5. Risk Response Review (introduction of mitigation and contingency to the analysis)
6. Risk Management Review

7. Risk Review Reporting

Risk reviews are evidence-based assessments that quantify uncertainties (risks) and estimate probability distributions for project cost and schedule compared to the project baseline.

The type of FTA Capital Investment Grant (CIG) determines the timing for the risk review process:

- For projects seeking New Starts and Core Capacity grants, FTA generally performs a risk review before approving the project to enter Engineering and a risk refresh review before awarding the Full Funding Grant Agreement (FFGA).
- For projects seeking Small Starts grants, FTA performs a risk review before awarding the Small Starts Grant Agreement (SSGA).

A risk review may occur at other points in the project lifecycle, as directed by FTA.

The risk review requires close coordination with the project sponsor. Appendix C, PMOC Coordination with the Project Sponsor, provides guidance regarding this interface.

6.2 Project Baseline Establishment

The PMOC must first assess the project sponsor's core project documents and supporting data that form the basis of the project sponsor's PMP, scope, cost, schedule, and other reviews, as directed by FTA. The establishment of the project baseline through assessment of the core project documents is a critical step toward the accuracy of a Risk and Contingency Review. An inaccurate project baseline would lead to incomplete data or biased results.

Informed by results of the baseline review, the PMOC shall:

- Recommend adjustments to the scope of work;
- Recommend adjustments to the contingency-free project baseline schedule; and
- Recommend adjustments to the contingency-free project baseline cost estimate.

PMOC recommendations shall be consistent with the findings of OP 20, OP 32C, OP 33, OP 34, and other reviews ordered by FTA.

The result of this effort establishes two key interim work products:

- Stripped and Adjusted Base Schedule (SABS); and
- Stripped and Adjusted Base Cost Estimate (SABCE).

Project baseline establishment guidelines are provided in Appendix D.

6.3 Risk Identification Review

Risk identification plays a significant role in the risk management process. Following the PMOC review and establishment of recommended scope, schedule, and cost baselines, the PMOC shall evaluate and characterize the existence of potential risk events that may impact the project's scope, schedule, or cost.

The PMOC shall review and comment upon the project sponsor's efforts in defining the risks in the project sponsor risk register. The risk register shall generally include a description of the risks, their qualitatively and quantitatively evaluated potential consequences, and the likelihood

of each risk's occurrence. The risk register shall also include, as appropriate for the project, risk categorizations such as SCC category, FTA risk category (or similar), contract package; a method for prioritization; and potential actions to mitigate the risk. A sample risk register and listing of FTA risk categories are provided in Appendix E.

Special considerations are warranted for megaprojects, defined as very large, complex projects that apply for FTA funding and are characterized as generally having budgets greater than $1 billion or other complex elements with multiple, distinct design phases and construction phases. These phases are typically separated by time, such that one phase may have progressed into preliminary design while a subsequent phase is still in the concept phase, etc. Similarly, separate construction contracts may be issued non-concurrently. When such phases are to be developed significantly in the future, it becomes extremely difficult to forecast base requirements and scope, schedule, cost, and risk. Thus, baseline and risk evaluations are difficult and generally unreliable unless the project review is broken into phases and the conditions surrounding such projects are thoroughly considered. Guidelines for identifying risk in a megaproject environment are provided in Appendix F.

The PMOC shall report key risks that are expected to have a high impact on the project's goals, whether identified by the project sponsor or by the PMOC.

The risk workshop supports the risk identification review by providing an opportunity to tour the project alignment as well as review and confirm the project scope, schedule, cost and PMP baseline. It is expected that the project sponsor, FTA, and the PMOC collaboratively confirm or amend the identification of risks on the project sponsor risk register. The risk workshop conclusions and results are summarized in the risk report and used in the development of the PMOC schedule and cost risk models. Appendix G provides guidance on how to conduct an FTA risk workshop.

6.4 Risk Assessment

6.4.1 Schedule Risk Assessment

Schedule risk is any risk that can cause delay on the project's critical path or that substantially decreases available float among non-critical activities. Note that schedule risk may also indicate cost risk. It is necessary, therefore, that the PMOC perform the schedule risk assessment before proceeding with the cost risk assessment to account for the cost impacts of schedule risks.

The PMOC shall use their professional judgment to evaluate and report on the project sponsor's assessment of the schedule risk and provide an independent PMOC assessment of the schedule risk. The PMOC shall report key schedule risks that may affect the schedule risk assessment.

The PMOC shall review and comment upon the project sponsor's schedule risk model, including whether appropriate technical experts have been consulted to establish the duration variations for activities associated with identified project risk, and the application of appropriate schedule risk modeling techniques.

The PMOC shall review and develop, in collaboration with the project sponsor, if necessary, a schedule risk model that will be either a full or summary schedule based upon the SABS for risk analysis purposes. Where possible, the PMOC compares the schedule risk model with the project sponsor schedule and considers whether the risk model schedule reasonably mimics project sponsor schedule outcomes under conditions of applied risk.

The schedule risk model is created for the specific purpose of assessing and quantifying risks using a commercially available project scheduling software system that is capable of critical path scheduling and stochastic modeling for probabilistically described activity durations. This project scheduling software will be used for capturing both activity duration uncertainty ranges and specific project risk events, and for analyzing and reporting their impact on the project-level schedule. See Appendix H for schedule risk modeling guidelines.

The PMOC shall report the confidence levels of (percentiles) P40, P50, P65, and P80. Methods used in the analysis are to be reported clearly, so that all parties may understand the analysis of the schedule risk assessment. Additionally, the risk report shall include a schedule model histogram graph with a cumulative distribution function (S-curve) overlay that illustrates the modeled confidence as shown in Figure 1. The histogram plots the Monte Carlo simulation results according to the relative likelihood of potential project completion outcomes (i.e., taller bars represent more likely outcomes and shorter bars reflect less likely outcomes). The S-curve plots the likelihood of achieving the predicted project dates. The yellow box in Figure 1 shows the difference in days between the deterministic date and the P65 date. Consistent with standard practice, the confidence interval is calculated using the P10 to P90 range (covering 80 percent of possible outcomes) which leaves a 10 percent probability of exceeding the upper confidence boundaries and a 10 percent probability of completing earlier than the lower confidence boundaries.

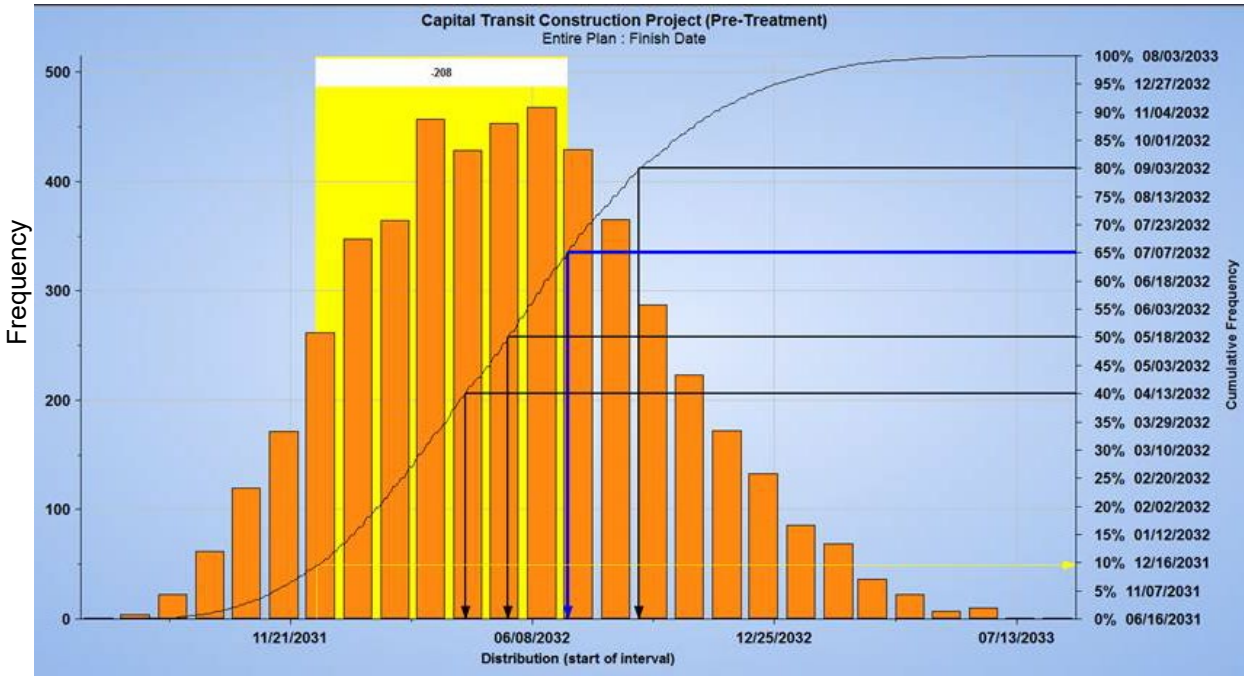


Figure 1 – Sample Schedule Model Histogram

The PMOC shall fully identify, describe, and analyze the adequacy of the project sponsor's schedule contingencies. The PMOC shall recommend a schedule contingency to be added to the SABS. FTA guidance generally recommends a risk-adjusted schedule of 125 percent of the SABS remaining duration of the critical path (i.e., a top-down schedule contingency of at least

25 percent of the SABS remaining duration). This 125 percent value is based on historical data and applies at any time in the life of the project. Generally, the schedule contingency recommended by the PMOC is the larger of 125 percent of the SABS or the 65th percentile, as determined from the bottom-up histogram chart analysis (e.g., Primavera). However, the PMOC may make a different recommendation (e.g., 90th percentile), based on the soundness of the underlying assumptions and their professional judgment along with clear justifications to support the recommendation.

The PMOC must clearly state the reference Schedule Data Date starting point and explain any identified risks that are not fully captured in the Monte Carlo P65 Revenue Service Date (RSD).

The PMOC shall graphically present in the risk report a comparison of the schedule risk assessment results in a manner shown in Figure 2.

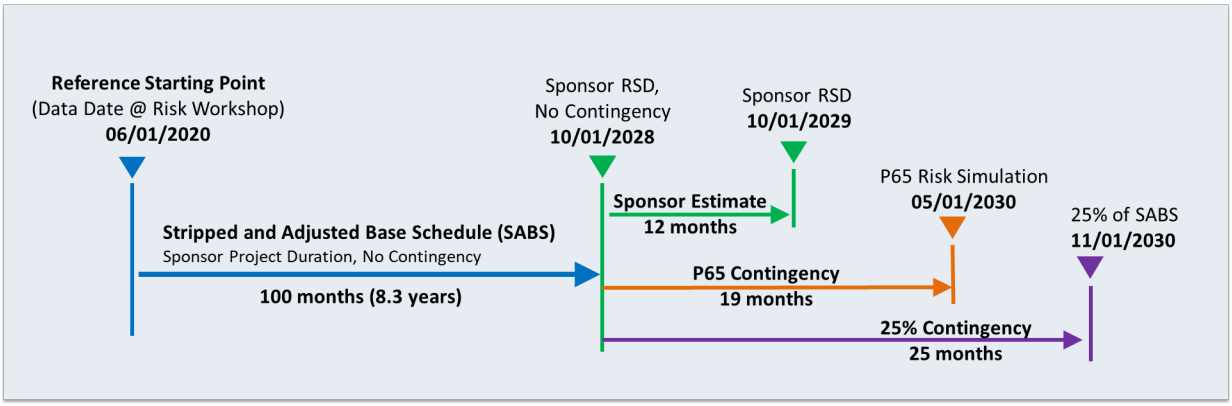


Figure 2 – Comparison of Schedule Risk Assessment Results

6.4.2 Cost Risk Assessment

The PMOC shall use their professional judgment and cost data to evaluate the impacts of cost risk on the overall project. The PMOC shall include the impact of general uncertainty and specific risks in the analysis. The report shall summarize the project sponsor's assessment of their cost risk and present an independent assessment of the cost risk. Precedent to the cost risk assessment process, the schedule risk assessment is completed as described in Section 6.4.1, above.

Cost risk is any risk that can cause changes to the project budget. This may include decreases as well as increases, although cost increases are most common. Note that cost risk may be derived from schedule risk. It is necessary, therefore, that the PMOC performs the schedule risk assessment before proceeding with the cost risk assessment to account for the cost impacts of schedule risks.

The PMOC shall identify and report key cost risks that are expected to have a high impact on the project's cost goals, including risks identified by the project sponsor or by the PMOC. Focus should be placed on those key risks that may affect the cost risk assessment.

The cost risk assessment is based on risk adjustments to the SABCE. The adjustments involve recognizing general project uncertainty, for which standard Beta Range Factors (BRFs) have

been developed through the study of historic FTA-funded projects. Then, the process recognizes project-specific conditions or risks that either increase or decrease that historic uncertainty. Cost risk assessment guidelines are provided in Appendix I and cost risk BRFs are discussed in Appendix J.

Differing PDMs for project construction may impact the timing and scope of project sponsor risk, but not necessarily the overall magnitude of risk shared among all parties, nor the sequence of risk mitigation. The cost risk effect of contracting under varying PDMs must be evaluated on each project. Guidelines for PDM consideration are available in Appendix K.

Quantification of cost risk is achieved using the Excel-based FTA Cost Risk Model Workbook (Risk Workbook) (link downloads file). The Risk Workbook provides a consistent method for developing and documenting these calculations; the PMOC shall use this Workbook unless otherwise directed by FTA. The Cost Risk Workbook modeling process, which is shown in Figure 3, consists of five steps to complete the cost risk assessment in the Risk Workbook.

- **Step 1:** Document understanding of the overall project conditions.
- **Step 2:** Document the project sponsor cost baseline from the FTA SCC Workbooks, in terms of Base Year (BY) and Year of Expenditure (YOE) values.
- **Step 3:** Adjust project sponsor baseline cost estimate; establish SABCE.
- **Step 4:** Account for uncertainty and project-specific risk.
- **Step 5:** Review, amend, and report cost risk model results.

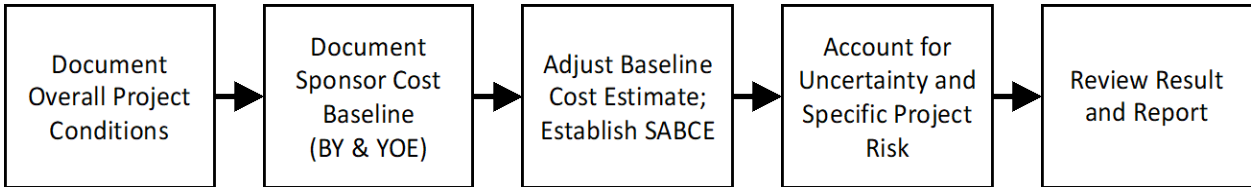


Figure 3 - Cost Risk Workbook Modeling Process

These five steps and the cost risk assessment guidelines are further discussed in the Risk Workbook and Appendix L.

In addition to direct cost adjustments, additional BY adjustments may be required due to the findings of the schedule review from OP 34, as well as recommendations resulting from the PMOC schedule risk analysis. These adjustments generally involve an extension of time-related costs, such as construction overhead (usually found in SCCs 10-50), or project management costs (usually found in SCC 80). FTA may direct the PMOC to perform additional analyses to provide further insight into the project-level risk assessment.

The Risk Workbook provides results for reporting the confidence levels of (percentiles) P40, P50, P65, and P80. The PMOC shall include a cost-risk probability graph that illustrates the modeled confidence. Figure 4 is an example of a cost-risk probability graph with a cumulative distribution function for the range of project costs (solid black curve), an incremental probability distribution function (solid gray curve), the FTA target of P65 (blue dashed lines), and the project sponsor estimate (red dotted lines).

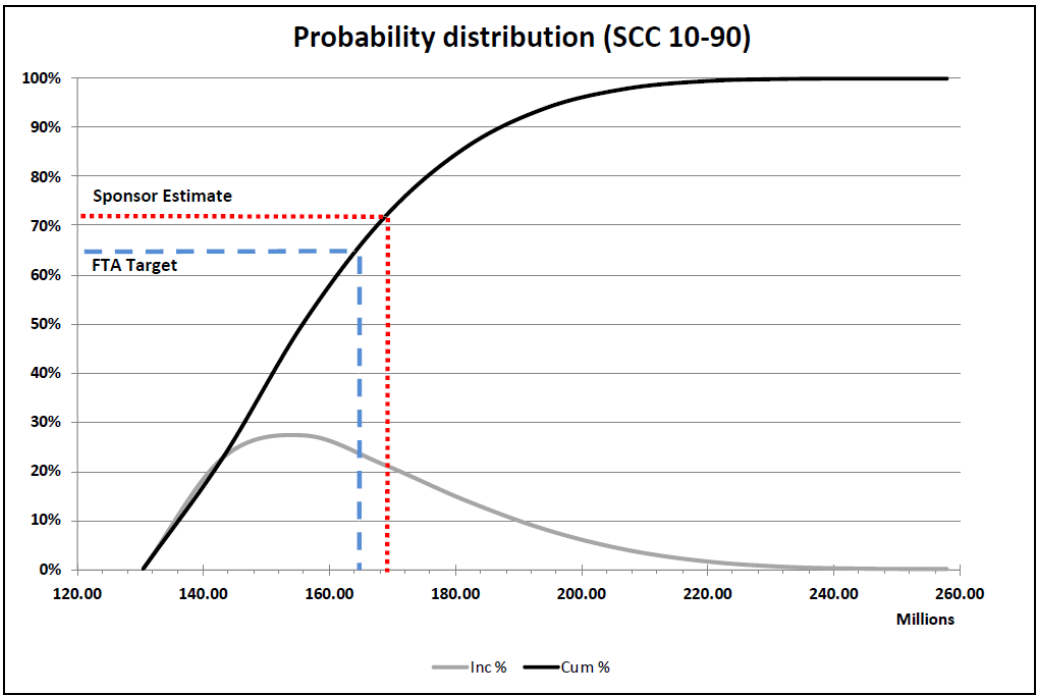


Figure 4 - Sample Cost Risk Probability Graph

The PMOC shall fully identify, describe, and analyze the adequacy of the project sponsor's cost contingencies. The PMOC shall make recommendations as to minimum amounts of cost contingency for inclusion in the project sponsor's PMP, RCMP, and supporting documents.

Since July 2018, FTA has adopted the P65 confidence level (i.e., 65th percentile) as the confidence level to determine cost contingency to allocate to its funded projects.[1] Project sponsors are required to provide cash funding at the 65th percentile (P65) level per FTA's cost risk model for their projects. The PMOC shall recommend cost adjustments to conform to the PMOC SABCE, and a cost contingency that is equal to the difference between the SABCE and the PMOC-modeled P65 cost. Discussions of secondary mitigation are to be noted as additive protection measures that project sponsors can choose to implement while meeting the P65 contingency cash levels.

6.5 Risk Response Review

6.5.1 Risk Mitigation and Contingency Review

The PMOC shall review, comment, and recommend changes to the project sponsor's risk mitigation procedures or plans. Areas of review and comment shall include the development and management of:

- Primary mitigation,

[1] See the FTA Fact Sheet: Updated Risk Assessment Process for Capital Investment Grants Projects

- Secondary mitigation, and
- Contingencies.

The PMOC shall indicate whether the four mitigation types—Risk Avoidance, Risk Transfer, Risk Reduction, or Risk Acceptance—have been sufficiently considered in the project sponsor's list of proposed mitigation measures. Appendix M contains a glossary of mitigation terms.

Note that Secondary Mitigation identification is considered a prudent, but not required, project sponsor effort. The PMOC shall note whether any such Secondary Mitigation has been identified, and if so, characterize the Secondary Mitigation. No specific targets for cost reduction amounts are required by FTA.

6.5.2 Contingency Drawdown Review

It is well recognized that a project's ability to react to change through non-contingency mitigation efforts decreases as the project advances into its later phases. Therefore, it is important to preserve adequate cost and schedule contingency to manage all remaining risks at any point in time through the life of the project.

To assist in the management of contingency, preserved contingency (or "contingency drawdown") curves that define minimum levels of cost or schedule contingency to be preserved as a function of project advancement are prepared by the project sponsor and included in the project RCMP.

The PMOC shall review and comment on the project sponsor's development of the contingency drawdown curves. Guidelines for establishment of schedule and cost contingency drawdown curves are available in Appendix N.

6.6 Risk Management Review

The above sections of this OP provide for review of the project sponsor's actions to identify and quantify the risks that they face, to identify mitigation measures for these risks, and to set aside contingency for when the defined mitigations cannot eliminate all risk impacts. However, it is not enough to perform initial risk identification, assessment, and response; it is also critical for the project sponsor to actively and purposefully manage risks throughout the life of the project.

The project sponsor's processes for risk management are defined in the project sponsor's RCMP, which is a subplan of their PMP. The PMOC shall review and comment on the project sponsor's plans, as defined in the RCMP, to:

- Periodically re-evaluate the project sponsor's risk register by discovering or redefining the risks, mitigations, responsible parties, time frame for implementation, etc., as appropriate;
- Provide project staff to participate in ongoing risk management, including those not directly responsible for risk register management or risk assessments; and
- To clearly define and provide updates to the project RCMP, which includes the risk management processes, responsibilities for risk management, and risk reporting.

See Appendix O for suggested RCMP content.

7.0 REPORTS, PAPERS, PRESENTATIONS

The PMOC shall provide the COR/ACOR with a written report, formatted in compliance with OP 01, of their findings, analyses, recommendations, professional opinions, and description of the review activities undertaken, as well as other supporting information.

After the COR/ACOR has transmitted formal acceptance of the report, the PMOC should share the report with the project sponsor. If there are differences of opinion between the PMOC and the project sponsor regarding the PMOC's findings, the COR/ACOR may direct the PMOC to reconcile their findings with the project sponsor and provide the COR/ACOR with a report addendum covering the modifications agreed upon by the project sponsor and PMOC.

When directed by the COR/ACOR, the PMOC shall perform data analysis and develop data models that meet FTA requirements using Microsoft Office products, such as Excel and Word, and use FTA templates when provided.

Upon approval by the COR/ACOR, the PMOC may add other software as required, but they should provide the COR/ACOR with documentation and report data when complete.

The PMOC shall prepare a written report in the format discussed in Appendix P; attach the most current project sponsor SCC estimate, schedule, and other related documents; and include the OP 40 Cost Risk Workbook model used for the PMOC cost risk analysis. The PMOC may also include embedded references to, or exhibits from, the project sponsor's cost estimate and schedule or other documents that clarify the analysis, findings, and recommendations.

The PMOC's report will integrate and summarize available information and data for the project, providing professional opinion, analysis, information, data, and descriptive text in an accessible and understandable format. Figure 5 shows the format to include in the report's Executive Summary, which presents the model results and recommended contingencies.

Figure 5 – Example Format for the Report's Executive Summary

<table>
<tr><th>Executive Summary</th><th colspan="2">Cost Risk Results</th><th>OP 40 Contingency</th></tr>
<tr><td rowspan="9">City Light Rail Project
Risk Workshop Date: 06/01/2020
Project Phase: Engineering
Project Type: LRT
Project Delivery Method: Design Build</td><td>Project Sponsor Cost Estimate</td><td>$402.6 M</td><td rowspan="8">Recommended</td></tr>
<tr><td>P-value of Project Sponsor Cost</td><td>62%</td></tr>
<tr><td>P65 Cost</td><td>$415.5 M</td></tr>
<tr><td colspan="2">Schedule Risk Results</td></tr>
<tr><td>Project Sponsor RSD Date</td><td>10/01/2029</td></tr>
<tr><td>P-value of Project Sponsor Date</td><td>56%</td></tr>
<tr><td>P65 Date</td><td>05-01-2030</td></tr>
<tr><td>125% of the remaining duration of the critical path</td><td>11/01/2023</td><td>Recommended</td></tr>
</table>

A short time after the risk workshop conclusion, FTA will share the risk model results with the project sponsor and provide a copy of the draft risk report to the project sponsor for review of the facts presented in the PMOC's report for accuracy, not the PMOC's assessment of the project. The PMOC shall distribute to the following individuals one copy of the final PMOC risk report:

- FTA Contracting Officer's Representative (COR)
- FTA Alternate Contracting Officer's Representative (ACOR)
- FTA Headquarters/TPM Office of Capital Projects staff assigned to project
- FTA Headquarters/TPM Office of Capital Projects – Project Controls Engineer.

Finally, the PMOC shall submit a copy of the Cost Risk Workbook model to FTA Headquarters/TPM Office of Capital Projects – Project Controls Engineer.

APPENDIX TABLE OF CONTENTS

APPENDIX A: ACCEPTABLE QUALITY LEVEL

PLACEHOLDER

APPENDIX B: PROJECT SPONSOR SUBMITTAL

Appendix B presents the typical types of documents and the related content expected from the project sponsor.

Before performing the risk review, the Project Management Oversight Contractor (PMOC) obtains and studies the following project sponsor documents, as appropriate for the project phase and level of review required. The list of project sponsor documents identified in section 5.0 Review of Project Sponsor's Submittals and Project Status is a subset of the documents listed in this Appendix. Many of these documents are necessary to accomplish the Project Management Plan (PMP), scope, schedule, and cost reviews. After an initial review of the documents, the PMOC must notify the Federal Transit Administration (FTA) of important discrepancies in the project information that would hinder the risk review; an example would be insufficient detail or a mismatch between drawings and the cost estimate in which the drawings are current and the cost estimate is significantly older.

It is advised that the PMOC coordinate these submittals with those required for OP 51 - Readiness to Enter Engineering or OP 52 - Readiness to Execute Full Funding Grant Agreement (FFGA)/Small Starts Grant Agreement (SSGA).

PMP and Subplans

- Project Management Plan
- Basis for the project
- Environmental Assessment/Mitigation Plan
- Design control, including, but not limited, to Value Engineering, agreements with railroads, utilities, or other third parties
- Project controls (scope, cost, schedule, change management, disputes)
- Risk and Contingency Management Plan, risk register, Risk Assessment, project sponsor's (and if post contract award, contractor's) Risk Allocation Matrix
- Project Delivery Method (PDM), Contracting Plans, and Procurement
- Project Sponsor Management Capacity and Capability (MCC)
- Quality Assurance (QA)/Quality Control (QC) Plan
- Safety and Security Management Plan
- Real Estate Acquisition and Management Plan (RAMP)
- Fleet Management Plan

Scope/Project Definition

- Project plans, drawings, and specifications
- Basis of Design Reports, Design Criteria Reports
- Constructability Review
- Master Permitting Plan and Schedule

- Right-of-Way (ROW) and/or RAMP
- Geotechnical Baseline Report
- Passenger level boarding design documents
- Vehicle design documentation
- Transit capacity and operating plan
- Documentation of changes to scope that have occurred since the last FTA review

Schedule

- Project schedule, including all exposed contingency or float
- Basis of schedule
- Schedule narrative describing critical path, expected durations, and logic

Cost Estimate

- Capital Cost Estimate in Standard Cost Category (SCC) format, including all contingencies exposed
- Capital Cost Estimate in original format, including all contingencies exposed
- Basis of Estimate or Capital Cost Estimating Methodology memo
- Value Engineering initiatives and results
- Inflation and market studies
- Summary of Operations & Maintenance (O&M) cost assumptions/productivities
- Capital Cost Estimating methodology memo
- Capital Cost Estimate backup documentation
- Before and After Study documentation

Programmatic

- Alternatives Analysis Final Report
- Feasibility or Ridership/Revenue Studies
- Metropolitan Planning Organization (MPO) adoption of the Locally Preferred Alternative (LPA) into the Fiscally Constrained Long-Range Plan
- Verification that the Transportation Improvement Program (TIP) and Statewide Transportation Improvement Plan (STIP) documents include the project for Preliminary Engineering, Final Design, and Construction phases
- Final environmental documents and National Environmental Policy Act (NEPA) determination
- Financial Plan defining local funding commitments, status (planned, budgeted, committed) and steps to achieve committed status

FTA Documents

- Entry to Engineering Checklist (if applicable)
- FFGA/SSGA Checklist (if applicable)
- Record of Decision (ROD)
- Full Funding Grant Agreement (FFGA)/Small Starts Grant Agreement (SSGA) and Attachments, if available

APPENDIX C: PMOC COORDINATION WITH THE PROJECT SPONSOR

Appendix C presents the recommended topics for the Project Management Oversight Contractor (PMOC) to coordinate with the project sponsor during a risk assessment.

Close coordination with the project sponsor during the risk review facilitates the process and provides the project sponsor with the background necessary to become an integral part of the process and eventually incorporate the risk review recommendations into the Project Management Plan (PMP). A project sponsor interface begins with the PMOC assessing the level of project completion and familiarity of the project sponsor with the risk review process to determine whether adjustment to the following structure is appropriate.

Kickoff discussions (preferably on-site; alternatively, virtual):

- Introduce PMOC team and project sponsor team.
- Project sponsor presents the project to PMOC team.
  - Agency organization, including project team and plan for staffing
  - Description of work and reviews over the previous year
  - Overview of the project by discipline
  - Overview of design, schedule, cost estimate, project sponsor's Risk and Contingency Management Plan (RCMP) and risk register
- The PMOC presents the FTA risk review process to the project sponsor.
  - Discuss the overall intent and timing for the risk review, including the importance of the risk review concerning the FTA milestones for funding. Figures C-1 and C-2 may be helpful aids for this discussion.
  - Discuss the requirements of the project sponsor for the successful conclusion of the risk review process.
  - Provide the project sponsor with a proposed schedule for the risk review activities.
  - Provide the project sponsor with a list of documents required from the project sponsor for review.
  - Discuss required participation at risk workshop and assure adequate level of project sponsor participation.
- Tour of alignment, station, and support facility locations

FTA may request the PMOC complete an OP40 review at various points in the project lifecycle; at a minimum, prior to entering an Engineering phase and prior to grant award

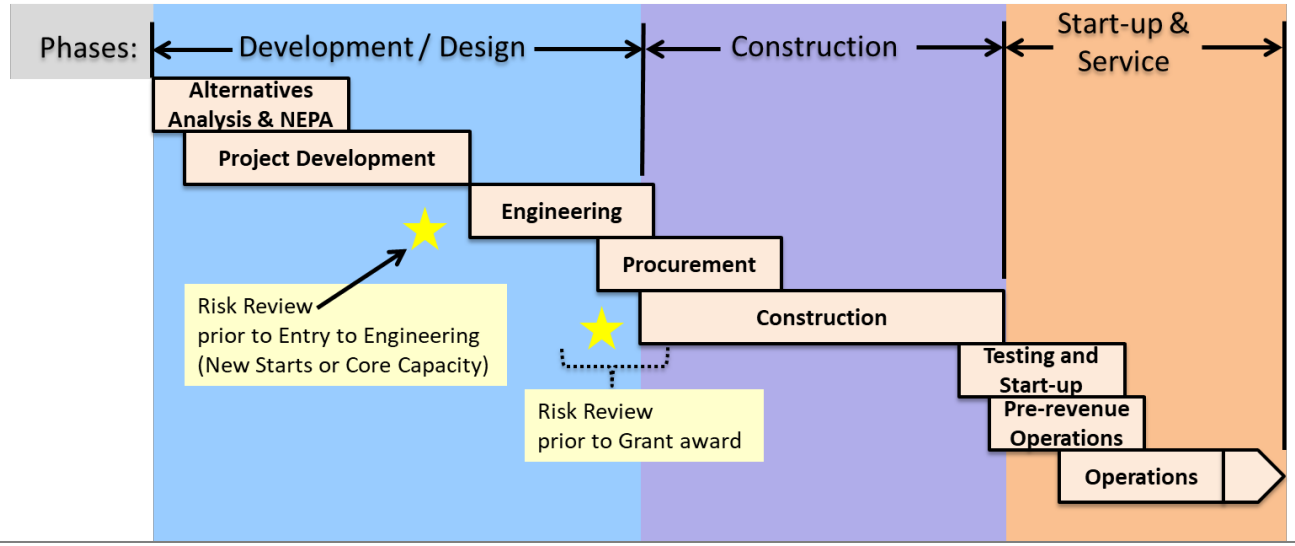


Figure C-1 FTA Risk Review in the Project Lifecycle

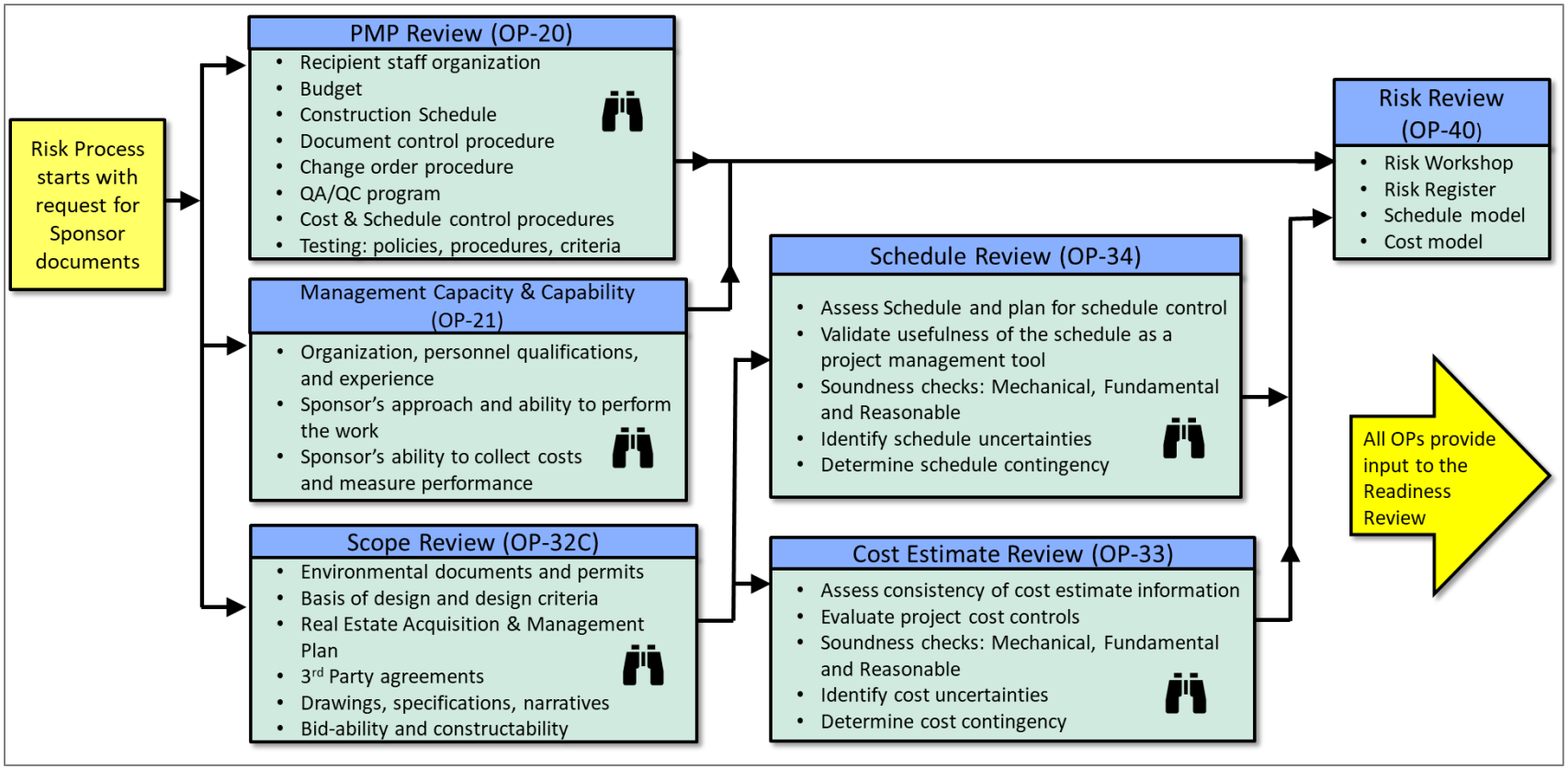


Figure C-2 FTA Risk Review Process

Risk Workshop (on-site or virtual) with FTA and Project Sponsor:

Project baseline and risk discussions may be broken into multiple sessions. The risk workshop occurs after the PMOC team has reviewed the project sponsor's core documents, written and exchanged issue papers for each discipline, and preliminarily developed management, scope, schedule, cost, and risk assessment products. Additionally, the PMOC must be prepared to discuss project risks contained within the project sponsor's risk register and to comment on project sponsor's RCMP. Refer to Appendix G for a sample risk workshop agenda template.

- Introduce FTA/PMOC team and project sponsor team.
- Project sponsor presents project details to the FTA/PMOC team; PMOC poses clarifying questions and provides comments:
  - Details of design, schedule, and cost estimate
  - Agency organization, including project team and plan for staffing
  - Details from project sponsor's RCMP and risk register. Discuss risks, categorized by Standard Cost Category (SCC) structure and/or summary schedule activity, through review of project sponsor's risks listed on their risk register, and discuss and record any additional risks discovered during the workshop or identified by the PMOC during their review of the project sponsor's core documents, including qualitative characterization of likelihood and magnitude of cost and/or schedule impact for the identified risks. Where possible, confirm or establish draft mitigation actions for the identified risks.
- Summarize findings, conclusions, recommendations, questions, and jointly discuss resolving open questions.
- Discuss actions required to facilitate the next stage of risk review.
- Inform the project sponsor of the next steps in the risk review process.

Risk Report discussions:

Upon FTA approval, the PMOC's Risk Report is shared and discussed with the project sponsor. These discussions include PMOC-developed recommendations regarding the adjustment of the project sponsor's target schedule, budget, contingency and risk mitigation, and action items required to advance the project in the FTA process.

- Introduce PMOC team and project sponsor team as appropriate to further key areas of discussion.
- Describe the process used to review and establish quantitative risk recommendations.
- Summarize the key findings of the review and recommendations.
- Provide recommendations regarding baseline adjustments, including possible changes to scope, budget, schedule, Project Delivery Method (PDM), construction methodology, risk mitigation options and/or alternatives, and/or the use of cost and schedule contingencies.
- Review details of individual risks, as appropriate, regarding the method of quantification of risk and which risks strongly influence overall project risk.
- Review specific recommended mitigation measures and solicit completion dates.
- Discuss action items and next steps in the risk management and FTA process.

APPENDIX D: PROJECT BASELINE ESTABLISHMENT GUIDELINES

Appendix D describes the project baseline establishment guidelines.

PROJECT BASELINE SCHEDULE AND ADJUSTMENTS

Stripped Base Schedule – Contingency durations that the Project Management Oversight Contractor (PMOC) should identify and remove may include unallocated (i.e., placeholder activity at the end of the project or sub-network) and allocated (increases to individual activity durations) schedule contingency. The PMOC will identify both patent (exposed) contingency durations and latent (hidden) contingency durations. The latent contingency is usually discovered during interviews with project sponsors. The PMOC should carefully review contingent durations that may be embedded as lag time sequestered within the activity logic ties or artificially applied constraints.

Once identified, these contingency durations shall be quantified and removed from the schedule to form a Stripped Base Schedule. The Stripped Base Schedule is the project sponsor's most optimistic schedule for the project.

Stripped and Adjusted Base Schedule (SABS) – Utilizing scope, cost, schedule, and other information developed in prior-performed reviews or joint PMOC and project sponsor workshops, the PMOC shall develop suggested revisions to the Stripped Base Schedule, increasing or decreasing the various activity durations, inserting activities, or revising logic. When applied to the Stripped Base Schedule, the suggested changes will develop a SABS. Any such adjustments and their rationale shall be fully documented.

Subsequent analyses of risk depend on accurate schedule adjustments. While the SABS is intended to be an independent PMOC assessment of the project schedule, the PMOC shall strive to obtain project sponsor consensus on any adjustments where possible before moving forward with the schedule risk evaluation.

PROJECT BASELINE COST ESTIMATE ADJUSTMENTS

The cost-risk assessment heavily depends upon a well-vetted and properly adjusted project cost estimate. OP 33 provides direction regarding methodologies to determine project sponsor estimate adequacy, to suggest recommended estimate adjustments, and to quantify project sponsor's exposed and hidden contingencies.

Base Year (BY) Stripped Cost Estimate – Based on a review of the cost estimate as outlined in accordance with OP 33, the PMOC shall ensure that all project sponsor-included contingency funds embedded within the cost estimate are removed from the cost-risk analysis. Contingency removal is necessary to avoid duplication of contingencies since the Risk Workbook will calculate suggested contingency levels based on the PMOC-adjusted estimate free of project sponsor contingency. Contingency funds may include both unallocated funds (usually applied as a percentage of summary costs) and allocated funds (usually applied as potential increases to individual estimate line items or as allowances for "just in case of…." items). Both patent (exposed) contingency funds and latent (hidden) contingency funds shall be identified. The identification of latent contingency funds will likely involve interviews with the project sponsor

and the OP 33 cost reviewer. Further, PMOCs should similarly remove any contingent funds embedded within estimates for inflation or escalation risk.

The intention of this removal of contingency is not to develop an adjusted baseline that represents a highly unlikely base estimate, but to develop a reasonably achievable market-level baseline estimate for expected project scope that experienced, prudent industry cost estimators would normally include at the level of design development within their professional opinion. The foregoing is the basis upon which the Federal Transit Administration (FTA) cost risk model was developed. Be mindful when reviewing contingency or "design allowances" in the project sponsor estimate for known but not-yet-quantified items. These allowances are often intended to represent a combination of knowns (which should remain) and unknowns (which should be stripped out).

The primary basis for this contingency removal is the project sponsor's Standard Cost Category (SCC) workbook, which exposes both allocated and unallocated contingencies in BY values. Latent contingencies (if any), however, must be additionally removed.

Once these contingency funds have been quantified, they shall be removed from the project sponsor cost estimate to form a BY stripped cost estimate. The Risk Workbook provides a method for stripping the exposed contingencies and for additionally removing hidden contingencies identified by the PMOC.

BY Stripped and Adjusted Cost Estimate – The BY stripped and adjusted cost estimate is created by the PMOC and includes any PMOC line-item cost revisions at the prime SCC level, as noted in the OP 33 cost review. Information to create the BY stripped and adjusted cost estimate can be found from the Project Management Plan (PMP), scope, schedule, and cost reviews, and workshops with the project sponsor, usually documented in prior PMOC OP reviews. The estimated adjustments are to be made at the prime level of the standard SCC Cost Elements (e.g., 10.01, 10.02, etc.). These adjustments are entered the Risk Workbook.

In addition to direct cost adjustments, additional BY adjustments may be required due to the findings of the schedule review from OP 34, as well as recommendations resulting from the PMOC schedule risk analysis. These adjustments generally involve an extension of time-related costs, such as construction overhead (usually found in SCCs 10-50), or project management costs (usually found in SCC 80).

The PMOC determines whether line-item revisions should also become elements of the risk register if potential costs for a particular line item are not fully reflected in the BY cost adjustment. The BY stripped adjusted cost estimate shall be inflated to the Year of Expenditure (YOE), as indicated below.

YOE Stripped and Adjusted Base Cost Estimate (SABCE) – The BY stripped and adjusted cost estimate shall be inflated to the YOE. The first step of this process is to evaluate the results of the schedule risk analysis and the sufficiency of the project sponsor's inflation rates contained within the project sponsor's SCC Workbooks, and then make appropriate adjustments to the project sponsor YOE inflation calculations if required. These adjustments may be the result of the PMOC review of the project sponsor-proposed inflation rates, or the result of PMOC schedule recommendations through the PMOC schedule review or schedule risk analysis. The process involves spreading project costs in the SCC Workbook inflation matrix across an

adjusted duration and/or adjusting the inflation rate in the same matrix. These calculations are made within the Risk Workbook.

The SABCE, which has been appropriately stripped of contingencies and adjusted to YOE, establishes the basis upon which the risk modeling will recommend project contingency amounts. The PMOC should obtain adjustments consensus from FTA and PMOC subject matter experts before moving forward with the risk assessment.

While provisions for most of the above steps in the top-down risk modeling process are contained within the worksheets of the Risk Workbook, some separate calculations may be necessary to develop values to enter in the Risk Workbook. Where possible, add notes and descriptions to the Risk Workbook to document these supplemental calculations.

APPENDIX E: SAMPLE RISK REGISTER

Appendix E shows the format of a sample risk register and defines the Federal Transit Administration (FTA) risk categories.

The following is provided as an example of a risk register used for risk identification; the intention is to convey the basic content for a robust risk register. Other more detailed formats have been found useful in practice, depending on professional experience and project-specific requirements.

Following the risk register example is the definition of FTA risk categories; other similar categories may be defined in project sponsor's risk registers. The FTA risk categories are based upon the progression of project efforts and have proven useful to ensure that risks from one project phase do not linger and disrupt efforts or create high impact risk in subsequent phases. These or similar categories are used to inform FTA cost risk modeling.

The risk register developer is encouraged to obtain the most recent examples before determining the risk register format. An example of a risk register is shown in Figure E-1.

RISK REGISTER

Grantee:
Project:
Date:

1-Requirements
2-Design
3-Market
4-Construction

Rating	Low (1)	Med (2)	High (3)	Very High (4)	Significant (5)
Probability	<10%	10><50%	>50%	75%><90%	>90%
Cost	<$250K	$250K><$1M	$1M><$3M	$3M><$10M	>$10M
Schedule	<1 Mths	1><3 Mths	3><6 Mths	6><12 Mths	>12 Mths
Rankinig	<=3	3.1-9.49		>=9.5	

						Risk Ranking				
						Probability	Cost	Schedule	Risk Rating	
SCC	ID	Risk Cat.	Risk Description	Outcome		[P]	[C]	[S]	(P) X (C+S)/2	Mitigation Action
10.01	3	1-Requirements	Third parties may influence the alignment in an untimely manner.	Delay and cost.		2	1	0	1	Obtain municipal consent buy-in at 30% design.
10.01	5	1-Requirements	Delays may occur in reconfiguring Railroad connection project.	If Railroad connection is not completed in time, entire Agency project could be subject to indefinite delay.		3	2	5	10.5	Agency undertake design
10.01	6	1-Requirements	The drawings indicate that there are freight tracks close to the LRT guideway. Is clearance an issue at any of these locations? Is there the possibilty of crash walls or something similar required?	Could cause additional costs and studies involved with providing greater physical separation between light rail and freight rail lines.		3	4	0	6	Evaluate whether the current estimate reflects this scope for crash walls. May be an estimate reduction
20.01	43	1-Requirements	As all stations have center island platforms at grade, if a decision, for safety or operations reasons, is made to avoid pedestrian grade crossings, all stations will need tunnels or bridges along with multiple vertical circulation elements to replace them.	Much greater cost per station.		1	5	0	2.5	History indicates a very low probability
20.01	153	2-Design	Potential elevated pedestrian connection between park-and-ride and LRT station (814)			3	3	0	4.5	
30.02	55	1-Requirements	Failure to identify economical, environmental-suitable, and practical location for maintenance facility could cause excessive project costs.	Much higher costs, both for real estate acquisition and construction cost and for O&M costs when the project goes into operation.		1	3	0	1.5	Is currently under choice selection, among final 4 sites. Re-evaluate costs when a site is chosen.
40.01	61	1-Requirements	Balance of earthwork is unknown at this time, although it would appear that there may be more fill than cut. Lack of economical embankment material could be a problem.	Higher cost if material is hard to find.		4	4	3	14	Evauate as an estimate adjustment. Figure out more during design.
40.02	62	1-Requirements	Since a number of the "tunnels" are only shallow cut & cover grade separations under existing streets (where the utilities are usually buried), there are likely to be utility issues to be dealt with.	Costly relocations of utilities. Short construction season may require expedited advance utiliy relocation packages to avoid delaying project.		2	3	0	3	Perform utility location studies during early PE
60.01	139	1-Requirements	Potential impact to loading dock access of existing commercial building (124)			5	4	0	10	Evaluate for estimate adjustment

Figure E-1 Example Risk Register

RISK CATEGORIES

For FTA cost risk modeling, evaluation of the existence of phased-based risk informs the magnitude of project risk. These phase-based risk categories are shown below:

- **Requirements Risk** relates to uncertainties of the efforts of the project team to identify and meet the political, social, regulatory, and physical environmental needs and challenges while developing a design that meets the project's goals. Generally, Requirements Risk is associated with the earliest project concept through the definition of the project's locally preferred alternative (LPA) through the completion of the environmental assessment (NEPA) process; it is not uncommon that Requirements Risks may not be fully resolved even beyond this point. A significant portion of Requirements Risk can be attributed to requirements of the environmental mitigations and differences in project stakeholder goals, third parties (such as regulatory and partner agencies), utilities, real estate, permitting, steps to secure local funding commitments, and other undefined requirements.
- **Design Risk** is associated with the performance and variability of design activities. Design Risk occurs when design-related assumptions change, become unfeasible, or in situations where unknown factors cause designs to change.
- **Market Risk** refers to the risk of procuring project management, administrative, Right-of-Way (ROW), design, or construction services, materials, and equipment in the timeframes or at the costs established in the project baseline goals. This risk refers to both the effects of the open-market supply and demand pricing of goods and services and inflation, as well as the effects of the project sponsor's delivery methods and contract packaging strategies or contractors' perceptions and pricing of risk.
- **Construction Risk** includes both risks that are due to variability of the project's environment—including unusual weather, unexpected subsurface conditions, operational work arounds, and unexpected construction contractor failure.

APPENDIX F: MEGAPROJECT RISK GUIDELINES

Appendix F presents guidelines for identifying risk in a megaproject environment.

DEFINING MEGAPROJECTS

Megaprojects are characterized as having very large budgets (greater than $1 billion) and multiple phases with distinct design phases and construction phases. These phases are often separated by time, such that one phase may have progressed into preliminary design while a subsequent phase is only conceptual. Similarly, separate construction contracts may be issued non-concurrently. When phases are developed largely in the future, it may be difficult to accurately forecast base requirements and scope, cost, and schedule.

For megaprojects, cost and schedule risk assessment is facilitated by breaking the project into distinct risk profiles (see Appendix I, section I.3). Each risk profile may represent a separate phase of the project and reflect varying risk.

RISK IMPACTING MEGAPROJECTS

Risks that merit additional consideration for megaprojects generally fall into the following categories:

- Risks that may not happen at all, and are considered so unlikely as to not be relevant to the analysis and/or are specifically excluded from non-megaproject risk analysis; and
- Risks that are more likely to happen and have a potentially greater impact and sensitivity to the analysis on a megaproject.

It is a challenge to capture all emerging risk since the exposure may fall into the "known unknowns" and even "unknown unknowns." However, it is possible to be very specific about what has been assumed in a baseline and the degree of uncertainty assumed in the risk assessment against the various exposures such as those in the examples below. Taking into consideration the examples below can assist in the characterization of the specific project under review and aid decision making.

SCOPE/REQUIREMENTS RISKS:

Example areas of exposure itemized below are also applicable in design, market, construction, and start-up.

Stakeholder influences: Scope definition on megaprojects typically evolves as multiple stakeholders get involved. Over the extended passage of time associated with megaprojects, leadership changes may occur in stakeholders at all levels and when these changes occur at the highest and most influential levels, these events may introduce change, delays, and cost over-runs.

Political Cycles: Political climate, political party policy and changes in the governing/majority political party at the local and State level may introduce delays or policy changes affecting basic project objectives enough to result in meaningful cost and schedule impacts. Political changes

can introduce taxation impacts, subsidies, and Buy-America conformances, all acting to influence the funding assumptions and availability of funds on megaprojects. These funding constraints can then influence contract packaging, award dates, assumed and planned for contractual interface dates, change the project scope, and impact the availability of funding, potentially resulting in delays and cost overruns.

Property: Property definition limits and acquisition of property itself (temporary or permanent) may take on a different form in a megaproject. Gaining access to a property for surveys and geotechnical investigations can meet with politically influenced and/or strong landowner opposition that may delay negotiations or initiate legal processes. Large-scale property acquisition programs may produce localized changes in real estate market conditions. Pressure to award contracts and commence construction without property clearance may result in delays and associated additional costs as the project advances.

Third-Party Agreements – Railroads: Interfaces with third-party railroads, particularly private freight railroad providers, warrant close review. Safety or regulatory responsibilities often require inspection or witness by rail agency staff. An awareness of competition with regional maintenance and expansion programs, or storm/disaster recovery emergency activities, that often have multiple competing objectives, priorities, and deliverables, is integral to assess potential adverse impacts and delays.

Third-Party Agreements – Other (Developers/Major Landowners, Municipal Facilities, Manufacturing Facilities, Government Public Facilities, etc.): Multiple stakeholders and associated third-party agreements to access, work over, under, or within facilities/property, and the longer-term associated future operations and maintenance agreements, are often not finalized in sufficient detail at the time project budgets and schedules are established. Final execution of complex or highly politically influenced agreements can take many months or years. Megaprojects are frequently highly impacted by the agreement evolving scope and conclusion.

Third-Party Utilities: Scoping the extent of major utility relocations at the early stages of a project has been very challenging historically. Megaprojects typically interface with and are impacted by more and larger utilities, resulting in higher exposure than the more contained project. Cost sharing, time to relocate, ability to relocate, constraints on required third-party resources, and constraints in subsequent construction, in addition to influencing the core project designs, can significantly impact cost and schedules.

External influencing events: After a loss of life or major property loss 'event,' the resulting inquiry increases the potential for a change in national policy, codes, working methods, or safety procedures that can impact an infrastructure project. Rail incidents, terrorist attacks, storm inundations, unrelated sector disasters (e.g., Fukushima nuclear inundation), fires (e.g., London King's Cross station), at-grade crossing incidents, etc. are more likely to occur during a megaproject due to the longer project lifecycle. The likelihood of a significant event occurring and influencing a project increases with longer project durations, thereby consequentially impacting scope, cost, and schedule. Safety and security monitoring and protection are necessary costs that may change scope given continual influencing factors. Increasing incidence of cyberattacks, particularly influencing the safety and integrity of emerging digitally controlled systems, and monitoring and management controls, is likely to increase scope and cost on megaprojects, as technology advances and cultural changes in people movement and communications evolve after project inception and continue through project delivery.

DESIGN RISKS:

Information Technology Influence: Everything from passenger information displays and interactive 'walls' to paperless fare-collection systems and facial-recognition entry systems to holographic signage and the entire integration with advertising and promotional displays is evolving quickly for all sizes of projects. Technology acceleration is influencing change in everything from vehicle and car design to the way that stations and infrastructure operates and communicates with each other. These changes influence the back of house space, heating and cooling, and whole zoning in air conditioning requirements, power feeds, and associated distributions, lighting and architectural interfaces, and the structural space and clear spans in which it all resides. It is challenging to accurately predict technology requirements over a five- to ten-year construction span, which may lead to deferred scoping, consequential changes in the construction, and late construction project phases. The result may be a formidable gap between a traditional risk drawdown profile and reality.

Environmental Clearance: New types of risk are regularly evaluated within environmental regulatory agencies. Requirements for wetland replacement and hazardous material (HAZMAT) clearance and containment may be magnified in a megaproject, resulting in multiple opportunities for delays, public objections to proposals, and changing standards and measures over time. Megaprojects are more likely to require Environmental Impact Statements (EIS) to be completed, which involve additional studies and longer time frames compared to Environmental Assessments or Categorical Exclusions, which are often sufficient for smaller projects.

Technology Advances: Technology advances in construction means and methods are continuously pushing the limits of constructability and testing new boundaries which may expose innovators to unforeseen risks. Examples include the increasing diameter of single bore tunnels, the acceleration and speed of high-speed trains, influencing the formation and structural stability and pressure differentials in tunnels, and the increasing move to and reliance on automated train technologies. These and other similar advances in technology and construction appear to be accelerating at a pace that is overtaking the life of a megaproject delivery. The advantages of a single large bore tunnel over traditional twin bore tunneling in reducing construction duration and limiting utility relocations and reducing surface property impacts has been tested on recent large projects. However, the increased scaling of tunnel diameters, whereas technically feasible and proven, has shown to give rise to other risk exposures. Advances in both tunnel machine technology and increasing tunnel diameters will continue and megaprojects are likely to be the testbeds. Technology advances result in changing system and operational needs during design and construction phases, which may require modifications to accommodate the new technologies or give rise to further delays and additional costs. In addition, municipal efforts and strategies to move to digital integrated transportation networks, having wide control and monitoring, are likely to impact projects caught in the transition.

Security: The terrorist attacks of recent years have changed the way we travel and what we travel with, where we wait, how we are directed through facilities, and how our movements are recorded and analyzed. The resultant protective measures grow after new incidents. Because of their long delivery period, megaprojects are highly impacted by these external influencing events by changing communication routes, fire and smoke control systems, facility structural isolations, the number and size of escape routes, and provisions of safe havens. Requirements changes can occur at any time in the megaproject lifecycle.

Quantity and Computational Errors: Scope omission, calculation errors and the like are frequent causes for cost overages in any project and can be magnified when occurring on complex megaprojects. Efforts to manage the large number of consultants commonly involved in megaprojects and the integration of potentially different systems and approaches to the standardization of estimating methods adopted may pay dividends toward the collection and summarization of quantity and computational totals.

Quantity Errors and Omissions in Material Take Offs: Material take offs are commonly extracted from design models. The quality and completeness of a design model is highly influential on the quality and accuracy of quantities generated and resulting cost estimates. All projects are exposed to the material take off deficiency (upwards and downwards) but megaprojects are at risk from multipliers adopted and used as a basis for much larger quantities, where any errors could magnify disproportionately.

MARKET RISKS:

The objective when addressing market risks is to establish a strategy for maximizing competition for contracts while also minimizing claims and fostering positive and effective relationships with contractors and consultants. An optimization of risk through the procurement approach objectives can be summarized as:

- Place risk with the party best able to manage the risk.
- Avoid transfer of excess profit opportunity to bidders through the poor transfer of risk.
- Structure contract packages and perform industry outreach to attract as great a bidding pool as possible for construction bids.
- Ensure balanced and comparable bids are returned, avoiding significant differences caused by ambiguous contract scope and/or unquantifiable risk transfer.
- Provide bidders the greatest opportunity to offer the most favorable price through constructability and means and methods.
- Ensure critical risk components impacting the Insurance strategy (Owner Controlled Insurance Program (OCIP) or Contractor Controlled Insurance Program (CCIP)) are well defined and ensure policy premium and deductibles are kept to appropriate limits.
- Provide incentives to contractors that create an environment for a best value result for the project sponsor and funding partners like the Federal Transit Administration (FTA).

Micro 'Heated Market' Climate: Megaprojects can create their own local microclimate, limiting the availability of resources and exhausting local material supply chains. Megaprojects can also promote transit-oriented developments, both planned and unplanned, which then compete in parallel with the host project. These competing developments are most often residential/office/retail mixed developments that may divert the local construction market, union halls, and supply chains away from the host megaproject.

Signature Architectural Designs: Megaprojects are frequently associated with signature architectural designs that are usually very complex. Signature architectural designs often contain purpose designed components that can be challenging to specify and procure, require special mockups or color matches, or that may increase the number of change orders during

construction. Unique architectural designs may require increased coordination between trades. Minimize the gaps between responsibilities for each trade by carefully coordinating the contractor bid specifications.

CONSTRUCTION RISKS:

Extreme Weather Events: Extreme weather events of wind, rain, storm surge, heat, snow, or ice appear to be occurring more frequently and more severely in their impact. Megaproject designs must take into consideration the possibility of extreme weather conditions that may introduce extended delays in everything from material deliveries to physical work completion and impacts to schedule and cost control.

Laydown Areas: Space for construction assembly, construction and management staff accommodation, parking, storage of materials, delivery and installation of oversized components, access for tunnel and stations constructions, and storage and treatment of excavated materials is a common major impacting constraint on megaprojects. Inadequate access and availability of space can significantly delay construction and increase costs and be an order of magnitude greater in impact than on smaller more-contained projects. Lack of early constructability efforts often awaiting a delivery partner (e.g., Design-Build (DB), Construction Manager (CM)/General Contractor (GC) or Public-Private Partnership (P3)) can result in incorrect budgets and schedules from the outset due to failures in early planning to identify such constraints.

Major Site Cleanup: Larger work zones on megaprojects increase the likelihood of incurring major cost and schedule exposure from frequently a HAZMAT clean-up and enabling works of demolition and preparatory advance works, which themselves can contain considerable uncertainty, risk exposure, and operational constraints. The 'battery' limits of risk exposure and extent or remediation should be carefully drafted as part of the assumptions in the risk report.

Change Orders and Claims: The incidence and magnitude of change orders and claims on megaprojects can be substantially greater than in contained projects. Changes arise through complex interfaces and repercussions in often unconnected parts of the project's component scope.

Contractor Failures: The incidence of contractor and key sub-contractor failures and/or terminations due to quality or management deficiencies is common on megaprojects. The project sponsor and stakeholders are unlikely to be protected from the full consequences of failures given limits of liability constrained by the insurance and surety market capacities for risk coverage, bonding capacities of contractors, and the objective to not unduly limit bidder participation. These factors all work together to result in higher-retained risk by the owner.

Schedule Interfaces: Megaprojects are characterized by complex multiple interface delays in parts of one contract impacting multiple areas of the project, resulting in changes in the criticality of previously unconnected scope. Professional services costs (typically captured in SCC 80) are highly impacted by schedule delays on megaprojects, and resolving multiple and complex disputes and mitigating delays often results in a disproportionate increase in management and controls resources.

Staffing Knowledge, Staff Complacency, and Loss of Momentum: Megaprojects, by definition, span over many years and involve many staff who, through normal attrition, may require reallocation or reconfiguration of project leadership and/or management services. This

turnover can result in a loss of momentum, create inefficiencies, and incur additional costs that may influence risk exposures to required timely documentation reviews and approvals.

TESTING AND START-UP:

Pressure to Open: Piece-meal politically driven public openings result in cost increases and schedule delays in the late construction/system testing and integration phases mainly due to the necessary workarounds and associated implementations to achieve phased public openings and the necessary segmented system testing and integrations.

Interfaces to Existing Systems: Interfacing and connecting existing large operational systems is very complex, especially where multiple operators are involved, given new technology and the ever-growing usage and reliance of software automation interlinking passenger information systems with fare collection, centralized emergency monitoring, and security systems, as well as building and systems management systems. In megaprojects, estimating this scope and boundaries at the early stages of project delivery, together with the infrastructure and backbone support required, is a common source of cost increases and delays magnified in a megaproject.

ALTERNATIVE DELIVERY IMPACTS ON MEGAPROJECTS

DB and its many variants are the most common forms of alternative delivery to traditional Design-Bid-Build (DBB) and can exacerbate many of the issues identified above. A poorly developed or incomplete set of Owner's Requirements, e.g., due to political pressure to start as soon as is possible, magnifies future incidence of change as scope evolves with a growing stakeholder influence.

The growth in cost and schedule delays associated with alternative delivery should be carefully weighed against the project's complexity. For example, on a very large but relatively straightforward project with little signature architectural content and having standard components, a DB approach may result in a successful outcome as far as alignment to original budget and schedule. Conversely, a very complex project with a scope highly likely to evolve as stakeholders become more involved and signature designs are presented, will tend to attract a significantly higher level of risk of cost escalation and schedule delay. Whereas perhaps such a delivery process may result in an earlier completion overall than a traditional approach, all things being equal, it will likely nevertheless see a more severe cost growth and schedule delay profile.

The CM/GC delivery method or the Engineering/Procurement/Construction Management (EPCM) delivery method both seek a similar objective to that of the DB of early contractor involvement and start to construction. Once again, in the megaproject, poor and rushed initial scope definition can lead to disproportionate cost increases and schedule delays as the project progresses through delivery.

In the P3 delivery approach, the same issues can occur under the megaproject scenario. Whereas the P3 Project Contractor/Joint Venture financing partner will seek to establish a clear risk allocation, this will not avoid change driven by the external impacts discussed above, and a similar approach should be made in addressing the different risk profile a megaproject is likely to encounter.

There are recent examples on megaprojects where the delivery method has been changed after contract award due to complexities in coordination, changing design responsibility (e.g., owner to contractor), changing contract package scope due to scope change and contractual failures (design, management, and construction) which has, in turn, caused serious delays and cost overruns.

DEFINING LIMITS OF A RISK EXPOSURE FOR A MEGAPROJECT

The Project Management Oversight Contractor (PMOC) should consider the risk profile of a megaproject and make note of the assumptions and any exclusions assumed so that the degree of risk is clearly understood as part of the risk analysis and report.

The drafting of a comprehensive baseline scope, cost, and schedule assessment is even more important in a megaproject as the risk assessment should be aligned closely to the baselines established to correctly characterize the exposure and establish the limits or borderlines upon which the analysis is based.

To provide a consistent characterization of risk in megaprojects, Table F-1 provides a list of risk exposures to include in the risk report and notes those risks qualified or specifically excluded. For all risk events, temporary delays should not be excluded. Legal challenges to environmental documents are a significant risk on many projects and should be considered.

Table F-1 Megaproject Risk Qualifications and Exclusions

Risk Event	Qualification	Excluded from Analysis
Project is canceled		Impacts due to project cancellation or stoppage with no clear path forward.
Environmental clearance rejected/project stopped pending hearing	Delays in Record of Decision (ROD) included	Excluded if after ROD. Delays pending National Environmental Policy Act (NEPA) hearings should not be excluded.
Inability to acquire Right-of-Way (ROW) at all/Right to build denied/Title to land refused		Excluded if no design alternative available/impacts excluded
Access to project site denied/delayed (by owner/operator)		Denied access impacts are excluded; however, delayed access should not be excluded.
Political changes – Presidential elections/Governing majority Party changes	Included to the extent project is not delayed	Excluded if project stopped or cancelled
Stock market crashes	See inflation	Risk of project stoppage or cancellation is excluded.

Risk Event	Qualification	Excluded from Analysis
Trade wars/tariffs	See inflation	
Inflation/currency devaluation (USA))	See inflation	
Inflation/currency devaluation (Global)	See inflation	
Inflation/deflation (materials/labor/components)	Capped at 8% in any one year	
Wars/terrorists attacks		Risk of project stoppage or cancellation is excluded.

It is essential on megaprojects to reset the baseline, with agreement from all key stakeholders, and update the risk assessment following any major event where the project is significantly delayed. Lack of a public audit trail as to why and when a project was delayed, or budgeted costs were exceeded, are frequent causes of criticism of reported risk exposure limits.

When benchmarking a megaproject against historic data, a careful analysis of the common issues should be made on a case-by-case basis referencing the 'risk headings' typically influential in defining a megaproject in Table F-1.

APPENDIX G: RISK WORKSHOP AGENDA TEMPLATE

Appendix G provides guidance on how to conduct a Federal Transit Administration (FTA) risk workshop.

WORKSHOP BASIS

The Project Management Oversight Contractor's (PMOC's) review of project risk and risk mitigation plans requires an evaluation of project scope, project sponsor's cost estimate, and project sponsor's schedule with special focus on elements of uncertainty associated with the project sponsor's project implementation plan and project conditions. Additionally, for major capital projects with a requirement to have a Project Management Plan (PMP), the evaluation would encompass those sections that describe the management of risks and contingencies.

During a Risk and Contingency Review, the PMOC must review the project sponsor's Risk and Contingency Management Plan (RCMP) so that the PMOC can:

- Evaluate, explore, and analyze uncertainties and risks as they pertain to the core assumptions included within the current project scope, cost estimate, and schedule;
- Establish an appropriate qualitative and quantitative risk-informed assessment of ranges of forecasted cost and schedules;
- Consider risk mitigation options and alternatives including the use of cost and schedule contingencies;
- Describe and evaluate the management and analytical methods used; and
- Prepare a report with independent recommendations for adjustment to scope, cost, schedule, PMP, and risk and contingency management.

A risk workshop prepares for risk modeling, using the FTA top-down cost-risk model and bottom-up schedule-risk modeling techniques, by confirming assumptions and assessing or confirming the inputs necessary for conducting the analysis. These techniques depend upon an up-to-date understanding of the project's status regarding expectations for:

- Scope, cost, schedule, Project Delivery Method (PDM), construction methodology, organization and staffing plans, and project management;
- Risks and uncertainties that threaten the expectations of the project; and
- Potential opportunities to improve cost and schedule projections.

It is an expectation that the risk workshop will be preceded by scope, schedule, and cost assessments, to include establishing the Stripped and Adjusted Base Schedule (SABS) and the Stripped and Adjusted Base Cost Estimate (SABCE), in accordance with FTA Oversight Procedures (OPs) and other project-related reviews as requested by FTA.

WORKSHOP TOPICS

The topics and agenda for the risk workshop should be developed to inform the PMOC and FTA of the current status of these core elements, to best reflect a consistent, correlated, and accurate picture of the project before engaging in risk modeling and producing reports to the FTA.

A site visit prior to the workshop should be arranged for FTA and PMOC representatives not familiar with the project site or alignment to acquaint them with the social, physical, and environmental challenges facing the project.

The workshop agenda typically follows this or a similar sequence; all topics should reflect the individual project specifics:

1. Introductions and workshop overview
2. Project scope
   a) Design, procurement, and execution:
      i) Civil construction and systems (SCC 10-50)
      ii) Right-of-Way (ROW) (SCC 60)
      iii) Vehicles (SCC 70)
      iv) Any ancillary material or equipment purchases
   b) Third-party interfaces, permits, ROW acquisitions, and agreements that are necessary
   c) Construction closeout and operations start-up plans
3. Schedule
   a) Basis of schedule (core assumptions)
   b) Third-party interfaces and agreements
   c) Design, procurement, and execution:
      i) Civil construction and systems (SCC 10-50)
      ii) ROW and relocation plans
      iii) Vehicles
      iv) Any ancillary material or equipment purchases
   d) Critical path definition (if developed)
   e) Construction closeout and operations start-up plans
   f) Schedule contingencies
4. Cost estimate
   a) Basis for cost estimate (core assumptions)
   b) Third-party interfaces and agreements
   c) Design, procurement, and execution:
      i) Civil construction and systems (SCC 10-50)
      ii) ROW and relocation plans
      iii) Vehicles
      iv) Any ancillary material or equipment purchases
   d) Construction closeout and operations start-up plans
   e) Cost contingencies
5. Professional services (SCC 80)
   a) PMP
   b) Time-based organizational staffing plan:
      i) Design-phase staff and consultants
      ii) Construction-phase staff and consultants

   iii) Closeout and operations start-up phase staff and consultants
   iv) Other staffing and consultants
c) Professional services cost estimate (SCC 80)
d) RCMP
e) Risk Register
f) Project sponsor-developed risk analyses or assessments

6. Action items and next steps

WORKSHOP PROCESS

The workshop is a collaboration among the project sponsor, FTA, and the PMOC.

Project sponsor's Role:

- Succinctly present the most current status of project elements as indicated in workshop topics, above, with special focus on areas of uncertainty.
- Indicate known changes that have occurred that cause variance from documents provided earlier for FTA/PMOC review. The purpose is to establish the most accurate basis of scope, cost, schedule, and project management as of the workshop date.
- Provide appropriate supporting documents and exhibits for workshop participants.
- Coordinate with PMOC/FTA regarding the timing of the workshop, especially regarding timing for precedent PMOC review of scope, cost, schedule, and project management.
- Establish project sponsor-related attendance for appropriate portions of the workshop. Manage communication with attendees.
- Provide a meeting facility, and coordinate/provide for a site visit.

FTA's Role:

- Provide direction for overall timing and intent of risk workshop.

PMOC's Role:

- Review scope, schedule, cost documentation before the workshop. Inform FTA of insufficient or poorly correlated project sponsor documentation or project progress that may inhibit completion of a satisfactory risk review.
- Prepare draft scope, schedule, cost, and PMP and management assessment reports.
- Prepare areas of inquiry or need for supplemental information regarding each workshop topic.
- Prepare a listing of PMOC-identified risks.
- Facilitate discussion with project sponsor to review the risk register and develop a shared understanding of both project sponsor-identified and PMOC-identified risks, their potential impacts relative to the baseline cost and schedule, and the likelihood of those impacts occurring.

WORKSHOP TIMING

The workshop timing depends on the stage of project progress, typically prior to Entry to Engineering or at pre-grant (Full Funding Grant Agreement (FFGA) or Small Starts Grant Agreement (SSGA)) approval, or at key milestones during construction if requested by FTA. Further, the project timing also depends upon the scope and complexity of the project. Small simple projects may require no more than 1 to 1.5 days; very large and complex projects may require 2.5 days or more. The following guidelines should be adjusted accordingly. The risk review is intended to inform FTA regarding its decision-making and provides the project sponsor with an independent project and risk assessment that is useful for project planning, mitigation plans, and goal modifications. The review is best undertaken when all project elements are measured on the same basis, i.e., when scope-cost-schedule and PMPs all coincide with each other. When project elements are not synchronized, many ad-hoc adjustments must be made by either the project sponsor or PMOC, and greater uncertainty arises.

Due to the often-large number of participants involved and the need to find concurrence in availability, the workshop timing should be planned a few weeks in advance once the project sponsor documents are deemed sufficient to establish the project baseline and perform the risk review.

The duration of the workshop is generally two or three days, often preceded by the site visit and follow-up with an FTA/PMOC/project sponsor debrief and closing session. It may be useful to begin the site tour in the afternoon before the workshop to allow travelers to view the project site. Likewise, it may be useful to end the project wrap-up session in the morning following the workshop to allow travelers to leave with sufficient time for travel home. The duration of each section of the workshop may vary depending on the specifics of the project, including project size and complexities, project sponsor sophistication, and project phase. The following represents a typical agenda sequencing; timing among topics may vary depending on project scope and complexity. Table F-1 shows an example risk workshop agenda.

Table F-1 Example Risk Workshop Agenda

Day	Duration	Workshop Topic	Facilitator(s)
Pre-Workshop day afternoon	2-4 hours	Site tour; generally attended by those unfamiliar with the site	Project sponsor
Day 1 Morning	0.25 hour	Introductions & opening statements from FTA & project sponsor	FTA, project sponsor
	0.25 hour	Review process overview: project characterization, risk review	PMOC
	1.5 hours	Project overview and scope	Project sponsor, PMOC comment
	2 hours	Schedule review: SCC 10-50	Project sponsor, PMOC comment

Day	Duration	Workshop Topic	Facilitator(s)
Day 1 Break	1 hour	*LUNCH Break*	
Day 1 Afternoon	1 hour	Schedule Review: SCC 60, 70, construction closeout and operations start-up	Project sponsor, PMOC comment
	2 hours	Cost review: SCC 10-50	Project sponsor, PMOC comment
	1 hour	Cost review: SCC 60, 70, construction closeout and operations start-up	Project sponsor, PMOC comment
Day 2 Morning	0.5 hour	Introductions, Day 1 review	Project sponsor, PMOC
	2 hours	Project management	Project sponsor, PMOC comment
	1 hour	Key risks review Review SCC 10-50 SCC 60, 70 Project organization & staffing plans	Project sponsor, PMOC comment
Day 2 Break	1 hour	*LUNCH Break*	
Day 2 Afternoon	2 hours	Key risks review (Cont'd) Review SCC 10-50 SCC 60, 70 Project organization & staffing plans	Project sponsor, PMOC comment
	0.75 hour	RCMP and ongoing risk management	Project sponsor
	0.5 hour	Project sponsor risk modeling results, PMOC risk modeling process	Project sponsor, PMOC
	0.5 hour	Day 2 wrap-up and expectations for next day	PMOC
Post-workshop Day 3 Morning	1 hour	PMOC internal discussion	PMOC
	1 hour	PMOC discussion with FTA	PMOC, FTA comment
	1 hour	Closeout with project sponsor; next steps: action items, objectives, and reports—expectations and timeline	PMOC, FTA, project sponsor

PROCESS AFTER THE RISK WORKSHOP TO SHARE RISK RESULTS

Several activities occur after the risk workshop; these should be clear to all parties, including responsibilities and timing for completion of the activities:

1. Project sponsor completes all action items necessary for the PMOC to finalize the models and reports.
2. Risk models completed by the PMOC.
3. The PMOC prepares and presents to FTA HQ (TPM-20) and regional team the preliminary risk results one-page summary, modeling/analysis assumptions, and a briefing. FTA HQ (TPM-20) will provide the briefing template to the PMOC.
4. FTA HQ TPM-20 engineer notifies the Regional Alternate Contracting Officer's Representative (ACOR) when FTA leadership has directed that the risk results be shared with the project sponsor. The FTA Regional ACOR communicates the preliminary risk results to the project sponsor.
5. The FTA Subject Matter Expert lead compiles all FTA comments to the PMOC draft risk report and sends the annotated file to PMOC for update of the draft report.
6. FTA regional ACOR shares the updated draft risk report with project sponsor (shortly after the preliminary risk results are communicated) and requests project sponsor's review of the draft report for accuracy.
7. FTA Regional ACOR schedules a meeting between FTA, PMOC, and project sponsor technical team to review the risk results and model/analysis assumptions.
8. FTA HQ TPM-20 engineer coordinates any project sponsor comments to the risk report, then finalizes the risk report and distributes a copy to all stakeholders.

APPENDIX H: SCHEDULE RISK ASSESSMENT GUIDELINES

Appendix H presents guidelines for schedule risk modeling.

The schedule risk model shall be a mechanically correct critical-path method schedule that reflects the relationships between activities so that it adequately models the impacts of risk-based schedule changes on other activities. The number of activities modeled should be reflective of the level of development of the Stripped and Adjusted Base Schedule (SABS) (see Appendix D) and the level of detail available at the time of analysis. Large models that are difficult to understand should be avoided. To aid in the development of the schedule risk model, particularly on large or complex projects, representation of near-critical activities and paths should be included to reflect shifting schedules as risks are realized in the model.

The schedule risk assessment shall consider whether non-construction activities, such as funding, vehicle procurement, or Right-of-Way (ROW), etc. introduce a relationship that creates a critical path that masks construction or other activities. In the construction schedule, consider tracking the construction start/notice to proceed milestone and the completion milestone as separate outputs in the schedule analysis. Additionally, potential impacts to construction by other activities (such as ROW acquisition) can be understood as they may lead to cost impacts (i.e., delay claims, etc.).

The Project Management Oversight Contractor (PMOC) shall identify and include the following inputs to the schedule risk model before running the stochastic simulation:

- *Uncertainty risk*, by identifying the risk-related duration variance ranges for each activity or groups of activities;[1] and
- *Project-specific risk* from the risk register or as otherwise found by the PMOC; only modeling the risks that are not considered as within the scope of *uncertainty risk*.

The PMOC shall provide recommendations for adjustment to the project sponsor's schedule, schedule contingency, and Project Management Plan (PMP) to reduce the risk of not meeting the project's schedule-based goals.

Uncertainty risk may result from systemic organizational risk, inability to identify current and future project risk, etc. The PMOC shall capture duration uncertainty by eliciting ranges of potential duration variations for each activity in the schedule risk model. The choice of probability functions or other technical parameters used in the analysis should be clearly documented.

Project specific risk is comprised of specific threats and opportunities that may potentially have positive or negative schedule impacts that may affect any of the project objectives and are risks that are (or should be) documented in the project risk register.

[1] Once detailed schedules (e.g., design schedules) have been established, accepted, and are being actively managed, the uncertainty is essentially zero and only risks remain. If uncertainty ranges are to be applied to separate schedule activities, then correlations among these uncertainty ranges should be considered, included in the model, and documented.

Project specific risk shall capture the schedule duration impact of each risk that is not considered as within the scope of *uncertainty risk* by establishing a duration variation of affected activities in the SABS.[2] This effort may require the addition of risk activities or adjustment of existing activities based upon the specific risk. The PMOC should document the choice of probability functions used for each project specific risk adjustment, along with the activity allocation, during the stochastic simulation.

The PMOC shall report on any assumptions and exclusions for modeling purposes, such as unmodeled risks that are highly unlikely but severe in impact or risks that are not possible to reliably assess.

[2] Caution is advised when applying duration uncertainty (+/-) to a schedule that has already been stripped of conservatism. When the SABS has been stripped to the optimistic durations, then there may be little, if any, opportunity for further reduction. Uncertainty ranges, if applied, must carefully consider this.

APPENDIX I: COST RISK ASSESSMENT GUIDELINES

Appendix I presents cost risk assessment guidelines. Cost risk Beta Range Factors (BRFs) are described in Appendix J

I.1. Cost Risk Assessment Overview

The following guidelines apply for the Project Management Oversight Contractor (PMOC) cost risk assessment. This method involves assigning and adjusting risk factors that are applied to a defined probability distribution function, which was derived based on studies of Federal Transit Administration (FTA) historic experience. These factors are evaluated in terms of the risk types of requirement risk, design risk, market risk, construction risk (see Appendix E). Because it is expected that project risk reduces as the project progresses, these risk factors commensurately also are expected to reduce as the project progresses.

The PMOC shall identify and include the following inputs to the cost risk model:

- *Uncertainty risk*, by establishing standard risk factors to the project; and
- *Project-specific risk* from the risk register or as otherwise found by the PMOC; only modeling the risks that are not considered as within the scope of *uncertainty risk*.

Risk modeling depends upon inputs that are collaboratively created, applied to a common technical risk assessment system. The results are used by project management and funding decision-makers to provide adequate resources for a successful project. The risk modeling results must meet the needs of these key project participants.

There are many steps precedent to the cost risk assessment. The following focuses primarily on the cost risk assessment that occurs after the determination of the Stripped and Adjusted Base Cost Estimate (SABCE) (Appendix D).

I.2. FTA Risk Factors

Based on FTA historic experience, a generalized, standard risk-based probability distribution function has been established to reflect the likelihood of project risk. This function represents general project uncertainty when modified by risk factors that vary upon the level of project progression. These factors are termed BRFs; the BRFs are made up of the sum of partial BRFs that represent risk from the risk types of requirement risk, design risk, market risk, construction risk; these partial BRFs are added to a fixed post-construction factor to calculate a total BRF for a particular Standard Cost Category (SCC). Further discussion regarding these factors and their use is included in Appendix J.

I.2.1. FTA Cost Risk Workbook Model

An Excel-based Cost Risk Workbook Model (Risk Workbook) has been developed to utilize the FTA's BRFs and to serve as an analytical tool for a project. The Cost Risk Workbook file (file automatically downloads) is available for download from the FTA website. This workbook is based on the organizational structure of the FTA SCCs as presented in the project sponsor-provided FTA SCC workbooks:

- **SCC Category 10 through 80:** Project sponsor's capital cost elements of a project, without allocated contingency, are used as the starting point for the risk modeling;
- **SCC Category 90:** Unallocated contingency is specifically excluded as a duplication of the contingency recommendation that is calculated by the Risk Workbook; and
- **SCC Category 100:** The finance cost review and any related risk analysis are provided separately through other FTA reviews, thus values calculated in the Risk Workbook are exclusive of finance cost and related risk.

There exist conditions where an adjustment may apply broadly across several SCC elements; for example, it is often found that the categories of SCC 10-50 (Civil and Systems) have risks that apply across all these categories. In this case, a "global" adjustment may be made across these categories. The Risk Workbook provides a facility for this type of global beta adjustment.

The Risk Workbook contains the formats and bases of calculations that execute the cost risk assessment model. The PMOC shall become familiar with the Risk Workbook prior to developing their project risk model and shall adjust the Risk Workbook to meet specific project conditions.

The PMOC shall use the Risk Workbook results to report a summary table that lists the project sponsor's estimated values and the PMOC's recommended project cost adjustments with their assessment data. The summary table includes the reportable range of variability determined in the risk assessment and its effect on the overall budget. The PMOC will also report the key risk drivers and model inputs.

I.2.2. Risk Assessment Process

The cost risk assessment process, as described in Appendix D, is dependent upon PMOC establishment of the SABCE. Figure I-1 shows the cost risk analysis process flow. The cost risk assessment provides the basis for cost goal recommendations.

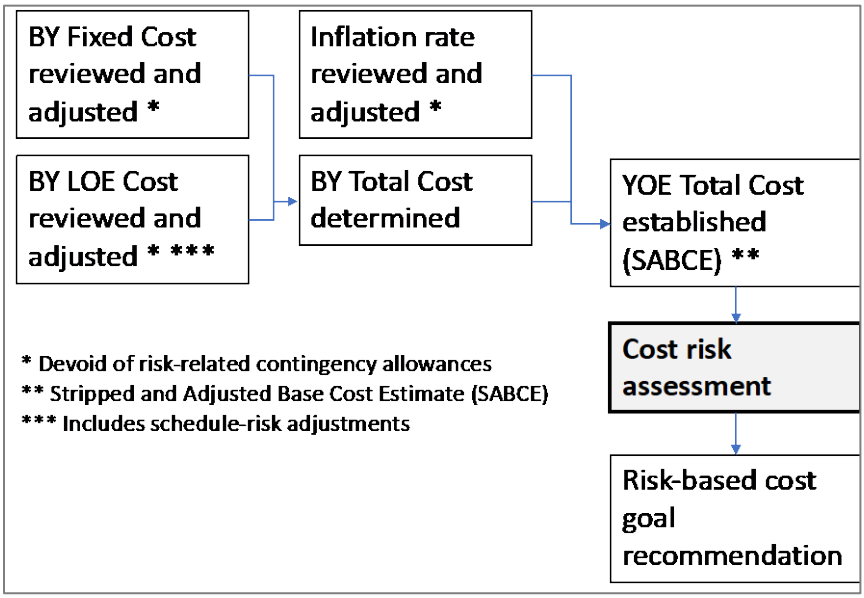


Figure I-1 Cost Risk Analysis Process

The cost risk assessment proceeds in several overall steps:

- Establish uncertainty levels;
- Establish risk events and impacts (without duplication of uncertainty impacts);
- Model these two impacts together through the Risk Workbook; and
- Establish and report modeling results and project budget recommendations.

I.3. Risk Profiles

Many large transit projects are planned, built, and funded in multiple phases, and phases frequently overlap but exist in differing levels of completion; especially important to identify are phases that are delivered in distinctly different timeframes. This condition likely exists in megaprojects (Appendix F) but may be found in other projects as well. Additionally, each phase may be delivered with varying contracting methods (Appendix K). The overlap of phases, separation by timeframes, and/or different contracting methods create situations where phase-based risks are difficult to quantify unless segregated.

Where practical for accurate assessment of project cost risk or contingencies, the project's cost, and risks may be apportioned into risk profiles based on different project phases. These risk profiles have non-duplicated costs, while some risks and mitigations may cross several profiles; cost risk is assessed separately for each risk profile. The profiles are subsequently combined using appropriate techniques into an overall project risk recommendation. The Risk Workbook provides for up to four risk profiles; quite often only one profile is used.

Risk profiles should be determined as early as possible and collaboratively with the entire PMOC review team. Pre-risk assessment reviews, especially the cost review, are best made within the context of these risk profiles to have cost information easily flow into the Risk Workbook.

Note that many projects do not have distinct project phases and thus may have only one risk profile.

I.3.1. Establishing Uncertainty Risk

A key step of the analysis of risk is determining the impact of uncertainty—that portion of risk that is commonly present in transit projects. This is evaluated as follows:

- Evaluate project progression for each risk profile; and
- Assign risk factors to the project elements by risk category and SCC or groups of SCCs.

Uncertainty impacts, as developed above, are one portion of project risk. This uncertainty evaluation is intended to account for broad risk that is common among projects and underrepresented as identified risk events.

The process to establish uncertainty risk is described in Appendix J, the facility for which is provided in the Risk Workbook.

I.3.2. Establishing the Impact of Project-specific Risk Events

Project-specific risk events are listed on the project sponsor risk register or are identified otherwise by the PMOC. These risks are used to guide BRF adjustments to amend the

uncertainty analysis described above. These adjustments may be increases or decreases to the uncertainty BRF assignments.

The process for evaluating the project-specific risk event impact follows the following steps:

- Establish which risk events are not represented in the uncertainty evaluation;
- Assess risk impact value; and
- Model and apply BRF adjustments to the prior uncertainty determination.

Many risk events are common among projects (for example, some utility relocation risk). The uncertainty impact analysis in the section above is intended to cover these common risks. Most risk registers list these risks to manage the risk response. However, the resulting risk impact should not be included twice in the PMOC risk assessment—once under uncertainty and again as a risk event. Therefore, the Risk Analyst must determine one of three conditions for each identified risk event. The risk should either be covered by the uncertainty impact, be partially covered by the uncertainty impact, or not covered by the uncertainty impact. Only the risks not covered or partially covered by uncertainty should be included in the risk event impact quantification. For those partially covered by uncertainty impact, only the amount of impact not covered as uncertainty should be included in the analysis.

For project-specific risk events, the cost impact of the risk event must be determined. While most risks cause cost additions to the project, potential cost-saving opportunities may also be included. This evaluation is often best made through a collaboration of experienced project personnel and an experienced Risk Analyst.

To determine the BRF adjustment, either one of two values must be established and then provided in the Risk Workbook for calculation of the BRF adjustment:

- The PMOC-estimated contingency requirement for the specific risk, or
- The PMOC-estimated maximum impact for the specific risk.

Given these values, the Risk Workbook will calculate the BRF adjustment, which the PMOC will make to the appropriate SCC/Risk Category partial BRF.

Often, many risk events share impacts if occurring coincidentally and the impact of each risk may be improperly compounded; if so, such a condition should be considered, and appropriate adjustment made to avoid overstating such compounded risk.

When the impacts of project-specific risk events have been determined, an adjustment to the uncertainty BRF is calculated. The adjustment is added to (or subtracted from) the uncertainty BRF to establish a combined BRF for a particular risk profile/SCC/risk category BRF.

When making such adjustments in the Risk Workbook, the PMOC should highlight the amended BRF cells and add a note that indicates the purpose of the adjustment.

I.4. Modeling project-level risk

The uncertainty and project-specific risk event analyses lead to a project estimate recommendation, calculated by the Risk Workbook. The final modeling steps are:

- Review completeness of risk profiles and risk events to be included in the risk assessment model;
- Review quantitative model inputs;
- Obtain Risk Workbook summary outcome; and
- Review for reasonableness. Revise and rerun as necessary.

I.5. Setting the Recommended Project Budget

Both uncertainty and risk event cost impacts have a bearing on the overall cost of a project. Once the summary project-level impact is determined by the Risk Workbook, a recommended estimate may be established based on the FTA-targeted level of risk tolerance.

Results of the Risk Workbook calculations are presented in a summary worksheet, which should be reviewed for reasonableness. If necessary, review and revise inputs with the aid of project personnel to establish changes if the results do not appear reasonable. Any such changes should be made at a detailed level and should be thoroughly documented.

The steps to finalize this cost risk analysis follow and are:

- Review the risk modeling results;
- Determine the range of risk-based project cost outcomes;
- Establish the project budget recommendation, based on FTA risk tolerance; and
- Report the modeling methodology and the resulting recommendation.

The results of the project budget recommendation have great importance to the project team and the funding partners. These results must be credible and are often (and should be) subject to outside review. All steps in the process should be carefully recorded so that a reasonable peer may review and understand the process. The process and details should be recorded in such a way that a peer could also independently duplicate the result.

The risk tolerance level, i.e., whether a 50 percent likely outcome ("P50") or a 65 percent likely outcome ("P65") that is desired must be expressed by FTA. While a common standard, say P65, may be in place, certain projects may require a higher or lower level of risk comfort. The risk tolerance level—an FTA management prerogative— should always be confirmed.

The Risk Workbook-derived cumulative risk curve and the risk tolerance level combined are used to establish the recommended project budget. The recommended project budget less the SABCE yields the recommended project contingency. For completeness, other modeled values (e.g., P40, P50, P65, P80) should be included, as directed by FTA. Key graphics, especially the risk model curve, are important evidence of the modeling results. Other factors, such as the influence of key risks should also be included.

Documentation of PMOC-established parameters for the risk modeling process should be provided in the Risk Workbook and OP 40 Risk Review report. The cost risk section of the report should follow other sections that describe, at a minimum, summaries of PMP, scope, schedule, cost reviews, and details of the schedule risk modeling to form a comprehensive report. See Section 7.0 and Appendix P for reporting details.

APPENDIX J: COST RISK BETA RANGE FACTORS (BRFS)

Appendix J presents cost risk BRFs to be applied in the Federal Transit Administration (FTA) cost risk model workbook.

Through the study of prior project results, the FTA has determined that a pattern of uncertainty exists among transit projects. The uncertainty decreases as the project progresses. Due to the inability to forecast risk in the far future and other reasons, uncertainty is generally underrepresented in project sponsor risk registers, so a general adjustment for the impact of uncertainty must be considered in the Project Management Oversight Contractor's (PMOC's) cost recommendations. This uncertainty adjustment considers five different consecutive project stages:

- Requirements stage—the time during which the basic parameters that form the physical project design are established. These may include project performance goals, physical environmental challenges, cost and/or schedule constraints, political and social environment constraints, third-party interfaces, etc.;
- Design stage—the period of development of the graphic and written details of the design that meets the project requirements. These design documents are what forms the basis for the scheduling and pricing of the acquisition of a construction contractor(s) and construction, necessary real estate, transit vehicles, or project staffing;
- Market stage—the final contracting for the physical acquisition of alignment and systems construction, real estate, vehicles, staffing and consultants, etc.;
- Construction stage—the period of the actual construction of the civil and systems portion of the work, the legal acquisition of the real estate, the construction of the vehicles, etc.; and
- Post-Construction stage—the process that occurs after completion of the project to finalize the remaining details of closing out contracts and shutting down the development process.

These stages are useful in representing a partial amount of uncertainty risk for each stage and sum to a total amount of uncertainty; an "average" amount of uncertainty for transit projects at each stage has been established, based on FTA project experience. As the various stages of the project complete, the total amount of uncertainty decreases. Risk categories have been developed to reflect each stage of project effort, namely Requirements Risk, Design Risk, Market Risk, Construction Risk, and Post-Construction Risk.

FTA RISK MODELING BASIS

The uncertainty impact is expressed as a range of likely project outcomes in an FTA defined probability distribution function, which has a *lower bound* and an *upper bound*. Figures J-1 and J-2 show the probability curves under a possible scenario; actual project

results will vary in curve width. The vertical axes represent probability values, and the horizontal axes represent potential project cost outcomes.

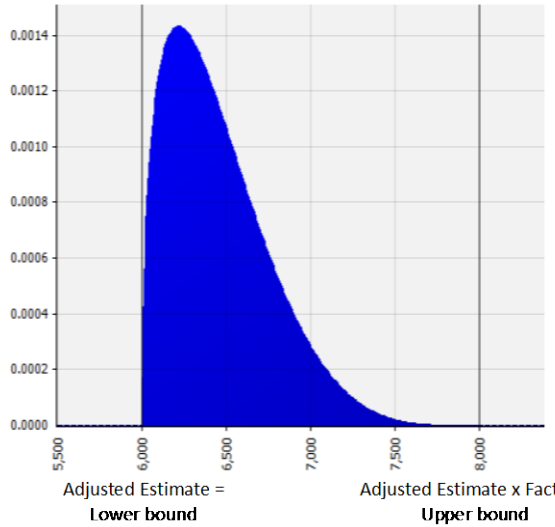


Fig. J-1 – Incremental Probability Distribution Curve

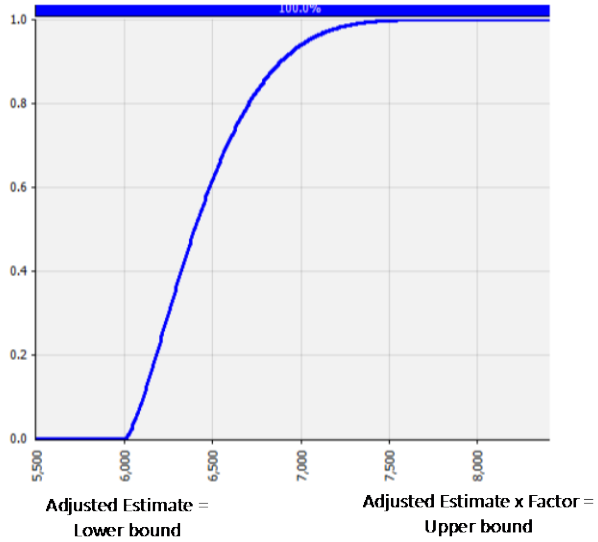


Fig. J-2 – Cumulative Probability Distribution Curve

The shape of the Figure J-1 curve is prescribed to be consistent with studied actual project outcomes. Additionally, the shape of the curve is "left-leaning," meaning there's a tendency for project budgets to be optimistic, and has a long, slender right-hand tail, meaning that extremely large project overruns occur, but are rare. A method for establishing the lower and upper bounds of this curve has been developed, whereby the lower bound is defined as the Stripped and Adjusted Base Cost Estimate (SABCE) (Appendix D) and the upper bound is established by multiplying the SABCE by a *BRF*; i.e., *Upper Bound = Adjusted Estimate* x *BRF*. For example, the curve in I-1 shows the lower bound as the SABCE (6,000) and the upper bound (8,000) is the product of the SABCE and a BRF of 1.33. The curve is further defined as a Beta distribution with fixed shape parameters of α=1.5 and β=5.1. These values are embedded in the Risk Workbook.

The shape of the Figure J-2 curve reflects the cumulative probability distribution which provides the ability to forecast cost outcomes given a targeted level of tolerance. For example, in Figure J-2, if a targeted level of confidence was the P60 level (0.6 in the figure),

then the corresponding cost outcome would be approximately 6,500. Conversely, with an estimated cost of, say, 6,300 the confidence level could be determined as approximately P40 (0.4 in the figure).

The FTA guidance provides that these BRFs are evaluated across cost elements in the structure of the FTA's Standard Cost Categories (SCCs). Specifically, the factors are considered in common groups of SCCs 10-50 (civil and systems), SCC 60 (real estate), SCC 70 (vehicles), and the individual breakdown levels of SCC 80 (professional services). FTA has developed BRF guidance for each of these groupings of SCC elements. The PMOC is tasked with adjusting the factors to reflect the project sponsor's risk level across each of the stages of progression indicated above.

Especially important is to consider the degree to which risk has been transferred through a purchased contract (evident in contract terms); when uncontracted, all risk remains with the agency. Various forms of contracting or Project Delivery Methods (PDMs) have developed in the industry, and traditional assumptions of risk allocation will vary across PDMs. See Appendix K for discussion of considerations when modeling under various PDMs.

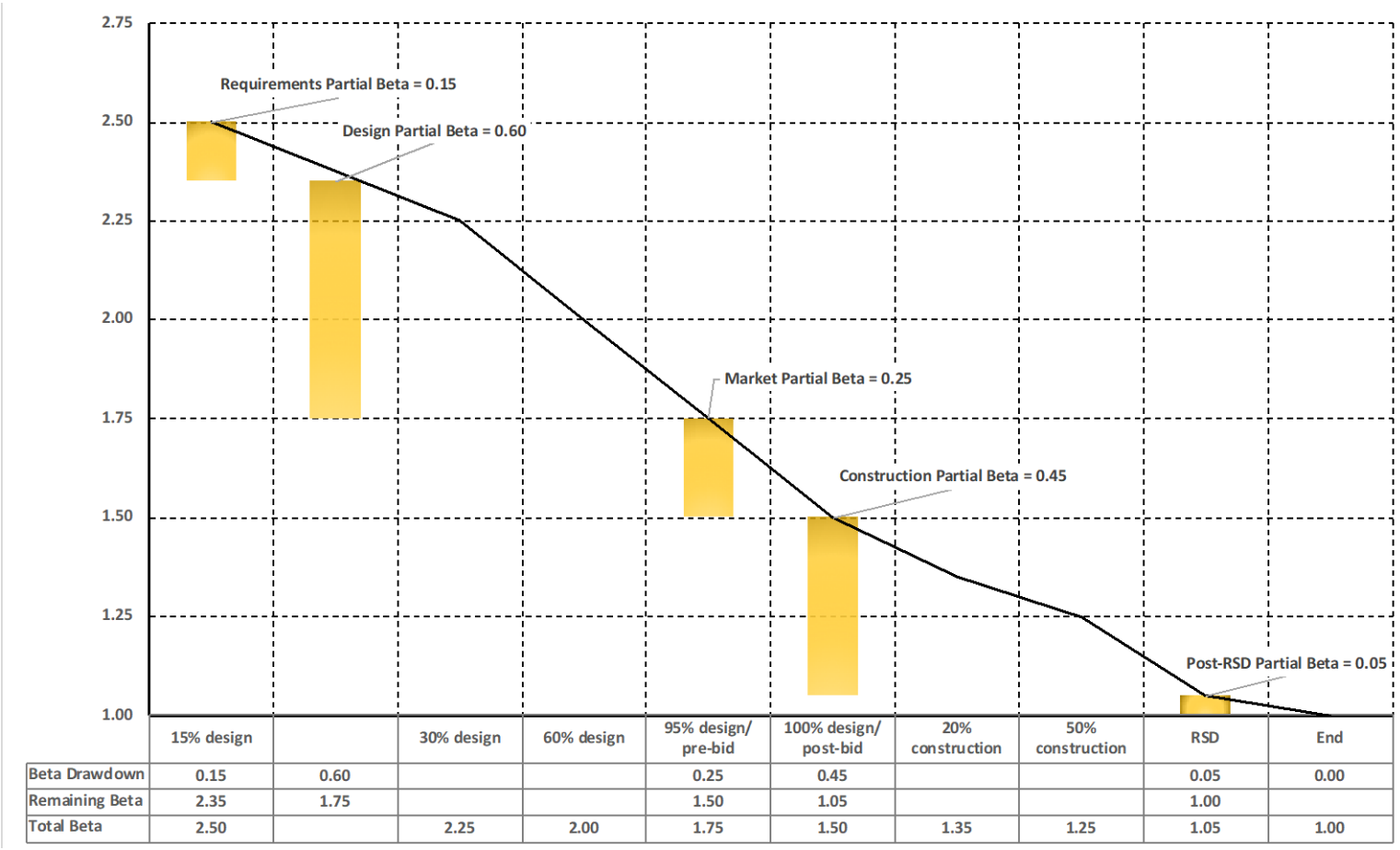
BRF STANDARDS BY SCCS

Figure J-3 displays the individual and accumulated partial *BRFs* for SCCs 10-50 to be used in determining the upper bound of the uncertainty curve, as described above. Similar diagrams are presented for SCCs 60, 70, and 80. The Risk Workbook codifies the following. It is important to note that these BRFs are generalized across historic projects and are assumed to be sequentially reduced; these BRFs must be adjusted for project-specific conditions and risks (see Appendix I).

SCC10 through 50:

- A BRF above 2.35 implies uncertainty associated with project development, early design, and requirements risk; after completion of project development, some level of requirements risk remains;
- A BRF between 2.35 and 1.75 implies a full reduction of requirements risk, and increasing mitigation of design risk as design proceeds to completion of engineering;
- A BRF between 1.75 and 1.50 recognizes the existence and reduction of construction market risk (construction bid risks; uncertainties associated with reliable information on market conditions, leading to a project specific firm price, etc.);
- A BRF between 1.50 and 1.35 generally recognizes uncertainties related to construction associated with geotechnical/utility, other underground/construction activities occurring during the first 20 percent of construction;
- A BRF between 1.35 and 1.25 indicates a reduction of risk to the level of 50 percent of construction;

- A BRF between 1.25 and 1.05 indicates uncertainty associated with late construction activities, including activities through start-up and substantial completion to the Revenue Service Date (RSD); and
- A BRF of 1.05 implies that no unresolved risk events are identified for this project and only unknown risk events remain.
- Where project-specific, exceptional risks exist (such as, perhaps, significant geotechnical conditions, especially deep excavations and/or tunneling), the PMOC shall provide a separate analysis and explanation of the BRFs that apply to the corresponding estimate elements. Such BRFs may significantly exceed standard BRFs. These conditions are usually noted on the project sponsor's risk register or PMOC risk analysis.



	15% design		30% design	60% design	95% design/ pre-bid	100% design/ post-bid	20% construction	50% construction	RSD	End
Beta Drawdown	0.15	0.60			0.25	0.45			0.05	0.00
Remaining Beta	2.35	1.75			1.50	1.05			1.00	
Total Beta	2.50		2.25	2.00	1.75	1.50	1.35	1.25	1.05	1.00

Figure J-3 Standard SCC 10-50 BRFs by Risk Type by Project Progression

SCCs 60 through 80

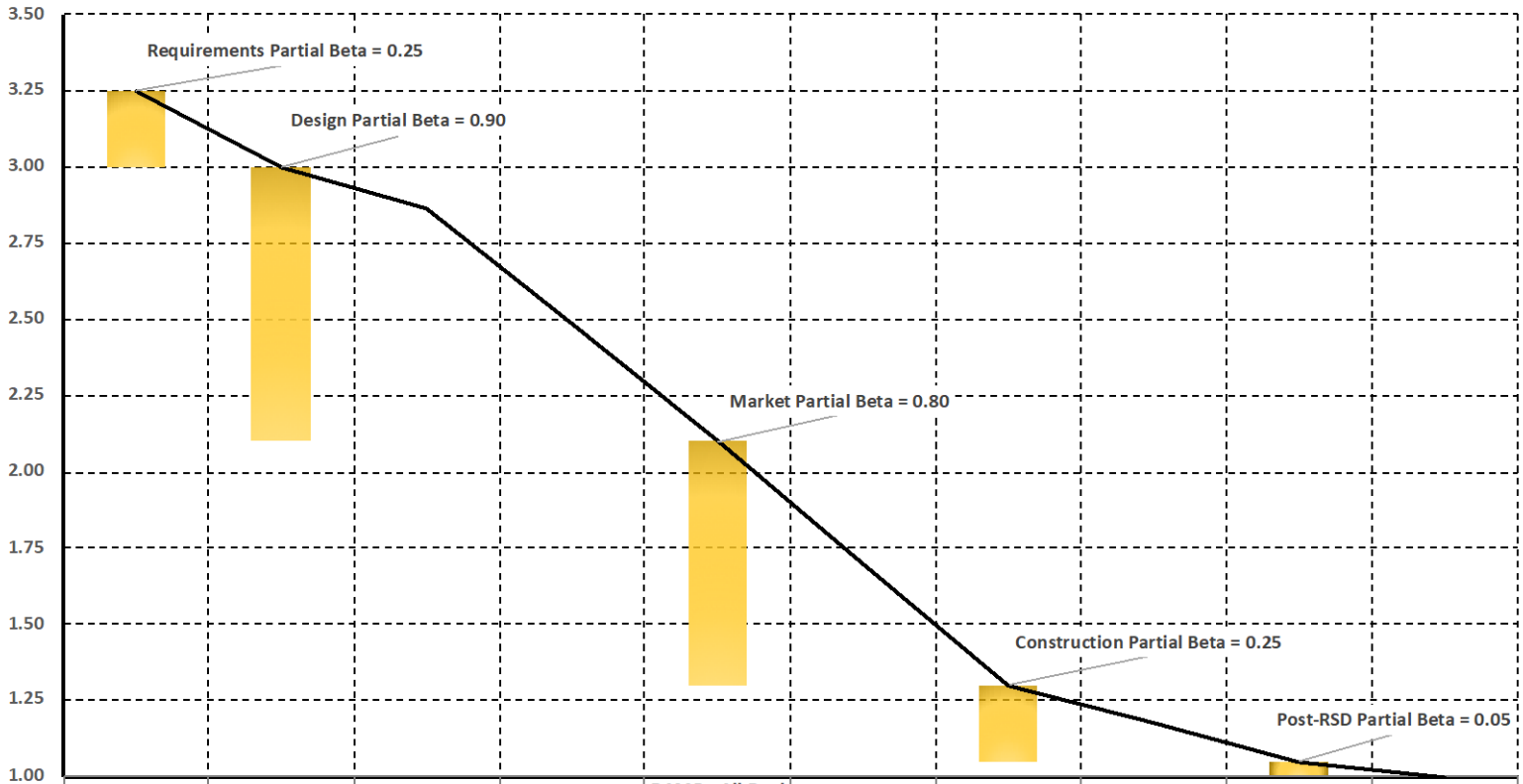
SCCs 60 through 80 represent project elements that are not traditional construction elements. As such, the risk categories shall be interpreted as follows:

- Requirements risk is similar to that defined above, wherein it is related to the uncertainty of environmental conditions, the uncertainty of third-party requirements or regulations, or uncertainty of project goals;
- Design risk is related to the sufficiency and potential error of the development of plans for execution of the element. For example, for SCC 80, this may relate to the development of staffing plans for project management;
- Market risk is similar to that defined above. It is related to the potential variance in price for the acquisition of the property, equipment, or staffing necessary to complete the element; and
- Construction risk relates to the actual act of completing the element itself, including any variances that result from conditions only evident at the time of acquisition of property or equipment, or at the time of execution of management or technical activities, such as design or construction management.

The following sections of this Appendix further clarify the bases that have been used to establish the SCC 60-80 BRFs, which are codified in the FTA Risk Workbook according to a normal SCC 10-50 progression.

SCC 60:

- Risk for Right-of-Way (ROW) tends to survive later in the progression of this activity and suffer high early risk due to large uncertainties and commonly delayed resolution of ROW acquisition; therefore, cumulative BRFs are generally estimated larger than that of SCCs 10 through 50 until ROW acquisition is substantially complete. Figure J-4 shows standard SCC 60 BRFs by risk type by project progression.

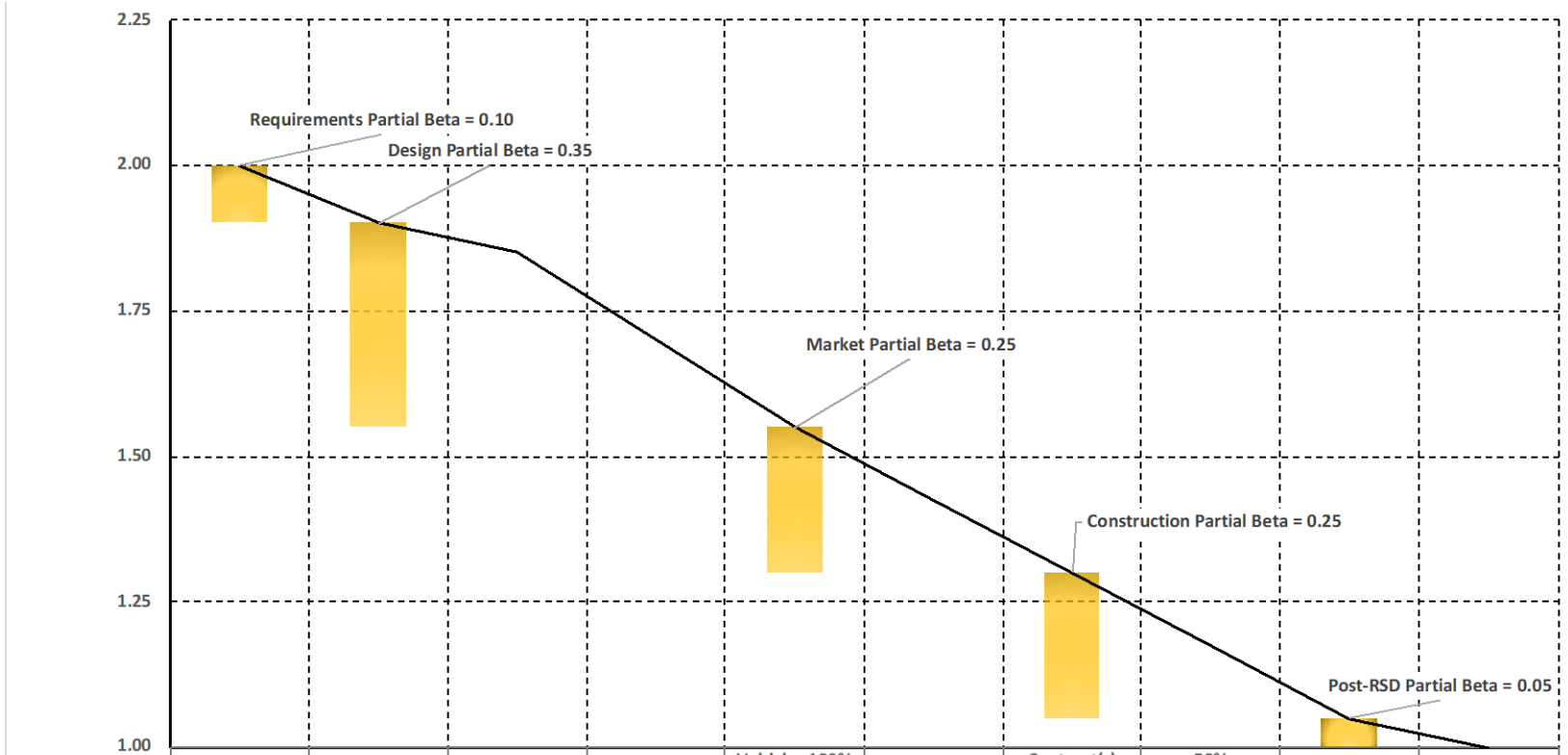


	RAMP begin		25% RAMP Development	50% RAMP Development	RAMP-- All Real Estate Identified/ Offers Begun	50% Offers Negotiated	Offers complete/ Closures Begun	50% Closures Complete	Closures Finalized	End
Beta Drawdown	0.25	0.90			0.80		0.25		0.05	0.00
Remaining Beta	3.00	2.10			1.30		1.05		1.00	
Total Beta	3.25	3.00	2.87	2.48	2.10	1.70	1.30	1.18	1.05	1.00

Figure J-4 Standard SCC 60 BRFs by Risk Type by Project Progression

SCC 70:

- Risk for vehicles tends to be removed more quickly in time due to reduced design uncertainties and early vehicle purchasing; therefore, cumulative BRFs are generally less than that of SCCs 10 through 50 during the early phases of the project. Figure J-5 shows standard SCC 70 BRFs by risk type by project progression.



	Vehicle Design Begun		25% Vehicle Design	75% Vehicle Design	Vehicles 100% Designed/ Proposals Begun	Offers in Negotiation	Contract(s) Complete/ Manufacturing Begun	50% Manufacturing Complete/ Initial Delivery	Vehicles Fully Delivered and Accepted	End
Beta Drawdown	0.10	0.35			0.25		0.25		0.05	
Remaining Beta	1.90	1.55			1.30		1.05		1.00	
Total Beta	2.00	1.90	1.85	1.70	1.55	1.43	1.30	1.18	1.05	1.00

Figure J-5 Standard SCC 70 BRFs by Risk Types by Project Progression

SCC 80:

- Risk for each minor SCC for professional services is highly dependent upon the phase in which it is performed. For professional services, the cumulative BRFs should be mostly drawn down at the point at which the category of services has been largely completed. BRFs for other services (i.e., insurance, etc.) in this category shall be estimated in consideration of the commensurate risk factors. Figure J-6 shows an example of cumulative beta drawdown by project progression for professional services (SCC 80).
- Each minor SCC 80 category progresses differently depending upon project progression. Details are contained within the FTA Risk Workbook.

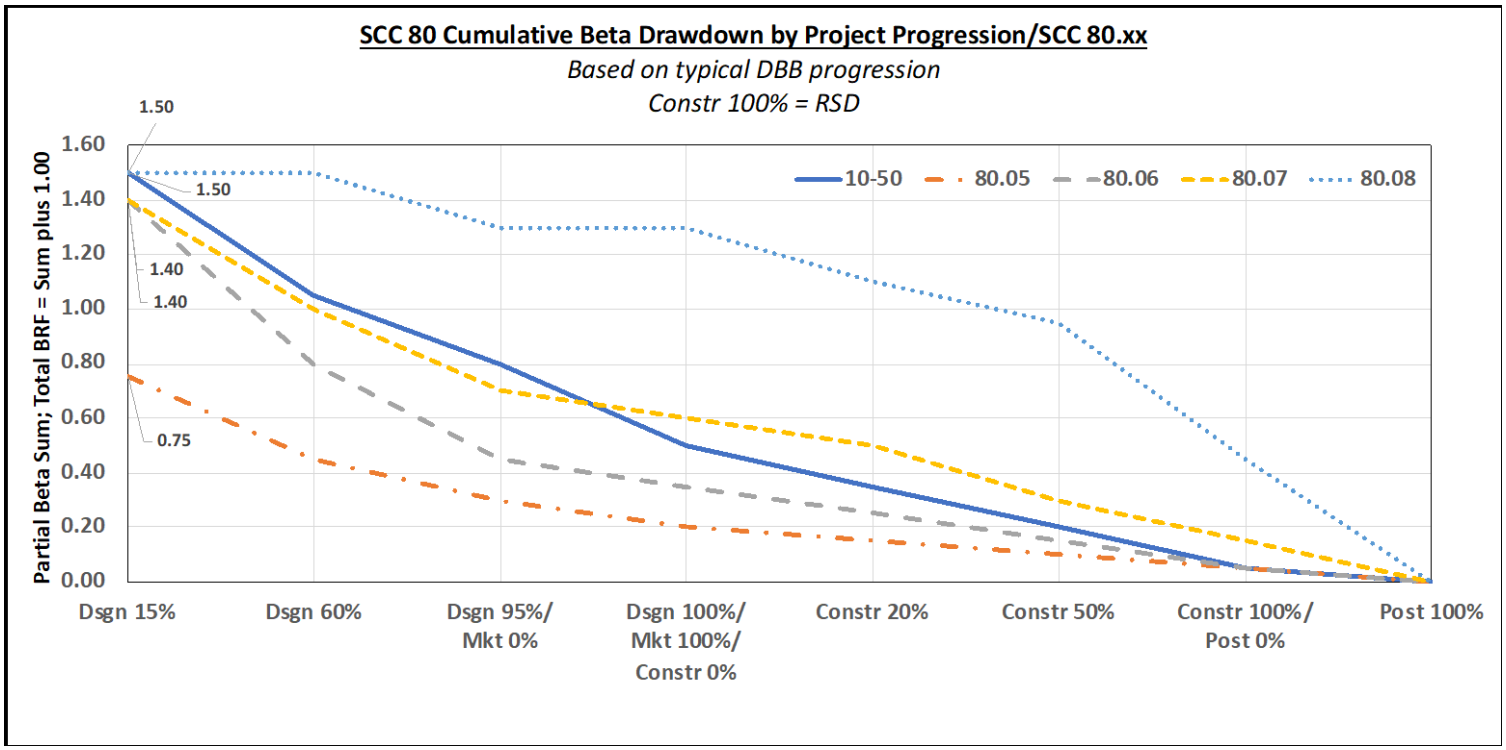


Figure J-6 Standard SCC 80 Cumulative Beta Drawdown by Project Progression

APPENDIX K: PROJECT DELIVERY METHOD RISK ASSESSMENT GUIDELINES

Appendix K presents guidelines for consideration of Project Delivery Methods (PDMs) in the risk assessment. The cost risk effect of contracting under varying PDMs must be evaluated because each project phase may be delivered with varying contracting methods.

Differing PDMs for project construction may impact the timing and proportionate allocation of project sponsor risk, but not necessarily the overall magnitude of risk shared among all parties nor the sequence of risk mitigation. The increasing prevalence of various forms of PDMs includes Design-Bid-Build (DBB), Construction Manager (CM)/General Contractor (CG), Design-Build (DB), and Public-Private Partnerships (P3s). PDMs continue to evolve, and contracting forms vary widely, especially in non-DBB contracting. The following is intended to provide guidance for modeling risk as presented in the Federal Transit Administration (FTA) Risk Workbook (see Section 6.4.2). This discussion presents consideration for the following PDMs:

- DBB,
- CM/GC (also Construction Manager at Risk (CMAR) or General Contractor/Construction Manager (GC/CM)),
- DB (also Design-Build & Finance (DBF), and
- P3 (also Design-Build-Finance-Operate and Maintain (DBFOM)).

The main principle to consider regards the amount of project responsibility (and risk) retained by the project sponsor or their contracting parties, and to whom responsibility and risk have been transferred contractually, for cost consideration. In all cases for this discussion, the contracting party contracts for project construction (or vehicles or real estate, etc.) and therefore is expected to be liable for construction risk (or product risk) to the extent defined in the specific contract. Some services, such as design, may not become the responsibility of the PDM contractor discussed here. In general, the risk for these separate services is covered within risk factors provided as standard within the FTA Risk Workbook.

It is important to realize that prior to contracting for the project construction (or a combination of design and construction), all risk remains with the project sponsor regardless of PDM; i.e., the magnitude of the effect of risk, whether schedule or cost, should be accounted for as a potential cost that must be budgeted by the project sponsor. After contracting, some risks may have been effectively transferred to the contractor and the project sponsor will have costed in the base estimate the amount that the contractor has agreed to pay for risk that the contractor now assumes and retains. The risks that are transferred are best determined through a project sponsor risk allocation matrix, which is reflected additionally in the provisions of the contract for construction (or design and construction). The effectiveness of these risk transfers and risk retention methods should be considered when developing recommendations for Beta Range Factor (BRF) assignment.

All non-DBB forms of PDM bring on the contracting party before design completion. When fixed pricing is required of the contractor before design is complete, the risk to the contractor is higher. In most cases, the proposing contractor may price that risk more severely than would

occur in a risk analysis for project sponsor-retained risk. Careful consideration of appropriate allocation of risk, found within bridging, proposal, and contract documents, and allocation matrices will expose areas of increased or lessened risk to the project sponsor.

Figure K-1 represents the multiple elements that a project sponsor must undertake to successfully complete a project. The purpose here is to focus on the capital project delivery portion of the project. The various elements considered in this discussion are:

- Project development activities
  - Overall program management during project development
  - Project development financing
  - Pre-engineering activities, such alternatives analysis, project programming and environmental analysis, third-party agreements, Right-of-Way (ROW) acquisition/easements/permits;
- Capital Delivery Activities
  - Overall project management during capital project delivery
  - Project implementation financing
  - Design and construction
  - Project measurement services such as scheduling, cost estimating, and quality control
- Operational Activities
  - Facility commissioning
  - Operations and maintenance

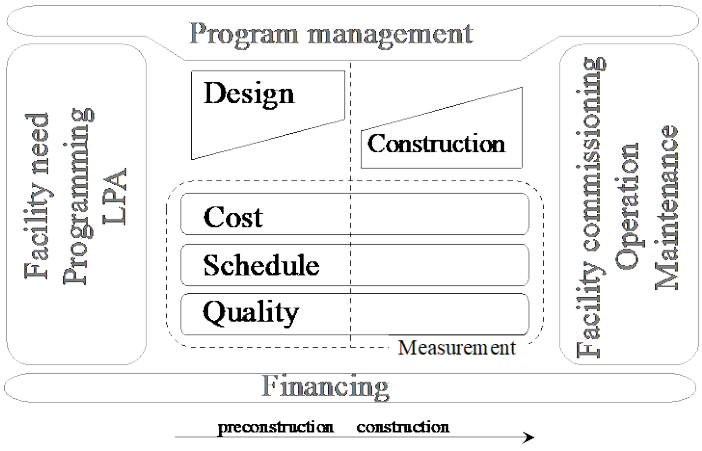
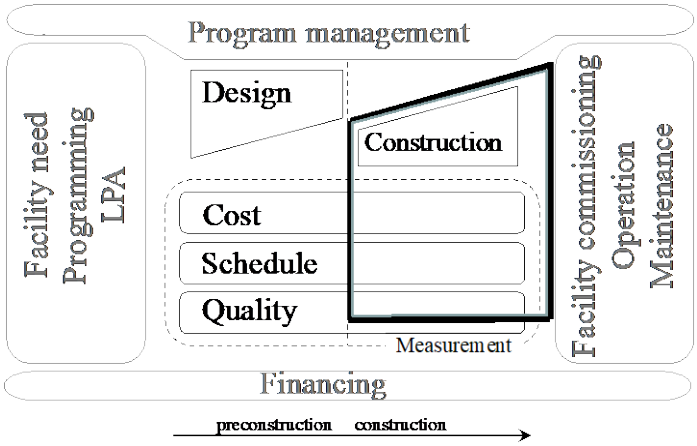


Figure K-1 Typical Project Services

The following discussion presents the various noted forms of PDMs, schematically indicates the services provided and guides considerations for establishing adjustments to the standard BRFs presented in the OP 40 and the Risk Workbook.

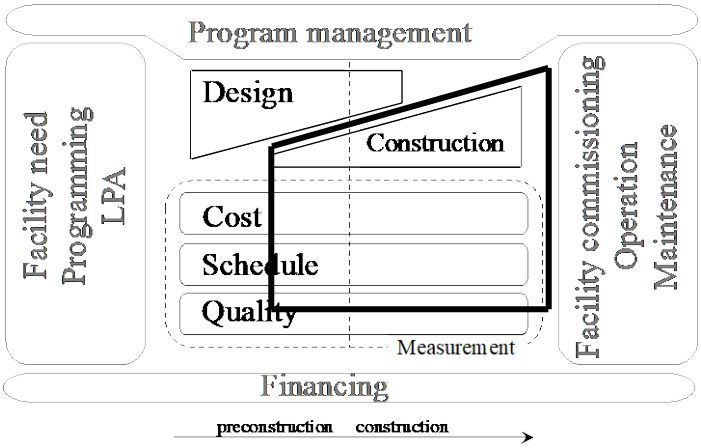
DBB



In a DBB project, the primary contracted responsibility and risk transferred is for Construction Risk and for tracking construction schedule, cost, and quality. Modeling considerations, as compared to the standard BRFs, include:

- Requirements risk
  - Assumes requirements risks resolved; increase otherwise
- Design risk
  - Assumes project sponsor holds all design risk; increase if design risk left at time of bid
- Market risk
  - Assumes competitive market; adjust if not
- Construction risk
  - Assumes project sponsor holds traditional owner-side construction risk through to end of construction
- Project management risk
  - Traditional standards of staffing generally well-implemented

CM/GC (also CMAR, GC/CM)

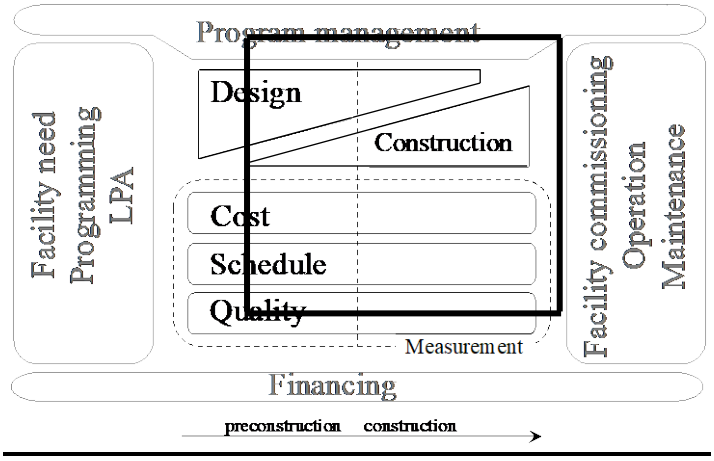


In a CM/GC PDM, the primary contracted responsibility and risk transferred is for construction; because the CM/GC is generally involved during the design phase, some design risk may also be transferred contractually. However, since the CM/GC does not control the design entity, any such design risk transfer may be limited and may be specifically excluded in any Guaranteed Maximum Price (GMP) contract amendment. Modeling considerations, as compared to the standard BRFs, include:

- Requirements risk
  - Assumes requirements risks resolved before GMP; increase otherwise—look to GMP document for requirements risk inclusions or exclusions.
- Design risk
  - Assumes project sponsor holds all design risk; increase if design risk left at GMP—look to GMP document for risk inclusions or exclusions. Beware of "shared" risk allowances; likely will be spent and should be estimate adjustments. GMPs executed very early in the design phase may include significant pricing increases to cover unknown design changes, even if such changes are indicated as compensable to the CM/GC in the GMP provisions.
- Market risk
  - Not a competitive bid; willfully price any known Requirements and Design risk. Determine project sponsor's method for retaining open-market, competitive pricing. Strongly consider market risk increase.
  - Some projects allow partial GMPs to occur as the design progresses. While this allows early construction starts, it locks in the CM/GC to the project, creating a barrier to the project sponsor against changing contractors. In this case, the opportunity for higher subsequent partial GMPs exists, increasing market risk.
- Construction risk

  - Generally traditional risk allocations, but review GMP docs. CM/GC has the ability in the GMP to exclude some traditional construction risks. Fast-tracking may increase expensive Geotech risk costs.
- Project Management risk
  - Traditional standards of project sponsor staffing generally well-implemented. Some project sponsors understaff, expecting the CM/GC contract to require less supervision. May cause a risk increase.

DB (also DBF)

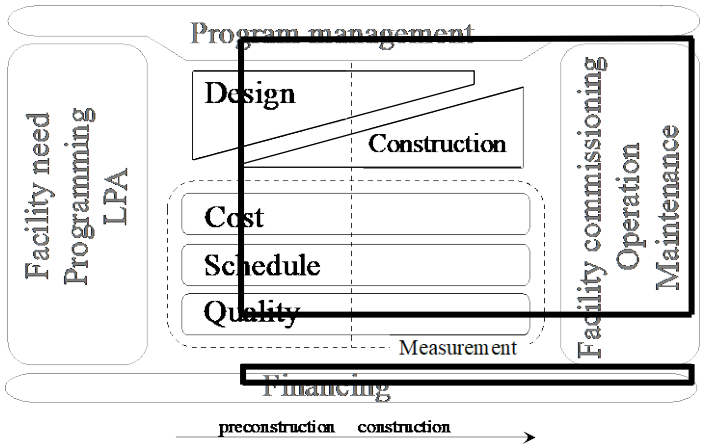


In a DB PDM, the primary contracted responsibility and risk transferred is for design and construction. Modeling considerations, as compared to the standard BRFs, include:

- Requirements risk
  - Many requirements risks are resolved before proposal; examine DB document for requirements risk exclusions. DB will price requirements risks fully; adjust BRFs up for these risks. Examine the project sponsor risk allocation matrix to understand how risks are treated. Encountering excluded requirements risks will likely lead to costly change orders.
- Design risk
  - At pre-proposal, the project sponsor retains the design risk. Post-proposal, the DB takes the risk and will price fully; account for this. Bridging documents—provisions and design documents that establish the basis of the proposal may reduce this risk bump if carefully crafted and are more effective when the DB is brought on board later in the design progression. Alternate Technical Concepts (ATCs) (value engineering proposed by the bidders) may create direct cost efficiencies.
- Market risk

  - DB pricing is generally competitive. Market risk is relatively standard. If financing is also provided (DBF), the proposer may include financing risk in the design and construction proposal price. Evaluate how financing costs and risks are treated in the specific proposal or contract documents and adjust as appropriate.
- Construction risk
  - Generally traditional risk allocations, but review risk allocation matrix. Fast-tracking may increase expensive Geotech risk cost or costs due to inefficiencies.
- Project Management risk
  - Project sponsors expect less staffing. Carefully review if project sponsor project management staffing is adequate, especially during start-up phase.

P3 (also DBFOM)



In a P3 PDM, the primary contracted responsibility and risk transferred is for design and construction, including post-Revenue Service Date (RSD) operations and financing for the contracted portion of the work. For FTA grant-funded projects, the operations and related financing costs are excluded. Therefore, risk modeling considers only the capital project costs. The pricing for this work requires careful accounting for the separation of capital project costs versus operations costs. Modeling considerations, as compared to the standard BRFs, include:

- Requirements risk
  - Many requirements risks are resolved before the proposal; look to the P3 contract document for risk exclusions. The P3 will price requirements risks fully; review carefully and adjust up appropriately. Look for the project sponsor risk allocation matrix to understand where risks are transferred, shared, or retained. Encountering requirements risks after contracting will likely lead to costly change orders.
- Design risk
  - During the pre-proposal period, the project sponsor retains the design risk. Once contracted, the P3 takes the design risk and will price fully, account for this. Bridging documents—provisions and design documents that establish the basis of

the proposal— may reduce this risk bump if carefully crafted and are more effective when the PPP is brought on board later in the design progression. ATCs (value engineering proposed by the bidders) may create direct cost efficiencies.

- Market risk
  - This is competitive pricing; standard market risk generally applies. Opportunities for profit in the operations and maintenance phase and potential transit-oriented development opportunities may increase competitiveness and encourage better pricing. These opportunities may also offset finance risk and create lower capital cost proposals.
- Construction risk
  - Generally traditional risk allocations, but review risk allocation matrix. Fast-tracking may increase expensive Geotech risk costs or create cost inefficiencies.
- Project Management risk
  - Project sponsors expect less staffing. Carefully review if the staffing estimate is adequate, attentive to retain some degree of Quality Assurance (QA).

APPENDIX L: COST RISK MODEL WORKBOOK CONTENTS AND PROCESS FLOW

Appendix L summarizes the contents and process flow of the FTA Cost Risk Model Workbook.

	Overview
	Risk Workbook Overview
	Table of Contents: Worksheets (this worksheet)
Step ONE	**Sponsor Project Background**
	Project Background Instructions
	Project Background
Step TWO	**Sponsor Data**
	Sponsor Baseline Instructions
	Sponsor SCC Main Worksheet
	Sponsor SCC Inflation Calculations
Step THREE	**PMOC Adjustments to Stripped Sponsor Base**
	PMOC Baseline Adjustments Instructions
	--Risk Profiles
	Risk Profile Descriptions
	Risk Profile Values Breakdown
	---Base Year Adjustments
	PMOC Adjustments to Sponsor Base Year Values
	---Year of Expenditure (YOE) Adjustments
	PMOC Global adjustments to Sponsor inflation
	PMOC Inflation adjustments by profile and calculation of PMOC- Inflated, Adjusted, Stripped Estimate
Step FOUR	**PMOC Risk Assessment**
	Risk Assessment Instructions
	---Assign Project Base Uncertainty and Specific Risk
	Assign Project Uncertainty (Beta values) Instruction
	Project-specific Risk Instruction
	PMOC Risk Profile 1 Assessment
	PMOC Risk Profile 2 Assessment
	PMOC Risk Profile 3 Assessment
	PMOC Risk Profile 4 Assessment
	Summary additional Profiles from addendum workbook
	---Risk Assessment Total
	PMOC Risk Profile Total Assessment
Step FIVE	**PMOC Project Risk Analysis**
	Risk Assessment Analysis Instructions
	Risk Assessment Analysis
	Reporting Graphic
Appendices	**Beta Factor Standards**
	Standards Instruction
	DBB / CMGC Beta Uncertainty Standard
	DBB Beta Drawdown Graphs
	Beta factor tools
	Project-specific Risk Calculations
	SCC 10-50 Beta Calculations
	SCC 60 / 70 Beta Calculations
	SCC 80 Beta Calculations
	Other Helpful Tools and Information
	Inflation / Deflation Calculator
	Cost Risk Calculations Schema

APPENDIX M: GLOSSARY OF MITIGATION TERMS

Appendix M contains a glossary of risk mitigation terms, as defined for Federal Transit Administration (FTA) risk assessments.

MITIGATION STRUCTURE

Mitigation Structure refers to defined roles of whom and how the project sponsor and their consultants and contractors respond to risks identified in the review process. This structure consists of three parts: Primary Mitigation, Secondary Mitigation, and Contingencies.

Primary Mitigation occurs during all project phases and is the result of the planned actions of the Risk Management Plan and recommendations of the Project Management Oversight Contractor (PMOC). Mitigation activities should be scheduled at the earliest phase during which the mitigation activity may occur and should be completed quickly so that cost and schedule risks can be reduced early. Examples of mitigation might be completing a design or performing a geotechnical survey.

Secondary Mitigation consists of pre-planned, potential scope, or process changes that do not change the basic requirements and functionalities of the project. Secondary Mitigation may be triggered when risk events cause overuse of project contingencies; where such potential changes are unavailable on a project, additional contingency allowances may be required to protect the project. Example events that may trigger secondary mitigation include construction bids that are significantly over the estimate, or unexpected geotechnical hazards that are encountered and cause the project to be significantly over budget. Such "triggered" mitigation enables the project sponsor to make cost reductions in a planned and orderly process and preserves contingencies for use later in the project. Secondary Mitigation is fundamentally different than value engineering, which is a formal, systematic, multi-disciplined process designed to optimize the value of each dollar spent.

Contingencies are set-aside estimated amounts (monetary set-asides for cost and time set-asides for schedule) that are included within the overall cost or schedule targets for the project. The amounts are to be used to overcome increases in cost or schedule that are caused by potential risks. Contingency amounts may be associated with an activity or category of cost or may be set aside in a general fund. In most cases, the project's risk decreases as the project progresses toward completion. Because of risk decreasing over a project's life, the amount of required contingency also decreases. However, some contingency should always be available even beyond project completion.

MITIGATION TYPES

Risk Avoidance is available when project elements may be alternatively delivered through a less-risky process or design or may be eliminated.

Risk Transfer occurs when responsibility and consequences for risk are transferred to a party other than the project sponsor. Risk transfers may be partial or complete. Risk is transferred to a third-party through contract requirements, warranties, or insurance policies. The PMOC may

recommend risk transfers or may recommend scope changes to transfer risk to parties better suited to mitigate risk.

Risk Reduction is a planned action that will either reduce the consequence or the likelihood of a risk event. When listing risk reduction, the PMOC should annotate: 1) The cause of the risk, 2) the possible outcomes of the risk, 3) how the mitigation measures will reduce the risk, 4) who within the project sponsor organization or project team will carry out the mitigation, and 5) the timing to effectively implement that mitigation or action.

Risk Acceptance results from the recognition that further reduction of a risk would only come at the expense of the project's fundamental goals, such as unacceptable service loss or cost increase, etc. or the cost of risk mitigation outweighs the benefits. Risk acceptance may be a preferred method to deal with those risks that are of a high-level of impact yet low level of probability and that mitigating them would put an undue financial burden on the project. Risk acceptance involves the potential consumption of project cost or schedule contingencies, project schedule float, leading to a potential increase in either project estimate or schedule.

APPENDIX N: CONTINGENCY DRAWDOWN GUIDELINES

Appendix N presents guidelines for establishment of schedule and cost contingency drawdown curves.

During project implementation, the cost and schedule contingency consumed is documented, and actual remaining contingency (by subtraction) is compared to the drawdown curves' minimum contingency levels at that point in project advancement. The Risk and Contingency Management Plan (RCMP) defines actions to be taken if either cost or schedule contingency consumption is such that the remaining contingency is trending to drop below the defined minimum contingency curve.

SCHEDULE CONTINGENCY DRAWDOWN CURVE

The project sponsor shall prepare a schedule contingency drawdown curve taking into consideration the minimum contingency requirements as determined by the following Forward Pass and Backward Pass schedule contingency analysis methods at each of the Federal Transit Administration (FTA) major project milestones and additional milestones as identified by the project sponsor and the Project Management Oversight Contractor (PMOC).

Forward Pass Schedule Contingency Analysis (Generalized Contingency Levels)

The initial schedule contingency drawdown curve shall follow the two principles below:

- The amount of schedule contingency required as the starting point of the schedule contingency drawdown curve is the amount determined by a recent schedule risk analysis; and
- For future project progression milestones and based on FTA historic project information, a nominal schedule contingency amount that is to be available at any major future project progression milestone should be sufficient to absorb a project schedule delay equivalent to 25 percent of the duration from the project progression milestone to the Revenue Service Date (RSD) proposed for the project, calculated based on 25 percent of the non-contingency schedule.

Backward Pass Schedule Contingency Analysis

The schedule contingency drawdown backward pass analysis shall be performed by sequentially "stepping back" in time from the end of the project through various completion milestones for the project, considering the schedule uncertainty and risks that remain at each given milestone under consideration and an assessment of the minimum total schedule contingency that may be required to address those risks at that point in time. This process should include a thorough review of the risk register and knowledge of project conditions, especially of those items identified with a high schedule risk.

COST CONTINGENCY DRAWDOWN CURVE

Similar to the schedule contingency drawdown curve above, the cost contingency drawdown curve shall be prepared by the project sponsor taking into consideration the minimum contingency requirements as determined by the following Forward Pass and Backward Pass cost contingency analysis methods at each of the FTA major project milestones and any additional milestones as identified by the project sponsor and the PMOC. Cost contingency curves should be developed for each risk profile. The curves may then be summed across time to develop a project-level cost contingency drawdown curve.

Forward Pass Cost Contingency Analysis (Generalized Contingency Levels)

FTA has determined, from historic project information, that the following minimum levels of contingency (the aggregate of allocated and unallocated cost contingency) are prudent, where the amount of contingency is calculated as the percentage noted multiplied by the current estimate at completion, without contingency:

- At nominal 15 percent design level, 40 percent contingency;
- At nominal 30 percent design level, 33 percent contingency;
- At nominal 60 percent design level, 26 percent contingency;
- At nominal 95 percent design level (pre-bid), 20 percent contingency;
- At nominal 100 percent design level (post-bid/construction start), 13 percent contingency;
- At nominal 20 percent construction completion, 9 percent contingency;
- At nominal 50 percent construction completion, 7 percent contingency;
- At RSD, 1 percent contingency.

The above contingency estimates are based on an FTA risk-tolerance level at P65 and may be straight-line interpolated for points of completion between the above milestones (see Figure N-1). When construction contracting precedes the completion of design (such as often exists with Design-Build (DB) or other Project Delivery Methods (PDMs), the cost contingency analyst should adjust appropriately from the guidance above. Further, when a project is broken into multiple risk profiles or phases, the above analysis should be made independently for each profile and the profiles added across time to achieve a total project contingency drawdown curve.

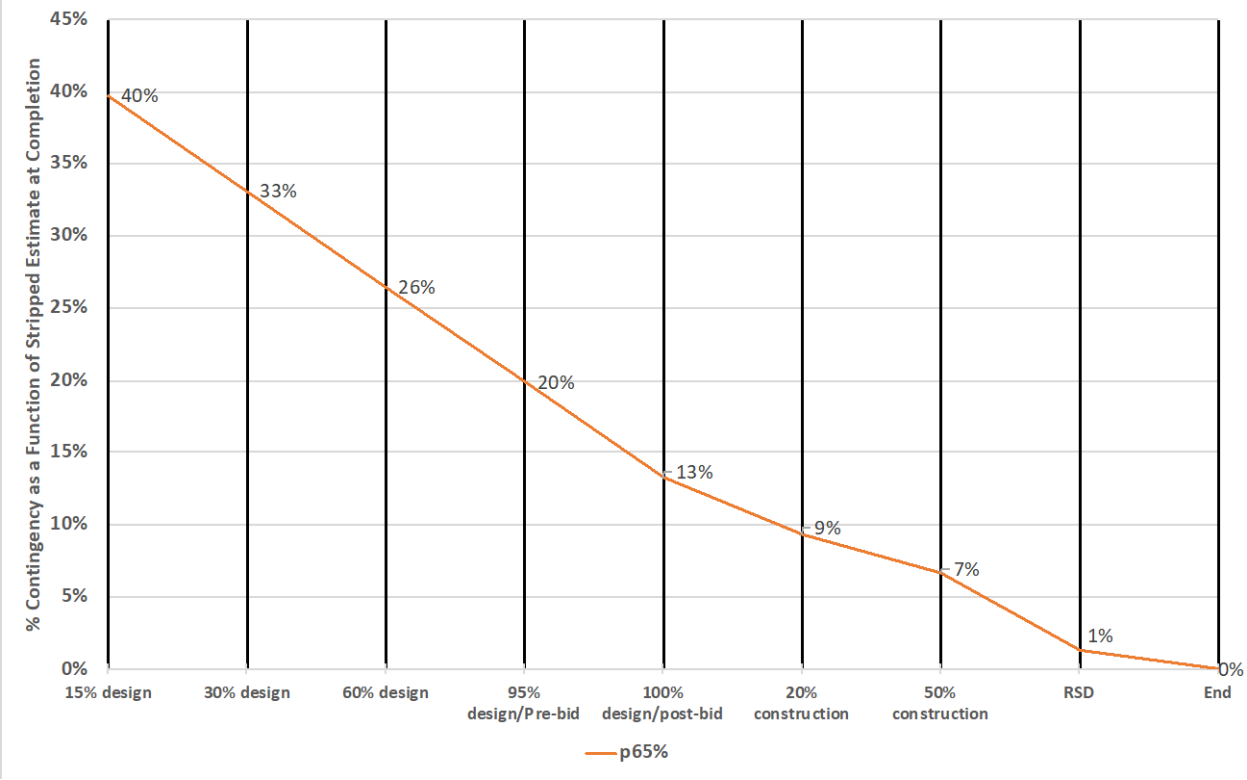


Figure N-1 FTA Top-Down Model Nominal Contingency Levels (P65) by Project Phase

The above generalized contingency levels reflect historic risk undertaken through mostly Design-Bid-Build (DBB) delivery methods, at the prescribed FTA risk-tolerance level of P65 percent. When alternate delivery methods are used, some portion of project sponsor risk associated with design and procurement (Design, Market, or Construction Risk Categories) may be transferred to the contractor (at a cost that has been included in the contractor's price) at points in project advancement that differ from the above graphic. A breakdown of these elements and an analysis of the actual design, bid, or construction progression is necessary to determine how much risk is transferred and the resulting contingency requirements.

These generalized contingency levels are to be used as the Forward Pass for the preparation of the Cost Contingency Drawdown Curve. In the case of multiple project phases that are in different levels of development, or significant portions that exhibit differing risk profiles, a project forward pass contingency curve may be constructed as the addition of several contingency curves reflecting each significant project portion.

Backward Pass Cost Contingency Analysis

The Backward Pass method considers the project-specific risks that remain or are likely to remain at any given milestone under consideration and an assessment of the minimum total cost contingencies that may be required to address those risks. This process should include a thorough review of the risk register, especially the anticipated duration of each of the risks along with risk probabilities and magnitudes. Items of high risk identified in the risk register, especially those identified with the Mitigation Type of "Risk Acceptance," or for which

prescribed mitigation actions may not be effective, shall be specifically reviewed when performing the backward pass analysis.

This process begins by considering the final stages of the project (say RSD) and determining how large of a contingency fund should remain in the project budget to solve potential risk-laden events that remain at that milestone. This amount becomes the minimum amount of contingency that should be maintained at that final stage. The next step is to work backwards and consider another point in time when the project is less complete (say at 50 percent completion) and to similarly determine the size of contingency fund that should remain available at the 50 percent completion time to address active risks. This process is completed—moving backwards stage by stage toward the beginning of the project—until the current phase is reached.

APPENDIX O: RISK AND CONTINGENCY MANAGEMENT PLAN CONTENT

Appendix O contains the suggested guidelines for the Project Management Oversight Contractor (PMOC) review of the project sponsor's Risk and Contingency Management Plan (RCMP).

Note: the following narrative for potential content of the RCMP contains elements or details that may not be appropriate for all phases of the project. For example, early in the design phase, some details may be undeveloped and only broad characterization of project elements or risk management plans may be available. The PMOC's review of the project sponsor's RCMP should appropriately consider the phase of the project development, and the PMOC should adjust their review accordingly.

The RCMP is a subplan of the project sponsor's Project Management Plan (PMP); its successful implementation depends upon a fully updated and active PMP. The purpose of the RCMP is to highlight specific areas of management focus as identified through the risk evaluation process, which should be implemented along with project sponsor's normal project operations as described elsewhere within the PMP. Further, the RCMP provides a means for monitoring the project sponsor's progress as it moves the project forward to its next phase. These areas of management focus may include actions to strengthen Management Capacity and Capability (MCC), project performance, cost and schedule analyses, mitigations of identified project risks, and others.

Information contained within the RCMP should complement and not conflict with information contained elsewhere within the PMP or in other Federal Transit Administration (FTA) guidance documents. Such areas of concordance should include, for example, the project estimate and schedule, FTA's completion criteria for the various phases such as Entry to Engineering and Full Funding Grant Agreement (FFGA)/Small Starts Grant Agreement (SSGA), master checklists for being considered ready to proceed into the next phase, as well as associated FTA PMOC work products used to review the various technical elements or core assumptions of the project, etc.

Successful implementation of the RCMP is important to the goals of both the project sponsor and FTA; monitoring of the RCMP implementation will be undertaken by both the project sponsor and the FTA (through the PMOC). It is important, therefore, that the FTA, PMOC, and project sponsor work collaboratively and develop agreement on the substance of the RCMP.

It is the project sponsor's responsibility to actively and purposefully exercise risk-informed management of their project, and therefore the RCMP needs to fit within the specific management structure of each project sponsor's organization. However, it is important that the RCMP clearly and completely define the Who, What, When, Why, and How of the project sponsor's Risk and Contingency Management process.

Introduction/Forward

- Include a statement of the project sponsor's management commitment to risk-informed project management, and
- Acknowledge that the RCMP is part of the PMP, and that it will be used by the project and the FTA/PMOC to assess the health of the project on an ongoing basis.

Project Sponsor's Risk Organization

- Identify the project team members who have a role in the administration of the RCMP, including their responsibilities (and limits of responsibilities as applicable), and
- Identify project-specific organizations (committee/task force/Working Group, etc.) and the corresponding role in the Risk and Contingency Management process, including the members and reporting paths.

Best Practice:

- *It is recommended that the project sponsor assign a designated representative to act in the role of Risk Manager, as risk management is the responsibility of the Project Team and not the FTA/PMOC. This individual can be part of the project sponsor's Team or can be a representative outside of the project, but in all cases to avoid conflict of interest, this representative should maintain some degree of independence from project management and also have the direct authority to conduct follow-up activities associated with updates to the risk register, evaluating the success or implementation of mitigations, and evaluating the Cost and Schedule Contingencies consistent with the Drawdown tables and curves included in the RCMP. Additionally, it is recommended that the project sponsor assign risk stewards responsible for monitoring each risk and implementing the mitigation strategy for significant risk events.*

Project Risk Matrix

- Include the proposed (pre-contract) or actual (post-contract) Risk Allocation Matrix for all major contracts, related to the chosen Project Delivery Method(s) (PDM(s)).

Risk identification, Assessment and Response Process

- Define the process:
  - For initial risk register preparation, define the information to be stated for each risk, including the scoring and ranking rubrics to be used.
    - Include risk type(s). i.e., requirements, design, market, or construction.
    - Include risk connection to Standard Cost Category (SCC) codes and schedule activity codes.
  - For ongoing periodic review/update of the risks, define the process to address:
    - Has the risk definition changed (document reason)?
    - Have risk probability or impacts changed (document reason)?
    - Are the prescribed mitigations being implemented?
    - Are mitigations being effective?/Do new mitigations need to be defined?
    - Can the risk be retired?
  - Address how emerging risks are identified and incorporated into the Risk Register.

  - Address how discrete events, including the FTA/PMOC-led Risk Assessment and/or project-sponsor-led Risk Assessment fit into the process.
  - If project sponsor-performed quantitative risk models are to be used, identify the specific models/software.
  - Discuss how an assessment of individual risks relates to project contingencies.
- Define the forum(s), for example:
  - Risk workshop (and at what proposed points in the project advancement);
  - Risk Committee/Task Force/Working Group, etc. meetings; and
  - Other regularly scheduled project meetings.
- Define frequency:
  - Define reports or deliverables (and their content) that are produced by this process, the report frequencies, who prepares them and who receives them.

Best Practices:

- *A flowchart may be helpful to define the routine risk register update process.*
- *The risk register may be a stand-alone document incorporated by reference in the RCMP, as opposed to an included appendix of the RCMP, since the risk register will likely need to be updated much more frequently than the RCMP itself. In this case, the risk register should also show the rubrics being used to score and rank the risks.*
- *Including a discussion of project risks in other project meetings heightens awareness and also encourages non-risk committee/task force/working group members of the project team to identify other potential risks from their perspective.*
- *Risks should not be "retired" based on significant progress (probability may be reduced, though), but should be retired only after "the ink is dry". It should also be acknowledged that retired risks may need to be brought back into active status under certain changed circumstances.*
- *The RCMP revisions should coincide with significant events during the project progression, and no less frequently than each FTA project advancement milestone or at least approximately annually, as well at any project event that results in a major change in project risk profile. It is important to note that project sponsor risk register reviews, including risk identification and risk mitigation updates, occur more frequently, often no less frequently than monthly.*

Contingency Management

- Include the Contingency Drawdown Curves and associated tables of values for both cost and schedule contingency and define how they were prepared.
- Describe how the consumption of cost and schedule contingency is tracked and identify who is responsible for tracking and reporting it.
- Define the processes for:

  - Comparing actual remaining contingency to the minimum contingency prescribed by the Drawdown curves;
  - Implementing non-contingency mitigations when a project change would otherwise cause remaining contingency to drop below the minimum required contingency amount; and
  - Reallocating unused budget to contingency for potential future cost contingency needs.
- Include authorities and procedures for the distribution, transfer and use of cost contingencies, and procedures used to trend contingency usage.
- Define reports or deliverables (and their content) that are produced by this process, their frequency, who prepares them and who receives them; include reporting remaining contingency vs. drawdown curve required minimum contingency with the project cost updates provided to FTA/PMOC.
- Describe the plans to recover in those cases where cost estimates or schedule forecasts indicate that contingency levels have fallen below the minimum planned contingency amounts, including as necessary implementation of a formal Recovery Plan or adjustment of the expected project final cost/schedule with FTA approval.

Best Practices:

- *The RCMP can include by reference already existing agency policies and/or procedures for change control, such as Change Control Boards, contingency reporting systems, process for Board of Directors approvals (if required), etc.*
- *Since project schedules are subject to change, it is considered more accurate to define the x-axis of the drawdown curve by project milestone instead of an absolute calendar date. Then the currently projected calendar dates can also be included for reference.*

RCMP Management

- Define who is responsible for preparing and maintaining the RCMP.
- Describe the frequency and process for revising/updating the RCMP.
- Define reporting to key project stakeholders beyond the project team, including the FTA and agency administrators, etc. Include report content and frequency of reporting.

APPENDIX P: REPORT FORMAT

Appendix P presents the report format the Project Management Oversight Contractor (PMOC) shall follow when preparing the written report Additionally, the PMOC shall attach the most current project sponsor Standard Cost Category (SCC) estimate, schedule, and other related documents, and include the OP 40 Cost Risk Workbook model used for the PMOC cost risk analysis.

Reporting should occur soon after conclusion of the risk workshop and any associated risk modeling; timely reporting will facilitate the project sponsor's early adoption of the recommended risk mitigation measures into the Project Management Plan (PMP).

In the conduct of this report, the PMOC shall use their professional judgment to identify and categorize, assess, and evaluate the uncertainties in the project sponsor's project information, considering the project's administrative, management, political, legal, financial, and physical conditions. The PMOC will document and report their professional opinions and their recommendations for responding to identified risk, including recommendations for mitigations including contingencies. Unless otherwise directed, the report will be sectioned as follows:

TITLE PAGE

Include the following disclaimer:

Disclaimer Insert: This Project Management Oversight Contractor (PMOC) report and all supporting reports and back up materials contain the findings, conclusions, professional opinions, and recommendations stemming from a risk-informed evaluation and assessment, prepared solely for the Federal Transit Administration (FTA). This report should not be relied upon by any party, except FTA or the project sponsor, in accordance with the purposes of the evaluation and assessment as described below. For projects funded through FTA's Major Capital Investment Grant (New Starts) program, FTA and its PMOCs use a risk-informed process to review and reflect upon a project sponsor's scope, schedule, and cost, and to analyze the project sponsor's project development and management. This process is iterative in nature. The results represent a "snapshot in time" for a particular project under the conditions known at that point. The evaluation or assessment and related results may subsequently change due to new information, changes in circumstances, additional project development; specific measures a project sponsor may take to mitigate risks, project sponsor's selection of strategies for project execution, etc.

EXECUTIVE SUMMARY

The PMOC should provide an executive summary in three pages or less that includes the following:

1. Purpose
2. Project description
3. Baseline summary of findings from PMP, scope, schedule, cost, or other salient reviews
4. Risk results in the Executive Summary format and PMOC's professional opinion and recommendations regarding:

a) Top Risks and recommended actions;
b) Project schedule risk assessment results (P40, P50, P65, and P80); schedule target and contingency recommendations, including the top-down contingency value of 125 percent of the remaining duration of the critical path; and other recommendations;
c) Project cost risk assessment results (P40, P50, P65, and P80); budget target and contingency recommendations; and other recommendations; and
d) Summary of project sponsor risk and contingency management review process.

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PROJECT BACKGROUND

Project descriptions and data shall be consistent with the monitoring report guidance, current monitoring report and the most recent FTA project profile. Notwithstanding the foregoing, FTA may direct the PMOC to use an identifiable draft version of these materials. Ridership shall include peak hour ridership data. Sub-sectioning shall also include Guideway Components, Project Delivery Method (PDM), proposed contract packaging strategy and, as applicable, master planning for the corridor.

SUMMARY OF PROJECT STATUS FROM OTHER OPs

Summary-level information from project sponsor Management Capacity and Capability (MCC), project scope, project estimate, and project schedule reviews. Include elements from prior reviews that are particularly important to developing an understanding of the issues presented later in this report.

RISK IDENTIFICATION

Provide a summary of the process used for identification of risks and provide a narrative discussion of key risk events (categorized by SCC), including their potential impact on the project. Characterize the remaining elements of the risk register, which is to be attached to the risk report as an appendix.

RISK ASSESSMENT

For projects with prior risk reviews, include comparisons of the currently assessed project risk to the prior-assessed project risks and comment on the changes indicated.

Discuss the third-party agreements and any issues and obstacles that the PMOC foresees.

PMOC Schedule Risk Assessment. This section shall present the findings resulting from the PMOC schedule risk modeling, including characterization of specific risks that influence important schedule activities; development and amendment of the modeled risk schedule activities, uncertainty ranges for activity durations, and; characterization of the results of the schedule risk modeling, including confidence levels for achieving the project sponsor's Revenue Service Date (RSD) target; the PMOC's professional opinion regarding the FTA-

prescribed confidence level for RSD; recommended amount of schedule contingency; and PMOC's recommended actions.

PMOC Cost Risk Assessment. Provide a summary of key risks that influence PMOC's characterization of the level of project risk by SCC. Describe the PMOC methodology used to establish the risk assessment. Further, present any cost estimate adjustments and selection of cost range factors; especially discuss any factors that vary from standard recommendations. The PMOC shall present detailed data and analysis in a separate appendix as necessary to maintain the readability of the report.

RISK MITIGATION

The purpose of this section is to present the PMOC's review of project sponsor's risk mitigation efforts, including any recommendations for any adjustment of project sponsor risk mitigation. The report should include separate subsections for Primary Mitigation, Secondary Mitigation and Contingency Recommendations.

Primary Mitigation - Specific recommendations regarding the project sponsor's mitigation processes shall be presented. Where specific mitigations are recommended, include appropriate timeframes for completion of the mitigation activity, especially focused on those mitigations considered necessary for successful approval at the current or next FTA milestone.

For projects with prior risk reviews, include discussions (as appropriate for project phase) of project sponsor's historic mitigation efforts by Risk Category.

Secondary Mitigation – If appropriate for the project, characterize the project sponsor's efforts at identification of potential Secondary Mitigation. Note that the FTA does not require a specific number nor amount of Secondary Mitigation items.

Contingency - Provide a narrative comparing minimum recommended levels of both cost and schedule contingency as compared to project sponsor's planned contingencies. Further, provide graphical or tabular representations of the project sponsor's contingency draw-down curves, including review comments and PMOC's recommendations for adjustment, if any.

RISK AND CONTINGENCY MANAGEMENT PLAN

Provide a narrative review of the project sponsor's Risk and Contingency Management Plan (RCMP), including the sufficiency of efforts to manage risk across the project; organizational responsibilities; reporting of risk, especially reporting to project sponsor administration and funding stakeholders; timing of the various risk management efforts (risk identification and mitigation assessment, mitigation, etc.)

CONCLUSION

APPENDICES

As required, include the following or other additional information:

- Risk register;
- Project sponsor data characterization;
- Descriptive listing of documents used in this analysis; and
- Risk Results Summary as shown in the example below.

RISK RESULTS SUMMARY

FTA/PMOC Project Risk Results	
Risk Workshop Date: Enter Workshop dates	
Project Name: Enter project name (same as FTA grant name)	
Project Sponsor: Enter project sponsor name	
Project Phase: Enter FTA CIG phase	
Project Type: Enter project mode	
Project Delivery Method: Enter method	
Key Project Scope Elements	**Summary Cost Risk Results (Excludes Financing)**
## miles	Grantee Estimate: $###.# M
## stations/## platforms	P-value of Grantee Estimate: P##
# of other features, e.g., surface Park and Ride lots, etc.	P50 Estimate: $###.# M
# and type of vehicles	P65 Estimate: $###.# M
	P80 Estimate: $###.# M
Comment on whether project sponsor's budget is considered sufficient and has met FTA's P65 requirement	
Top Project Risks	**Summary Schedule Risk Results** (highlight the recommendation)
	Grantee RSD: ##/##/####

FTA/PMOC Project Risk Results	
Enter top Risk	P-value of Grantee Date: P##
Enter top Risk	P65 Date: ##/##/####
Enter top Risk	FTA 125%: ##/##/####
	P80 Estimate: ##/##/####
Comment on whether project sponsor needs to add ### Calendar days to their schedule to meet FTA's required RSD	

APPENDIX Q: ACRONYMS

Acronym	Term
ACOR	Alternate Contracting Officer's Representative
ADA	The Americans with Disabilities Act
AGC	Associated General Contractors of America
ATC	Alternative Technical Concepts
AVS	Associate Value Specialist
BEA	Bureau of Economic Analysis
BLS	Bureau of Labor and Statistics
BRF	Beta Range Factor
BY	Base Year
CATEX or CE or CX or Exclusion	Categorical Exclusion
CCIP	Contractor Controlled Insurance Program
CE	Categorical Exclusion
CER	Cost Estimating Relationship
CFR	Code of Federal Regulations
CIG	Capital Investment Grant
CLIN	Contract Line Item Number
CM	Construction Manager

Acronym	Term
CM/GC	Construction Manager/General Contractor
CMAR	Construction Manager at Risk
COR	Contracting Officer's Representative
CPM	Critical Path Method
CPTED	Crime Prevention Through Environmental Design
CR	Constructability Review
CVS	Certified Value Specialists
DB	Design-Build
DBB	Design-Bid-Build
DBE	Disadvantaged Business Enterprise
DBF	Design-Build-Finance
DBFOM	Design-Build-Finance-Operate and Maintain
DBOM	Design-Build-Operate and Maintain
DEIS	Draft Environmental Impact Statement
DF	Designated Function
DHS	Department of Homeland Security
DTS	Department of Transportation Services
EA	Environmental Assessment
EIS	Environmental Impact Statement

Acronym	Term
EMP	Emergency Management Plan
ENR	Engineering News-Record
EPCM	Engineering/Procurement/Construction Management
ESWA	Early Systems Work Agreement
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FFGA	Full Funding Grant Agreement
FHWA	Federal Highway Administration
FLSSC	Fire/Life Safety and Security Committee
FONSI	Finding of No Significant Impact
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
GAO	Government Accountability Office
GC	General Contractor
GC/CM	General Contractor/Construction Manager
GMP	Guaranteed Maximum Price
HAZMAT	Hazardous Materials
IP	Implementation Plan
LONP	Letter of No Prejudice

Acronym	Term
LPA	Locally Preferred Alternative
MBE	Minority Business Enterprise
MCC	Management Capacity and Capability
MDBF	Mean Distance Between Failures
MPO	Metropolitan Planning Organization
NEPA	National Environmental Policy Act
NTE	Not-to-Exceed
NTP	Notice to Proceed
O&M	Operation and Maintenance
OCIP	Owner Controlled Insurance Program
ODCs	Other Direct Costs
OHA	Operational Hazard Analysis
OIG	Office of Inspector General
OMP	Operations and Management Plan
OP	Oversight Procedure
P3	Public Private Partnership
PCMG	Project and Construction Management Guidelines
PD	Project Development
PDM	Project Delivery Method

Acronym	Term
PHA	Preliminary Hazard Analysis
PMO	Project Management Oversight
PMOC	Project Management Oversight Contractor
PMP	Project Management Plan
POP	Project Oversight Plan
PTASP	Public Transportation Agency Safety Plan
QA/QC	Quality Assurance/Quality Control
R&D	Research and Development
RAMP	Real Estate Acquisition Management Plan
RAP	Rail Activation Plan
RCMP	Risk and Contingency Management Plan
RET	Risk Evaluation Tool
RFI	Request for Information
RFP	Request for Proposal
RFQ	Request for Qualifications
ROD	Record of Decision
ROW	Right-of-Way
RSD	Revenue Service Date
S/DBE	Small/Disadvantaged Business Enterprises

Acronym	Term
SABCE	Stripped and Adjusted Base Cost Estimate
SABS	Stripped and Adjusted Base Schedule
SAVE	Society of American Value Engineers
SCC	Standard Cost Category
SCIL	Safety Certifiable Items List
SGR	State of Good Repair
SIT	System Integration Testing
SITP	Systems Integration Test Plan
SOP	Standard Operating Procedure
SOW	Scope of Work
SSCVR	Safety Certification Verification Report
SSGA	Small Starts Grant Agreement
SSI	Sensitive Security Information
SSMP	Safety and Security Management Plan
STIP	Statewide Transportation Improvement Program
SYGA	Single Year Grant Agreement
TAR	Travel Authorization Request
TBM	Tunnel Boring Machine
TCC	FTA Office of the Chief Counsel

Acronym	Term
TCRP	Transit Cooperative Research Program
TIFIA	Transportation Infrastructure Finance and Innovation Act
TIGER	Transportation Investment Generating Economic Recovery
TIP	Transportation Improvement Program
TOD	Transit-Oriented Development
TPE	FTA Office of Planning and Environment
TPM	FTA Office of Program Management
TRB	Transportation Research Board
TSA	Transportation Security Administration
TVA	Threat and Vulnerability Assessment
URA	Uniform Relocation Assistance and Real Property Acquisition Act
U.S.C.	United States Code
VE	Value Engineering
VECP	Value Engineering Change Proposals
WBE	Women Business Enterprise
WBS	Work Breakdown Structure
YOE	Year of Expenditure