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6. AUTHOR(S) Kam Shadan, lead author*

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PMA Consultants LLC
226 W. Liberty Street
Ann Arbor, MI 48104

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11. SUPPLEMENTARY NOTES* Assisted by: Mary Aiello, Jeffrey Plant, Bruce Stephan, Francisco Cruz, Ken VanderJagt, Scott Rodda, Richard Garrabrant, Dr. Dorothy Schulz, Robert Merryman, Arun Virginkar

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13. ABSTRACT This is the newest version of the document originally published in September 1990 and updated four times, most recently in March 2016. The document is addressed to an experienced project sponsor working with multiple project managers to implement a major capital improvement program or bundle of projects. It is not the same as the FTA *Construction Project Management Handbook* written for transit project managers in smaller transit agencies implementing a large capital project. These guidelines incorporate the latest from FTA publications and include updates from relevant sections of the Infrastructure and Investment Jobs Act enacted in November 2021 (aka the Bipartisan Infrastructure Law [BIL]); the 2020 U.S. Government Accountability Office *Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Program Costs;* and the FTA January 2025 *Capital Investment Grants Policy Guidance*. It covers general principles of transportation and environmental planning but defers details to documents published by the FTA Office of Planning and Environment and other FTA circular and guidance documents.

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Throughout this update, FTA's Dale Wegner provided direction on content modifications. Selected FTA subject matter experts were asked to review various sections of the initial draft of the *Guidelines*.

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ABBREVIATIONS

AA	Alternatives Analysis
AACE	Association for the Advancement of Cost Engineering International
AC	Alternating Current
ADA	Americans with Disabilities Act
AHJ	Authorities Having Jurisdiction
AI	Artificial Intelligence
APM	Automated People Mover
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ATC	Alternative Technical Concept
BABA	Build America, Buy America
BAFO	Best and Final Offer
BFMP	Bus Fleet Management Plan
BRT	Bus Rapid Transit
CBTC	Communications-Based Train Control
CCTV	Closed-Circuit Television
CE	Categorical Exclusion
CFR	Code of Federal Regulations
CIG	Capital Investment Grant
CIL/CEL	Certifiable Items List (also referred to as a Certified Elements List)
CIP	Capital Improvement Program
CM	Construction Manager/Management
CM/GC	Construction Manager/General Contractor
CMAA	Construction Management Association of America
CMR or CMAR	Construction Management/Manager At-Risk
CPM	Critical Path Method
CPTED	Crime Prevention Through Environmental Design
CSI	Construction Specifications Institute
CSSM	Construction Safety and Security Manual
CVS	Certified Value Specialist
DB	Design-Build
DBB	Design-Bid-Build
DBE	Disadvantaged Business Enterprise
DBIA	Design-Build Institute of America
DC	Direct Current
DHS	Department of Homeland Security
DMU	Diesel Multiple Unit
DOT	Department of Transportation
DoR	Designer of Record
DRB	Dispute Review Board
EA	Environmental Assessment
EEO	Equal Employment Opportunity
EIS	Environmental Impact Statement

ABBREVIATIONS

ESWA	Early Systems Work Agreement
EVM	Earned Value Management
FAA	Federal Aviation Administration
FAR	Federal Acquisition Regulations
FEIS	Final Environmental Impact Statement
FFGA	Full Funding Grant Agreement
FLSC	Fire-Life Safety Committee
FLSSC	Fire-Life Safety and Security Committee
FMO	Financial Management Oversight
FMP	Fleet Management Plan
FMVSS	Federal Motor Vehicle Safety Standards
FONSI	Finding of No Significant Impact
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
GBR	Geotechnical Baseline Report
GEC	General Engineering Consultant
GMP	Guaranteed Maximum Price
HA	Hazard Analysis
HRT	Heavy Rail Transit
HRV	Heavy Rail Vehicle
HVAC	Heating Ventilation and Air Conditioning
IMPS	Integrated Master Project Schedule
IoT	Internet of Things
ISO	International Organization for Standardization
ITP	Integrated Test Plan
KPI	Key Performance Indicator
LONP	Letter of No Prejudice
LPA	Locally Preferred Alternative
LRT	Light Rail Transit
LRV	Light Rail Vehicles
MCC	Management Capacity and Capability
MCP	Major Capital Project
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NS	New Starts
NTD	National Transit Database
NTP	Notice to Proceed
O&M	Operating/ion and Maintenance
OBS	Organizational Breakdown Structure
OCS	Overhead Contact System
OLI	Operation Lifesaver, Inc.
OSHA	Occupational Safety and Health Administration
OSR	Operating Spares Ratio
PD	Project Development

ABBREVIATIONS

PHA	Preliminary Hazard Analysis
PLA	Project Labor Agreement
PM	Project/Program Manager/Management
PMI	Project Management Institute
PMIS	Project Management Information System
PMO	Project Management Oversight
PMOC	Project Management Oversight Contractor
PMP	Project Management Plan
PPHPD	Persons Per Hour Per Direction
PRO	Pre-Revenue Operations
PTASP	Public Transportation Agency Safety Plan (commonly referred to Agency Safety Plan)
PTC	Positive Train Control
PVR	Peak Vehicle Requirements
QA	Quality Assurance
QC	Quality Control
QMP	Quality Management Plan
RAC	Rail Activation Committee
RAM	Rail Activation Manager
RAMP	Real Estate Acquisition and Management Plan
RAP	Rail Activation Plan
RCMP	Risk and Contingency Management Plan
RE	Resident Engineer
RFI	Request for Information
RFMP	Rail Fleet Management Plan
RFP	Request for Proposal
RFQ	Request for Qualifications
ROD	Record of Decision
ROW	Right of Way or Rights of Way (also R/W)
RSD	Revenue Service Date (formerly Revenue Operations Date)
SAVE	Society of American Value Engineers
S/DBE	Small/Disadvantaged Business Enterprise
SC	Safety Certification
SCC	Standard Cost Categories
SGR	State of Good Repair
SIT	System Integration Test
SITC	System Integration Test Committee
SMS	Safety Management Systems
SOW	Scope of Work
SS	Small Starts
SSC	Safety and Security Certification
SSCC	Safety and Security Certification Committee
SSCP	Safety and Security Certification Plan
SSGA	Small Starts Grant Agreement
SSMP	Safety and Security Management Plan

ABBREVIATIONS

SSO	State Safety Oversight
SSOA	State Safety Oversight Agency
SSP	System Security Plan
SSPP	System Safety Program Plan (aka System Safety Plan)
SSPS	System Safety Program Standard
SSRC	Safety and Security Review Committee
STB	Surface Transportation Board
TAM	Transit Asset Management
TCRP	Transit Cooperative Research Program
TrAMS	Transit Award Management System
TVA	Threat and Vulnerability Assessment
ULB	Useful Life Benchmark
URA	Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970
VAC	Volts Alternating Current
VDC	Volts Direct Current
VE	Value Engineering
VECP	Value Engineering Change Proposal
WBS	Work Breakdown Structure

CHAPTER 1. INTRODUCTION

1. Purpose

The ***2025 Project and Construction Management Guidelines*** (hereafter referred to as the *Guidelines*) have been developed under Federal Transit Administration (FTA) sponsorship to assist those involved in advancing major transit capital projects to achieve implementation success in terms of project scope, function, schedule, cost, safety, and quality.

This 2025 revision is the fifth update and replaces the document originally published in September 1990 and four updated versions, most recently in March 2016. It is addressed to the more experienced project sponsor with multiple project managers implementing a major capital improvement program (CIP) or bundle of projects. It complements the FTA *Project Construction Management Handbook*, which is tailored for transit project managers in smaller transit agencies implementing large capital projects.

The *Guidelines* describe proven methods to manage a project successfully and highlight the importance of project readiness during each project cycle of Project Development (PD), Engineering, Construction, and Commissioning for major CIPs. It incorporates the latest content from FTA publications and includes updates from relevant sections of the Infrastructure and Investment Jobs Act (IIJA) Public Law 117-58 enacted November 15, 2021 (also referred to as the Bipartisan Infrastructure Law or BIL); and the U.S. Government Accountability Office (GAO) *Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs* (GAO-20-195G, 2020). It covers the general principles of transportation and environmental planning but defers further detail to documents published by the FTA Office of Planning and Environment and other FTA circular and guidance documents.

The *Guidelines* are designed for use by FTA sponsors—synonymous with a grant recipient, an owner, a transit agency, or an experienced public agency acting on behalf of the owner—and their consultants, as well as by FTA staff and Project Management Oversight (PMO) Contractors (PMOCs).

The *Guidelines* address a full range of issues and present management principles applicable to all FTA-funded capital projects. These projects could encompass a variety of modes (e.g., rail, bus, other fixed guideway); improvement types (e.g., equipment, facility); system evolutions (e.g., newly developed, expanded, modernized); and project sponsor capacities, capabilities, and maturities (e.g., newly constituted or established with experienced staff).

2. Using the Guidelines

With the exception of FTA regulatory mandates, this document is intended for use as a general reference in combination with other FTA documents and industry best practices. As indicated by its title, this document guides the reader, but it should not be used as a prescriptive manual for project execution.

Significant knowledge can also be gained by professionals in the construction industry who can enhance and complement the information conveyed throughout this document.

The *Guidelines* consist of 7 chapters covering project milestones and general management principles. Each chapter begins by describing the purpose of the chapter. The sections within each chapter provide detailed content for chapter main topics and are supported by pictures, graphics, tables, charts, and appendices as applicable. Each chapter, starting with Engineering, is organized to highlight the capacity and capability needs and management plan needs for the subject. All chapters summarize key points throughout in Important to Know and Important to Do text boxes.

Important to Know

These text boxes summarize important points for the reader on select major topics.

Important to Do

These text boxes summarize important action items for the reader on select major topics.

Important to Know 

This document is meant as a guide and not as a prescriptive manual except for federal statutory and regulatory requirements referenced.

✓ Grantees have a responsibility to comply with statutory and regulatory requirements associated with federally funded projects.

✓ FTA-mandated regulations referenced must be complied with.

✓ FTA regional offices provide additional information and resources.

✓ These guidelines are complementary to the *FTA Project Construction Management Handbook*.

✓ Additional details are available in the reference documents.

Chapter 2 – Project Development

Chapter 2 covers key activities leading to readiness to enter Engineering. It addresses general industry principles of transit and environmental planning but defers further detail to documents published by the FTA Office of Planning and Environment and other FTA circular and guidance documents.

Chapter 2 introduces topics in managing the PD such as transit planning, community outreach, third-party coordination, regulatory compliance, operational requirements, safety and security criteria, transit asset management (TAM) goals, design criteria and standards, quality management planning, and permitting agency concept design approvals.

This chapter also includes select complexities of major project elements and considerations for surface fixed guideways, aerial fixed guideways, transit tunnels, stations, railcars and buses, automated people movers, signal systems and controls, electrification and traction power, operations and maintenance (O&M) facilities, and procurement planning.

Important to Do

- ✓ Assign a project manager with adequate time and previous relevant experience.
- ✓ Organize a team early to cover all needed expertise for the phase being implemented.
- ✓ Review reference material for more detailed information.
- ✓ Document your plan for managing the project and stay with the plan.
- ✓ Plan ahead; follow the plan.
- ✓ Be flexible in revising the plan as a requirement change; keep FTA informed.
- ✓ Consult the FTA regional office for additional information.

Chapter 3 – Engineering

Chapter 3 covers key activities in Engineering leading to readiness to enter a grant agreement. It addresses topics such as the importance of third-party coordination, including utility agreements and real estate acquisition; design packaging and phasing; project delivery considerations; integrated testing and start-up planning; design reviews; scope, schedule, and cost compliance; quality assurance (QA) during design; value engineering (VE), constructability, and peer reviews; regulatory compliance considerations; transit asset management; and permitting and plan checks.

Chapter 4 – Procurement

Chapter 4 covers key activities in Procurement leading to the start of Construction. With the introduction of a variety of delivery methods beyond traditional design-bid-build (DBB), it is prudent to cover this topic in its own chapter. Information considered includes contractual requirements; special provisions; general provisions; insurance requirements; bonding; regulatory compliance; delivery methods; risk sharing; DBB; design-build (DB); progressive design-build (PDB); construction manager (CM)/general contractor (GC); construction manager at-risk (CMAR); and public-private partnerships (P3).

Chapter 4 also generally covers other nonconstruction major procurements, such as rail cars and buses, heavy machinery, signal and control systems, and automated people movers (APMs). The chapter is intended to be a complementary guide to the FTA *Best Practices Procurement & Lessons Learned Manual* (*FTA Report No. 0105,* October 2016).

Chapter 5 – Construction

Chapter 5 covers key activities in Construction leading to Commissioning and revenue service. Content includes preconstruction activities (e.g., identifying owner-furnished equipment, permits, and partnering); key submittals (e.g., schedule, equipment, contractual, and regulatory); key construction items (e.g., requests for information [RFI], change notices, change orders, claims, and safety compliance); QA/QC, payment applications, and as-builts; O&M manuals; and pre-revenue planning, including integrated testing and safety certification (SC).

Chapter 6 – Commissioning

Chapter 6 covers key activities in Commissioning leading to revenue service. Content includes establishing/modifying an operating organization to provide input throughout project execution and to assume subject assets after completion, including personnel recruiting and training and integrated testing compliance. Contractual requirements covered include system integration and operational requirements; managing rail activation (e.g., executing operating agreements); developing procedures, rule books, and manuals; pre-revenue operations (PRO); post-delivery audits for rolling stock; safety and security oversight; safety and security certification (SSC); emergency preparedness; public relations and marketing; and initial revenue service.

Chapter 7 – Project Management Principles

Chapter 7 covers key activities and general project management principles that are applicable to all other chapters, including management capacity and capability (MCC); project management plans and subplans; scope, schedule, and cost control; financial management; regulatory compliance; risk, quality, and safety and security management; document control; and information systems.

3. Working with FTA

Generally, the FTA regional or metropolitan office responsible for a specific geographic area will take the lead in providing necessary guidance. Each FTA regional office has personnel assigned for support in areas such as grants, planning, environment, procurement, program management, and legal. The project manager should establish contact with the FTA office that is responsible for the agency's project.

4. Contacting FTA

Outside of specific programs that are the responsibility of headquarters, FTA regional and metropolitan offices are responsible for implementing grants and for providing guidance to FTA grant recipients. Inquiries should be directed to either the regional or metropolitan office responsible for the geographic area in which the agency is located. To locate the FTA office responsible for serving your region, please visit the FTA website.

5. Finding Additional Information

References

Following is a list of references used in preparing both the FTA *Guidelines* and *Handbook* publications; references for each are also listed in the reference section at the end of this document.

- FTA *Buy America Handbook* (2017)
- FTA *Project and Construction Management Guidelines* (2016)
- FTA *Construction Project Management Handbook* (2016)
- FTA *Capital Investment Grants PolicyGuidance* (2023)
- Infrastructure and Investment Jobs Act (2021)
- FTA PMO Final Rule (2020)
- FTA *Best Practices Procurement & Lessons Learned Manual* (2016)
- GAO *Cost Estimating and Assessment Guide* (2020)
- FTA Project Management Oversight Program, "Utility Relocation – Challenges and Proposed Solutions" (2022)
- FTA Cost Estimation for FTA-Funded Transit Projects (2024)
- FTA *Transit Asset Management Systems Handbook* (2020)
- FTA *Quality Management System Guidelines* (2019)
- FTA *Office of Budget and Policy, Safety & Security Policy Manual* (2021)
- FTA Project Management Oversight Procedures
- FTA Lessons-Learned Program
- National Transit Database (NTD) *Safety & Security Policy Manual* (2023)

Index and Appendices

An Index is provided for searching relevant information; additional information is provided in the appendices and referenced in chapters as applicable. Appendices include the following additional FTA information for major capital project (MCP) implementation:

- Appendix A: Cost Estimation Methodology
- Appendix B: Project Contingency
- Appendix C: Utility Relocation Agreements
- Appendix D: Systems Integration & Pre-Revenue Operations Process

CHAPTER 2. PROJECT DEVELOPMENT

1. Purpose

Chapter 2 defines Project Development (PD) and familiarizes the sponsor with key activities that address general industry principles of transit and environmental planning but defers further detail to documents published by the FTA Office of Planning and Environment and other FTA circulars and guidance documents.

This chapter covers topics such as entering PD. It introduces topics in managing PD that include transit planning, community outreach, third-party coordination, regulatory compliance, operational requirements, safety and security criteria, TAM goals, design criteria and standards, quality management planning, and permitting agency concept design approvals.

Other topics covered include selected major project element considerations for surface fixed guideway, aerial fixed guideways, transit tunnels, stations, railcars and buses, APMs, signal systems and control, electrification and traction power, and O&M facilities.

For more information, refer to the FTA *Capital Investment Grants* (CIG) *Policy Guidance, January 2025*.

Project Development

PD completes the initial planning and environmental review in the project life cycle and includes developing and reviewing alternatives; selecting a locally preferred alternative (LPA)

Project Sponsor

The law specifies that a project sponsor is the entity designated to deliver the project per the terms set forth in the grant agreement. Throughout this document, we refer to such applicants as sponsors.

Recipient Definition

A recipient is defined as a direct recipient of federal financial assistance or the sponsor of an MCP. In the past, the term grantee was used for an agency that receives grants from FTA—either directly or through a third-party contract—to provide passenger transportation in a transit service area under an agreement with a state or local government.

Major Capital Project

An MCP is defined as a new fixed guideway project—or an expansion, rehabilitation, or modernization of an existing fixed guideway system—with a total project cost of $300 million or more and with a federal investment of $100 million or more.

It is not exclusively for acquisition, maintenance, or rehabilitation of vehicles or other rolling stock. The FTA administrator can designate a project to be an MCP regardless of the dollar amount. For additional information, please refer to the U.S. Code of Federal Regulations (CFR) Title 49, Part 633.

2. Grant Requirement Framework

The sponsor should comply with the grant requirement specific to the project being funded by FTA.

Project Management Oversight Program

FTA performs project management oversight (PMO) on MCPs. Usually, FTA utilizes a Project Management Oversight Contractor (PMOC) to support its PMO role.

PMO services usually begin when a project enters PD or when the FTA administrator determines it is appropriate to begin oversight.

PMO includes a review of the Project Management Plan (PMP), project scope, cost estimates, and schedules; and facilitation of a risk assessment and/or mitigation to increase the probability that a project is within scope, schedule, and budget.

Management Capacity and Capability

Project leadership and management are responsibilities of the sponsor's staff. If a sponsor is unable to provide adequate management staffing with prior experience on similar projects, the sponsor can outsource program management support consulting services while retaining decision authority and responsibility. The skills required for managing projects are different as a project moves from Project Development to Engineering and Construction and results in a handoff from the planning organization to the engineering organization and later to the construction organization in most cases. Continuity of leadership for project and program management must exist, however, throughout the project life cycle.

It is recommended that the sponsor organize a multidisciplinary design team to perform planning, engineering, and construction management services. This work is outsourced primarily to program and construction management firms, to a general engineering consultant (GEC), or to an on-call engineering consultant for planning and engineering. Note: It is not advisable that the consultant who performs PD environmental clearance and conceptual engineering continue with Engineering due to potential or perceived conflicts of interest (e.g., the consultant, if performing Engineering, may benefit from a concept design and project definition it developed). The sponsor should seek a determination from FTA regarding any conflict of interest if the sponsor considers using the same consultant.

While these approaches—or an approach using a mix of sponsor and consultant staff—can be successful, all design discipline roles and responsibilities should be covered in the PMP. Additionally, decision-making authority between the sponsor and the designer should be clearly delineated in the PMP, with the sponsor retaining final authority over all aspects of the project.

The sponsor's consultant selection should comply with the Brooks Act and be based on a consultant's qualifications, proven experience in similar work, and on a commitment to assign a manager and staff who are qualified to provide the required services.

Continuity of engineering services during design is highly desirable (i.e., the sponsor's design staff should be available throughout the Engineering). If a change in a consultant must be made during Engineering, additional time and budget should be included in the overall costs.

To facilitate successful design, transit operations should be involved during the design of a capital project. For a mature organization currently engaged in transit operations, review and approval of design decisions by operations help minimize conflicts and allow for safe and smooth integration of any improvements with existing operations. For new systems, both the consultant and sponsor's personnel, or the contracted staff responsible for operations, should be available and have sufficient expertise to perform these review functions. Other internal stakeholders—including procurement, community outreach, information systems, safety, quality, finance, accounting, legal, and real estate—should be represented on the team.

Project Management Plan

A PMP is an overarching document that demonstrates a project sponsor's authority and MCC to implement and maintain a new transit capital project together with any existing public transit system elements. Normally, PMPs and subplans are submitted initially during PD and updated through subsequent project milestones or when significant changes are identified. PMPs are required for all MCPs.

Americans with Disabilities Act

As a recipient of FTA financial assistance, a project sponsor is required to carry out provisions of the Americans with Disabilities Act (ADA) of 1990; Section 504 of the Rehabilitation Act of 1973 as amended; the Department of Transportation's (DOT) implementing regulations at 49 CFR Parts 27, 37, 38, and 39; and the guidance provided in FTA *Circular 4710.1*. These regulations require reasonable modifications to policies, practices, and procedures to avoid discrimination and to ensure accessibility to individuals with disabilities. Many public agencies form ADA advisory communities made up of key stakeholders to provide feedback to the project sponsor. An ADA compliance plan should be addressed in the PMP.

Important to Do

✓ Contact the FTA region for guidance before request for entry into PD.

✓ Form a team with experience in the FTA project development process before starting PD.

✓ Consider the impact and risk of key project elements being proposed early in planning; choose alternatives to remove or mitigate risks.

Third-Party Coordination

Identifying third-party and utility agreements in PD helps mitigate or avoid risks that could have cost and schedule impacts later in the project life cycle. Timely execution of critical third-party and utility agreements is necessary to avoid changes that are neither contemplated nor incorporated into the project's baseline scope, budget, and schedule. A lack of executed agreements could slow the progress of design, impede the start or progress of project construction, delay start-up, or interrupt operations.

Whether a third-party agreement is considered "critical" depends on a variety of factors, including the type of project, the legal authority of the project sponsor, the intended project delivery method, the project schedule, and the project progress in the PD process. Agreements that are considered critical before grant/loan award must generally be executed prior to receiving a grant/loan. Agreements not considered critical at the grant/loan approval phase may be executed later (e.g., prior to the start of service operations).

Verifying the execution of critical third-party agreements is an important part of the readiness review and is included in the PMOC's report. This report informs the FTA decision for project advancement.

Regulatory Compliance

FTA-funded capital projects need to be reviewed for compliance with federal, state, and local regulatory requirements, including the federal NEPA and other relevant federal environmental laws, and state and local authorities having jurisdiction (AHJ) on the project. The list of regulatory agencies that may have jurisdiction varies from project to project but should be developed through consultation with potential AHJs in PD.

Operational Requirements

Capital projects involving modifications or extensions to an existing transit system must be sensitive to the requirements for the continuity of transit O&M activities in a safe and secure manner for all customers, employees, and the public. Transit operations staff should be integral members of the project team from early PD through Construction, testing, and turnover to operations. Transit operations staff will also be increasingly involved in the project as the project gets closer to completion.

Safety and Security Criteria

Safety and security risks should be considered throughout all project milestones as prescribed by FTA *Circular 5800.1* (2007). During PD, the project sponsor prepares a Safety and Security Management Plan (SSMP). The SSMP is an element of a project's PMP and is required by CFR, Part 633, Project Management Oversight; the SSMP is then submitted to FTA prior to entry into Engineering. Necessary updates for each milestone are covered in subsequent chapters; more guidance on preparing an SSMP is provided in Chapter 7.

While safety and security are different disciplines, the two are often discussed together.

Safety refers to unintentional events. A safety incident occurs when, for instance, a worker is injured because of a hazard that was unintentionally created. These are commonly called “accidents.”

Security, on the other hand, refers to intentional, malevolent events, including terrorist acts; civil disturbances; sabotage, pilferage, and theft of property or information; workplace violence; extortion; or other willful attacks on the system, its property, its employees, or its patrons. These are commonly called “crimes.”

Because safety and security are closely linked, an analysis of safety or security hazards will often ask the same questions, such as What can go wrong?; What is the likelihood that it will go wrong?; and What are the consequences of a wrongful act occurring?

These risks are generally addressed in two different documents: a hazard analysis (HA) for safety and a threat and vulnerability assessment (TVA) for security. The impact and severity of the safety and security risks are considered during a risk assessment workshop as applicable.

An HA begins early in a project with a preliminary hazard analysis (PHA). This analysis explains the methodology the project will use to identify, assess, and resolve conditions that could affect a system’s safe operation and is intended to assist the project in designing, building, and operating a safe transit system. Updates to an HA may continue to be titled a PHA, but some sponsors change the title of the first update to HA. In all cases, all versions of all documents must be properly numbered and dated.

A TVA is the security equivalent of an HA or a PHA. The TVA assesses the likelihood that a specific threat will endanger the system, and it provides recommendations to eliminate or mitigate threats and vulnerabilities that meet predetermined thresholds.

While many elements of the documents are similar, accurate assessments rely on knowledge in specific safety or security disciplines. Because project teams often include safety experts but do not include security experts, the project sponsor may need to employ an outside person who has conducted security analyses specific to transit systems. This will be very important to complete Section 4 of the SSMP, which calls for an explanation of the project’s approach to, and its requirements for, safety and security analyses.

The SSMP must also provide a safety and security organization chart that illustrates the entire safety and security management organization and its place in the overall organization, including lines of authority and any committees to which the safety and security personnel report. Regarding lines of authority, the safety and security leadership reporting must be above the management that is directly responsible for the project.

A sponsor should establish a liaison with the State Safety Oversight Agency (SSOA) at the initiation of the project. Most often, the state’s DOT serves as the designated SSOA.

The responsibilities of the SSOA are explained in 49 CFR, Part 674 State Safety Oversight (Final Rule). The SSOA works closely with the FTA Transit Safety Office and should be invited to participate in safety briefings and meetings at the earliest stages of a project. The SSOA is responsible for approving and auditing a number of transit agency safety documents, policies, and procedures. A project sponsor should also contact and work closely with the PMOC.

Transit Asset Management Goals

Transit asset management (TAM) is the process of implementing capital improvements to maintain existing fixed guideway systems in an SGR to provide efficient and effective service. The IIJA/BIL of November—signed into law on November 15, 2021—specifically enacted changes related to CIG grant award requirements that an applicant must demonstrate progress toward achieving TAM plan SGR performance targets. Per the FTA TAM Performance Measures Fact Sheet (October 2021), performance measures should be established for the following:

Rolling Stock. The percentage of revenue vehicles by asset class that have met or have exceeded the useful life benchmark (ULB).

Equipment. The percentage of nonrevenue service vehicles by asset class that have met or have exceeded the ULB.

Facilities. The percentage of facilities by group that are rated less than 3.0 on the Transit Economic Requirements Model Scale. Condition assessments must be no more than four years old.

Infrastructure. The percentage of track segments by mode that have performance restrictions. Track segments are measured to the nearest 0.01 of a mile.

At the end of PD and prior to entry into Engineering and before an FFGA or SSGA, FTA requires a statement signed by the CEO describing the progress the agency has made toward meeting TAM plan SGR targets. The statement should include an up-to-date TAM plan and narrative report from the NTD as supporting documentation.

Design Criteria and Standards

Design criteria and standards should be established early during PD. Standards are reference documents published by agencies and institutions having jurisdiction over the design and construction of the project. They play an important role in ensuring that appropriate accessibility, safety, security, environmental, and quality considerations are incorporated into every project. In addition to national standards, consideration must be given to individual state and local standards. Generally, the most stringent applicable standards should apply.

Design criteria should be established for every project based upon the applicable standards and the desired performance objectives of each project. As the design advances, the sponsor refines the established baseline cost estimate and schedule based on sufficient definition of project requirements for entry into Engineering. This level of design is generally designated as the 30% design level.

Establishing a reliable baseline cost estimate is a critical element for successful major capital transit project delivery. FTA requires that a sponsor's cost estimate be reasonably firm and reliable before commitment of federal funds for MCPs, including for CIG projects. When requested by FTA, a thorough evaluation of the project scope, schedule, and cost is performed by the PMOC to confirm the sponsor's estimate reliability.

FTA encourages sponsors to consider applying the 12-step methodology found in the U.S. GAO *Cost Estimating and Assessment Guide* (GAO-20-195G, 2020) when developing a project cost estimate. The *GAO Cost Guide* outlines best practices pertaining to cost estimation principles and presents 12 steps to create high-quality estimates. These steps are generally applicable in a variety of circumstances and range from defining the purpose of an estimate to obtaining data to presenting the estimate to management for approval. Applying these principles should result in reliable and valid cost estimates that sponsor management can use to make informed decisions (see *Oversight Procedure 33 – Capital Cost Estimate Review*, September 2015 or as updated at the time of sponsor's reading).

Important to Do

✓ Evaluate the impact of each project element on neighboring stakeholder and environment before selection.

✓ Assure all impacted third parties, communities, and stakeholders are informed and participate in the planning process.

✓ Evaluate availability to power sources or alternative fuels when deciding on propulsion options for the rolling stock.

✓ Develop the procurement plan as a part of the Project Management Plan in the development phase.

A comprehensive checklist of requirements to be addressed in PD and prior to entry into Engineering is shown in Appendix D of these *Guidelines*. This checklist provides a categorized list of elements to be completed, ideally, prior to obtaining FTA approval for entry into Engineering. Each listed item is followed by a brief description of the level of completion expected for that item. See also Appendix A for more information on FTA's cost estimation methodology.

Quality Management Planning

The sponsor should establish quality requirements in PD. Quality management refers to the policies, procedures, and activities necessary to ensure that quality requirements are satisfied at all stages of a project.

The sponsor should define minimum quality requirements for each project through reference to various industry standards and best management practices. Reference should also be made to the latest edition of the FTA *Quality Management System Guidelines* (October 2019).

At the sponsor level, a quality management plan (QMP) should summarize the policies of the sponsor in areas such as leadership, organizational design, stakeholder relations, employment, health and safety, the environment, procurement, communications, quality management, risk management, financial management, project management, administration, and continuous improvement. A QMP may contain the project sponsor's vision and mission statements, as well as a summary of its goals and objectives.

Project-specific procedures and checklists for QC and QA consistent with the QMP should be referenced in the sponsor's PMP. If a sponsor is undertaking multiple projects, each project should have a PMP that references the sponsor's QMP.

QC activities are generally performed on work products created by the initiator. Different levels of quality control may be required depending upon the potential consequences of errors in the work product.

QA is typically a higher-level review of QC procedures and QC records. Additional testing, inspection, or investigations may be conducted during a QA review.

Quality auditing is the process of reviewing the level of conformance of an organization with the requirements of its QMP. Audits may be comprehensive or specific to one area of the QMP and may be conducted either by internal or external auditors. Audit reports usually identify minor noncompliances, major noncompliances, and observations. Organizations are expected to address the findings of audit reports in a timely manner.

QMPs that satisfy the requirements of the International Organization for Standardization (ISO) 9001 may be certified by an external auditor recognized by the registrar. A QMP that is certified as compliant with ISO 9001 confirms that the organization has followed a recognized and rigorous process to implement its QMP.

As consultants, contractors, and subcontractors join the project, it is important to confirm that they also have QMPs in place and that the QMPs are being followed by their organization members.

Permitting Agencies Concept Design Approvals

Design is an iterative process. Most projects have many stakeholders who will influence the final design of the project and require approvals prior to entry into Construction. It is advisable to identify all agencies having jurisdiction early in PD and to seek sequential approvals from the public, agency stakeholders, and permitting agencies of the design, starting with the conceptual design and continuing throughout Engineering.

3. Key Project Element Considerations

Surface Fixed Guideways

A surface fixed guideway facility uses and occupies a separate right-of-way (ROW) or rail at ground level for the exclusive use of public transportation. Surface fixed guideways may be used for bus rapid transit (BRT), rail-based transportation, and other forms of public transportation.

The use of dedicated ROWs may impact available lanes for traffic in the corridor, reduce the availability of on-street parking, and restrict traffic movements to and from cross streets. In addition, there may be a need for transit signal priority or preemption to allow prioritized movement of vehicles on the at traffic signals.

Traffic, ROW, and underground utility impacts, as well as impacts on neighboring businesses and residential communities, will need to be considered thoroughly during the PD process and environmental clearance.

Aerial Fixed Guideways

Aerial transit structures, also referred to as elevated guideways, offer the highest maximum transit speed, greatest passenger capacity, fastest travel times, and the lowest potential for conflicts between motor vehicles and pedestrians. Transit structures include construction to support the track itself and operational equipment (e.g., traction power, overhead contact system [OCS], or third rail); signaling, communication, and lighting; intrusion detection; and safety and security. Additional structures may include drainage, retaining and sound walls, fences, passenger stations and platforms, and towers.

Design goals for studying and evaluating track alignments are to maximize transit speed, capacity, and reliability. Aerial structure alignments are evaluated based on factors that include connections to stations or to other transit systems and minimizing potential impacts to adjacent buildings or other structures. The availability and cost of ROW for transit guideways are major considerations. In addition, aerial stations require consideration of access, facility services, and fire and life safety needs.

When planning and designing an aerial transitway, environmental factors that include visual, noise vibrations, and other negative local impacts should be taken into consideration. Aerial structures are costly and may not be acceptable in some communities due to aesthetic concerns. Also, sufficient community outreach must be conducted to achieve consensus for the project. For this type of project to be successful, it is important that all stakeholders agree that an aerial structure is the preferred alternative.

Costs and schedules need additional attention on an aerial transit project. In addition to the initial cost analysis and estimates—which should be prepared using a cost estimate range—planned, regular estimates of the cost should be made throughout the process and should include a deferred maintenance plan for future aerial structure upgrades and repairs. Like the costing process, the schedule analysis must be continuously reviewed and updated; mid-course adjustments should also be expected as part of this process.

Transit Tunnels

Tunnels represent significant financial investments with challenging planning, design, construction, operational, and maintenance concerns due to their complexity and cost. Each tunneling project presents a new and unique set of challenges. Cost can vary significantly depending on factors that include tunnel location, alignment, length, station locations, geologic, and other subsurface conditions, as well as construction methodology.

Once it has been determined that a tunnel is the preferred alternative for a project, there are major activities in the planning process that require early consideration and substantive completion.

These activities include functional analysis; alternative studies; alignment and site selection; hazardous material and geotechnical studies; utility and third-party coordination; compliance with federal, state, and local requirements for real estate acquisitions; air quality; fire and life safety; ventilation; and security.

Developing an engineering geological model will assist the design team in decision-making and in establishing design parameters for evaluating construction methods, groundwater control, temporary support design, and final linings design (see *Making Transportation Tunnels Safe and Secure*, Transit Cooperative Research Program [TCRP] Report 86/NCHRP Report 525).

The Geotechnical Baseline Report (GBR) is a required deliverable during scoping and project definition. As part of this report generation, a thorough geologic analysis should be conducted to determine the type of material that will be tunneled through and to assess the relative risk of different tunnel alignments and methods. The selection of the tunnel profile must consider potential ground movements and avoid locations where such movements or settlements could cause surface problems for existing utilities or to surface facilities. The tunnel location should avoid being in proximity to an active fault zone.

The tunnel construction methodology considered depends primarily on the type of material through which the tunnel must pass. A tunnel will likely be progressed through more than one type of material (e.g., soil and/or rock types) and/or encounter multiple hazards (e.g., water tables, methane gas, unidentified utilities, etc.). Additionally, tunneling through different ground types mandates different techniques. Tunneling under water is the most challenging and necessitates specialized methods. Reviewing best practices and lessons learned from completed transit tunnel projects is extremely useful to inform the planning process.

Figure 2.1 illustrates the importance of initial planning and preliminary Engineering in terms of how they directly impact the sponsor's ability to influence scope, schedule, budget, risk, and project quality. In relation to tunnels, this figure has even greater impact due to the higher degree of up-front planning, subsurface exploration programs, engineering, and preconstruction project preparation required.

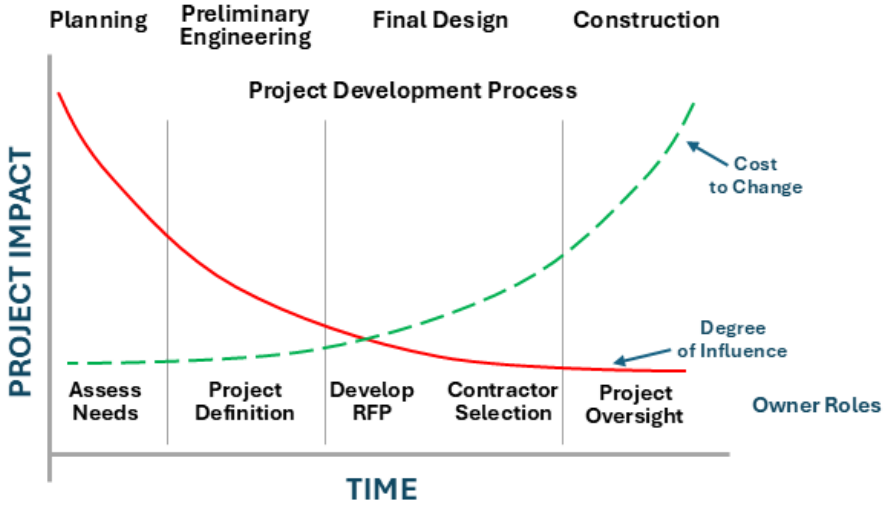


Figure 2.1 Project Life Cycle Cost Impacts and Mitigation Capability

Once tunnel construction has started, there is very little room for change without very large cost increases and project delays.

Tunneling risk elements include inadequate geotechnical studies and, in urbanized metropolitan areas, proximity to buildings with a high level of obstructions (e.g., foundations and utilities). An initial risk register should be created early in PD that includes mitigation methods. Continuous reviews and updates of the register should be made throughout the project life cycle.

Key items to focus on for tunneling projects include the following:

- Determine whether a tunnel is the best option through an alternatives analysis.
- Perform all needed studies (i.e., geotechnical, alignment, site, hazards, utilities, and government requirements). If a station is involved, perform additional studies (i.e., access; and fire, life, and safety).
- Determine the type of tunnel boring machine (TBM) required for the soil conditions and whether a single bore, which requires a much larger TBM, or twin bore is most appropriate for the project. Note: Two TBMs working in tandem is a generally accepted industry approach from a cost and schedule perspective.
- Carefully consider the locations of underground stations from construction and service standpoints. Underground stations may be pit constructed or mine constructed.

- Determine the location of the TBM launch pit and access and hauling routes. If stations are pit constructed, a station site should also be considered for the launch site to save schedule time and costs.
- Determine a timeline and project schedule with variances for best- and worst-case scenarios. Using a TBM requires additional pre-project schedule efforts to secure, assemble, and place it.
- Prepare an initial cost estimate using hard and soft costs; use a range of cost estimates to reflect potential uncertainties.
- Begin identifying risk by preparing an initial risk register (matrix format) and an initial PMP that incorporates the GBR.
- Plan for regularly scheduled team/project review points to address new information and project changes.

Stations

Transit stations facilities are designed for the safe embarking or disembarking of passengers from public transportation systems. They range from simple bus stops on a BRT system to complex facilities on elevated rail or subway systems. Station design considerations during PD are specific to the type of station.

Aerial and underground stations have significant fire and life safety requirements and are more costly to build. The need for aerial and underground stations should be carefully considered during PD. Surface stations may impact traffic, ROWs, and utilities, as well as neighboring business and residential communities.

Railcars and Buses

Railcars or buses, also addressed as “rolling stock” or vehicle(s), are the most critical element and showpiece of any transit system because they are designed and constructed to transport fare-paying patrons—reliably, safely, and in a timely manner—from one destination to the next. Since numerous transit technologies are available that can meet project rolling stock requirements, the selection of vehicle technology for project construction alternatives necessitates their evaluation during PD for the LPA. While many relevant and viable bus and rail technologies are available, the focus should be on those that are readily applicable and proven—buses and streetcars; light rail transit (LRT); heavy rail transit (HRT); and commuter rail, including a diesel multiple unit (DMU) option.

System ridership service requirements must be established prior to determining the number and types of vehicles needed before procurement. Spare vehicles will also need to be added to the total number calculated. All FTA-funded procurements must meet Buy America and ADA requirements.

Railcars

Rail transit describes a conventional fixed guideway system that uses a railroad track; rail transit categories include streetcar, LRT, HRT, and commuter rail. LRT can operate in fully controlled, exclusive ROWs; grade-separated (e.g., aerial, fill, cut, tunnel); or at-grade with no crossings or with crossings that have protection.

LRT can also operate in a separate or shared ROW. LRT may have high or low boarding platforms that allow level boarding. LRT may also have low-floor light rail vehicles (LRVs).

LRVs can operate as single or multiple units and typically draw traction power from an OCS. Other options include a third rail electric pickup, underground inductive regeneration, and off-wire traction power technology that uses batteries and/or supercapacitors. Streetcar technology is very similar to LRT technology in operation and vehicle construction. As the name implies, streetcars mainly operate in mixed street traffic.

HRT (aka rapid rail or metro) is comprised of an electrically powered system operating within or between urban areas and suburbs. HRT uses exclusive tracks that are fully grade-separated (e.g., aerial, fill, cut, tunnel, or at-grade) with no crossings. HRT trains are high capacity and serve complex, multilevel stations that are typically one to two miles apart. This configuration allows a heavy rail vehicle (HRV) to operate at up to 75 mph, making this mode of transportation much faster than LRT systems. HRVs typically range from 45 feet to 75 feet. Shorter vehicles can negotiate a shorter turn radius while longer vehicles require substantially larger turn radii. Due to HRT's higher energy demands for propulsion, high voltage power is provided through a third rail or by an OCS.

Commuter rail is best suited to longer distance trips. Commuter rail trains typically operate every 30 to 60 minutes and stations tend to be three to five miles apart. The trains have slower acceleration and longer braking distances compared to other rail technologies.

The development of DMU rail vehicles has allowed commuter rail technology to extend LRT and HRT lines in corridors that do not warrant the high investment cost associated with electrified rail transit technologies or with locomotive-pulled commuter trains. Federal regulations require that commuter rail systems use a positive train control (PTC) system to assure safe operation and provide level boarding whether with high or low platforms.

Buses

Buses are the most common operating transit mode, traveling on existing roadways in vehicular traffic. They can run as local, express, or commuter; or as BRT. Buses vary in length—up to 40 feet for a single unit and 60 feet for articulated units—and they maneuver in local geography and in short-turning radii. Various sources of bus propulsion include diesel, compressed natural gas, hydrogen fuel cells, OCSs, or battery electric power. Standard buses have a typical 12-year life cycle. The interior layout of a bus can be configured with options that include all passengers standing, seated, or a combination of both.

Transit Technology Considerations

Consideration should be given to the capacity of transit technologies, site-specific requirements, and service performance characteristics.

Vehicle capacity of a transit line is measured by calculating the number of persons per hour per direction (PPHPD). This calculation measures the number of potential passengers who can pass by a point. Reviewing available rolling stock technologies identifies the PPHPD for each technology type and assists planners in their analysis and determination of the rolling stock technology best suited for the project. Project planners select the best combination of technology, passenger load demand, and headways (i.e., time intervals between trains).

Site-specific requirements address geometric constraints, general system parameters, and preliminary ridership requirements. These requirements also consider existing system architecture, grade crossings, hills or sharp turns, and the proximity of opposing traffic. Each vehicle technology should be assessed and compared to the physical and operating characteristics of the anticipated route to allow for optimum travel that meets operational needs. The physical characteristics determine the relative ease or difficulty of travel that a specific technology must overcome to operate in existing geographic areas.

Service performance characteristic requirements address each transit technology's ability to meet operational system requirements, including geometric parameters, peak service demands, optimum maintenance intervals, and reliability.

Demand for Vehicles and Fleet Management

Parallel with the review and analysis of the available transit technologies and their elements to define rolling stock recommendations for the LPA, the sponsor should prepare Rail Fleet (RFMP) or Bus Fleet Management Plans (BFMP) that demonstrate the sponsor's focus on reliability, safety, and quality to optimize fleet quantity. These plans could be newly drafted (e.g., for a New Starts project) or updates could be made to a plan for an existing transit system.

The FMP confirms that the project sponsor has thought out a sound basis and an accurate estimation of peak vehicle requirements (PVR), as well as the operating spares ratio (OSR) for the vehicle fleet quantity being recommended.

Interfaces with Project Elements

Since railcars and buses interface with other elements of the projects, these issues must be addressed during PD to define more precisely the appropriateness of the rolling stock and to estimate the schedule and cost of the project. Interfaces include infrastructure (e.g., roadways, guideways, tunnels, bridges, stations, etc.); maintenance facilities; and train control, communication, and traction power systems.

Automated People Mover

An APM system is a fully automated transit system with driverless operations and features vehicles that travel on guideways with an exclusive ROW. APM systems are distinct from traditional HRT and LRT systems in that they operate without drivers or station attendants. APM vehicles are similar to a railcar in physical and performance characteristics, operate on a fixed guideway, and draw tractive power through a third-rail pickup. Typically, APMs use a narrower ROW and smaller vehicles than traditional railcars.

The Transportation Research Board and the Airport Cooperative Research Program Report 37, *Guidebook for Planning and Implementing Automated People Mover Systems at Airports*, provides comprehensive guidance for airport APM systems. Although written for airport APMs, the same concepts, planning, and principles are also applicable to non-airport APM systems.

APM Technology

The APM system is a complete transit system consisting of an operating system and fixed facilities. Being proprietary in nature and typically not interchangeable, the system is procured as a "turnkey" from a single contractor. The APM system consists of a guideway; vehicles; stations; propulsion power; command, control, and communication systems; and maintenance and storage facilities (MSF).

The guideway can be constructed at ground level (at-grade); elevated (above grade); or below grade in a tunnel. Vehicles are fully automated and driverless, either self-propelled or cable-propelled, and are designed for passenger comfort and safety. Vehicle speed, capacity, and maximum train length are dependent on the type of technology selected and the system configuration.

Stations are located along the guideway to allow passenger access to the APM system. Station equipment typically includes automatic platform screen gates; variable passenger message information signs; and rooms to house a command, control, and communications system, as well as other APM equipment. Vehicle propulsion is provided by direct current (DC); alternating current (AC); or by AC linear induction motors using either a 750- or 1500-volts direct current (VDC) or a 480- or 600-volts alternating current (VAC) power distribution subsystem.

Cable-propelled vehicles are pulled by an attached cable driven from a fixed electrical motor drive unit located along the guideway, usually at one end of the system.

The MSF provides for all vehicle maintenance and storage and houses administrative offices, maintenance equipment, tools, machinery, recovery vehicles, and equipment for train control and power within the MSF.

APM Technology Considerations

Consideration should be given to APM technology capacity, site-specific requirements, and service performance characteristics.

Vehicle capacity of an APM line is measured by calculating the number of PPHPD. This calculation measures the number of potential passengers who can pass by a point, including maximum demand, and assists planners in their analysis and determination of the best technology option, passenger load standards, and headways (i.e., time interval between trains).

Site-specific requirements address geometric constraints, general system parameters, and preliminary ridership requirements. Physical characteristics determine the relative ease or difficulty of travel that the technology must overcome to operate in an existing geographic area.

Service performance characteristic requirements address the APM technology's ability to meet operational system requirements, including geometric parameters, peak service demands, optimum maintenance intervals, and reliability.

Demand for APM Vehicles and Fleet Management

Parallel with the review and analysis of the applicable APM technology, the sponsor should prepare a RFMP to demonstrate the sponsor's focus on reliability, safety, and quality to optimize fleet quantity. The RFMP confirms that the project sponsor has thought out a sound basis and an accurate estimation of PVR, as well as the OSR for the vehicle fleet quantity being recommended. The FTA memorandum document titled, "Guidance: Rail Fleet Management Plans" (September 2, 1999, in *OP 37*, Appendix D) provides detailed guidance for vehicle and fleet management planning.

Interfaces with Other APM System Elements

The interfaces of the APM vehicle with other system elements are of the same nature as that for railcars; they include the infrastructure (i.e., guideways, tunnels, stations, etc.); an MSF, train control system; communication system; traction power system, etc. These interfaces and the integration of the APM system are typically the responsibility of the APM system provider, thereby posing minimum scope and cost risk to the project sponsor.

Signal Systems and Controls

During PD, it is critical to plan for appropriate signal systems and controls. Signal systems and controls are utilized on transit systems and railroads to keep trains at a safe distance, thereby avoiding collisions. They come in several configurations depending on the needs of a new system or a system undergoing an overhaul. One basic system contains track circuits to keep trains separated. A track circuit detects the absence or presence of a train on a section of track, known as a block, by noting whether the tracks are shunted by the wheels and axles of a train.

Only one train should occupy a block of track at any given time. The train picks up signals from the wayside to determine whether it is safe to enter the next block. This form of signal system is mostly utilized for heavy rail systems (e.g., subways) and some commuter rail systems.

Newly built heavy rail systems and some overhauls are moving to a communications-based train control (CBTC) system. This train control scheme is sometimes known as moving block since it allows the safe occupancy of track sections to be reduced or lengthened as needed to allow maximum throughput. The signal system configuration utilizes radio transmission to accurately determine the position of each train. Retrofitting CBTC to an existing heavy rail system has proven to take longer and be more costly than originally anticipated due to complex system-to-vehicle integration issues. A CBTC is ideal for new transit systems as it allows flexibility for throughput, high top speeds, and accurate positioning of trains.

Most LRT systems in the United States are manually operated, sometimes with a speed control system. Most of these systems incur large costs for operation, maintenance, repair, and equipment replacement. In recent years, new technologies for LRT systems have been developed with well-defined goals of increasing capacity, enhancing safety, and providing a high degree of interchangeability. However, older systems have been slow to adopt newer technologies.

Railroads and commuter trains utilize a PTC system to maintain safe operations. After a major head-on collision in 2008 in Chatsworth, California, the Federal government imposed a mandate for all railroads and commuter rail systems to install PTC systems. PTC is GPS-based safety technology that can stop a train and prevent train-to-train collisions, over-speed derailments, and unauthorized train movement. PTC combines GPS, wireless radio, and computer technology to send up-to-date visual and audible information and to notify train crew members when a train must be slowed or stopped.

When contemplating a signal system, top speed, station spacing, and train throughput are important considerations since these parameters dictate the scope, complexity, and cost of the signal system. Higher top speeds require additional spacing between trains to allow safe stopping distances while higher throughput necessitates a moving block system to allow trains to travel close together though at a safe distance.

When designing a signal system, personnel who understand train dynamics will need to create a train braking model. This model should include worst-case scenarios at any design speed level for a train to come to a stop. The model's use in establishing system parameters will facilitate a safe system.

Electrification and Traction Power

Traction power systems efficiently distribute electrical power through various means to electric railcars. A main feature of a traction power system is the substation, which receives power from a local utility company at high voltage AC and converts it to DC voltage for use by railcars. In some cases, the trains use an AC voltage that is collected from overhead wires. The distribution system for a heavy rail system is typically by a third rail, which is connected to the cars through collector shoes attached to the trucks.

For light rail systems, overhead catenary wire distributes voltage to the cars through pantographs mounted on the car roofs. In each case, the DC voltage is fed to systems on the car, such as traction motors, heating ventilation and air conditioning (HVAC), auxiliary converters, air compressors, and brakes. In all cases, the running rails act as the ground and are connected back to the substation.

When designing a traction power system for light and heavy rail, consideration must be given to the value of the DC voltage used by the railcars. High voltage reduces the number of substations since the higher voltage allows greater distances between substations. Although for many years the standard voltage for distribution has been 750 VDC, some recently developed heavy and light rail systems have adopted 1000 VDC.

There has been consideration for raising the voltage to 1500 VDC. Since the cost of substations has escalated significantly over the years, the goal of reducing their number is well justified. One of the downsides to increasing the voltage is the need for car builders and their sub-suppliers to design nonstandard subsystems.

Some commuter rail systems, especially on the East Coast, operate using overhead catenary and pantographs. These systems use high-voltage AC power directly from the substation. While the frequency may be changed, the higher voltage serves the purpose of allowing fewer substations.

For new power stations, the site selection, acquisition, and development process requires consideration of environmental impacts, such as traffic and noise, on neighboring communities and businesses. In addition, their placement requires an operational analysis to optimize the number of stations needed to provide reliable service from adjacent stations when a power outage occurs. Coordination with power utilities early in the PD process is critical to assessing the availability of power grid sources that have redundancy and capacity.

Operations and Maintenance Facilities

A new bus or rail maintenance facility, or the major modernization of an existing facility, is an opportunity to organize and optimize O&M processes with the latest technology to produce maximum efficiency. For new facilities, site selection, acquisition, and development processes require thorough consideration of the environmental impacts (e.g., traffic, noise, and air quality) on neighboring communities and businesses.

In addition, with the mandate to convert fleets to zero emissions, the availability of electric power and the feasibility of placing hydrogen storage and fueling facilities should be carefully considered prior to site selection. The FTA *Construction Project Management Handbook* was developed and updated to assist in guiding sponsors in the development and construction of such facilities.

4. Procurement Planning

It is important to develop a procurement strategy early in PD. The project sponsor will need support from a wide range of professionals during all aspects of the project. Decisions should be made early on as to which professional services can be provided from existing sponsor or stakeholder resources, which can be provided by new hires, and which should be contracted from service providers.

When evaluating resourcing options, it is important to consider whether the resource need is short term or long term. Sponsors should realistically assess the qualifications and experience of internal resources and potential new hires to determine whether engaging external service providers would provide better overall value.

Sponsors should develop a formal procurement policy that defines selection criteria for external service providers. Similarly, human resource policies should clearly outline candidate selection and hiring processes.

As the project moves from PD through Engineering and into Construction, decisions will need to be made about procuring rolling stock, equipment, materials, and construction resources. The method selected for procurement and project delivery will affect the level of engineering required prior to tendering various supply contracts and work packages. In some cases, the sponsor may decide to preorder items or self-perform certain elements of the work.

A value-for-money analysis may be undertaken to compare project delivery and procurement options. Key to value-for-money analyses is the evaluation of risks associated with each option considered. The selected project delivery and procurement method for each element of work should deliver the best value for the project.

CHAPTER 3. ENGINEERING

1. Purpose

Chapter 3 discusses key activities undertaken in the Engineering after completing the environmental review and the PD work. Engineering activities focus on the development of sponsor MCC, project management planning, third-party coordination, real estate acquisition, design packaging and phasing, project delivery consideration, risk register and contingency drawdown updates, integrated testing and start-up planning, design reviews, regulatory compliance, TAM (only if CIG), permitting agency plan check, and procurement planning. Work product outcomes from these activities include a set of project design plans, specifications, and a cost estimate for inclusion in the bid documents to procure equipment and construction services for a DBB project delivery method. An alternative project delivery method would combine some level of design and construction into a single contract (see Chapter 4 for information on alternative delivery methods).

For the CIG funded projects, the Small Starts projects move from PD to the award of an SSGA. Unlike New Starts and Core Capacity projects, the law does not specify an Engineering timeframe within which sponsors must complete PD. Upon completion of the environmental process, Small Starts projects proceed with engineering activities within PD.

2. Project Management Plan

The organization and management tools employed during Engineering should be documented in a PMP that is tailored to the project type, costs, and complexity and to the sponsor's MCC. PMP sections requiring a high level of development include design management, procurement, QA, safety and security, community outreach, and project controls.

The PMP should also include subplans describing the Fleet Management Plan, Real Estate Acquisition Management Plan, Project Delivery Plan, and Risk and Contingency Management Plan (RCMP). Third-Party and Utility Coordination

All project activities requiring third-party utility and interagency agreements and approvals must be identified and scheduled in PD (or early in Engineering at the latest); critical third-party agreements must be executed before the FFGA or the SSGA. These activities include, but should not be limited to, the following:

- Utility relocations and/or new utility service agreements (see Appendix C: Utility Relocation Agreements)
- Encroachment on other public transportation ROW needs
- Permits and/or waivers

Under traditional delivery methods, it is typically necessary to relocate or rearrange existing facilities prior to the construction of a major transit project. These include franchise utilities (e.g., power, telephone, cable, gas, steam, etc.); public facilities (e.g., highways, streets, sewer, water, drainage, fire services, traffic control, etc.); and railroads. With the exception of environmental permits and ROW acquisitions, DB and other alternative delivery contracting methods may transfer the responsibility and risk for some or all utility relocations and construction permits to the contractor if these risks can be controlled by the contractor.

Master agreements should be developed and negotiations completed with utilities and public and private agencies during PD, or at the latest, in the early stages of Engineering. All critical agreements as determined by FTA should be executed prior to the grant agreement. The agreements should confirm that the project will not be delayed as design progresses, during Construction, or prior to revenue service. The agreements should provide for the following:

- Scope of work (SOW)
- Responsible decision-maker for each party
- Financial obligations/rights of all parties
- Assumption of associated risks for each party
- Responsibility for design, construction, and relocation/rearrangements; inspection; safety and security at the site(s); and acquisition of substitute easements
- Acceptance of improvements criteria (short of agreeing on “betterments”)
- Procedures for billing and payments
- Dispute resolution procedures
- Preparation and terms of detailed agreements
- Salvage materials/credits
- Substitutions and betterments
- Conflict resolution procedures
- Improvement and replacement standards
- Scheduling work parameters

The need for interagency agreements and approvals should be continually monitored throughout Engineering in preparation for the commencement of Construction. The master utility agreements initially negotiated during PD or early Engineering should be refined into detailed agreements for each contract/section as the design progresses and should indicate provisions for the following:

- Detailed design for specific relocation/rearrangement and/or for new services
- Schedule
- Cost, salvage, and betterment
- Conditions of performance

- Responsibility for safety and security at the site(s)
- Payment for services
- Work orders (direction to proceed)
- Criteria and process for the acceptance of work

Governmental Jurisdictions

Transit projects involve interaction with government agencies as funding partners or regulators or as representatives of the communities in which the project will operate. The role of each agency must be negotiated after an early examination of the agency's requirements without jeopardizing the project's public support or schedule.

Utilities

Utilities can have both direct and indirect impacts on a project. Direct impacts occur when a utility connection (e.g., electricity, water, or telephone) is required for the project itself. Utilities are involved indirectly when their infrastructure must be relocated to make way for the project. The sponsor is required to determine who is responsible for acquiring easements to relocate utilities and for assuring that all permits, etc. are obtained.

In some cases, lateral or longitudinal utility corridors created by the project can accommodate the relocation of several utility facilities more efficiently by bundling or colocation. If this design feature is used, any additional real estate interest needed must be incorporated into the ROW project design so it can be acquired with other real estate property parcels. Utilities with franchise agreements should relocate facilities in accordance with the terms of these agreements.

Railroad and Other Transportation Entities

Railroads and transportation entities, including other federal, state, and municipal transportation agencies, may control property that a sponsor needs to acquire or access (either temporarily or permanently) to construct or operate a transit project. The sponsor should begin negotiations early in the PD process to assure successful resolution of any conflicts.

The sponsor should create a memorandum of understanding or an outline of an agreement early on to set the basis for the project. The memorandum may include an operating plan, service impacts, improvements to be constructed, financial obligations of parties, responsibility for construction, and a permit/approval process. If these terms can be worked out in advance with a reasonable and narrow "order-of-magnitude" final costs forecast, Engineering can continue with an understanding of the basis of an affordable and high probability agreement.

Projects that come under the jurisdiction of the Federal Railroad Administration (FRA) and Federal Aviation Administration (FAA) require additional documents that are separate from those required by FTA. Sponsors whose projects require FRA or FAA coordination should meet with FRA and/or FAA regional personnel to determine the FRA or FAA requirements within their jurisdiction.

The approach taken to considering possible acquisition scenarios is determined by whether a railroad corridor is subject to Surface Transportation Board (STB) regulations.

Often, an existing railroad corridor ROW may be a viable alternative for developing a transit project. This option can be available in various configurations as follows:

a. An abandoned, unused corridor not subject to STB regulations.

b. An unused corridor that has not been abandoned and, thus, is still subject to STB regulations but that possibly may be approached based on pursuing an "involuntary abandonment."

c. An operating corridor with sufficient ROW available for transit to coexist with freight or other passenger operations without sharing tracks.

d. Same as c. except freight and other facilities must be relocated or adjusted to accommodate transit and/or transit may have to acquire additional ROW.

e. Same as c., except no sufficient ROW is available for transit to have exclusive track facilities and, therefore, must share track with freight or other operations. This may involve potential "cost-to-cure" adjustments in existing facilities for the various operations to coexist. Most adjustments required to accommodate transit would be an eligible project expense as long as the adjustments are reasonable and necessary.

While other scenarios may exist, the aforementioned are the most typical; items b. through e. would typically be subject to STB regulations. Where this is the case, generally a state or local agency cannot use eminent domain to condemn property owned by the railroad if an agreement cannot be reached because of STB authority or control.

See Section 5 in this chapter for a discussion of detailed real estate acquisition and relocation activities and methods to preserve a corridor for transit use.

3. Real Estate Acquisition

Real property for use in a federally assisted transit project should be acquired and its occupants relocated in compliance with 49 CFR 24, Uniform Relocation Assistance (URA) and Real Property Acquisition Policies for Federal and Federally Assisted Programs as amended (Uniform Act). Compliance with FTA *Circular 5010.1E Award Management Requirements* (July 2018) or its successor document is also required. Chapter I, Section 5, Definitions and Acronyms; and Chapter IV, Section 2, Real Property are specifically applicable. A project's acquisition and displacement activity should also comply with relevant individual state statutory and judicial case law.

While the sponsor has pre-award authority to acquire property after the issuance of the environmental document (i.e., ROD, FONSI, or categorical exclusions), federal participation is not assured until an obtained grant authorizes acquisition activities.

Because the acquisition of property can prejudice the alternatives selection process, generally only certain ROW corridors and associated property can be acquired prior to issuance of the project's environmental document. Latitude is given early in the process to address corridor preservation, hardship, and protective purchase parcels. Use of these exceptions should be both coordinated with FTA and meet specific criteria.

Important to Know

✓ The Uniform Act regulates the acquisition of real property interests and the relocation of affected individuals.

✓ FTA requires completion of the environmental process (NEPA) prior to negotiations to acquire or lease real property.

✓ ROW identification occurs when the limits and boundaries of real estate needs are defined and a legal description is prepared in the Engineering phase by a licensed professional in the state in which the property is located.

✓ Sponsors should offer estimated costs for just compensation based on appraisal and review appraisals

✓ Sufficient and adequate replacement property should be available for all displaced residential occupants.

✓ State and local laws impact the ability to acquire real estate.

Chapter 5 covers key activities in Construction leading to Commissioning and revenue service. Content includes preconstruction activities (e.g., identifying owner-furnished equipment, permits, and partnering); key submittals (e.g., schedule, equipment, contractual, and regulatory); key construction items (e.g., RFI, change notices, change orders, claims, and safety compliance); QA, payment applications, and as-builts; O&M manuals; and pre-revenue planning, including integrated testing and SC.

Early Real Estate/Right-of-Way Activities

Real estate acquisition planning should begin as early as PD and is considered during the NEPA environmental impact documentation process. The environmental process is required to analyze socioeconomic impacts that may be caused by a project and alternatives under consideration. Qualified real estate/ROW professionals should provide input into the decision-making process regarding potential alignments and property damage mitigations. This approach often saves money and time as the project progresses. Input is primarily obtained through studies regarding acquisition and relocation impacts, costs, and time constraints for different options.

Sponsors are required to prepare a Real Estate Acquisition and Management Plan (RAMP; also referred to as the Real Estate Acquisition Management Plan) in PD; this plan is updated during Engineering as a subplan to the PMP. FTA *Oversight Procedure 23 – Real Estate Acquisition and Management Plan Review* provides additional information on developing the RAMP.

In accordance with the RAMP, real estate acquisition and management activities should begin during Engineering after the environmental review has been completed.

A sponsor's real estate staff or real estate consultant should understand the following:

- Legal requirements
- Acquisition and relocation requirements imposed by state and federal law and regulations and by FTA circular requirements
- Estimating time and costs to assure there are no delays or cost overruns

An outline of required RAMP content can be found in FTA *Circular 5010.1E*, Appendix C. RAMP content should be guided by the following general topical areas:

- Introduction/scope
- Organizational structure
- Acquisition schedule
- Real estate cost estimate
- Acquisition process
- Relocation process

Other Components

The RAMP should clearly inform the reader as to how the real estate will be acquired and how displaced persons will be relocated in compliance with all applicable laws and regulations. The plan should also discuss any unique state law requirements, how those requirements will be addressed, and unique features of the sponsor's real estate process.

Topics might include the following:

- Identification and preparation of legal descriptions/plats of real estate required
- Appraisal (i.e., developing an appraisal SOW required by the Uniform Act implementation regulations; see also FTA *Circular 5010*)
- Acquisition
- Property management
- Relocation planning
- Demolition
- Real property inventory
- Schedule and funding
- Identification of possible transit joint development

All real estate necessary for construction work should be acquired in accordance with a construction access schedule. Critical acquisitions should be completed prior to the award of a construction contract, and preferably, before bid advertisement. Exceptions exist under some alternative delivery methods where the schedule for ROW delivery is set in the agreement.

Uncertainty regarding the availability of a needed ROW affects contractor bids. Also, if the ROW is not available at the start of construction, contractors may have to work around unacquired parcels to maintain the project schedule. This can create a potential for contractor claims.

Real estate issues should be closely coordinated among project planners, programmers, designers, engineers, environmental and safety and security specialists, CMs, and the project's real estate organization. This coordination assists each team element in understanding the functions and needs of other team members.

Important to Do

- ✓ Assign qualified real estate professionals to advise the team at entry into PD.
- ✓ Prepare a RAMP in compliance with FTA regulations during PD.
- ✓ Include staffing and schedule for acquisition elements in the RAMP (e.g., titles, legal descriptions, environmental clearance, appraisals, appraisal reviews, negotiations, and condemnation).
- ✓ Update the RAMP in the Engineering phase.
- ✓ Begin outreach after the needed ROW requirements are fully defined.
- ✓ Check with state and local agencies having jurisdiction for additional requirements.

The development of the real estate program schedule should reflect the time required for acquisition, including relocation of existing occupants, potential condemnation, and property cleanup and demolitions. Delays may also occur as a result of a need to use eminent domain to acquire property by condemnation. This judicial process can be unpredictable in terms of the time needed to obtain physical possession of the property to construct the project.

The real estate schedule should be incorporated with all other functional schedules to form an integrated master project schedule (IMPS) baseline and be flexible enough to meet program modifications.

Relocation Process Considerations

The law requires that residential occupants displaced by a project be offered a comparable replacement dwelling that is decent, safe, sanitary, and in good repair and that is made affordable through supplemental payments. Thus, a failure to conduct timely relocation interviews to understand individual housing requirements; affordability; and decent, safe, good repair, and sanitary needs could unexpectedly affect the project schedule.

Business, farm, or nonprofit organization occupants should be similarly interviewed and afforded assistance in relocating to a new site. Specific interview requirements are listed in the CFR Title 49, Part 24.205(c)(2)(i).

Some nonresidential displaced persons may require extensive time to complete their relocation. For example, an existing complex or large operation could require many months to relocate before clearing the project for construction. If such business moves are not appropriately facilitated, the project could be delayed and/or the business may be adversely impacted with resultant economic impact to the immediate area.

All relocations should be integrated into the IMPS. All critical relocations should be completed prior to executing the construction contract.

Contaminated Property (including Brownfields)

Early in Engineering, it is prudent to negotiate the right of entry to perform investigations. If the owner refuses to provide entry, the sponsor may seek judicial intervention. A determination should be made as to whether a property to be acquired contains hazardous materials. The sponsor should also assess the impact on property value compliance with state requirements and FTA circular discussion and determine the measures necessary to protect the public during remediation and construction.

If a project involves contaminated property, including brownfields, appropriate due diligence regarding contamination is conducted as a part of the environmental process. This due diligence is discussed in the environmental document before selecting a contaminated property. Appraisals should consider the effect contamination has, if any, on the market value of the property. The terms “contamination” and “hazardous materials” should be interpreted broadly and should include all contaminants that can affect property value and that are subject to environmental controls.

If property contamination is found within the project limits and is impossible to avoid, the following actions should be followed:

- Mitigate the contamination to an acceptable standard for the most reasonable cost.
- Hold property owners responsible for the cost of contamination remediation.
- Maintain the project schedule, if possible, while undertaking the necessary remediation.

State condemnation laws vary as to the impact of contamination on valuation when property is being condemned. Sponsors should be aware of valuation impacts caused by state law or by legal precedents.

4. Design Packaging and Phasing

Preliminary design packaging and phasing should be developed in the late stages of PD or in the early stages of Engineering before the plans and specifications are advanced. Early packaging and phasing of the project design in Engineering facilitate timely scope development. Design consultants can mitigate negative impacts of project construction on operations and on surrounding businesses and communities.

For larger, complex projects, developing the design in smaller packages helps bring in specialized and focused construction expertise and increases small and disadvantage business enterprise participation. In addition, this process may increase competition and spread work to a larger pool of contractors.

Preliminary packages may be further refined to address VE and constructability and risk assessment recommendations and avoid costly segmentation of design after plans and specifications are more advanced. Schedule savings may also be obtained by advancing the design on multiple segments concurrently or by advancing construction packages such as utility relocations. The sponsor can also assign delivery methods most suitable to the risk associated with each package.

The sponsor should adhere to project definition and mitigation monitoring measures in the environmental document. FTA requires that the project defined in the environmental document and the grant application's purpose and need be implemented as one project within a reasonable time. FTA also prohibits segmentation to defer a portion of a project without reevaluation of the environmental document and FTA approvals.

5. Project Delivery Considerations

The sponsor should select a project delivery method and the general procurement and contracting approaches. These activities should take place as early as possible in Engineering with attention given to the project risk profile and needs. The selected procurement approach should be refined and contract documentation prepared in a timely manner to permit project implementation as scheduled. If alternative delivery approaches are being considered, these decisions should occur as early as possible so that the entire process is coordinated and the design approach is consistent with the delivery method.

The authority for procurement resides in legislatively mandated policies and procedures of the state and locality in which the transit project will be built. When FTA funding is used, Federal Acquisition Regulations (FAR) may also apply (see the FTA website for details). The sponsor should understand its state's procurement and contract laws prior to determining its procurement approach, whether traditional (i.e., DBB) or an alternative project delivery method (e.g., DB). In some instances, local laws or regulations may also control the manner in which construction contracts are developed.

At a minimum, the DBB delivery method requires the efforts of a sponsor, a separate design entity, and one or more construction contractors. The sponsor may also rely on the services of a GEC or program manager. The sponsor selects a designer to develop and design the project and produce sealed drawings and specifications. These drawings and specifications are packaged into bid documents that define the work and the terms and conditions for which contractors submit bids.

The traditional DBB delivery method is intended to give the sponsor control over the design and create a partnership with the designer in monitoring construction contractors. This situation, however, has sometimes resulted in an adversarial relationship between the designer and the construction contractors involving interpretation of the plans and specifications.

It is the sponsor's responsibility to have adequate construction management, put in place a contractual framework to mitigate any potential risks, and, ultimately, confirm that the project is completed within budget and on time. Many sponsors opt to use a separate CM consultant whose responsibilities would include expediting construction and resolving design disputes or issues of interpretation.

Compared to DBB, each alternative project delivery method presents different aspects and allocation of risk between the sponsor and the contractors. The contract provisions become the mechanism for assigning risk and for defining each entity's responsibilities. These provisions must be included in procurement packages to provide for different timeframes and for the contractor's design and construction responsibilities.

Chapter 4 provides detailed descriptions of various project delivery methods and their significant features.

6. Planning for Integrated Testing and Start-up Planning

During Engineering, various system elements—including guideway, traction power, trackway, power distribution, fare collection, train control, communications, vehicles, security systems, and ventilation—are designed and then advanced to Procurement. Each element should be planned and engineered to include the appropriate interfaces. This process is vital to building a system at an affordable cost that moves people safely and reliably. Likewise, facilities including stations, yards and shops, and administration buildings are designed and made ready for bidding. The execution of the testing program for these systems and facilities requires thorough planning and scheduling during Engineering. This section provides guidance for the planning process.

As Engineering develops, the integrated testing program requires careful thought and detailed planning. Contractual requirements detail how the individual systems and facilities should work according to specifications to confirm the complete system is safe and reliable. However, certain owner-furnished equipment and other interfaces may not be the responsibility of the contractor. These interfaces are integral parts of the systems and should work in unison with the contracted work.

As part of the integration process, an integration manager should be assigned to develop an Integrated Test Plan (ITP) and to do the following:

- Verify that design documents fulfill the functional requirements of the design criteria and are consistent with the operating plans, procedures, rules, and operations.
- Work closely with the safety and security team to confirm that SSCs are part of the planning process and are an essential theme throughout test integration execution.
- Confirm that system elements are mutually compatible and that facility elements accommodate the system design.
- Verify that individual and integrated testing has been programmed at the early stages of design activity.

- Assure that the work apportioned in one set of documents matches the work apportioned in documents for adjacent and underlying work.
- Confirm that detailed design reviews are performed. Note: Design reviews are a vital element of the entire design management process.
- Work closely with the rail activation team to assure planning, service, and O&M requirements are met in accordance with the Rail Activation Plan (RAP).

With many facets of testing involved throughout the program, each type of test should be considered during Engineering. These tests consist of the following:

- Design verification/qualification tests
- Software verification and validation
- Manufacturing inspections and tests
- Pre-shipment inspection and tests
- Installation inspection and testing and subsystem testing
- System integration testing (SIT)
- Safety and Security Certification Plan (SSCP) Certifiable Item List (CIL) testing
- RAP-related testing
- Integrated system demonstration testing (e.g., trial runs, emergency procedure/drills, etc.)
- System assurance monitoring during O&M

Important to Know

✓ Robust contract compliance testing during engineering is a prerequisite to integration testing.

✓ Integration testing requires a champion who is a qualified professional.

✓ Integration testing planning begins during engineering.

✓ An ITP is prepared during engineering.

✓ The ITP includes requirements for safety and security and for rail activation.

As part of Engineering, the systems integration manager should champion the testing and start-up planning and the commissioning of program processes along with design activities to completion. This manager should have the necessary experience, staffing, and tools to complete these activities, as well as an understanding of how the systems and facilities integrate to form a safe, reliable, and compatible system.

The systems integration manager should work with each engineering discipline to extract and identify the interfaces and verification testing required throughout the program. A complete list of tests should be developed and the tests placed in categories.

Tools, such as the Dynamic Object-Oriented Requirements System (or DOORS), can easily organize and capture listings and manage changes as the program progresses. DOORS can also support both the SSCP and the RAP. Some tests are conducted independently of other systems (e.g., component testing during manufacturing). Other testing, such as systems integration, is conducted on several systems and facilities simultaneously to verify compatibility between system elements.

Important to Do

- ✓ Assign an integration systems manager early in engineering.
- ✓ Develop an integrated test plan.
- ✓ Assure safety and security and rail activation requirements are addressed in the plan.
- ✓ Update and detail the plan in subsequent phases.

The integration manager should coordinate with engineering to verify that all aspects of the project are covered. Each test on the list should contain the following information:

- Test name
- System(s) to be tested
- Time of test
- Safety precautions
- Duration
- Special tools
- Location
- Test equipment
- Special instrumentation

Ultimately, the personnel directly responsible for each test establish pass/fail criteria, along with detailed steps in the test procedures, to verify the item under test performs as expected. Throughout Engineering, the integration manager should work closely with each discipline to continually update the list of tests. The test manager also needs to work closely with the personnel responsible for the master schedule. Each test should be inserted into the schedule at the appropriate time and with its expected duration.

Upon completing contractually required system acceptance tests, the systems integration testing is performed. This integration testing demonstrates the ability of various subsystems and facilities to work as a single system. Throughout the following phases, the ITP should be further developed until the test plan is ready for the actual systems integration testing.

7. Design Reviews

While design review is an important function of the sponsor, a designer of record (DoR) professional is legally responsible for the design. Design reviews update the sponsor on design progress and allow the sponsor opportunity to provide feedback to the DoR.

Important to Know

✓ A DoR must be a professional engineer or architect with licensure in the state in which the project is constructed.

✓ Design reviewers should be as equally qualified as the DoR and independent of the DoR.

✓ Review comments should be tabulated in a comments resolution matrix to verify all comments have been addressed and resolved.

✓ The DoR is responsible for QA and QC of all documents before submission.

✓ Design reviewers should verify that QA and QC checks have been conducted before they commence their reviews.

To provide meaningful feedback on the DoR's work, the sponsor may need to engage qualified technical resources independent of the DoR. When such resources are not available internally, the sponsor may need to draw resources from partner agencies or contract program management or general engineering services. These qualified engineering staff will oversee the DoR and perform technical reviews.

The sponsor should specify the required frequency and nature of design submittals and design review meetings that are suitable for the selected project delivery method. Typically for a DBB project, reviews are conducted at 30%, 60%, 90%, and 100%. Use of comment resolution matrices help keep track of and record the disposition of each comment. After review comments are responded to by the DoR, design review meetings should be held to resolve outstanding items.

Figure 3.1 demonstrates a simplified example of a comments resolution matrix. Records of meetings noting issues discussed, decisions made, and instructions given should be retained by the sponsor.

No.	Submittal Name	Date	Reviewer's Comments	Designer's Response	Resolution	Status

Figure 3.1 Simplified Comment Resolution Matrix

Managing submittals and reviewing comments can be facilitated using a project management information system (PMIS) with workflows that track the progress of a submittal through the review process. A submittal may contain multiple documents for review, each document may contain multiple pages or drawing sheets, and multiple reviewers may be responsible for reviewing submittals.

Reviewers typically classify their reviews in one of three categories: i) No Exception Taken; ii) Reviewed with Comments; or iii) Rejected (or Resubmit). If a submittal is reviewed with comments or rejected, detailed comments are usually attached.

During design review, the sponsor should recognize the professional responsibilities of the designers to conduct work in accordance with their approved QA plans and the codes of conduct and ethics of their respective professional organizations. Instructions from the sponsor that compromise the integrity of the DoR may result in the DoR refusing to take responsibility for the design. Owner reviews focus on adherence to the scope, design criteria, and operational requirements. The review should not relieve the DoR of its responsibility to fully check the quality of the work verified by the signature of the DoR and by its QA and QC personnel.

8. Scope, Schedule, and Cost Compliance

The revenue service date (RSD), levels of service, and baseline cost estimate are significant terms of an FTA grant agreement. Per FTA grant agreements, the sponsor is responsible for cost overruns and for meeting the proposed RSD. Sponsors should establish a realistic project work scope, baseline schedule, and cost estimate during PD. This forecast should be further developed in Engineering.

As a project proceeds through Engineering, the baseline schedule and cost estimate should be updated as the design progresses. These updates are considered design development and not a change in scope of the work.

Scope creep presents a major challenge for sponsors. To illustrate using a project that calls for two stations within the scope, if, during Engineering, it is determined that the location of one of the stations needs to change slightly to clear a major underground utility, a scope development update and scope creep occur. Scope creep also occurs if the number of stations is increased. Scope creep may trigger supplemental environmental reviews and should be cleared through the necessary internal and external reviews defined in the owner's change management process.

9. Quality Assurance

The sponsor needs assurance that the work of the designers satisfies the contracted SOW, is in accordance with applicable standards, satisfies all regulatory requirements, and is completed in accordance with good design practice. Accordingly, the DoR should submit for approval a performance of work QMP prior to the commencement of design. Reference should be made to the latest edition of the FTA *Quality Management System Guidelines and ISO 9001 Quality Management Systems - Requirements*. The design QMP should reflect best management practices (see the American Society of Civil Engineers *Policy Statement 351 - Peer Review* for an example of best management practices).

Multidisciplinary design coordination is an important consideration when structuring design work packages. Poor design coordination can result in gaps or omissions between design packages and lead to costly claims during Construction. It is not unusual for a sponsor to assign design coordination responsibility to a lead design firm that would provide, or subcontract, specialist services as required.

DoRs should provide evidence of a formal internal QA and QC in compliance with their approved design QMP.

Important to Do

- ✓ Choose qualified personnel with required licensure and adequate capacity to perform the design.
- ✓ Select a team independent of the DoR to review the work.
- ✓ Tabulate and resolve all comments in a comments resolution matrix.
- ✓ Verify all quality control and quality assurances have been conducted by the designer of record.

FTA suggests that design review submittals be accompanied by a QC certificate confirming that the quality of the work has been checked in accordance with the design QMP and that the work satisfies the project requirements.

The sponsor should retain the right to conduct audits of DoR quality processes and procedures. The audits can provide assurance to the sponsor that the DoR is designing in accordance with the design QMP.

10. Value Engineering

Value engineering (VE)—also referred to as value analysis, value management, value planning, or value control—is the process of seeking to add value to projects or processes by either reducing costs while maintaining functionality or by increasing functionality while maintaining costs. In simple terms, VE may be defined as value = function/cost.

The federal government policy on VE is set out in the U.S. Office of Management and Budget (OMB) *Circular No. A-131*. The Society of American Value Engineers (SAVE) International, the U.S.-based international nonprofit organization that trains and certifies value practitioners, published the authoritative *A Guide to the Value Methodology Body of Knowledge* that provides a body of principles and practices for value-improving techniques. Guidance can also be found in FTA *Oversight Procedure 30 – Value Engineering and/or Constructability Review*.

VE is typically conducted as a formal workshop led by a Certified Value Specialist (CVS) or by an equivalently trained and experienced facilitator. This individual leads a multidisciplinary team of subject matter experts (SMEs) and project sponsor staff through a six-step process as outlined in *OMB Circular A-131*:

1. *Information*: The team gathers information to understand the project and constraints that may impede performance.

2. *Functional Analysis*: The team identifies for further study basic project functions and goals and any performance shortcomings or mismatches between identified functions and customer needs.
3. *Creative*: The team conducts brainstorming to generate new ideas and alternatives to improve a project, product, or process, with a particular focus on high-cost variables, speed of execution, quality, and performance.
4. *Evaluation*. The team ranks ideas to find the best design solutions that meet project value objectives.
5. *Development and Presentation*: The team develops best ideas into viable alternatives with net life-cycle cost savings and implementation details and presents the ideas to stakeholders.
6. *Implementation*. The agency incorporates selected alternatives into the project.

Important to Know

✓ VE and constructability reviews are intended to add value and minimize design, procurement, and construction risks.

✓ The VE team should be independent of the designers.

✓ VE and constructability reviews should be performed before the 30% design is finalized and scope, cost, and schedule are baselined.

✓ Additional VE and constructability reviews may be conducted as necessary.

VE reviews can have the greatest impact on improving the value of projects when undertaken during the early stages of PD. Formal VE reviews are necessary before PD is completed and are suggested at 30%, 60%, and 90% stages of design.

Contractors may also initiate VE reviews post-award of the contract. Depending on the form of construction contract, cost savings associated with VE improvements might accrue that benefit the contractor or that can be shared with the sponsor.

VE-related savings that accrue 100% to the contractor can be implemented by the contractor as long as the value suggestion does not change project performance specifications (e.g., substituting materials that satisfy the specification or making changes in construction methods that yield savings).

VE-related savings shared with the sponsor require a change to the project performance specification (e.g., by way of a VE change proposal [VECP] following the procedures set out in the construction agreement).

Reductions in the SOW that result in cost savings should accrue to the sponsor. However, the savings may be subject to overhead cost adjustments that might accrue to the contractor. Cost cutting by reducing scope is not considered VE.

11. Constructability Review

A constructability review is a formalized process typically involving experts independent from designers, peer agencies, or contractors who have extensive construction and site-specific knowledge. The constructability review goal considers whether a project is constructable using reasonable means and methods. Constructability reviews should be conducted at 30% and 60% design. For larger projects that span longer periods of time, the review should also be conducted at 90% design.

Important to Do

✓ Choose a VE and constructability review team that is independent of the designer.

✓ Select a VE and constructability review team that is knowledgeable of the type of work and specific site conditions.

✓ Complete VE and constructability reviews before the 30% is finalized and the scope, budget, and schedule are baselined.

✓ Repeat VE and constructability reviews through the project life cycle when appropriate.

It is important to consider constructability when planning and designing transit projects. Transit projects are typically constructed in built-up urban areas; many conflicts may exist with the existing infrastructure. Municipal bylaws may impose environmental constraints, such as limiting working hours, imposing noise and dust control restrictions, and aesthetic considerations. Additionally, federal and state laws may impose restrictions related to health and safety, fair wages, employment, and using disadvantaged businesses. Buy America policies may limit sources of supply for materials and equipment. Permitting and approval requirements from diverse agencies may profoundly affect the project schedule.

Implementing environmental mitigation requirements arising from the environmental process may impact constructability or the schedule for project delivery and lead to applications to amend the environmental approvals.

A constructability review is a formalized process typically involving experts independent from DoRs who have extensive construction knowledge. The goal of a constructability review is to consider whether a project is constructable using reasonable means and methods.

A constructability review typically includes an evaluation of the following:

- Environmental reports
- Design briefs and engineering reports
- Latest design drawings
- Latest specifications
- Latest project schedule
- Latest cost estimate

- Traffic management plans
- Utility considerations
- Project risk register
- Operational constraints
- Federal, state, and municipal regulatory requirements

Constructability reviews may be completed using a facilitated workshop process that is often linked with a site visit. Typically, a presentation is made by the DoR to the constructability team at the start of a workshop. At workshop conclusion, constructability observations and suggestions are consolidated by the team leader and submitted to the sponsor in the form of a report.

The sponsor discusses the constructability observations and suggestions with the DoR, and agreement is reached on which, if any, to implement. The sponsor then documents the decisions reached.

Biddability reviews may also be incorporated into the constructability review process. A biddability review includes reviewing the proposed project delivery method and bid documents. A similar process is followed when additional contract specialists are involved.

12. Peer Reviews

A sponsor can consider two types of peer reviews: mandatory and ad hoc. The ASCE defines peer reviews as follows:

> The practice of obtaining an independent, unbiased evaluation of the adequacy and application of engineering principles, standards, and judgment from an independent group of professionals having substantial experience in the same field of expertise. Peer reviews are in addition to the normal QC and checking procedures required on any engineering assignment. (*ASCE Policy Statement 351*)

Mandatory peer reviews are mandated either by the sponsor or by a regulatory agency for specific types of engineering work involving potentially significant risk to the public.

Ad hoc peer reviews may be initiated by the sponsor if the sponsor requires an independent opinion on the appropriateness of a design element or system proposed by the DoR. ASCE further notes: “Peer review can add a measure of increased confidence to the designer or consultant which leads to improved practices and benefit the public health, safety, and welfare” (*ASCE Policy Statement 351*).

13. Transit Asset Management

FTA CIG policy guidance was updated after the passage of the IIJA/BIL specifically requiring sponsors to demonstrate progress toward achieving TAM plan SGR targets to complete Engineering. The review during Engineering should address performance measures noted in Chapter 2 with progress focused on goals established on vehicles, equipment, track, infrastructure, and facilities.

Only for CIG FTA-funded projects, at the end of Engineering and prior to entry into FFGA, FTA requires a statement signed by the CEO that describes the progress the agency has made toward meeting TAM plan SGR targets. The statement should include as supporting documentation an up-to-date TAM plan and narrative report from the NTD.

14. Safety and Security Compliance

A safety and security compliance review is a key element of design reviews required during Engineering.

Along with updating the SSMP, the sponsor's safety and security team should complete at least one revision of the project's PHA, including all civil or system elements, and a TVA to complete Engineering. This process provides assurance that any changes to the project include a reassessment of safety hazards and security risks.

The sponsor should prepare an SSCP and an accompanying safety and security CIL that includes subsystem elements. The sponsor should develop a *Safety and Security Design Manual* (*SSDM*), and, if not developed earlier, a *Construction Safety and Security Manual* (*CSSM*).

While safety and security compliance is the responsibility of the contractor, the CSSM documents safety and security requirements for each specific worksite. The requirements should be distributed with all bid documents and should include a clause specifying that a project employee—generally the safety and security manager—has the authority to review contractor/construction logs, enter the worksite, question employees, etc., to determine whether safety and security requirements are being adhered to.

The FTA *Handbook for Transit Safety and Security Certification* (November 2002) and *Hazard Analysis Guidelines for Transit Projects* (January 2000) are excellent sources of additional information. For TVA-specific information, see American Public Transportation Association (APTA) *Security Risk Assessment Methodology for Public Transit* (March 2021).

If the sponsor has not yet done so or is not working under the transit agency's sensitive security information (SSI), the sponsor should develop a policy that meets the requirements of 49 CFR, Part 15; 49 CFR, Part 1520; and the FTA *Sensitive Security Information: Designation, Markings, and Control* (March 2009).

Any information or record whose disclosure may compromise the security of the traveling public, transit employees, or transit infrastructure is considered SSI, including data, documents, engineering drawings and specifications, and records whose disclosure could increase the agency's risk of harm. All TVAs are considered SSI and should be distributed only in conformance with the confidentiality requirements.

All design reviews should consider the principles of APTA *Crime Prevention Through Environmental Design* (CPTED) *for Transit Facilities,* Rev. 1 (September 2020). The CPTED is based on the concept of defensible space, which uses design to create opportunities for safe activities and deter criminal activity. For transit-specific information on CPTED, also see the APTA publication mentioned in this paragraph.

Two committees specified in FTA *Circular 5800.1 Safety and Security Management Guidance for Major Capital Projects*—the Safety and Security Review Committee (SSRC) and the Fire-Life Safety and Security Committee (FLSSC)—should be formed early in Engineering to play key roles in reviewing and updating safety and security documents.

While many older FTA documents refer to these as the Safety Review Committee (SRC) and the Fire-Life Safety Committee (FLSC), FTA now recommends that "security" appear in each committee's name to recognize the difference between the two disciplines. For more information on the composition of the SSRC and FLSSC, see the FTA *Handbook for Transit Safety and Security Certification* (November 2002).

15. Permitting Agency Plan Check

Permitting agency requirements identified during PD need to be addressed during Engineering. The sponsor's design team should communicate with all authorities having jurisdiction to identify the authority's design review and plan check requirements. These requirements outline the form and frequency of design submissions.

Most transit capital projects require coordination in one or more jurisdictions—including municipalities, cities, counties—and with state and federal agencies. In addition, the project may impact third parties, railroads, and utilities and may require submittals for design reviews and plan checks.

One challenge during design review is tracking the closure of all comments at each required review milestone, using the comments resolution matrix, and communicating back to the reviewing party with written documentation of the decisions reached.

The agency having authority over the project may impose additional capital improvements not directly related to the project. In such cases, the sponsor should keep an account of these betterments as concurrent non-project activity (CNPA). FTA does not fund CNPAs.

A successful design review and plan check process expedites approval and permitting processes.

CHAPTER 4. PROCUREMENT

1. Purpose

Chapter 4 discusses key activities undertaken in Procurement, which usually occurs after completion of the Engineering unless a sponsor has otherwise received pre-award authority or a Letter of No Prejudice (LONP). The output of Engineering includes a set of design drawings and project specifications supported by design reports, calculations, third-party and utility agreements, technical reports, an updated schedule, and a cost estimate.

The level of design detail corresponding to the level of design progression and to the nature of the specifications varies depending on the project delivery method selected. This chapter also addresses project delivery methods. It is intended to supplement the FTA *Best Practices Procurement & Lessons Learned Manual* (October 2016). Also see FTA *Oversight Procedure 32D – Project Delivery Method Review* and the FTA *Construction Project Management Handbook*.

2. Management Capacity and Capability

The sponsor is responsible for leading and managing the project. If a sponsor is unable to provide adequate management staffing who have experience with similar projects during Procurement, the sponsor can outsource procurement support while retaining decision authority and responsibility.

Skills required for managing Procurement are different than the skills required for Engineering. Managing Procurement requires procurement, legal, and other professionals to support project management staff (see subsequent sections of this chapter for details on procurement processes for various project delivery methods).

3. Project Management Plan

To appropriately allocate project risks, the sponsor needs to thoroughly understand the project packaging and delivery methods for each solicitation package. Organization and management policies, processes, and procedures should be documented in the PMP (see Chapter 7 for typical content in a PMP and related subplans).

Procurement should be programmed into the Integrated Master Project Schedule (IMPS). For major complex projects, industry outreach is recommended, which may increase competition and reduce procurement risks.

4. Contractual Requirements

Each procurement should be structured for the appropriate delivery method selected. The selection of an appropriate delivery method helps reduce market procurement and construction risks.

The authority for any type of procurement method resides in legislatively mandated policies and procedures of the state and locality in which the transit project will be built. Where FTA funding is used, FAR applies to third-party contracting activities. Also, state and local laws may restrict the use of certain project delivery methods or add cost or time due to additional requirements for value-based selections.

Important to Know

✓ Selecting the project delivery method is one of the most important decisions a sponsor makes.

✓ The selected project delivery method defines needed sponsor resources, scope of consultant assignments, and the entire project delivery strategy.

The project delivery method decision should be based on a rigorous assessment of the risks associated with each potential delivery method and on the value-for-money associated with each method (see Chapter 7 for a discussion of qualitative and quantitative risk management). For best overall value, the sponsor should assign risk responsibility to the party most capable of managing the risk. A sponsor should also manage and reduce critical risks (e.g., ROW acquisition, environmental, or utility relocation) before construction begins.

Value-for-money analyses compare the expected cost of a project delivered using various delivery methods to the traditional method of project delivery. Table 4.1 summarizes the primary project delivery methods used to deliver MCPs. Current trends in MCP delivery point to alternative delivery methods, such as DB and PDB, and as described in detail in this chapter.

Table 4.1 Primary Project Delivery Methods

Delivery Method	Description	Advantages
Design-Bid-Build (DBB)	Traditional method of public sector project delivery. Sponsor retains contractor designer to complete design to 100%. Contractor with lowest responsive bid based on 100% design and specifications is selected.	Greatest level of sponsor control with prescriptive specifications.
Design-Build (DB)	Sponsor's contractor designer advances design to approximately 15% to 65% level of completion depending on risks. Two-stage procurement process: i) short list bidders based on qualifications; ii) selected bidders submit technical proposal and guaranteed maximum price (GMP) based on sponsor's preliminary design and performance specifications. Best-value selection is based on predetermined weighted selection criteria between the technical score and price.	Shorter completion time due to design concurrency with construction and to potential savings suggested in alternate design contractors' proposals.

Progressive Design-Build (PDB)	PDB contractor is selected during early stages of PD in a two-stage process similar to DB. PDB contractor's designer advances design progressively in packages from construction to completion. PDB contractor submits final GMP at agreed level of design completion to complete the construction.	Increased level of design certainty compared to DB; potential fewer expected changes during construction.
Construction Management/er at-Risk (CMAR or Construction Management/ General Contractor [CM/GC])	Sponsor retains GC to advise on constructability during design development. Sponsor designers advance design to 100% level of completion. GC provides GMP or lump sum at 75% to 90% stage of design.	High degree of sponsor control and construction price certainty.
Public–Private Partnership (P3); also referred to as DBFOM Concessions	Variations of DB involving finance, operations, maintenance, and hand-back requirements. Typically, a two-stage selection process: i) qualification of potential partners; ii) technical and price proposals. Best-value selection is based on predetermined relationship between technical score and price.	Finance and operations revenue components drive timely completion.
Progressive Public–Private Partnership (P4)	Variation of P3 model; private partner is selected early in design development process and provides a GMP or lump sum at 75% to 90% stage of design.	Reduced design and construction risk.
Integrated Project Delivery (IPD, or Alliance Model)	A multiparty agreement between owner, designers, GC, major subcontractors, and other stakeholders using a two-stage procurement process. Profit pool is fixed at the GMP stage; all parties are committed to the success of the project to maximize their share of the profits. Profit pool increases if costs are under budget.	Improved transparency and aligned interests of all parties to the project.

Design-Bid-Build

DBB is a traditional project delivery approach used by many public sector agencies to deliver capital projects.

In a DBB delivery model, the sponsor prepares a 100% design package and typically retains a lead firm of consulting engineers or architects to perform design and provide design support during Procurement and Construction. The sponsor may also select a construction management firm to oversee construction. FTA and general industry practice discourage the use of a design consultant as the sponsor's CM due to potential or apparent conflict of interest issues.

Important to Know

- ✓ DBB is a traditional project delivery method.
- ✓ Non-DBB delivery methods are categorized as alternative delivery.
- ✓ FTA *Best Practices Procurement & Lessons Learned Manual* includes applicable regulations.
- ✓ Additional information is available in the FTA *OP 32D – Project Delivery Method Review*.
- ✓ Design Build Institute of America (DBIA) has published helpful information on alternative delivery.
- ✓ The Construction Management Association of America published an *Owner's Guide to Project Delivery Methods*.
- ✓ *23 U.S.C. 112 – Letting of Contracts and 23 CFR 636 – Design-Build Contracting* are excellent resources from FHWA for alternative delivery contracting.
- ✓ Industry outreach can provide additional input for bid packages.
- ✓ Selecting an appropriate delivery method helps reduce risks.
- ✓ State and local laws may not allow certain alternative delivery methods.

Contractors are usually selected through a public bid process, either with or without prequalifying potential bidders. A construction contract is typically awarded to the lowest compliant bidder.

The DBB delivery method provides the owner with the greatest level of control over project design and construction. Specifications and drawings are prescriptive and allow for few opportunities for contractor-initiated design changes. DBB contracts may contain conditions for VECPs where potential cost savings are shared between the sponsor and the contractor.

Sponsors should be aware of the Spearin Doctrine (also referred to as the doctrine of implied warranty of the adequacy of plans and specifications), a decision of the U.S. Supreme Court that has defined owner responsibilities in construction contracts for more than a century. Spearin states the following:

> "'…if the contractor is bound to build according to plans and specifications prepared by the owner, the contractor will not be responsible for the consequences of defects in the plans and specifications. This responsibility of the owner is not overcome by the usual clause requiring builders to visit the site, to check the plans, and to inform themselves of the requirements of the work…the contractor should be relieved if he was misled by erroneous statements in the specifications." (*United States v. Spearin*, 248 U.S. 132, 1918)

DBB contracts are typically awarded on either a unit price or lump sum basis. Liquidated damages are assessed when contractors fail to reach completion milestones by the scheduled dates.

When determining the quantum of assessed liquidated damages, it is important to 1) establish reasonable target completion dates; and 2) base damage amounts on reasonable costs that the sponsor will incur if project completion is delayed beyond the contracted target completion date. Excessive liquidated damages may contribute to lower quality if contractors attempt to complete on time.

Multiple-prime contracting is a variation of DBB. In this approach, the sponsor may contract with multiple contractors to provide certain construction services or equipment. If this approach is selected, the subject work should be separated by time or location. For example, separate contracts could be awarded for different sections of work in the ROW, different stations, or to supply different types of equipment. When awarding multiple-prime contracts, special attention should be directed to interface risk. Under a multi-prime procurement, the owner, or its CM, manages the overall schedule and budget.

The DBB project delivery method generally requires a longer amount of time between project inception and completion when compared to alternate delivery methods.

Design-Build

The DB delivery method is a two-step best-value process for selecting a DoR and construction contractor. The sponsor's designers typically prepare a preliminary design to a 15%-to-30% level of design detail, and, at times, to 65%. Preliminary design is usually accompanied by performance specification and design criteria that outline the minimum standards a sponsor will accept during detailed design and construction.

Important to Do

- ✓ Select a contracting method that provides best value for the project.
- ✓ If an alternative delivery method is selected, consult state and local laws.
- ✓ Allow sufficient time for alternative delivery procurement.
- ✓ Be open to contractor's design proposals within the general project scope definition.

Before selecting the DB method, the sponsor should consult with the state in which the project is located to confirm it is permitted under the state regulations. In addition, the sponsor should review 23 CFR 636 Design-Build Contracting requirements as applicable.

The two-step process starts by issuing a request for qualifications (RFQ), including selection criteria; contractors submit a statement of qualifications (SOQ) in response to the RFQ. The sponsor then establishes a short list of qualified contractors based on qualifications only.

Sponsors are encouraged to conduct a pre-submittal conference to review the project and address questions. Contractors can submit questions in writing; the sponsor should respond in writing after the pre-submittal conference. Confidential commercial or technical questions should be responded to in confidence.

The sponsor then issues a request for proposals (RFP) with value-based selection criteria (i.e., technical concept proposals and price proposals) to short-listed contractors. DB proponents may be encouraged to submit alternative technical concepts (ATCs) within the project definition and scope of their SOQ. In addition, the sponsor should conduct a pre-proposal conference and site review with the short-listed proponents; the sponsor can also address questions at that time.

The proponents submit separate price and technical proposals. The sponsor reviews and scores the technical proposals based on the selection criteria independently of the price proposals. The price proposals are then evaluated. The sponsor combines the price and technical scores and ranks the proposals in order of value.

The sponsor's engineer or architect is typically retained through design and Construction to review design submissions and construction work for compliance with the DB agreement.

DB contractors typically start construction of early works (e.g., utility relocations) while design continues. Concurrent design and construction can result in shorter-than-expected project delivery times than with the DBB project delivery method.

A CM independent of the sponsor's designers may be retained to manage construction if sufficient construction management resources are not available within the sponsor's organization (see Chapter 5 to review the role of the CM).

Progressive Design-Build

PDB is a variation of DB. In PDB project delivery, the PDB contractor is selected early in Engineering to collaboratively work with the sponsor's designers to advance the construction design within budgetary and schedule requirements. Selection criteria are similar for DB and subject to the same federal, state, and local laws. The owner's designers perform the initial concept design.

The PDB contractor and its designers work collaboratively with the sponsor's designers to advance the design to a predetermined level. Once at that level, the PDB contractor submits a GMP or lump sum to take the project to completion. In some cases, the PDB contractor develops early packages and submits a bid after each package is sufficiently advanced. The PDB contracting process provides for an "off-ramp" whereby the owner can terminate the contract with the PDB contractor and revise its contracting strategy.

The PDB project delivery strategy increases collaboration between the sponsor and the DB contractor. When retaining the PDB contractor while design is ongoing and before the PDB contractor submits a price to complete the work, estimating risk is reduced for the PDB contractor; fewer changes should be required during Construction.

Reduced competitive tension during the pricing of the work may result in increased project costs for the sponsor. Sponsors may require an "open-book" approach with the PDB contractor to ensure fair pricing.

Construction Management at-Risk

Construction management at-risk (CMAR; also referred to as CM/GC) combines aspects of DBB and PDB delivery models. The sponsor's designers typically take the design to 100% completion and continue reviewing the design through Construction. A GC is selected early in the design process and participates in the detailed design of the proposed project. The GC either leads or supports cost estimating and helps the designers optimize the design for constructability.

The CMAR is usually paid a fee during design development. Somewhere between 75% and 90% design completion, the CM at-risk submits a GMP or lump sum to construct the work. If the price is accepted, a contract similar to DBB is executed with the contractor; at that point, the contractor will own the risk. If the contractor's price is not accepted, the sponsor has the option to submit the construction contract to bid either publicly or to prequalified bidders.

The role of the CMAR should not be confused with the role of the sponsor's CM. The sponsor's CM represents the sponsor during Construction and may provide project controls functions, including schedule reviews, cost and document management, progress reporting, risk management, change processing, quality auditing, and claims support.

Public–Private Partnerships

P3 projects take many forms. Common to all P3 project delivery models is the concept of financing. The private partner typically gets paid upon achieving milestones. In some cases, a single payment is made following completion of the contracted works. Until the public partner makes a payment, the private partner should finance regular payments due to its designers and contractors on the project.

Important to Know

- ✓ Well-conceived P3 can deliver exceptional cost and schedule benefits.
- ✓ Risks should be thoughtfully assigned to the party most capable of managing them.

The private partner may be a developer, an investment bank, or a GC. On major projects, the private partner may be a consortium of several investors organized through a special purpose vehicle (SPV). The SPV may be an incorporated company, a partnership, or other form of joint venture.

One of the simplest forms of P3 is the design-build-finance (DBF) model. In DBF, the SPV typically retains a DB contractor, arranges project financing, and submits an offer to the public partner based on an RFP and terms of reference. Like DB, the sponsor retains an architect or engineering firm to prepare a preliminary design and performance specification. The sponsor's designers are usually retained through Construction to review submittals, respond to RFIs, and perform quality audits.

Although the private partner's interest rate on borrowed money will normally be higher than the sponsor's interest rate, overall financing costs on a P3 project will usually be less than on a DBB project due to the shorter overall design and construction schedule. Sponsor administration costs are typically much lower on a P3 because the private partner administers design and construction subcontracts and pays its designers and contractors.

Project financiers will usually appoint a lender's technical advisor to monitor the use of borrowed funds and confirm that the private partner will be able to repay lenders per the agreed schedule. The cost of the advisor is paid by the private partner and included in its offer. The involvement of project financiers and an advisor provides another level of scrutiny and brings additional discipline to the conduct of designers and construction contractors.

Other roles common on P3 projects include a fairness monitor, an independent engineer, a checking engineer, a dispute review board (DRB), and a payment certifier.

The role of a fairness monitor starts early in the project delivery cycle. The fairness monitor is usually retained by the project sponsor to ensure that the Procurement process is conducted fairly. The fairness monitor may review and opine on all correspondence between the project sponsor and proponents and typically attends all meetings between the project sponsor and proponents. At the end of the Procurement process, the fairness monitor produces a report summarizing its observations and conclusions.

An independent engineer (IE) may participate in reviewing design submittals, quality auditing, and progress reporting. The IE may be called upon to mediate disagreements between the sponsor's designers and the SPV's DoR regarding interpretation of the technical specifications. The IE is usually retained jointly by the project sponsor and the SPV. A checking engineer may be retained by the DoR to independently check critical infrastructure designs. Typically, independent checks are required for complex structures.

Timely resolution of disputes that may arise during a P3 project is important. Many P3 projects include a summary dispute resolution process involving an independent panel of experienced subject matter specialists, often referred to as a DRB. This panel of experts may be called upon at short notice to hear and opine on disputes. DRB members with legal, financial, and technical backgrounds can manage a broad range of issues that may arise.

DRB decisions may be binding up to a certain financial limit and are appealable through a dispute resolution process for proposed settlements above that limit. DRB members are usually paid jointly by the sponsor and by the SPV.

Payment certifiers may be retained either by the sponsor or jointly by the sponsor and the SPV to certify that condition precedents have been satisfied for milestone payments. If an IE has been retained, the IE may fulfill the duties of a payment certifier.

P3 models that incorporate O&M obligations can increase the value for money of a P3 delivery model. A major benefit of including O&M obligations is the ability to include hand-back conditions at the end of the O&M period. By doing so, the private partner is held responsible for the condition of the project works until hand back, effectively providing an extended warranty on the works. Typical O&M periods are between 20 and 50 years, with many P3 contracts having a 30-year O&M period.

There are growing emergence and related experience in the marketplace with P3 projects. Sponsors with limited P3 experience should seek professional support from experienced legal, financial, and technical advisors.

Progressive Public–Private Partnerships

In P4 project delivery, the P4 contractor is selected following a qualifications process during design development. The P4 proponent is usually led by a project developer or financier. P4 proponents usually include a proposed DoR at the qualifications stage but may reserve the right to select and name construction contractors at the pricing stage.

The selected P4 proponent is paid for design and management services to complete the project during design development up to the submission of a GMP or lump sum. The sponsor usually retains the right to terminate the P4 contract if agreement cannot be made on a mutually acceptable price for the work.

Integrated Project Delivery

IPD is an emerging collaborative project delivery method, contractually requires collaboration among the primary parties so that risks, responsibilities, and liabilities for project delivery are collectively managed and appropriately shared.

IPD involves structuring a multiparty agreement between the sponsor, designers, a GC, major subcontractors, and, potentially, other stakeholders using a two-stage procurement process. During the first stage, design is developed to the 75% to 90% level of completion. Parties are compensated by the sponsor for their involvement in the first stage.

A GMP and profit pool are established at the end of the first stage. Each party in the IPD agreement is allocated a share of the profit pool. Parties earn their maximum share of profits only when the entire profit pool is earned. Thus, each party is effectively committed to maximizing the overall success of the project and to assisting other parties in achieving their project objectives.

IPD teams are selected primarily based on qualifications and are typically managed by the sponsor or by the sponsor's project manager. The sponsor's project manager may be selected from a specialized firm of project management consultants or, in some cases, be provided by the sponsor's design consultant. IPD teams share the success of a project. Use is made of collective experience and decisions are made jointly for the overall benefit of the project. Additional information is available in the Construction Management Association of America (CMAA) *Owner's Guide to Project Delivery Methods*.

Other Project Delivery Considerations

Project delivery models continue to evolve in response to issues encountered with various project delivery methods. Target-cost design (also referred to as design to budget) is a method that can be combined with various forms of DB procurement. This method is applicable following a VE review that fails to bring costs within budget while maintaining the desired functionality. At times, it is necessary to reduce functionality and re-scope a project to satisfy budgetary constraints.

In a target-cost procurement, prequalified proponents are provided with a prioritized list of functional requirements and asked to address as many of the requirements as possible within a set maximum budget (e.g., Twenty light rail stations are desired. How many can be constructed within the available budget?).

DB contractors may be reluctant to submit a lump sum or fixed price on major projects where risks are difficult to quantify or manage. If the industry outreach process produces limited interest in the marketplace for qualified proponents to participate in a conventional DB procurement process, the sponsor may need to consider strategies to reduce contractor risks.

CMAR, CM/GC, cost-plus-fixed-fee, and cost reimbursable/time and material contracts reduce risks for contractors and encourage competitive bidding. Under such forms of project delivery, prequalified contractors might compete on elements such as proposed fees, craft rates, and markups on subcontracted work.

Controlling cost and schedule creep on CMAR, CM/GC, cost-plus-fixed-fee, or cost reimbursable contracts can be challenging for the sponsor. Project controls specialists can provide tools and methods to monitor progress and early warning of works that may be running behind schedule or over budget so that action may be taken to mitigate potential impacts.

For example, it is not uncommon on CMAR, CMGC, cost-plus-fixed-fee, or cost reimbursable contracts to approve budgets for specific scopes of work on a not-to-exceed basis. Earned value can be compared to actual costs by comparing the percentage complete of work in the scope to the percentage of the budget invoiced. If invoiced amounts exceed the earned value, the sponsor's CM team determines the reasons for the excess and takes action. Actions could include requiring the contractor to revise work methods, change personnel, or submit a request for additional budget allocation.

Risks can also be fairly shared with contractors by using target pricing with a gain-share/pain-share mechanism. For example, instead of locking in a GMP or lump sum at 70% to 90% design, a sponsor might reach agreement on a target price. If the contractor completes the project below the target price, savings are shared with the contractor. If the contractor completes the project at a cost above the target price, the contractor becomes responsible for paying 100% of the cost overrun to a set percentage of the target price, usually equal to the expected profit that the contractor would have earned had the project been completed at the target cost.

Beyond the set overrun percentage for which the contractor is held responsible, the sponsor might pay 100% of the direct cost overrun, excluding any markup for profit. Increasingly, sponsors are looking at collaborative project delivery models. While alternative project delivery methods to traditional DBB encourage a level of collaboration, these models are not universally successful in preventing adversarial relationships and in eliminating claims.

To forecast how well prospective team members will interact, a formal collaborative behavioral tool can be required as a component of the selection process. This type of evaluation can assess the likely behavior of a potential private partner or contractor. *ISO 10667-1:2020 Assessment Service Delivery* contains requirements and guidance on carrying out behavioral assessments for work-related purposes for sponsors working with one or more service providers; Part 2 contains guidelines for service providers.

5. Contractual Requirements

Regardless of the selected project delivery method, the project sponsor should prepare contract documents that clearly define the roles, responsibilities, and commitments of the parties to the agreement. Multiple agreements may need to be prepared at different stages of the procurement process.

Important to Know

✓ Construction contracts include the agreement and incorporate multiple documents by reference.

✓ Drafting construction contracts requires specialized legal, bonding, and insurance expertise.

Agreement templates are available from multiple trade associations, including the American Institute of Architects; Associated General Contractors of America; and the Engineers Joint Contract Document Committee, which is comprised of the National Society of Professional Engineers, American Society of Civil Engineers, and the American Council of Engineering Companies. Additionally, the American Bar Association published "Construction Law 101: Anatomy of a Standard Form Construction Contract," which provides a high-level overview of construction contracts.

Establishing the order of document governance is important when conflicting requirements arise. Generally, a specific requirement governs over a general requirement. Documents with the most current date should govern over earlier documents of the same type. Amendments to documents should govern over the document amended. On complex major projects involving alternative project delivery models, specialized legal, insurance, and bonding expertise is required to develop appropriate contract documents.

Design-Bid-Build Contracts

DBB procurement is a well-established form of contracting for infrastructure construction services. The process may start with prequalifying potential bidders based on criteria that the project sponsor establishes and that is consistent with applicable laws and regulations. Once bidders have been preselected or a decision is made to publicly bid the work, tender, or bid documents, are prepared. DBB bid documents typically contain the following:

- Instructions to bidders
- Bid forms
- Attachments

Instructions to bidders set out the rules of engagement and define the required documents and breakdown of costs to be submitted by bidders. Bid forms and attachments may include bidder information, a bid bond, an agreement to bond, and other information the project sponsor deems relevant.

Once a preferred bidder is identified—generally the lowest priced bidder that satisfies the formal bid requirements—a DBB contract is executed. A typical DBB contract contains the following sections:

- Agreement
- General conditions
- Special or supplementary conditions
- Specifications
- Contract drawings
- Attachments

The agreement describes the parties to the agreement, work to be undertaken, schedule for completion, and compensation amount and references various documents. Contract design documents are typically sealed by authorized representatives of the parties under their respective discipline seals.

General conditions define the obligations of the parties and set out terms and conditions for performing the work. Project sponsors and agencies that undertake multiple projects on a regular basis develop standardized general conditions that are applicable to a wide range of projects. Bidders who regularly bid on projects for a project sponsor or agency become familiar with standard general conditions and understand expectations.

Special or supplementary conditions may modify the general conditions or add requirements. Standard conditions that substantially modify the general conditions are best avoided to reduce potential confusion in the marketplace. Alternatively, project-specific terms and conditions may be developed to replace general conditions, thereby eliminating the need for special or supplemental conditions.

Specifications provide detailed descriptions of the SOW, materials, and equipment to be incorporated into the project; reference applicable standards; describe methods required to deliver the work; and may set out measurement and payment provisions.

Specifications generally follow Construction Specifications Institute (CSI) MasterFormat divisions or equivalent tools available to the sponsor. The CSI MasterFormat has been updated and expanded to include 35 divisions numbered from 00 to 48. CSI MasterFormat specifications are written in three parts: General, Products, and Execution. The sponsor may use other available products with a proven industry record for preparing the specifications.

Specifications are usually prepared by the DoR at an advanced stage of design. Contract drawings are prepared under the seal of the registered architect or professional engineer responsible for the content of the drawings (i.e., DoR). Contract drawings visually represent the intent of the contracted work. They may include additional requirements, notes, schedules, and schematic diagrams.

Where 3D models are used in design, building information modeling (BIM) or other digital models may accompany, or even replace, the contract drawings. The United States National CAD Standard® V6 is made up of the American Institute of Architects CAD Layer Guidelines; Construction Specification Institute's Uniform Drawing System (Modules 1-8); and the National Institute of Building Sciences' BIM Implementation & Plotting Guidelines.

Alternate Project Delivery Contracts

Alternate project delivery models using two or more procurement stages require customized prequalification and bid documents prepared under the direction of specialized legal advisors and procurement specialists.

At minimum, the contract should describe the parties to the contract, purpose of the contract, intended schedule for completion, and value of the contract. An alternate project delivery agreement usually references numerous other documents (e.g., schedules or attachments, general conditions, special provisions or supplementary conditions, specifications, and contract drawings).

Alternate project delivery agreements may incorporate terms and conditions in the primary agreement that might otherwise be included in general conditions, special conditions, or supplementary conditions.

Specifications in some alternate project delivery models may be performance based as opposed to prescriptive. Similarly, contract drawings may illustrate a solution but allow significant opportunity for design development and innovation by the contracting party. Performance specifications and illustrative solutions may lead to unintended consequences for the sponsor if not carefully developed. Avoiding unintended consequences is a primary incentive to use with collaborative project delivery models, such as CMAR, CM/GC, PDB, P3, P4, and IPD.

Risk allocation should be explicitly defined in alternative delivery contracts, particularly for contracts that may continue over a long period of time. Contract design documents are typically sealed by authorized representatives of the parties under their respective discipline seals.

Insurance

Regardless of the form of project delivery, the sponsor should confirm that it and the contracting parties are adequately insured.

Insurance has become a very specialized field, and coverage can be structured in many ways on major projects. Insurance needs should be discussed with an insurance advisor or broker and evaluated against the risks being insured. Insurance coverage limits and deductibles affect the availability and cost of insurance products.

Typical insurance requirements may include the following:

- General liability
- Director and officer liability
- Professional liability (errors and omissions)
- Automobile liability
- Manned aircraft and watercraft liability
- Unmanned aircraft liability
- Broad form property insurance
- Boiler and machinery insurance
- Contractor's equipment insurance
- Contractor "all risks" insurance
- Pollution liability insurance
- Project wrap-up insurance

Bonds

Bonds are a form of insurance that provide protection to the sponsor if a selected contractor fails to 1) enter into a contract (bid bond); 2) complete contractual obligations (performance bond); or 3) pay its suppliers or subcontractors (payment bond).

FTA currently requires bonding or an equivalent security for all construction contracts exceeding the simplified acquisition threshold as specified by FTA *Best Practices Procurement & Lessons Learned Manual* unless FTA determines that other arrangements adequately protect the federal interest. FTA bonding requirements are set out in the *FTA Best Practices & Lessons Learned Manual*.

The bid guarantee should be equal to 5% of the contract amount and be in the form of a bid bond, certified check, bank draft, or other negotiable instrument to ensure that the bidder honors its bid upon acceptance.

Contractors usually provide a performance bond equal to 100% of the contract price to ensure completing its obligations under the contract. Additionally, contractors usually provide a payment bond to ensure that suppliers of labor and materials are paid as required by law. The value of the payment bond typically varies between 50% of the contract amount to a maximum of $2.5 million.

Important to Know

✓ FTA requires a 5% bid guarantee, 100% performance bond, and variable payment bond, depending on the size of the contract.

✓ FTA will accept reduced bonding or other security alternatives that protect the federal interest.

FTA understands that bonding is expensive and will consider reduced bonding requirements provided that the federal interest is adequately protected (see FTA *Best Practices Procurement & Lessons Learned Manual*).

In some cases, state and local bonding requirements may exceed the minimum thresholds recommended by FTA. If FTA considers that excessive bonding requirements may reduce competition, FTA may choose not to provide federal assistance for procurements encumbered by those requirements (see FTA *Best Practices Procurement & Lessons Learned Manual*).

The bonding capacity of a contractor is established by the bonding or surety company. Capacity is based on the financial strength of a contractor and on an assessment of the project risks for which bonding is required.

Bonding requirements should be carefully considered with the assistance of a financial advisor or broker. The bonding capacity of individual contractors may govern a contractor's ability to participate in the project delivery process. Contractor bonding capacity limitations may necessitate creating joint ventures to share risk and combine their bonding capacities to meet required thresholds.

6. Other Major Procurements

Vehicles

The sponsor's procurement department should have experience with the vehicle acquisition process. This department can also write the RFP with support from engineering and operations. Should the procurement department not have adequate experience or resources, the sponsor can use a consultant to perform or support major procurements.

To facilitate certain procurement processes, APTA has published guideline documents that include the "Light Rail Vehicle Request for Proposals Procurement Guideline." Though primarily for LRV procurements, this document is also useful for HRV procurements due to rail vehicle similarities. Guidance for bus procurements can be found in the APTA "Standard Bus Procurement Guidelines RFP". In addition, the APTA Zero Emission Fleet Committee is a forum for discussing and sharing information and best practices regarding battery electric, fuel cell electric, and near-zero emission buses and infrastructure.

Important to Know

✓ Major procurements are generally value-based.

✓ The selection committee should include representatives from operations and maintenance, as well as from engineering.

✓ U.S. service-proven products should be considered in preparing specifications.

✓ FTA-funded procurements must adhere to federal Buy America Act requirements.

Initial planning for vehicle procurement involves researching the market for potential manufacturers to determine interest in the vehicle procurement under consideration. When the market indicates that interest may be low, the sponsor should conduct an industry survey to determine impediments that may exist. The results of this survey provide the information needed to avoid specifying a vehicle with restrictions that will result in low participation from railcar or bus manufacturers.

A best practice is to look for service-proven products that meet federal Buy America Act requirements. If federal funds are part of the procurement, standard FTA provisions should be included in the solicitation documents. For Buy America compliance, 49 CFR 661 and 49 CFR 662 are required and enforced via audits. The TCRP *Guide to Federal Buy America Requirements* and the FTA *Buy America Handbook* are also excellent resources for information on Buy America requirements. These provisions require pre-award and post-delivery audits for the procurement of rolling stocks.

After completing the industry research, the sponsor should develop the vehicle technical specifications. Although many technical specifications for rail and bus vehicle procurements from peer agencies exist, persons responsible for developing these specifications should have the knowledge and experience to write sections of the specifications. The specifications should not be overly prescriptive or be lacking in detail; either approach could result in high quotations or expensive change orders during contract execution.

Terms and conditions and technical specifications should be developed in parallel. Most vehicle procurements are conducted through a best-value process, which allows the purchaser to award the contract to the best manufacturer when price and other factors are considered.

A successful best-value process involves developing evaluation criteria and scoring. Typically, four or five evaluation criteria are developed and a score assigned to each. Price, although not an evaluation criterion, should be assigned a score.

Prior to receiving proposals, two committees should be established to evaluate technical proposals and price proposals. The Technical Evaluation Committee should contain personnel from various sponsor departments (e.g., operations, maintenance, and engineering) who will be affected by the choice of the vehicle supplier. This committee should also include consultant advisors and peers.

Important to Do

- ✓ Conduct market research and seek peer sponsor experiences.
- ✓ Ensure adequate time is provided in the project schedule for major procurements.
- ✓ Include adequate spare parts and spare ratios for vehicle procurements.
- ✓ Consult APTA and TCRP standards when preparing the RFP.
- ✓ Comply with federal Buy America Act standards and requirements.

The Price Committee will have fewer members; participants should be familiar with the sponsor's finance and price quotations. The evaluation committee scoring associated with each proposal determines the competitive range of scores.

After the committees provide an initial review of the scores, top-scoring bidders are shortlisted and invited for discussion. The committees interview the shortlisted proposers, and the sponsor modifies the specifications as necessary and requests best and final offers (BAFOs) from the shortlisted proposers.

This same evaluation process is repeated to determine the proposer with the highest score. Although the sponsor could request another BAFO, an award is typically made to the highest-scoring proposer after one BAFO.

Pre-award Audits

The pre-award audit involves preparing and obtaining required certifications and reviewing documentation provided by the manufacturer in support of its certification. The pre-award audit is undertaken before contract award to ensure that vehicles delivered by the manufacturer will comply with Buy America and with contract specifications.

Heavy Equipment

Heavy equipment consists of items such as shop equipment (e.g., wheel truing machine); work trains consisting of a locomotive, flat cars, and a crane car; car moving equipment; etc. The process for purchasing heavy equipment is similar to that for purchasing vehicles.

If not already familiar with the equipment being purchased, the sponsor, its staff, or consultants should conduct market research regarding vendors providing the equipment. These professionals can also contact other transit agencies and inquire about equipment those agencies have purchased. These discussions can provide valuable information and help avoid pitfalls during the project.

If a sister agency is considering purchasing the same equipment, a joint procurement could be arranged. Joint procurements have an advantage as additional resources would be available to develop technical specifications, conduct market research, and potentially lower prices if equipment is purchased in larger quantities.

When technical specifications are in draft form, the sponsor, its staff, and procurement should decide on a procurement method and obtain approval. Typically, vehicles are purchased using best value. Depending on the nature of the heavy equipment, however, an invitation for bid (IFB) may be the best approach. In an IFB approach, criteria for selecting a bidder are based on the lowest and most competitive price, a thorough response to the IFB, a responsible track record, and financial stability.

If the item being purchased does not require additional changes to accommodate the sponsor, the IFB is the process of choice. However, if the item is complex and requires significant customization, a best-value process should be considered. The final choice between IFB and best value should be reached through collaboration between the sponsor and the procurement department and justified in a decision paper that can be reviewed by management as necessary.

After the procurement method decision is made, the sponsor, with support from its staff and other departments (e.g., maintenance, safety, operations, communications, etc.) should complete the technical specifications regardless of the procurement type. If best value is selected as the approach, the same process as described for vehicle procurements should be undertaken. If an IFB is the selected approach, the procurement department should support this process by developing the IFB documents and by assisting with bid evaluation and SOQs submitted by the bidders.

Signal Systems and Controls

For a new train control system, it is important to first decide on the type of signaling equipment that should be purchased. Heavy rail systems with closed ROWs are migrating to CBTC; light rail systems are likely to adopt traditional train control systems (e.g., manual with automatic speed control). Some light rail systems with tunnels and significant lengths of track with no grade crossings are adopting modern CBTC technology.

With the technology decision made, the sponsor, with support from its staff and SMEs, should develop detailed technical specifications. Engaging personnel with current knowledge in signal system technology is critical to this development. As with vehicle procurements, surveying potential signal system suppliers is important to understanding the market and the suppliers likely to propose on the program.

Providing a draft of the technical specifications allows suppliers the opportunity to provide comments that will improve the specification content; it will also encourage suppliers to take part in the procurement. This is especially true for a CBTC system since this newer technology requires sound technical specifications that have only one interpretation.

Regionalization occurs when the sponsor replaces the train signal and control system with a modern system such as CBTC. A sponsor may choose to keep the existing system as a backup. The integration of the new signal system with existing vehicles could pose a significant challenge due to the proprietary nature of protocols that come with the signal system. The sponsor will need to stipulate this risk in the procurement documents by requiring the signal supplier to be responsible for integrating the new system with existing systems and vehicles.

Should a challenge occur where the sponsor needs a new fleet of vehicles simultaneously with the replacement of the signal and control system, the procurement contract can be packaged with both the new signal system and new rail vehicles. For this alternative, the same contractor would be responsible for both sides of the interface.

Due to the complexity of the technology and the evolving nature of train control systems, the procurement process should be based on best value like that described for vehicle procurements. Evaluation criteria should be adjusted, however, to conform to critical aspects of a signaling system.

CHAPTER 5. CONSTRUCTION

1. Purpose

Chapter 5 contains project management guidelines for the construction of transit capital projects. This chapter addresses tasks related to managing contractors and sponsor force account employees. These tasks include fabricating and installing equipment, building fixed facilities, and integrating facilities and equipment into a functioning system. Chapter content also addresses construction work performed in accordance with plans and specifications developed during Engineering for DBB delivery. Note: The level of construction management effort and team makeup change to fit alternative delivery methods. Additional guidance is provided by the CMAA.

Important to Do

✓ Avoid conflicts of interest by having a CM independent of the DoR.

✓ Acquire project staff with expertise and experience in CM before procuring construction services.

✓ Retain a CM consultant if the agency does not have adequate and qualified staff.

✓ Delegate levels of authority to the project team to handle construction issues and contractor change requests.

✓ Serve as liaison between the DoR and contractor to address RFIs and review change requests that impact design.

✓ Focus quality management on oversight of contractor's QA/QC compliance with the contract.

✓ Focus safety management on safety oversight and audit of contractor safety enforcement, education, and incentive actions.

2. Management Capacity and Capability

Sponsors should develop a project management organization that is qualified to oversee Construction from start to completion; this development should occur during the final phases of design and Procurement. For large projects, this entails establishing a project management team comprised of the following:

- A lead manager with the authority to represent the sponsor, lead the team, and act as the primary point of contact for all parties, including the contractor.
- Members who:
  - have the authority to make contractual decisions and initiate actions affecting Construction and Commissioning;
  - respond promptly to emergencies and unexpected events;
  - conduct progress reviews, confirm QA, and direct preventive and corrective actions;
  - oversee the contractor's safety and security performance; and
  - coordinate with authorities having jurisdiction, external agencies, and third parties.

The project management team should not be burdened with day-to-day O&M of the existing system while simultaneously managing a complex construction project. The CM should be independent of the design management team. Additionally, and to avoid conflicts of interest, consultants used to manage construction should not be involved with project design.

It is imperative to staff the project organization with qualified professionals who have appropriate certifications in construction management, resident engineering, and inspection. These certifications confirm that the designated individuals possess the necessary expertise and skills to effectively handle the intricacies and challenges that arise during Construction. Forming a competent team solely dedicated to project management enables the project sponsor to focus on its primary objective without compromising ongoing O&M of the existing system. This separation of responsibilities provides a more streamlined and focused approach, ultimately enhancing the overall success of the construction project.

The construction project management team is responsible for updating the PMP for Construction before commencing construction. The checklist of items to be addressed, including third-party and utility agreements; real estate and site access; procurement policies and procedures for change management, dispute resolution, quality, and safety oversight procedures; and an RCMP. In addition, a review of the financial plan and availability of funds may need to be performed by the FTA financial management oversight (FMO) contractor.

3. Key Personnel and Their Roles

Key project personnel hold leadership positions and actively participate in the project's planning and execution. Key personnel span from the construction management representative designated by the sponsor to the resident engineer (RE) and inspectors; key staff may also include consultants based on their assigned responsibilities. The sponsor is responsible for identifying and assigning the necessary roles and authority to key personnel within their organization and among consultants involved on the project. Sponsors should also identify key personnel within the contractor's organization, including the corporate officer in charge, to facilitate effective coordination and management throughout the project life cycle.

Construction Manager

Project staff should have expertise and experience in construction management. The sponsor should retain a CM consultant if expertise is not available in-house. The CM acts as the agency's representative with the contractors, oversees work performed by the contractors pursuant to the contract drawings and specifications, inspects the work as acceptable, and recommends payment of contractor invoices.

The key construction management staff person reporting to the CM is the RE. The RE is the principal point of contact with the contractor and is stationed at the site for larger projects; for smaller projects, the RE meets with the contractor and visits the construction site regularly. The CM team must be independent from the DoR.

Designer during Construction

A designer who produces contract drawings and specifications sealed with its professional architectural and engineering seal is referred to as the DoR. The DoR continues to provide the following design support services during Construction:

- Receive and respond to construction contractor RFIs related to design. RFIs are communicated from the contractor to the designer through the CM.
- Review and recommend acceptance of contractor submittals called for in the drawings and specifications with respect to the construction deliverables and review comments on the contractor's schedule. This includes compliance with Buy America provisions of the contract.
- Review change requests and estimate costs for change orders.
- Make periodic visits to the site to confirm design compliance; provide certification efforts as required by the permitting agency.
- Verify, finalize, and seal the record as-built, marked-up drawings by the CM team.

DB contracts combine and overlap the final design and construction process to enable schedule savings. Under a DB contract, the final design consultant is part of the construction contractor's team and has similar responsibilities as the design consultant under a DBB contract, with the exception of changes resulting from internal design modifications. These changes are the responsibility of the DB contracting team. Additionally, agencies need to carefully vet the designs prior to Construction to gain time and cost advantages when using a DB process.

Contractor during Construction

The role of the construction contractor includes the following:

- Performs construction work defined by the contract drawings and specifications using means and methods that are the contractor's responsibility.
- Obtains permits related to the work for which the contractor is responsible and coordinates the necessary inspections.
- Develops and implements a QC plan for inspecting and testing the work.
- Develops and implements a safety plan to confirm a safe worksite.
- Delivers submittals defined by the contract drawings and specifications, such as the following:
    - Shop drawings, manufacturer drawings, calculations and data, and product information.
    - Contract schedule updated monthly that notes progress and looks ahead to upcoming work.
    - Requests for payment supported by reports called for in the contract.
    - Current record drawings of the as-built work.
    - O&M manuals and training of agency staff in the contract specifications.

- Submits RFIs to the CM to obtain clarification of the design intent.
- Submits requests for change.

Resident Engineer

On larger construction contracts, the CM should assign a qualified RE on a full- or part-time basis. Once the sponsor awards the contract, the RE assumes responsibility of contract administration under the CM. Acting as the primary field representative for the project sponsor, the RE serves as the contractor's main point of contact in the field. The RE receives and handles all submittals, RFIs, correspondence, and change order requests. Throughout the project—including final inspection, testing, and closeout—the RE confirms that the work adheres to the specifications and drawings.

Other Key Staff

Larger projects may use more than one RE. In addition, the construction project management team will include facility and safety inspectors, community outreach coordinators, contract compliance specialists, quality professionals, laboratory services staff, and commissioning professionals. These positions are provided by the consultant for many sponsors.

Consultants can fulfill either of two roles:

1. They can augment the sponsor's staff by offering technical support and assistance; or
2. They can act as direct representatives of the sponsor, authorized to function as CMs for substantial portions or for the entirety of the project.

In either case, maintaining harmonious relationships between sponsor staff and the consultant or consultant's staff is crucial. This is best achieved by clearly defining the roles and responsibilities of each group during all aspects of the project.

4. Project Interfaces

Sponsors should identify existing functional relationships during construction of a transit project. Among these relationships, interface management stands out as a challenging and time-consuming aspect of project administration. It encompasses coordinating and collaborating among the following:

- Companies participating as joint ventures or under contract.
- Interactions between different functional elements within the organization.
- Connections between various project locations.
- Interfaces bridging different project milestones.
- Interactions involving governmental, state, or local regulatory agencies.
- Interplay between private entities and other public interests.

The sponsor should clearly enforce responsibility, authority, and accountability at each interface; designate inputs and outputs in terms of organization, function, and schedule; and define lines of communication to enhance and establish interface management.

Interfacing with Utilities

During PD, the sponsor should establish master agreements with all relevant utilities. As Engineering progresses and prior to obtaining approval for CIG, specific agreements should be developed with these utilities. These agreements should align with the sponsor's plan for assigning design responsibilities for new or relocated utilities and estimate the duration of design work and actual construction or relocation. The scope of these agreements should be considered in the project schedule and cost estimate.

Utility master agreements should include provisions mandating compliance with FTA Buy America requirements. It is crucial to address this issue early with all utilities as it can significantly impact the project schedule, and technical aspects. During Construction, contractors should effectively coordinate utility relocations and project service requirements within their overall schedule and diligently manage interfaces to prevent project delays based on sponsor agreements. The sponsor, along with their in-house or consultant CM, bears the responsibility of supporting the contractor in managing these interfaces. Third-party and utility risks should be mitigated by the sponsor; they cannot be transferred to contractors.

Certain property acquisitions may also involve securing replacement ROWs for utility relocations. Ideally, all necessary real property interests and obstacles for the project should be acquired, controlled, and cleared before construction commences. However, if that is not the case, the construction contract specifications should address the availability of such areas and consider the following:

- Release dates for specific real estate parcels when acquisition or relocation is incomplete.
- Workarounds or designated "hold-off areas" as specified.
- Demolition or clearing of existing site improvements.
- Remediation of contamination.
- Access restrictions or maintenance requirements for specific parcels.

Inclusion of additional work elements or restrictions in the construction contracts may result in a proportional increase in costs. However, in certain situations, incorporating certain demolition or clearance activities in the construction contract could be the most efficient approach to address such items. If mandatory property rights have not been acquired, imposing restrictions on contractor access or activities within the project boundaries typically leads to increased construction costs and potential project delivery delays.

To mitigate these risks, sponsors should prioritize coordination between real estate acquisition and construction schedules from the project's inception. Through the risk assessment process of a transit project, potential impacts of schedule delays and associated cost increases should be continuously monitored and prevented.

At times, it may be necessary to relocate a utility before commencing a major contract for construction activities. As a result, many sponsors engage a pre-award authority to contract for utility work, enabling the sponsor or the utility to carry out site preparation, utility relocation, and restorations prior to awarding larger contracts for line, trackwork, or systems.

Interface with Transit Operations

When undertaking capital projects that involve modifications or extensions to an existing transit system, it is crucial to prioritize the continuity of transit O&M activities in a safe and secure manner for customers, employees, businesses, and the public. Construction contracts should incorporate these requirements and establish acceptable deviations or delays to normal transit operations based on time of day, day of the week, and specific calendar dates as defined by the sponsor. Contractors may be required to submit interface plans through the RE for approval by the transit operating department.

In certain cases, sponsor force account support may be necessary to supplement contractor construction activities. This support could involve flagging operations, work trains, bus bridges (e.g., in the event of fixed guideway system outages); and temporary modifications to facilities (e.g., tracks, signals, traction power, communications, and control centers) to facilitate construction.

Transit operating personnel should be kept informed of construction activities occurring on or near the operating system. Notices may include implementing slow orders to confirm safe operations. The contract documents should specify the cost, if applicable, of any force account support, including service outages, arrangements, timeframes, and associated consequences. For example, the sponsor may include a liquidated damage provision to account for a failure to restore track service within a specified timeframe. It is important to establish an internally documented basis for calculating such damages to confirm they are enforceable and not deemed excessive penalties.

The contractor bears responsibility for restricting access to the construction site while maintaining appropriate access for transit riders and the public. Proper signage, markings, lighting, walking surfaces, and railings should be designed, installed, and maintained to ensure the continuous operation of transit services in a safe and secure manner. The sponsor's oversight of the contractor's efforts in this regard is crucial. Bid documents and contracts should specify that designated personnel, whether from the sponsor's staff or a consultant, have the authority to issue stop orders or to temporarily halt contractor activities if construction site maintenance is inadequate.

Transit operations should be an integral part of the project team from the early stages of PD through Construction, testing and transition, to operations. As the project nears completion, transit operations play an increasingly significant role.

Interface with the Community and the Public

Facilitating positive public perceptions and disseminating accurate information are vital aspects of managing large-scale, costly, and prominently visible transit projects. Such projects inherently attract significant public attention and scrutiny. Additionally, numerous entities—including federal, state, local, and private organizations—have a vested interest in these projects and require information on various project aspects. Lastly, the environmental document that entitles the project mandates mitigation measures for project impacts on neighbors and on the surrounding environment.

Managing relationships with these diverse groups is crucial to maintaining factual and positive perceptions of the project and confirming that information is readily available. Key project personnel, particularly those involved in public relations, play a significant role in providing information and addressing misconceptions that may exist among external organizations or the public.

The PMP should encompass a section dedicated to the project's public involvement program. The program may include the following elements, as appropriate:

- Implementation of a strategic public relations program (e.g., displaying "Open for Business" signs and ensuring driveway access during construction).
- Community relations initiatives.
- Guidelines for the release of project information.
- Programs and procedures for workforce information dissemination and addressing grievances.
- Internal channels of communication for addressing project-related issues.
- Efficient procedures for promptly responding to external information needs.
- Scheduled meetings and forums to facilitate effective two-way communication between the workforce, external organizations, and various groups throughout the project lifespan.
- Use of social media and a project website to disseminate updated project information.

5. Project Labor Agreements

Executive Order 14063 mandates using project labor agreements (PLAs) for all large-scale federal construction projects. The order defines a large-scale construction project as "a Federal construction project within the United States for which the total estimated cost of the construction contract to the Federal Government is $35 million or more" (February 2022). Note: The sponsor should check the applicability of this order at the time the project is being implemented as a subsequent administration may have removed this order.

Local PLAs serve as a mechanism to mitigate potential conflicts or disputes related to project management and staffing. These agreements can encompass the sponsor, contractors, and labor unions. However, it is important to exercise caution when dealing with PLAs to confirm that agreed-upon actions are enforceable and that they comply with established laws and procedures.

Typically, the sponsor negotiates with relevant labor organizations to establish PLAs. As this can be a time-consuming process, the sponsor should initiate these negotiations well in advance of contractor procurement to confirm that the terms of the PLA are included in the initial solicitation documents. Once negotiated, the PLA becomes a part of the construction contract, informing bidders that they are required to enter into a PLA and providing them with knowledge of its terms before they submit bids. PLAs have a historical track record of minimizing labor staffing, wage, and benefit disputes that may lead to work disruptions and that commonly involve the following elements:

- Negotiations between contractors and labor unions to establish wages and work rules that supersede existing collective bargaining agreements.
- Provision of union scale wages and benefits while prohibiting strikes and lockouts.
- Obligation of contractors and subcontractors to adhere to agreement terms as specified in their contracts.

6. Project Management Plan

The sponsor CM should update the PMP to reflect the inclusion of the contractor and additional members joining the project team. The contractor should incorporate modifications in procedures or responsibilities resulting from preconstruction, including adjustments to project requirements and scope. The PMP should remain current and accurately reflect the project's evolving composition, procedures, and sustainability objectives.

7. Conformed Set of Bid Documents

A conformed set of bid documents contains a collection of documents that have been revised and updated by the sponsor and include all relevant addenda, amendments, and bidding clarifications. These documents serve as the official reference for bidders throughout the Procurement process and promote fairness and transparency. The conformed set ensures that bidders have equal access to consistent information and clarifications and enable a level playing field. The set includes essential components such as the RFP, specifications, drawings, terms and conditions, and other pertinent contractual documents. Once the sponsor awards the contract to a contractor, the conformed set ensures that the contractor possesses a comprehensive understanding of the project requirements and conditions.

A conformed set of bid documents incorporates all changes from pre-award addenda to ensure that the documents accurately reflect the project's evolving requirements. Sponsors should dedicate sufficient time and resources to confirm the completeness and accuracy of these documents to establish a solid foundation for the Procurement process.

8. Preconstruction

Owner-Furnished Equipment

Sponsors may opt to procure or contract separately for long-lead or specialty items to achieve cost or time savings and to maintain control over the project. Contractors play a vital role in supporting sponsors when establishing procedures for the transfer of owner-provided materials and equipment. This entails identifying specific personnel—whether from the contractor or from sponsors—who will be responsible for administering vendors and suppliers; performing factory tests; and determining the coordination of item delivery, shipping, customs, insurance, receipt, unloading, storage, installation, and testing.

The sponsor should thoroughly review material delivery schedules to confirm they align with the overall project schedule. This examination helps prevent delays caused by owner-furnished equipment. Additionally, contractors should collaborate with the owner to confirm whether owner-furnished items that may have been purchased prior to completion of contract documents comply with the project design requirements.

Permits

Sponsors are responsible for executing third-party and utility agreements, acquiring project clearances and environmental permits, and conducting design reviews and plan checks by construction permitting agencies so the contractor can pull building permits. Construction contractors are responsible for securing permits specific to the project scope so work can proceed smoothly. The cost and time required for obtaining these permits are the contractor's responsibility and should be accounted for in the contract pricing and scheduling. By incorporating these permit-related responsibilities and associated factors into the contractual agreement, both parties have a clear understanding of permit obligations and expectations to promote timely and effective project execution.

Partnering

Implementing partnering strategies plays a crucial role in preventing conflicts and facilitating their resolution. The sponsor should conduct partnering workshops before and during Construction, specifically at the onset of each major contract associated with the project. These workshops should involve key stakeholders (e.g., sponsor representatives, contractors and subcontractors, suppliers, facilities personnel, government agencies, designers, major utilities, etc.) and any other relevant parties. Workshop sessions should establish clear objectives, identify cross-functional requirements, and set expectations for the successful completion of the contract. Additionally, the sponsor should schedule a partnering workshop once the contract is well underway—potentially after accomplishing a significant milestone—to assess progress and reinforce commitments to effectively address any emerging issues.

The U.S. Army Corps of Engineers published *Standardization Construction Project Partnering Playbook, Engineer Pamphlet EP 34-1-1* that provides helpful guidance on partnering.

Submittals

The sponsor should require that the contractor provide a contract data requirements list (CDRL) to review against the contractual requirements or that the contractor prepare a list to monitor requirement submissions. The CDRL should contain a detailed list of items that includes:

- the construction schedule;
- shop drawings and manufacturer standard schematic drawings;
- manufacturer calculations and standard data;
- product literature installation instructions;
- test, safety, and traffic control plans;
- QA/QC plan;
- as-built plans;
- O&M manuals and training documentation; and
- other necessary documents or samples as specified in the contract.

Final as-built plans, shop drawings, and manufacturer product information should be retained as permanent project records. The sponsor should make the final payment only after all records have been submitted and approved.

Schedule

Contractors should provide detailed schedules of their work to the sponsor before beginning construction. The schedule format should be compatible with the scheduling software used by the sponsor. Project directives and contract bid documents should clearly outline the specific information required to assess project progress, which may include cost- and resource-loaded charts and equipment schedules.

To keep stakeholders informed, contractors are required to submit regular schedule updates—monthly or at more frequent intervals—along with a schedule narrative and supporting data. This regular monitoring and tracking of project milestones help maintain efficient communication among parties.

Managing the schedule during Construction is challenging due to the involvement of multiple contractors who are responsible for various components of the project and to coordinating with third parties and utilities. Often, contractors from different trades work concurrently in overlapping areas. Consequently, overseeing and regulating schedule performance require significant oversight by sponsor management and scheduling experts. On complex projects, the sponsor should create a supervisory schedule to forecast the impact of delays independently.

At the onset of the project, contractors submit schedules in multiple deliverables to facilitate comprehensive project planning. The initial deliverable involves a schedule that outlines the work to be carried out within the first 60 to 90 days of the contract. Contractors are usually required to submit this portion of the schedule within two weeks of receiving the notice to proceed (NTP) but prior to commencing work. Around 45 to 60 days into the project, a detailed, comprehensive schedule submittal that covers the duration of the contract is expected.

Typically referred to as a baseline schedule, this schedule includes a breakdown of all activities and may be cost and resource loaded, depending on the level of detail specified in the contract documents. A narrative describing contractor assumptions, basis of logic, and critical activity durations should accompany the schedule submittal. Additionally, the schedule should clearly show the critical path and include the float and its ownership per the contract requirements.

Equipment

Equipment and new technology can include advanced signal, fleet management, communications, fare media, information processing, and security systems that enhance the performance and efficiency of public transit O&M functions. Contractors install this equipment and materials with fixed facilities to form the system.

For each contract, the sponsor should create a dedicated plan indicating the party responsible for procuring, installing, and commissioning the equipment. Some equipment may be furnished by the sponsor early in the project due to the time needed for manufacturing. System equipment elements include signals and controls, traction power substations, communications, fare collection, vehicles, and others. This plan ensures strict adherence to the specifications and contract data requirements and integration of the final system. It encompasses comprehensive inspection and testing of subsystems before their assembly or shipment to the designated jobsite, as well as final inspection, testing, and start-up.

By implementing this plan, the sponsor can effectively monitor and verify that all necessary protocols are being followed by the contractor and by responsible parties, as well as assure quality compliance and integration of the system equipment elements throughout Procurement and Construction.

Contractual

Contractual submittals include the documentation and materials submitted by contractors to sponsors that verify that the work and equipment provided align with the contract documents. These submittals play an important role in ensuring project accuracy, compliance, and successful completion. Contractual submittals may be classified as the following:

- *Product Data*. Product data sheets provide detailed information about specific materials, equipment, or systems proposed for use on the project. This contractor-provided data includes specifications, performance characteristics, installation requirements, and maintenance instructions.

- *Materials Data*. Like product data, materials data submittals focus on providing comprehensive information about the materials proposed for use on the project. Details include material composition, strength, durability, and compliance with industry standards or specific project requirements.
- *Shop Drawings*. Contractors submit detailed drawings, typically created by subcontractors or manufacturers, that illustrate how specific components or systems will be installed or integrated within the project. Shop drawings help ensure that the design intent is accurately translated into the Construction process.
- *Samples*. Contractors may provide physical samples of materials, finishes, colors, or other elements to demonstrate their compliance with project aesthetic and performance requirements. These samples allow the design team to assess and approve proposed selections.
- *Mock-ups*. In some cases, contractors may be required to construct full-scale mock-ups of specific project components or systems to verify their design, functionality, and aesthetics. Mock-ups provide a tangible representation of the final product and allow time for the sponsor to assess and adjust before proceeding with the actual construction.

Sponsors review and approve contractor submittals. The review process ensures that the proposed materials, equipment, and systems align with the project's specifications, quality standards, and contractual requirements. Contractors should give prompt attention to contractual submittals to ensure efficient and clear transmittals and the use of software for version control. These submittals are essential for maintaining project progress, managing payments, and mitigating risks associated with design discrepancies, material noncompliance, and long-lead items. Contractual submittals and all manufacturer product information should become permanent project records.

Regulatory

Regulatory submittals include the documentation and paperwork required by regulatory bodies or authorities to ensure compliance with applicable laws, regulations, and standards in the transportation industry. These submittals provide evidence of adherence to regulatory requirements and facilitate the approval process for transit projects. The following are examples of regulatory submittals commonly found in transit projects:

- *Environmental Impact Compliance*. Transit projects often require environmental study to assess potential environmental impacts of the project. An Environmental Impact Statement (EIS) includes studies on air quality, noise, water resources, biodiversity, and socioeconomic factors and is submitted to regulatory agencies for review and approval. The EIS also provides a list of mitigation measures to which the contractor must adhere during design and Construction. The contractor may be required to demonstrate compliance with the required mitigation.
- *Permit Applications*. Transit projects may require various permits from regulatory authorities. These permits could include construction, ROW, utility, and environmental. The project team submits applications detailing project plans, specifications, and mitigation measures to obtain the necessary approvals.

- *Safety Plans*. Transit projects should comply with safety regulations to protect workers and the public. Safety plans outline procedures for hazard identification, risk assessment, emergency response, and worker safety training. The plans are submitted to regulatory agencies to ensure compliance and obtain necessary permits.
- *Financial and Cost Estimation Reports*. Transit projects often require financial analysis and cost estimation reports for funding and approval purposes. These reports demonstrate the financial viability, cost effectiveness, and economic benefits of the project and are submitted to regulatory agencies and funding organizations for evaluation.
- *Public Engagement and Consultation Reports*. Transit projects often involve public consultation and engagement processes to gather feedback and address community concerns. Regulatory submittals in this context may include reports summarizing public consultations, responses to public inquiries, and documentation of stakeholder engagement efforts.

Specific regulatory submittals required for transit projects can vary depending on the jurisdiction, project scope, and regulatory framework in place. Therefore, project teams should thoroughly review and understand the applicable regulations and engage with regulatory authorities throughout the project life cycle.

Build America, Buy America

While non-rolling stock procurements are not required to undergo formal pre-award and post-delivery audits, recipients must exercise due diligence in verifying and documenting compliance with Buy America requirements as well as Build America, Buy America (BABA) regulations for federally funded programs.

The BABA Act, part of Bipartisan Infrastructure Law of 2021, requires that all iron, steel, manufactured products, and construction materials used in federally funded projects for infrastructure must be produced in the United States. BABA language identifies specific materials in section 70917(c) that are entirely excluded from coverage under the category of construction materials. These excluded materials include cement and cementitious materials and aggregates (e.g., stone, sand, gravel, etc.).

Community Outreach

Transit projects inherently attract significant public attention and scrutiny. Sponsors should, therefore, facilitate positive, well-informed public perceptions to effectively manage transit projects of any scale. Various stakeholders—including government agencies at different levels and private organizations—have a vested interest in transit projects and require comprehensive project information.

Sponsors need to establish and maintain strong relationships with diverse groups to facilitate accurate and favorable opinions of the project. An important part of that process involves providing continuous access to reliable information.

Key personnel, particularly those involved in public relations, play a pivotal role in disseminating information and addressing misconceptions among external organizations and the public. Their efforts contribute to fostering a factual understanding and promoting a positive image of the project, especially during Construction when most concerns are raised.

Coordinated construction, particularly in high-density or busy public spaces, can improve local relations. The sponsor should establish a social media presence to keep the public informed on a continual basis. All communication with the media should be approved through the sponsor's public relations office.

9. Construction Management

The following are among key activities during the Construction process. The sponsor should establish logs for monitoring and controlling these activities when applicable.

Request for Information

An RFI serves as an official mechanism for contractors to seek clarification regarding the design documentation, site conditions, or contractual requirements from the sponsor. It provides a way for contractors to address aspects of the project that are not clear or evident. In the event of omissions, conflicts, or inconsistencies found in the contract documents (e.g., drawings, specifications), the sponsor should consult the DoR and issue a change notice to the contractor to rectify the issues. If clarifications are needed that do not require changes in the contract specifications, the sponsor should respond in writing to the RFI and provide the necessary explanations or information to address the contractor's concerns. This facilitates effective communication and project progress in accordance with the intended requirements. The sponsor should also establish and keep an up-to-date RFI log.

Payment Applications

Progress payment application management begins by 1) ensuring that contract specifications explicitly outline methods for measuring the contractor's work progress, 2) determining payment based on measured progress, and 3) specifying the necessary documents and reports that should be submitted by the contractor to substantiate payment requests. To facilitate prompt payment processing, sponsors should mandate that the contractor include a comprehensive schedule of values for bid items in their bids.

The project manager, CM, or RE can be authorized to approve payment depending on the project size, complexity, and type and pursuant to the recommendations of the CM. Payment is authorized only when the contractor's progress payment request fully adheres to the contract requirements and when updated progress reports and schedules confirm that the contractor performed the work. Contractors should confirm independently that their claimed work progress is verified before payment is approved by the sponsor. By following these procedures, sponsors can manage and control progress payments effectively, ensure compliance with contractual obligations, and maintain transparency and accountability throughout the payment process.

Sponsors should maintain accurate records related to progress and contractor performance. The PMP should establish internal mechanisms for reporting and develop necessary special management plans. One of these, the construction management plan, should provide guidance for the RE and inspectors.

The construction management plan should contain detailed information for communication purposes and include procedures and requirements for the following aspects of the project:

- Maintaining schedule updates, including daily work schedules and progress reports.
- Documenting construction and fabrication status reports.
- Reporting on materials status and shortages.
- Reporting safety incidents and handling accident emergencies.
- Maintaining and updating policies and mechanisms for reporting security breaches.
- Handling delays and stoppages.
- Maintaining daily costs and expenditures related to changes in the work.
- Issuing escalation and dispute resolution procedures.
- Reporting procedures for the project manager, REs, and inspectors.
- Performing QA/QC.
- Monitoring subcontractor utilization, including small and disadvantage business reporting.
- Maintaining and updating community outreach, public, and media relation protocols.

Progress reports—typically submitted monthly by the contractor—should generally include the following information:

- Milestone summary schedule and payment status.
- Current approved submittal and RFI schedules and status.
- Fiscal summary for the contract and major subcontracts, including award amount, executed change orders, current commitment, payment dates, percentage expended, actual expenditures versus baseline cash flow, potential claims, and value of executed change orders.
- Potential change orders with descriptions of their status and estimated cost and time impacts.
- Executed change orders, including their status, settled cost and time impacts, and any outstanding issues.
- Claims status with a description, status, and details of outstanding issues.

- A one-month look-ahead schedule and narrative.
- Systems design status by major milestone when applicable.
- Facilities construction status by major milestone when applicable.
- Major equipment procurement status.
- Systems procurement and installation status by major milestone.
- Integrated testing status by major milestone.
- Submittals/deliverables status in accordance with contract terms, at least by major milestone.
- QA/QC status, including test schedule status, nonconformance status and actions taken; and scheduled and completed audits with significant findings.
- Environmental mitigation status reporting compliance and noncompliance, completed mitigation efforts, public complaints, noncompliance issues raised by regulatory and oversight agencies, and hazardous material status.
- Construction safety status, including reportable accidents, training, and other pertinent safety information.
- Construction security status noting any breaches, particularly those resulting in employee injuries, significant losses due to theft, or crimes against the site or surrounding area.
- Photos illustrating recent progress.
- Disadvantaged business enterprise (DBE) status by subcontractor, including payment time and amount, amount paid to date, original subcontract value, and change orders.
- Permit application report detailing the status and expiration dates of permits obtained by the sponsor and contractor, as well as permit modifications.
- Coordination with other contracts, including meetings and written communications.
- Utility work status by major utilities.
- ROW access needs and status.
- Status of other activities (e.g., significant events, public outreach, etc.)

Change Control and Management

Accurate recording and comprehensive documentation of approved and completed changes are a priority. The contractor should request changes in writing and follow the project's change control procedures for approval by the sponsor. The sponsor should provide written identification of the authorized individuals responsible for approving equipment procurement and construction changes; dollar thresholds within their authority should also be specified.

Contractors should provide a thorough submission of detailed equipment drawings, operating manuals, warranties, and other relevant documentation after completing equipment procurement, installation, and construction activities. Contractors should also prepare comprehensive as-built drawings for the constructed facilities that accurately reflect the final state of the project.

During Construction, the designer's review of contractor submissions must adhere to the submission requirements outlined in the contract documents. These submissions encompass shop and working drawings, mock-ups, materials and equipment cut sheets, submittals as per CDRLs, and testing for systems contracts. Change control procedures should be strictly followed when designer review and approvals are necessary.

The contractor should maintain detailed records throughout the process, and clear levels of authority should be established for sponsor approval. Records should consider factors such as cost, functionality, and schedule impact particularly for any changes made to the project's baseline.

Changes that may arise during Construction can stem from various causes, including, but not limited to, the following:

- *Differing Site Conditions*. These include subsurface conditions that differ from representations made in the contract, unforeseen or unusual conditions that could not have been reasonably anticipated, and conditions created by others that could not be anticipated.
- *Errors or Omissions in Plans and Specifications*. Errors and omissions affect design, which may affect the contractor’s SOW and result in additional costs. Additional costs may be recovered from the DoR. The sponsor should include an errors and omissions clause in the designer's contract. This clause should be robust and have an insurance level to recover losses resulting from flawed designs. The sponsor may seek compensation through the designer's errors and omissions insurance when a change necessitated by an error or omission significantly impacts costs.
- *VE*. The construction contract should allow contractors to propose changes that could reduce capital or life-cycle costs for the sponsor. This provision is commonly known as a VECP clause. Cost savings resulting from approved changes proposed in a VECP are typically shared equally (i.e., 50-50) between the sponsor and the contractor. In some cases, sharing percentages may be adjusted (e.g., 60-40) to encourage VE when implementing complex or relatively new designs. While the contractor is responsible for engineering support for VE-related changes, the contract documents should specify a minimum expected value of savings to compensate for the sponsor's processing and evaluation costs and to discourage frivolous VE change proposals.

- *Sponsor Actions*. Sponsors should modify portions of the plans and specifications, change the allotted time for performing the work, modify contractor work methods, and issue stop orders. Other actions may include making regulatory changes, such as those related to environmental, security, and safety; an operational workaround not specified; unavailable ROW access when needed in a contractor's approved schedule; and delays in utility relocations that affect a contractor's approved schedule.

Exercising diligence during planning and design can help mitigate the risk of changes during Construction. When changes do occur, the sponsor should promptly provide written notice of the proposed change and include all relevant facts and costs. This enables an efficient decision-making process. The sponsor should have a change control process in place, along with an appropriate form that identifies the source of the change. The form can encourage oversight staff to designate errors or omissions as the cause of a change, where justified. Official notice of the change should be given to the contractor through a change order or by direction from the sponsor or its representative. Proper documentation should support the directed change.

Effective configuration management is of utmost importance when undertaking modifications to an operational transit system. Configuration of the existing system serves as the foundation for project definition. Any alterations must be meticulously planned to uphold or achieve the desired functionality.

Designated managers within the sponsor team should approve proposed changes and include personnel responsible for engineering, operations, maintenance, and system safety. Moreover, implemented changes should be thoroughly documented to facilitate future training, inspection, and maintenance activities and to confirm a comprehensive record of the system's configuration.

Change Orders

Requests for changes are common during Construction and can originate from sponsors, designers, contractors, and third parties. To minimize issues in managing changes, the sponsor should establish specific procedures, either within the contract documents or through mutual agreement, among all parties involved. These procedures include the contractor's obligation to promptly notify the sponsor in writing of any changed conditions, errors, omissions, or discrepancies that may result in additional work. Similarly, the sponsor should notify the contractor of any scope change or design modifications.

Any party implementing changes should obtain written directives prior to commencing extra work. The change control and management plan should clearly identify the authorized individuals within the sponsor's staff who have the authority to approve changes in the SOW, schedule, and work methods. It is important to establish a specified time limit within which the sponsor must respond to a change proposal submitted by the contractor. Similarly, the contractor should establish procedures that outline the contractor's obligations for demonstrating entitlement to a time extension or reduction due to changed work.

The process for determining fair compensation for changed work should be defined and include the level of detail and supporting documentation required for cost proposals related to changed work. Contractors need to submit their changes with information that supports their justification. An assessment accompanied by recommended actions should then be presented to the sponsor, designer, or PMOC.

The sponsor should be kept informed of the status of all project changes. The contractor is responsible for producing a monthly change order report that provides comprehensive information on approved and potential changes. Each potential change should be assigned a reference number that can be easily traced to the original RFI or communication from which it originated. The monthly change order report should include the description, status, and estimated cost and time impact of changes contemplated (yet not resolved); and settled cost and time impacts. These processes and inclusions facilitate a current report and provide a clear record of all changes and their respective outcomes.

Project Delays

A delay is a discrepancy between the planned progress and actual progress of work toward completion. Project delays occur when activities on the critical path are delayed. Delays on other paths use float and may not impact the project timeline until all float is consumed, making them critical delays. Common causes of delay include additional, disrupted, or suspended work; lack of resources; equipment delays; regulatory requirements; and sitework access limitations.

Delays are categorized as compensable, concurrent, excusable, and inexcusable. A compensable delay is caused by action or inaction of the sponsor. A contractor is entitled to a time extension and compensation for additional costs incurred due to a delay. If a delay is considered compensable, the affected party can receive compensation for delay costs and additional time needed to fulfill the contract. Nevertheless, while a delay could be compensable, it may not extend contract performance time. If a party could have avoided the delay through due care, the affected party suffering damage as a result of the delay's impact can seek compensation. A contractor can recover delay costs and obtain a time extension if the following three conditions are met:

1. The owner causes the delay or has control over it;
2. the delay leads to extra costs for the contractor; and,
3. the contractor has not assumed the risk of delay in the contract.

A concurrent delay arises when two or more delays occur simultaneously and affect the project completion date. Both the sponsor and the contractor can be held responsible for delays in completing the work. This can prevent either party from seeking damages against the other. A concurrent delay can also refer to multiple delays caused by the same party within a specific time period.

An excusable delay is any delay beyond the control of the contractor or sponsor, where neither party is at fault nor has a party been negligent. These delays are caused by events or circumstances not fully in control of the owner or contractor, such as force majeure events (e.g., fires, floods, hurricanes, tornadoes, epidemics, quarantine restrictions); intervention by third parties; actions of the government unrelated to the sponsor; freight embargoes; and labor disputes. The sponsor should consider having force majeure provisions in the contract that extend time to the contractor to perform the work without additional compensation.

An inexcusable delay is any delay resulting from events or circumstances within the contractor's control, such as insufficient crewing or slow submittals that could have been avoided through careful, prudent, far-sighted, or diligent action on the contractor's part. The contract should provide clear and specific examples for these terms.

It is crucial to have a critical path schedule to assess the actual impact of delays or potential changes. Many sponsors include provisions against granting damages for delays that are not under either party's control. Under this provision, a sponsor is willing to grant a time extension without providing financial compensation. If, however, a no-damage-for-delay clause is included in the contract, the contractor may incorporate an estimated cost for potential loss of compensation into its bid prices.

Claims

A claim is a written statement by one party seeking additional time and/or financial compensation for actions or omissions carried out by another party during contract execution. From the perspective of the sponsor, claims serve as the administrative mechanism through which both the sponsor and contractors fairly distribute the costs arising from events that fall beyond the contract scope. For contractors, claims may provide rightful compensation for unexpected cost overruns or serve to enhance the contract value and maximize profit.

Important to Know

✓ *AACE RP 29R-03* provides guidance to categorize and evaluate the varying forensic schedule delay analysis methods.

✓ In 2017, the Society of Construction Law issued the 2nd version of its delay and disruption protocol for determining time extensions and compensation for delay and disruption.

All projects carry a degree of vulnerability to cost escalation resulting from claims linked to altered conditions and authorized additional work. Claims leading to cost and schedule overruns may be attributed to the following:

- Insufficient provision for risk allocation in the contract.
- Unforeseen site conditions.
- Adverse weather conditions or other uncontrollable natural events.
- Ambiguities or inadequate development of contract provisions and contract drawings.
- Strikes impacting project progress.
- Poorly prepared specifications leading to uncertainties.
- Delays in acquiring permits and approvals from external agencies.
- Inadequate implementation of management procedures to mitigate unnecessary risks.
- Challenges related to site accessibility.
- Delays or modifications caused by granting extensions, design changes, or altered requirements to interfacing contractors that impact contractors involved on the project.
- Inadequate or absent construction documentation.
- Contractor claims that are frivolous or that lack substantial grounds.

Claims and change order processing procedures should promote early equitable settlements of extras to which the contractor is entitled by answering the following:

- Who receives and who analyzes the change order or claim?
- What information is required from the CM and RE and in what form(s) or format?
- Will support be available to review change orders in the technical group within the owner's organization? Within the consultant organization if retained to provide design services during Construction?
- Will an attorney be involved early on to analyze if a legal basis exists for the change order or claim?
- What levels within the organization will be notified when a change order or claim has been submitted? To what depth will they be involved?
- Will the individual in charge of the project have time to delve into the intricate details to establish whether there is a valid change order or claim and to what the contractor is entitled?
- What roles do the CM and RE play in helping to decide whether there is a valid change order or claim and to what the contractor is entitled?
- Will there be a separate department with responsible and knowledgeable staff who can assist the project manager in analyzing the change order or claim?

Sponsors should train project team personnel to ensure the effectiveness of staff who are responsible for assisting with claims avoidance.

Dispute Resolution

A dispute arises when the parties involved in a contract cannot reach a mutual agreement regarding the interpretation of contractual conditions. If a dispute cannot be resolved, either party may submit a claim. The primary objective of the project organization should be to prevent disputes and claims by implementing a planning and development process that leads to effective contract documents and procedures. The responsibility for understanding and implementing procedures to minimize disputes lies at every level within the project management hierarchy.

Examples of actions by sponsors that can give rise to disputes include the following:

- Failure to fully disclose geotechnical information.
- Changes in plans or specifications during Construction.
- Insufficient bidding information.
- Inadequate time provided for bid preparation in the Procurement process.
- Unclear or misleading requirements.
- Improper denial of a change request that includes a time extension request.
- Issues related to community agreements, third parties, utilities, and permits.

Construction contracts should incorporate procedures for addressing disputes between contractors and the sponsor. Additionally, procedures should be in place to allow construction operations to proceed, if appropriate, while disputes are being reviewed and resolved. The legal team should ensure that contractual documents are well written and include specific provisions for resolving disputes in a timely manner and at the lowest administrative level possible.

Important to Know

✓ The American Arbitration Association issued the *Construction Industry's Guide to Dispute Avoidance and Resolution* to outline principal dispute avoidance and resolution techniques and how they may be used at various stages of a project.

The contract should clearly define the procedures for dispute resolution. Selection of formal dispute resolution procedures should be based on project size and resources available to the sponsor. Common dispute resolution procedures include the following:

- *Negotiation*. Negotiation is the most common method for settling claims; it is cost effective and relatively quick.

- *Mediation*. After a dispute arises, involved parties typically choose a mediator. The mediator facilitates a resolution by creating an environment where the parties themselves can reach an agreement. The mediator may provide nonbinding recommendations for a settlement. Mediation offers informality and the involvement of an impartial third party. However, it lacks finality and may prolong the time required for a final resolution since mediator recommendations are not binding.
- *Arbitration*. Arbitrators are typically appointed after a dispute arises. The procedures for their appointment and hearing conduct are determined by the contract, which may incorporate the rules of the American Arbitration Association and applicable laws. Arbitrator decisions are final and binding. The advantage of arbitration lies in the arbitrator's independent expertise and impartiality. In most states, there is no right to pretrial disclosure; arbitrators are not bound by legal rules. Furthermore, there is limited right of appeal for significant procedural deficiencies only. However, arbitration has become almost as costly and time consuming as litigation.
- *Dispute Review Board* (DRB). The DRB consists of third-party members selected by the sponsor and contractor at contract inception. Throughout the project, the board periodically meets to review progress and address emerging issues. The board can serve as an arbitrator or mediator as specified in the contract. Establishing an ongoing DRB for the project's duration is an innovative approach to preventing and resolving disputes. However, due to cost considerations, it may be practical only for large-scale projects.
- *Litigation*. Litigation is the most expensive and time-consuming method of dispute resolution as it involves taking the matter to court. In some cases, a jury trial may be ordered. Judges in litigation cases are generally not specialists in construction, as construction-related lawsuits are relatively fewer compared to civil law cases. Litigation lacks the opportunity to have facts evaluated by an expert with independent expertise. However, it provides procedural safeguards, such as pretrial disclosure and the right of appeal, which are generally not available in other dispute resolution methods. Litigation is generally considered the least desirable approach due to its financial and time demands. Most other dispute resolution procedures were developed as alternatives to litigation.

To avoid disputes, potential problems should be addressed in the contract documents. Identifying and eliminating contract elements that are prone to change and misinterpretation can help prevent disagreements. Contract documents should include clear clauses that address changed conditions and quantity variations. Sponsors should avoid disclaimers and language that evade responsibility.

The PMP should detail sections related to inspections, scheduling, QA, and safety that could help the sponsor identify potential disputes early and provide guidance for preventive measures. The PMP should also outline actions to be taken for documenting contractor performance.

Safety Compliance Monitoring

The primary responsibility of sponsors is to ensure that incident and accident prevention—along with safeguarding employees, the public, and property—are given the utmost importance. Sponsors should develop a comprehensive SSMP with provisions that are integrated into the overall contract documents to confirm enforceability; this document should also include security requirements.

Important to Do

- ✓ Safety management requires contractor enforcement, education, and incentives.
- ✓ Sponsors should audit contractor safety, compliance, and performance.
- ✓ Sponsor safety oversight should be independent of the project management team.

Sponsors should assume the task of monitoring individual contractor performance concerning safety and their adherence to the contractual safety requirements. These tasks include conducting regular contractor safety audits and loss-control surveys to confirm compliance. In cases where a violation of job safety is detected, the CM promptly advises the sponsor to notify the contractor in writing, clearly indicating the violation and requesting immediate corrective action.

Contractors are responsible for implementing a safety management plan and for safety measures on the jobsite. They should also maintain a safe and healthy work environment; prevent incidents, accidents, and damage to adjacent public and private property; and provide adequate safety training to their staff.

Contractors are expected to respond in writing and promptly take corrective action according to their safety management plan upon receiving a safety violation notification from a sponsor.

To enforce safety protocols, contractors should develop a job hazard analysis for specific tasks at hand. Supervisors and superintendents utilize their safety expertise to guide and oversee the actions of their construction workers. Contractors should designate a safety professional among their staff who actively monitors operations to identify and eliminate potential sources of incidents and accidents.

Contractors are encouraged to prominently display signs and posters at the jobsite to reinforce safety training and serve as a reminder to prioritize job safety amid changing work assignments and jobsite conditions. Furthermore, sponsors should actively promote the implementation of contractor employee incentive programs that acknowledge and reward individuals, through personal recognition, for maintaining a high level of safety performance.

A sponsor should monitor and conduct regular audits of contractor safety performance. In cases where unsafe practices are observed, the sponsor notifies the contractor in writing. If a contractor fails to rectify an unsafe condition or practice, the project sponsor may issue a stop work order until the situation is resolved.

Contractors should conduct investigations into incidents and accidents and produce recommendations for preventive and corrective actions to keep similar incidents from occurring. The contractor's accident report, project records, progress reports, and daily time reports can serve as crucial evidence in potential legal proceedings. The contractor is responsible for preparing a monthly accident summary report (MASR). The MASR enables the sponsor to evaluate the contractor's safety performance by considering such factors as the frequency rates of recordable and lost time accidents and the types and causes of accidents. The sponsor should adhere to federal and state regulations that require reporting specific injury accidents to the appropriate authorities.

The sponsor assumes responsibility for executing and implementing an employee protection and accident prevention program on the project. The sponsor should designate a capable safety manager to administer and supervise the comprehensive project safety program. The FTA requires that the sponsor direct the safety manager to report independently to agency leadership or to a higher level beyond the project manager's authority. This arrangement serves as a safeguard against potential conflicts where project advancement may compromise safety.

While contractors hold primary responsibility for safety, the sponsor's safety manager is tasked with providing overall safety surveillance and guidance to contractors and monitoring their safety programs and performance.

Each contractor involved on the project is responsible for executing and implementing an employee protection and accident prevention program that aligns with the requirements of the overall project safety program. Consequently, contractors should designate their own safety manager to ensure a safe working environment. Observed unsafe acts or unhealthy conditions should be promptly reported to the supervisor in charge. Serious or recurring violations should be documented and communicated to the contractor's representative for corrective action.

If a condition or practice poses a foreseeable risk of serious physical harm, significant property damage, or loss of life, the sponsor should have in place a policy to halt operations in the affected work area until the hazardous conditions are rectified. Carelessness or disregard for mandatory safety and health standards should not be tolerated. Contractors are expected to discipline or terminate employees who violate established rules and regulations. Moreover, and as stated in the construction contract, the sponsor retains the right to remove any individual from the project who poses a safety risk to him/herself or to others.

Preconstruction Survey to Identify Potential Hazards

As part of a comprehensive system safety program, the sponsor and construction risk management experts should conduct a preconstruction assessment of both the project ROW and adjacent areas. This assessment identifies potential hazards that are specific to the project being considered. The survey focuses on existing physical structures and facilities to be monitored for structural integrity throughout the Construction process.

By assessing the frequency and severity of these hazards, the sponsor can obtain valuable insight to guide hazard resolution or mitigation. The information gathered from these surveys should then be utilized by the sponsor to evaluate risk responsibility and response. This process should also inform the development or modification of relevant contract documentation (e.g., drawings, specifications, and special conditions) as necessary based on the survey findings.

Construction Hazard Control

Throughout every stage of the Construction process, the following safety measures are implemented:

- *Certification*. Project approval may be conditional upon the sponsor and other relevant parties providing written documentation that outlines the scope and implementation of a safety management program in accordance with the PMP.
- *Responsibilities*. Typically, the RE assigned to the contract plays a pivotal role as the RE is closely involved with contractors and other project agencies. The RE is responsible for ensuring that all contractual requirements and applicable safety regulations are strictly followed.
- *Documentation*. While employers are legally obligated to provide a safe working environment, the sponsor is responsible for developing an SSMP. Contracts typically incorporate safety specifications and procedures that align with federal and state occupational safety and health standards.
- *Procedures and Controls*. Contract specifications should outline procedures for implementing and monitoring a comprehensive project safety program. The following considerations are recommended at a minimum:
    - Mandatory safety orientations for new contractor and subcontractor field employees.
    - A hazard analysis to identify potential risks.
    - Weekly safety meetings to discuss safety-related matters.
    - Site access control procedures to regulate entry.
    - A mandatory contractor safety program to facilitate compliance.
    - Preconstruction safety reviews to assess potential hazards before work begins.
    - Inspections to identify and address unsafe working conditions.
    - Tool inspections to ensure proper functioning and safety.
    - Daily housekeeping practices to maintain a clean and safe environment.
    - Encouragement of safety awareness through recognition and rewards for safe practices.
    - Availability of first aid and medical facilities.
    - Fire prevention and protection measures.

- Emergency response procedures and clearly marked evacuation routes on-site.
- Enforcement of subcontractor safety programs.
- Sanitation measures to maintain hygienic conditions.
- Public protection measures to ensure safety around the project site.
- A provision for protective clothing and equipment.
- Regular toolbox or lunchtime meetings to discuss safety-related topics.
- Regularly scheduled inspections and checklists for construction equipment operation.
- Employee skill certification to verify competency for specific tasks.

- *Accidents and Emergencies*. The sponsor should establish clear procedures to enable swift responses to accidents and emergencies and to confirm the safety of individuals and property. Employees should be familiar with these procedures. Following an accident or an unsafe incident, the RE, safety manager, and contractors should promptly investigate the cause and take measures to prevent similar occurrences. Similarly, the RE and contractor should follow contractual emergency procedures that include notifying relevant personnel, following operational protocols, coordinating with public agencies, protecting project and private property, and safeguarding individuals from further harm. A readily accessible list of emergency contact numbers should be maintained; employees should be made aware of its location.

Employee Orientation and Training

To promote safety awareness and minimize hazards, the contractor should conduct employee orientation and training. Three specific groups of employees should be targeted: 1) contractor employees, 2) the construction management team and support personnel, and 3) visitors to the jobsite regardless of their employer. Where a capital project involves modifying or expanding an existing transit system or facility, transit O&M personnel should be involved from the beginning of PD.

Safety orientation and training should initially focus on raising awareness and on ensuring adherence to procedures; periodic updates should be provided throughout the project. It is important to establish a continuous process of identifying and resolving hazards, as well as implementing a program for sharing lessons learned and best practices.

Contractors who are not familiar with fixed guideway rail or bus transit facilities and their inherent risks should receive comprehensive training and certification by the sponsor before being granted access to specific areas of the transit system (e.g., the trackway).

Safety Inspections and Audits

A well-structured construction safety program should include regular safety inspections and audits conducted by a group within the sponsor's organization independent of the construction team. Findings from these inspections and audits should be properly documented, and prompt corrective actions should be taken to establish a high level of safety at the jobsite.

Accident Reporting and Investigations

Accident reporting and investigations should be carried out in compliance with Occupational Safety and Health Administration (OSHA), state, and local requirements, as well as with procedures outlined in the project construction safety program. Accidents should be documented and analyzed; appropriate measures should be implemented to address any underlying hazards.

Quality Compliance Monitoring

Contractors should carry out their work in accordance with an approved QA/QC plan to ensure quality standards are met. As part of this process, construction contractors and suppliers should be obligated to submit suitable quality plans for their work for sponsor approval.

The contractor assumes responsibility for maintaining the quality of its deliverables by continuously monitoring and verifying adherence to the quality criteria outlined in the design documents. QC activities encompass various aspects that include construction site activities, submittals, installations, inspections, testing, and proper documentation. The contractor should retain inspection and test results as objective evidence of acceptability. The contractor should also provide this information to the sponsor as stipulated in the contract documents. Whenever quality problems arise, sponsors should document and issue a nonconformance report (NCR).

Important to Do

- ✓ Achieve quality by inspection, testing, and oversight of work.
- ✓ Contractors should have a QA/QC plan.
- ✓ Sponsors should audit contractor compliance with their QA/QC plan.
- ✓ Sponsor quality oversight should be independent of the project management team plan.

The contractor is responsible for investigating causes of an NCR and for implementing appropriate corrective action. If the quality issue persists, the sponsor should escalate the matter to the contractor's senior management, using collaborative partnering concepts agreed upon at project initiation. Sponsors may also recommend not paying for nonconforming work, and, if necessary, may issue a stop work order until the contractor satisfactorily resolves the quality problem.

The sponsor's QMP should include a comprehensive program of periodic audits. These audits should verify that contractors have effectively implemented and complied with relevant elements of the QMP. Follow-up audits, including re-audits of deficient areas, guarantee the implementation of effective corrective actions.

As-Built and Record Drawings

Sponsors should establish protocols for collecting and reviewing as-built and record drawings and provide a careful review of compliance with contract requirements before granting final payment approval. The contractor should maintain as-built and record drawings; these deliverables should also be verified by the sponsor's representatives. As-built and record drawings include accurate measurements, dimensions, and specifications of various components (e.g., tracks, stations, bridges, and other infrastructure elements). The drawings capture modifications or changes made during the Construction process and ensure that the final project reflects the approved plans.

As-built and record drawings may also include information about utility lines and underground structures, as well as other relevant details that can assist in future maintenance and repair efforts. Contractors should document and prepare as-built drawings while information is current and readily available. They should maintain in their field office one set of contract drawings for recording as-built conditions.

A sponsor and its DoR should review contractor as-built drawings to verify the accuracy and timely recording of relevant conditions and information. The contractor should reproduce and submit a complete set of as-built drawings before the sponsor releases the contractor's final payment. A sponsor may consider reducing the final payment if the contractor did not maintain adequate as-built drawings. In some projects, sponsors may submit as-built drawings to the design team for their review and approval; these drawings become the record drawings. The sponsor's DoR should stamp the as-built drawings as proof of compliance with plans and specifications and approved changes.

Operations and Maintenance Manuals

The contractor is responsible for diligently preparing and submitting all O&M manuals and training program documentation and for ensuring compliance with contractual obligations. Contractors should also conduct the actual training programs for the sponsor's facility and operations staff that align with stipulations outlined in the contract.

Contract specifications should explicitly address the systems and subsystems for which manuals and training are necessary. Contract specifications should also provide guidance on the appropriate media formats for these materials, specify the required quantity and schedule for submission, establish formatting standards, and outline other detailed requirements relevant to the O&M manuals and training program documentation.

Where a capital project involves extending an existing fixed guideway system, new O&M manuals and training materials should be consistent with existing documentation. This ensures a seamless integration between new and existing components of the system.

The involvement of facility and operations managers is crucial to guaranteeing this consistency. Facility and operations staff should closely participate in proposed revisions to the manuals and bring their expertise and insight to maintain continuity and effectiveness in the overall O&M processes.

Warranties

Contractors should submit a warranty document for all equipment prior to final payment. Warranties generally activate with the date of substantial completion and beneficial occupancy. Where warranty is activated before beneficial occupancy due to sponsor delays, the sponsor may purchase an additional warranty to extend the coverage time.

10. Pre-Revenue Planning

Integrated Testing

Contractors should conduct testing and inspection activities that comply with the contract obligations. The contract specifications should explicitly address specific systems and subsystems that require testing, and they should outline the functionality requirements that need to be assessed during the testing process.

Safety Certification

Obtaining an SC during the testing and start-up of a transit project is of utmost importance. It confirms that the project meets the highest safety standards and provides a secure environment for both the operators and passengers. The certification process involves rigorous inspections, assessments, and evaluations to verify compliance with safety regulations and protocols.

For additional information on pre-revenue planning, please see the Pre-Revenue Operations section in Chapter 6.

CHAPTER 6. COMMISSIONING

1. Purpose

Commissioning provides the link between construction Procurement and revenue service for fixed guideway projects. The principles may also be applicable to bus facilities and specialized equipment purchases. Commissioning determines the acceptability of a newly constructed or modified transit system in preparation for revenue operations. Commissioning planning starts in Engineering—with the inclusion of requirements, roles, and responsibilities in the procurement documents—and continues with the development of more detailed plans during Construction.

Important to Know

✓ Consultants can be used for commissioning under sponsor leadership.

✓ SIT follows construction substantial completion, which is immediately followed by pre-revenue operations.

✓ Successful contractual and operational testing are critical SIT prerequisites.

✓ Hiring and training key professionals for commissioning take place toward the end of construction.

✓ Operations and maintenance procedures, rulebooks, and manuals are living documents to be updated with lessons learned.

After Construction has been safety certified and completed, Commissioning implementation begins with qualification, acceptance, and performance and integration testing. In addition to the testing program SC, a period of pre-revenue service is required to familiarize project sponsor management and O&M personnel with the new system prior to beginning, resuming, or extending revenue service. Final safety and security issues, procedures development, training, emergency preparedness, and customer interface are also addressed during Commissioning.

2. Management Capacity and Capability

Project leadership and management for Commissioning are responsibilities of the sponsor. If a sponsor is unable to provide qualified personnel during Commissioning, the sponsor can outsource this support to consulting services while retaining leadership and ultimate authority and responsibility. Personnel required for managing Commissioning should have extensive experience in commissioning, operating, and maintaining a passenger rail system.

Establishing/Modifying an Operating Organization

The sponsor should establish an organization to perform and oversee project management, operations, maintenance, and supporting functions. If these functions are contained within the same organization responsible for implementing the project, a transition will be required from that organization to a more operations-oriented organization. In most organizations, separate capital projects and O&M functions collaborate in implementing projects.

Recruiting Personnel

The operating agency should assess the personnel required to operate and maintain the transit capital improvement project and recruit personnel with the skills required to support testing and start-up, as well as revenue service. Timing is critical for this effort since lack of qualified personnel could cause a schedule delay.

Important to Know

- ✓ FTA requires states to designate an SSOA to certify the safety of rail transit systems.
- ✓ SSOAs are required to have responsibilities during Engineering and Construction.
- ✓ Some SSOAs may allow the sponsor to self-certify the project as ready for revenue operations.
- ✓ Buy America regulations require that U.S.-produced component and subcomponent costs for rolling stock be more than 70%; final assembly of rolling stock must also occur in the U.S.
- ✓ Rolling stock procurements are subject to pre-award and post-delivery Buy America audit provisions.
- ✓ The safety and security process is guided by the SSCC and overseen by SSCRC.

Depending on labor contracts, local economic conditions, and a variety of other factors, the operating agency should carefully plan recruitment to establish sufficient time to screen and train employees. Recruitment will be directly related to the operating plan developed in conjunction with the capital improvement implementation.

Vehicle maintenance requirements are a function of fleet utilization and established inspection and maintenance standards. The hiring schedule may vary for different categories of employees, depending on the availability of personnel and training requirements.

Training

Plans for a comprehensive training program for O&M personnel should be part of the plan for PRO and should be integrated with the personnel recruitment plan. Training should begin in the late Construction and be completed during project start-up. Hands-on training for O&M personnel is a major aspect of PRO.

For a new rail service, the sponsor should develop rail transportation training for all operators, supervisors, maintainers, and dispatchers. For each course, a syllabus and detailed information are required for in-office training followed by hands-on training for operating and maintaining the equipment. Maintenance training should be specific to the equipment within a specific system (e.g., vehicles, fare collection, signaling, etc.).

Important to Do

- ✓ The sponsor should perform the SIT with support from consultants, if necessary.
- ✓ The sponsor should chair the SIT committee.
- ✓ All contractual operational tests should be accomplished successfully before SIT is implemented.
- ✓ Agreements with local utilities, fire, and police departments and with adjacent buildings and organizations should be made and signed as soon as possible.
- ✓ Rolling stock and other systems included in the Buy America regulations should be audited to verify compliance.
- ✓ Procurement documents should require equipment suppliers to participate in testing, especially SIT.
- ✓ Emergency preparedness drills should involve as many employees in the agency as possible, including nonoperational staff who may be involved in a real emergency.
- ✓ Public safety outreach should include schools, senior centers, hospitals, and other public facilities that can be expected to encounter the transit system.

Safety training should be completed for all employees who are exposed to the operating and maintenance environment. Some training will be performed by contractors who have a requirement in their contract to conduct specific training appropriate to their equipment.

The proficiency of all employees receiving training should be tested and verified; training should be fully documented in each employee's file. There may also be a requirement for state certification for certain categories of employees.

3. Project Management Plan

Planning for Commissioning should be established in Engineering and updated in early Construction, as required, based on experience and on new information as the project progresses. For MCPs, the sponsor should prepare and follow a formal RAP for the project. This plan should identify the management organization and the responsibilities for testing and start-up. RAPs from previous programs serve as a good reference when preparing the first draft.

The RAP should include the following elements:

- Identifying and defining contractual test requirements.
- Identifying SITs.
- Establishing a test program administration system.
- A test numbering system to assist in testing document retrieval.
- Developing a testing sequence schedule.

The sponsor should create a Rail Activation Committee (RAC) that is chaired by a rail activation manager (RAM). The RAC should consist of the sponsor's technical, construction, and operational personnel, as well as other stakeholders, responders, consultants, and contractor personnel. A typical rail activation organization structure is shown in Figure 6.1.

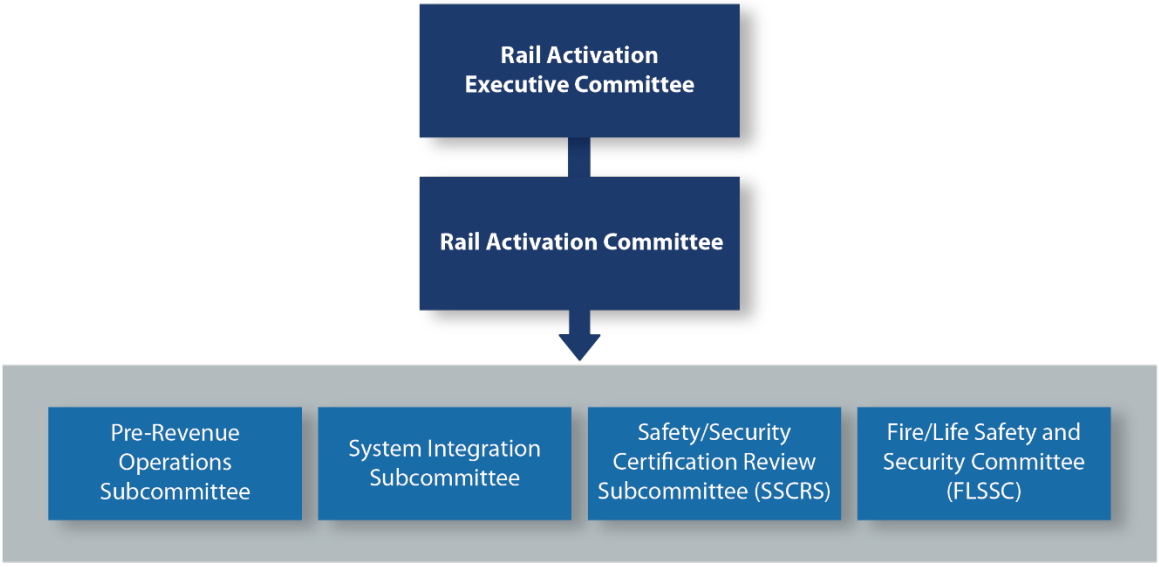


Figure 6.1 Rail Activation Organization Structure Example

4. Integrated Testing Compliance

A System Integration Test Committee (SITC) should be initially identified in the project's SSMP and then detailed in the ITP. In many projects, the SITC is a subcommittee of the RAC.

The committee starts functioning during mid-construction and has full responsibility for coordinating SIT, PRO, and other start-up requirements; and for completing SSC of the project. The SITC, or a similar group, should manage the test program; a designated sponsor manager should chair the SITC. Each SIT should be performed by a test engineer (i.e., either the SITC chair or the test engineer reporting to the chair) and be assisted, as appropriate, by contractor, consultant, and sponsor staff.

A test schedule should be included in the ITP and coordinated with the overall project schedule. The initial test schedule—developed when planning SIT during design—should be updated regularly during construction Procurement and testing and start-up.

Contractual Testing

Contractually required testing should begin during construction Procurement and continue through the end of the Construction process. Contractually required testing should be completed in a segment before that segment can enter Commissioning. Contractually required tests include the following categories:

- Qualification
- Production verification
- Construction inspection
- Installation and acceptance
- Demonstration

The sponsor should develop plans, procedures, and reports for acceptance and demonstration tests. Tests should be scheduled, conducted, and documented in accordance with approved schedules, plans, and procedures and monitored by sponsor representatives. Formal reports on the status of the test program should be issued at least monthly to project management.

Systems Integration Testing

Upon completing contractually required acceptance tests, SIT should be performed to demonstrate the ability of various subsystems and facilities to work as a system and for a new or modernized system to function with an existing system. An ITP should be developed to describe the SIT process. Each integration test should be documented in a formal report prepared by the sponsor representatives who conducted the test. The ITP should encompass the following:

- Organizational roles and responsibilities
- Testing objectives
- A test approval process
- All planned tests and schedule
- Test procedures
- Test reports
- Documentation requirements

Sponsor staff should perform the SIT with support as needed from consultants. An SITC, or a similar test management team, should be identified in the project's SSMP and detailed in the ITP. This organization has full responsibility for coordinating the test program, including the SIT, PRO, and other start-up requirements; and for completing SSC of the project.

The Safety and Security Certification Committee (SSCC) should review and sign acceptance of all SIT procedures for elements that affect system safety or security. The objective of this review is to ensure that SIT has been successfully completed and that identified hazards and vulnerabilities have been controlled or eliminated.

Contract and procurement documents should contain language that requires equipment suppliers to participate in testing their equipment so that problems can be expeditiously identified and corrected. Equipment changes resulting from systems testing should be subjected to the configuration management procedures defined for the project.

Operational Tests

Numerous SITs are required to interface train operations with constructed and installed systems. These SITs are performed after individual constructed elements and systems are tested to ensure that the systems support train traffic safety and security under test conditions. Sample operational tests verify the following:

- *Clearance*. Trains adequately clear fixed objects and other trains at all operational speeds.
- *Train Braking*. Calculated stopping distance is achieved.
- *Signals*. Signals operate as expected; sight distance for operators is adequate.
- *Power*. Substations supply the voltage and current as expected in every situation. A car/train still operates properly when voltage falls to its minimum.
- *Speed*. Train ride quality is acceptable at all speeds up to the maximum allowable.
- *Wheelchair Devices*: Devices interface properly with the cars.
- *Fare Collection Systems*. Devices collect and record fares properly.
- *Entry and Exit Points*. Elevators and escalators meet code requirements; stair banisters, pitch, etc., meet code requirements. If the system is not barrier free, turnstiles and similar equipment operate properly and are tested for exiting capabilities in the event of an emergency.
- *Emergency Equipment and Systems*. Specified emergency equipment and systems for ventilation and exhaust, electricity generation, water removal, fire detection and suppression, intrusion detection, communications, and lighting are installed and operating properly.

These operational tests vary from system to system but are important to complete to avoid any incident when the overall SIT is conducted.

5. Rail Activation Management

Management of rail activation should be established in Engineering—or updated in early Construction—and modified, as required, based on experience as the project progresses. Individuals who should be considered as RAC members or invited guests might include the following:

- RAC manager (chair)
- SSC manager
- SIT manager
- PRO manager
- Operations director
- Transportation planning manager
- Maintenance manager
- Control center manager
- Training manager
- System safety and security director
- Project manager
- Public relations manager
- Construction manager
- Fire department representative (invited guest)
- Police department representative (invited guest)
- EMS representative (invited guest)
- SSOA representative (invited guest)

The sponsor should develop the RAP and organize RAC subcommittees that reflect the complexity of the project.

Agreements

The sponsor should negotiate agreements with all affected jurisdictions and agencies that are involved in the operation of the transportation system. These organizations should be identified early in the project to assure that their requirements are accommodated in design and Construction.

Prior to initiating testing and pre-revenue service, additional required agreements may include the following:

- Utilities that directly support the improvement.
- Operating permits from the local municipality.
- Police, fire, emergency medical, and other emergency response liaisons.
- Shared owners of ROW (e.g., streets, highways, railroads, utilities).
- Local traffic management interfaces.
- Adjacent major ridership generators (e.g., university, airport, stadium, etc.).
- Developments with shared stations.

Procedures, Rule Books, and Manuals

The sponsor should develop or modify O&M manuals, procedures, and rulebooks to address areas affected by the transit capital improvement. These documents should be developed under the management of the PRO committee. They should then be approved by appropriate O&M managers and the RAC. Safety and security should be certified by the SSCC before turning the documents over to the operating organization at testing and start-up completion.

All O&M procedures, rulebooks, and manuals should be living documents and should be revised to incorporate lessons learned from start-up, as well as from those learned during operation.

Pre-Revenue Operations

SIT follows substantial completion and is immediately followed by pre-revenue operations (PRO). PRO should be designed to mimic revenue O&M activities, but with no passengers. Emergency drills are performed during SIT and repeated during PRO as additional training for both agency and responder personnel is good practice. The following items should be considered during PRO:

- Notification procedures internally and to external emergency agencies.
- Control center response.
- Transportation supervisory response.
- Maintenance response.
- Emergency responder response.
- Traction power sectionalization.
- Loss of signals and/or communications.
- Accident investigation procedures.
- Single-tracking performance.
- Simulated bus substitution.

- Train evacuation in stations and along the ROW.
- Station or other facility evacuation.
- Assumption of authority.
- Command post protocols internally and externally.
- Rescue trains.
- Simulated public notification.
- "On-the-line" vehicle troubleshooting.
- Simulated emergency training.

Rolling Stock Post-Delivery Audits

Prior to transferring the title for revenue service rolling stock vehicles, Buy America regulations require that the sponsor conduct a post-delivery audit verifying manufacturer compliance. The following certifications are required for each post-delivery audit:

- *Buy America*. Verifies that final assembly of all vehicles occurred in the United States and that the cost of components produced in the United States is more than 70% of the cost of all components for each vehicle type.
- *Purchaser's Requirements*. Verifies that a resident inspector (on behalf of the project sponsor) was on-site in the manufacturing facility during the final assembly period and monitored and documented the final assembly process; verifies that the project sponsor—or an entity on behalf of the project sponsor—performed visual inspections and performance tests demonstrating that the vehicles meet the contract requirements.
- *Federal Motor Vehicle Safety Standards* (*FMVSS*). The National Traffic and Motor Vehicle Safety Act creates a self-certification system of compliance and requires a manufacturer or distributor of a motor vehicle or motor vehicle equipment to certify that the vehicle or equipment complies with applicable *FMVSS*. For vehicles such as buses, trolley buses, vans, passenger cars, and trucks, the sponsor should retain copies of the manufacturer certification indicating that their products meet applicable standards. Note: Not all rolling stock vehicles under review require a SC.

Requirements for post-delivery audits are stipulated in 49 CFR 663; additional guidance is provided on the FTA website and in the FTA *Buy America Handbook*.

6. Safety and Security Certification

SSC is required to bring a project to completion and enter revenue service. It is a complex effort that requires the sponsor's SSC team to work closely with all project officers—especially with design, operations, and training—to ensure that safety hazards and security vulnerabilities have been addressed prior to the start of operation.

The project certification team is assisted by the FLSSC under the jurisdiction of the SSRC. This team should include the project's safety and security staff; and technical, operation, and construction personnel, as well as staff from the transit agency who will operate the system. Transit personnel should include safety and security staff, as well as operational, training, and human resources personnel to assist with assuring that training programs, manuals, and procedures are properly certified.

Important to Do

- ✓ Assign an SSRC team early in Engineering.
- ✓ Work closely with the rail activation team, SSRC, and FLSSC to develop an SSCP.
- ✓ Prepare a CIL as part of the SSCP.
- ✓ Include CIL items that may not appear to affect safety and security but that may play major roles in assuring the safety and security of the system, employees, and patrons.
- ✓ Plan and implement emergency preparedness using tabletop exercises and drills.

The certification team should work closely with the FTA—especially its PMOC—and with SSOA staff. Depending on the size of the project, both the FTA and the SSOA may participate in and approve certification document activities; for smaller projects, the FTA may delegate oversight activities to the SSOA. Both should be apprised of certification activities; they may also attend briefings, tabletop exercises, and full-scale drills.

The FTA *Handbook for Transit Safety and Security Certification* defines SSC (or commissioning) as the "processes that collectively verify the safety and security readiness of a project for public use" (DOT, November 2022).

An important document in the safety and security commissioning process is the SSCP. This plan highlights and provides a method of assuring that safety and security elements are verified prior to the start of revenue operations.

A key element of an SSCP is the CIL (referred to in the handbook as a Certified Elements List [CEL]). Following the dictates of *Circular 5800.1*, this list should already exist and should have been updated during each section of PD, increasing in size and specificity as the project moves toward Commissioning. Many new items will be based on design changes; changes to municipal, county, state, or federal regulations; or information developed during FLSSC meetings and approved by the SSRC.

The handbook provides step-by-step instructions on creating and maintaining an SSCP. It explains how certification fits into each phase of a project's life cycle, and it reviews the activities and documentation required at each phase. The handbook also explains the certification process; highlights the resources needed to implement the process, including an activities list; and includes a sample list of certifiable items and sub-items.

In addition to the handbook, the project SSC team should review *Circular 5800.1* directions for updating an SSMP. Particular attention should be given to processes for ensuring qualified O&M personnel; verifying safety and security; and coordinating with the Department of Homeland Security (DHS).

Certification and contractual acceptance of an item from a vendor or contractor have different requirements. Certification requires review and testing to assure an item aligns with applicable codes, regulations, and industry standards. These verifications—generally termed pre-revenue or integrated tests—should be accurately described and verified on test description sheets.

The handbook explains the testing process, provides sample forms for all steps in the process, and recommends responsible parties for signoff. The handbook combines safety and security processes under a single certification team. This practice is effective as there is overlap in items being certified. A single team with both safety and security expertise should be assigned to confirm that security receives as commensurate attention as safety.

Staff assigned to develop CILs should think broadly as there are numerous elements of a project that may not appear to affect safety and security but that play major roles in assuring the safety and security of the system, employees, and patrons. The following sections highlight items that should be considered in the Commissioning process.

7. Safety Oversight

Updating and reviewing the project's HA are important elements of safety oversight. These processes ensure that changes that affect safety have been incorporated into an updated HA, that new hazards have been addressed, and that countermeasures suggested prior remain appropriate. As part of the certification process, many sponsors set up resolution meetings with consultants, the safety and security team, members of the FLSSC, and operational personnel groups to brainstorm the HA. Items in these group discussions include the certifiable element of each hazard and its description, the potential cause and effect, the initial risk level assigned, engineering and operational mitigation suggestions, and the residual risk based on the suggested mitigations.

The sponsor should review key areas that have changes that are likely to affect safety and security. These areas include station design and associated access control, lighting, and wayfinding; and safety features of employee-only facilities, including restrooms, rest areas, or parking facilities with lighting, closed-circuit television (CCTV), and safe access. The sponsor should also confirm that employees are receiving training on safety rules, regulations, and features of the equipment they will be expected to work with. Planning for and documenting employee participation in emergency preparedness activities are included in the elements of safety oversight.

When certifying documents involving employee contact with patrons (e.g., enforcing fares; smoking or noise issues; package size, strollers, or similar proscriptions; etc.), the commissioning team should ensure that employees understand what is expected of them to avoid employee injuries and patron disputes.

All HAs—particularly later versions—should include information that identifies the assessor. HA sections marked Prepared By, Reviewed By, or Approved By should contain the signee's full name, affiliation, and sign date. Since projects can take many years to complete, a signee's affiliation is important. It is not unusual for FTA or another auditor to review a document in which the sponsor is unable to confidently identify the person who performed the analysis. This policy to obtain a reviewer's identification information should also apply to the TVA, as well as to other signed documents.

Safety oversight includes reviewing and updating the passenger emergency egress plan and station and train evacuation plans, as well as fire detection and protection system testing and a fire management and control plan. Each of these tests, along with similar tests, should be a CIL item. Final acceptance of these plans should be vetted through the FLSSC to assure that the plans comply with National Fire Protection Association 130 *Standard for Fixed Guideway Transit and Passenger Rail Systems* (2023) and with state and local codes.

The sponsor should closely review other issues for their safety and security impact, including hours of operation and access control for stations/platforms and parking facilities and how these areas will be monitored and protected. If stations include retail establishments, CIL items should include approval of their design, hours of operation, and safety and security elements. The sponsor should also review communication elements from a safety and security perspective. These elements include wayfinding, passenger information systems, variable message boards, CCTV, and emergency/blue light phones, and whether these elements will be monitored in real time or used solely for post-event investigation. Assuring that all emergency communication networks are described and tested for operability helps to prevent costly retrofitting.

The sponsor's review of operating and maintenance program documents should include the operating agency's Public Transportation Agency Safety Plan (PTASP). Note: The PTASP has been required by 49 CFR, Part 673 since July 20, 2020. The PTASP replaces the System Safety Program Plan (SSPP)—also known as the System Safety Plan—that was required under 49 CFR, Part 659. 49 CFR, Part 673 mandates that all recipients or sub-recipients receiving funds under 49 USC § 5307 who operate a public transportation system and rail systems subject to FTA's SSOA (SSO Program) create a PTASP. A key difference between the PTASP and the SSP is the requirement to include processes and procedures for implementing Safety Management Systems (SMS).

The FTA Technical Assistance Center provides detailed information on preparing a PTASP. Additionally, the National Public Transportation Safety Plan (NPTSP)—also known as the National Safety Plan—lists PTASP requirements, including targets on performance measures involving fatalities, injuries, safety events, and system reliability. When reviewing operating plans, the commissioning team should work with the SSOA to confirm that the PTASP complies with the state's System Safety Program Standard (SSPS), which may include requirements other than those set out by the FTA.

8. Public Relations and Marketing

As with the HA, the team should review the project's TVA to ensure that 1) changes affecting security have been incorporated into the latest document, 2) new vulnerabilities have been addressed, and 3) countermeasures suggested prior remain appropriate.

Many elements that impact safety also impact security, particularly those elements surrounding fares and fare enforcement and access and egress control of employee facilities, including lounges, restrooms, lockers, and parking areas.

Numerous safety and security elements are involved in fare collection and include the following:

- Will cash fares be accepted?
- Where will fares be collected (i.e., onboard or off the equipment)?
- Will employees collect fares?
- How will employees and fares be safeguarded?
- How have employee protections been considered in the design?

As with the HA, many sponsors set up resolution meetings to review the TVA. These meetings provide the sponsor opportunity to discuss each potential threat and the target(s) of the threat; the assessed vulnerability and severity of the threat (before and after suggested mitigations); possible system-related cause(s); potential effect(s) on the system's equipment, fixed facilities, employees, and patrons; potential countermeasures; and resolutions that have been enacted (generally completed after pre-revenue testing).

Under 49 CFR, Part 674, the FTA no longer requires agencies to submit a System Security Plan (SSP) for review and approval. However, Part 674 gives SSOAs the option to include security in their three-year transit agency reviews. Since not all SSOAs have opted to review security, the commissioning team should consult the SSOA to determine whether it expects to receive and approve security-related documents.

DHS coordination is necessary to meet specific mandates of the SSMP, particularly those that pertain to formal safety and security analysis requirements and to integration with other safety- and security-related documents.

9. Emergency Preparedness

Emergency preparedness includes planning and training, developing procedures, and evaluating safety and security criteria to enhance an agency's ability to mitigate the effects of natural or human-made disasters. It involves technology, agency personnel, and cooperation and coordination with state, regional, and local agencies, particularly those involved in emergency response (e.g., primarily police, fire, and emergency medical personnel).

The Passenger Train Emergency Preparedness Act (49 CFR, Part 239) requires that railroads operating passenger train service conduct full-scale emergency simulations to determine their capacity to execute emergency preparedness based on scenarios that could reasonably be expected to occur on its operation. These simulations should also ensure coordination with all emergency responders who voluntarily agree to participate in the emergency simulations.

Circular 5800.1, Section 6.d. Emergency Preparedness, incorporates 49 CFR, Part 239 into the SSMP, which requires that a sponsor identify "any exercises, drills, tabletops, or other activities that the recipient will perform to ensure…readiness." The SSMP should also explain how the sponsor will assess the documents and results (i.e., an after-action report or equivalent documents).

Documents relating to tabletops and drills are certifiable elements; the activities should take place and their results recorded as formal pre-revenue activities.

As part of certification, a sponsor should develop specific procedures, plans, and contingency plans that address emergency preparedness. The sponsor should verify the plans through tabletop exercises and field drills that certify employee and local agency responder knowledge of their roles in an emergency.

Emergency preparedness procedures and training help maximize the safety and security of employees, responders, patrons, and the public, any of whom may be affected by an event that involves vehicles or infrastructure. The *Guidelines for Transportation Emergency Training Exercises* (Transportation Research Board, 2006) provide detailed explanations and instructions for creating emergency preparedness exercises.

Emergency events include those naturally occurring (e.g., weather-related); intentional (e.g., crimes ranging from terrorist activity, labor disputes, and workplace violence to theft and vandalism); and unintentional (e.g., hazardous materials spills; gas or power outages; software malfunctions; and human error resulting in various accidents, particularly those involving agency equipment, personnel, or patrons).

Transit agencies generally certify tabletop exercises and full-scale drills/simulations. These activities are planned by the project's safety and security team in conjunction with FLSSC members since a major goal of these activities is to test the knowledge and coordination between transit agency personnel and local first responder agencies.

A tabletop exercise generally takes place in a conference room rather than in the field. Although less complicated than a drill, a tabletop exercise may include interactive elements, such as asking participants to move pieces around a board (similar to a checker or chess board) to show how they would prepare for and respond to various emergencies.

A train/car collision, for instance, might involve moving pieces to consider whether the point of crash could be minimized by better lighting or signage or by train preemption. Other pieces might represent locations to develop a command post, identify vehicle parking areas for responders to avoid obstructing ambulances or other responders, or establish a triage or media area. With improved technology, many tabletops use computer graphics (e.g., slide decks, video clips of media coverage, etc.) to enhance realism.

The exercise should include a briefing by the exercise leader and sufficient time for participants to discuss what went right, what went wrong, and how responses can be improved. The event should be documented; details should include the time and location of the event, participants and their affiliations, and follow-up activities. If a situation manual (also referred to as a SITMAN) was distributed, the manual, and any other handouts or after-action materials, must be retained and approved as part of the certification record.

Examples of tabletop exercises include the following:

- Small fire or smoke conditions with patrons injured and in need of evacuation.
- Demonstrators on the tracks protesting local, non-system-related problems.
- Persistent disregard of crossing regulations.

A drill is more complex than a tabletop exercise. A drill takes place on-site, in real time, and involves multiple performers. Drills have been compared to dress rehearsals for theatrical productions: they require a stage (e.g., the street and/or the ROW); a script for actors and supporting players (e.g., existing plans, policies, and procedures); and behind-the-scenes personnel who rely on drill-specific forms to monitor and assess performance.

The scenario selected for the drill is of the utmost importance. Ideally, it will be based on a threat or hazard that is likely to occur depending on the size, location, and vulnerability of the system.

While participants may want a dramatic storyline that reads like a current event headline (e.g., terrorists taking over a train; a radiological, nuclear, or cyber threat, etc.), such scenarios are unlikely to provide agency personnel with training for events they are more likely to encounter. Practical themes—such as a train/vehicle accident; or a train striking a trespasser; or an operator becoming incapacitated due to illness; or a fight between patrons that leads to threats involving weapons—provide a more practical basis for this type of training. The location is also important as the venue should match the scenario depicted during the drill.

While many drill directors rely on outsiders (e.g., local theatrical groups or students) to fill in as injured patrons or noisy bystanders, many sponsors solicit volunteers among nonoperating employees. This training provides opportunity for these “inside” employees to experience situations that could occur outside the office and prepares them to assume responsibilities in an actual emergency.

Drills are serious events. They generally involve street closures, advance notice to area residents and the media, and a large number of vehicles and equipment. Examples of drill exercises include the following:

- Fire and smoke on a railcar involving patron evacuation.
- A grade crossing collision with injuries.
- Patron evacuation on aerial structures and in tunnels.
- A derailment.

In addition to obtaining all required certification documents, the sponsor should consider videotaping the drills. The videos are useful not only for after-action meetings, but they can also serve as training materials for personnel who did not attend the drill.

10. Community Outreach and Marketing

The sponsor should conduct public outreach and an active public information program throughout the capital PD process. If the project relates directly to transit customers, especially for new or expanded service, the outreach should include an intensive marketing campaign to encourage the public to utilize the new and/or improved service. The campaign should include specific information on how to use the new service, including a reoriented feeder bus service and park-and-ride facilities.

Particularly if the transit system is new or the system initially met with negative public comments, the ease of use and safety aspects should be stressed. Studies have shown that communities without public transit are often apprehensive about how the system may alter their neighborhood's cohesiveness. Public information campaigns should include schools, senior centers, and other local institutions that might draw on the goodwill of community leaders and local elected officials.

A proactive public safety outreach program includes schools, senior centers, hospitals, and other public facilities that may encounter the transit system. Operation Lifesaver, Inc. (OLI) and other safety programs should be age-specific, particularly in areas where transit is new and where the tracks may traverse areas where free movement will not be curtailed. The program should also encompass security awareness (e.g., Transit Watch) and emergency preparedness elements to inform riders of personal safety practices while riding transit and vehicle emergency evacuation instructions.

11. Initial Revenue Service

While many project management concerns typically end at the conclusion of testing and start-up, others remain. These include managing warrantee claims and completing workaround and restriction removals that may have been put in place to allow safe and secure revenue service while non-client elements are brought into compliance with project requirements. The RAC remains active past the initiation of revenue operations to confirm the satisfactory resolution of workarounds and removal of operating restrictions.

During revenue service, the sponsor should organize and pay close attention to the following to maintain a high level of system performance:

- A continuous quality improvement or lessons learned program.
- A configuration management and change control process.
- An SGR program within the framework of the department(s) responsible for facilities and vehicle maintenance.
- A system capital and modernization replacement fund to obtain and install facilities, equipment, accessories, or appurtenances needed to maintain system capacity and performance.

Commissioning is the culmination of arduous work accomplished through planning, design, and Construction. Commissioning should be carefully planned, executed, and documented so the system performs in a safe, secure, and reliable manner.

CHAPTER 7. PROJECT MANAGEMENT PRINCIPALS

1. Management Capacity and Capability

FTA conducts management capacity and capability (MCC) reviews as part of the grant award process to evaluate a sponsor's MCC in developing a federally assisted project efficiently and effectively. The capacity review evaluates whether adequate staffing is in place; the capability review determines whether the personnel assigned have the minimum qualifications and experience. These reviews also evaluate the sponsor's overall organizational structure, reporting, management tools, policies and procedures, the PMP and subplans, and implementation methods, as well as consultant and partnering third-party team member qualifications.

The evaluation confirms that the sponsor can recognize and manage project risk factors and implement mitigation measures, stay within budget, and complete the project on time. In addition, it assesses the sponsor's ability to successfully manage real estate acquisition, third-party contracts, utility identification and relocation, environmental compliance, geotechnical investigations, safety and security, QA/QC policies and procedures, and other activities of concern. The results assist FTA in making programmatic and grant decisions regarding the sponsor's readiness to advance and deliver the project.

MCC evaluations are generally conducted by the FTA PMOC before approval to enter Engineering, Construction, and revenue service. The sponsor should provide the PMOC with its PMP and subplans; organization charts for the project and agency; and project team roles, responsibilities, and availability. The sponsor should also provide résumés for key agency staff and consultants, a personnel qualifications summary table, and a time-scaled staffing plan with a labor distribution table and chart. The PMOC also conducts interviews with select sponsor staff and consultants. Additional information on the scope of the MCC review and the documents required can be found in FTA *Oversight Procedure 21 – Management Capacity and Capability Review*.

Sponsor Organization

As a transit capital project evolves throughout planning and implementation (particularly an MCP), project objectives are refined and organizational participation is adjusted to accommodate the requirements of each phase. The project management framework should, therefore, be flexible. This is true specifically in regard to leadership and team makeup as a project transitions from planning to Engineering, from Engineering to Construction, and from Construction to revenue service.

To manage transit capital projects, sponsors may engage outside consultants and contractors to augment staffing for various stages of the project life cycle. The degree of outsourcing is influenced by the size and complexity of the project and by the capacity and capability of the sponsor. Staff quantity, qualifications, and availability should be considered in relation to the duration of the project.

Sponsors also have the option of assigning greater responsibility to contractors by utilizing alternative project delivery methods. Some sponsors partner with local public transportation agencies with prior FTA MCP experience in managing projects through design and Construction.

A benefit of using contracted support for a project of finite duration is the ability to terminate services and the associated expense when their involvement in the project is complete. For a small agency planning a new maintenance facility or a transit system developing a single fixed guideway segment, it may be prudent to contract for program management, design, and construction management services rather than hire or greatly expand staff. In the case of a large, fixed guideway system, a project may initially employ consultants until in-house staff capabilities are developed to replace the consultants.

When outsourcing services, responsibility for consultant and contractor oversight should stay with the sponsor's management personnel. The sponsor should have its own qualified organization to maintain overall control of the project, provide timely decision-making, and maintain appropriate communication with project participants and stakeholders. It is also important to have checks and balances among consultants. For example, it is not advisable for a consultant who performed the environmental and conceptual design to continue as the final designer or for a consultant who performed the design to act as the CM. On the other hand, retaining a final design firm to provide support during Construction (e.g., submittal reviews and RFI responses) after the design is complete helps maintain the integrity of the design intent and retains project knowledge.

Outside consultants should fully integrate into the sponsor's project team. The team setup should be compatible with the existing sponsor's organization, giving attention to the flow of authority and responsibility—from the sponsor through the project manager, functional area managers, and contractor managers—to each assigned project participant.

An integrated project team should include key management and staff from the agency; environmental, design, and CM firms; the operator; and other key stakeholders. Ideally, this core group is co-located on or near the project site throughout the project life cycle. Separating project teams from the sponsor and its support staff—and, at times, from agency design and operations—can cause unnecessary friction and the inability to profit from existing management and control system economies, synergy, and the gaining of "ownership" by those who will operate the completed project.

Typical Organizations

When considering the sponsor's existing capacity and capability, project complexity, and the sponsor's future role and responsibilities in the new project, typical organizational approaches to staffing the project are plausible. These include the following:

- Developing or reassigning in-house staff who have a prior successful track record on similar projects to a project office to undertake the project. This in-house staff organization may be augmented by a program management consultant or by a project advisor to provide independent advice or analyses to senior management.
- Using existing third-party agencies (e.g., another transit agency or state or local government agencies) who have a prior successful track record on similar projects to perform the work under a third-party agreement or contract. This third-party organizational arrangement may be augmented by a program management consultant or by a project advisor to provide support or independent advice to senior management.
- Using a dedicated management team with sufficient resources to oversee and supervise consultant(s); delegating responsibility to a general consultant with a track record in planning, designing, and constructing the facility; or assigning design and construction management to separate consultants.
- Delegating the responsibility of project management to a program/project management consultant if the sponsor does not have adequate, dedicated management resources to oversee the general consultant. Note: This option should include continuous oversight of all consultants by the sponsor's management regarding project scope, budget, and schedule.
- Using contractors for alternative project delivery methods (e.g., DB, PDB or CM/GC, or concessions).
- Using a combination of the above approaches.

In any organizational approach chosen, the sponsor has the ultimate responsibility for effectively managing the project.

If project staff are organized in a matrix format, the matrix should clearly indicate sponsor staff members responsible for overseeing and supervising non-project-sponsor (e.g., contractors, consultants, etc.) activities and indicate their level of commitment. A matrix organizational form is often defined with multiple reporting relationships.

In this type of organization, a staff person has dual reporting responsibilities: to the functional manager and to the project manager. Personnel assigned to the project report to the project manager for work priorities (i.e., what must be done and when) and to a functional manager for technical adequacy (i.e., how work is to be done). Staff can be assigned on a temporary basis while remaining functionally affiliated (see Figure 7.1).

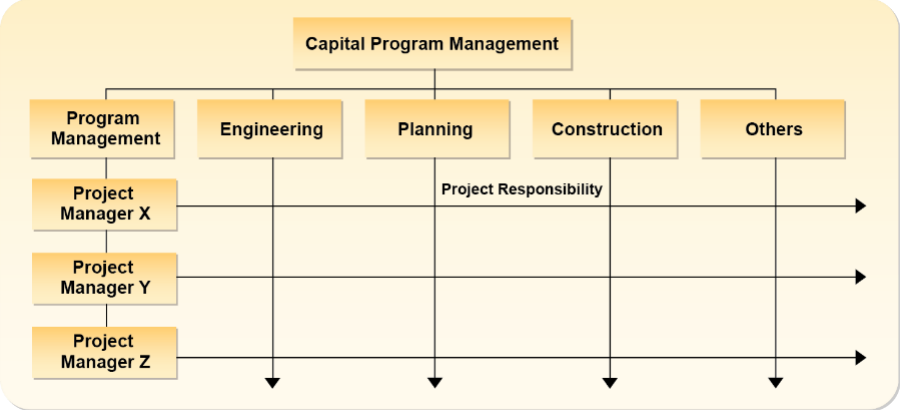


Figure 7.1 Simplified Matrix Organization Chart

Project Organization, Staffing, and Training

The sponsor should address organization and staffing updates during the project life cycle in the PMP. The sponsor should also develop organization charts for all project functions. On large, multi-segment fixed guideway projects, separate organization charts showing all participants and their reporting relationships should be prepared for each segment.

These charts should identify key personnel in all organizations and clearly define their principal duties, reporting relationships, assigned responsibilities, and delegated authority. Interface points within and outside the project organization should also be identified.

At the outset of a project, the sponsor should establish delegation levels that recognize changes the agency will encounter during the life of the project. Sponsors should assign authority at the level most knowledgeable and aligned with the responsibilities of that person. Delegation of authority should promote transparency in decision-making. All decision-makers should be accountable for their actions, and the actions should be based on clear documentation, sound analysis, and an understanding of the consequences. An appropriate level of authority should be assigned to review and approve contract amendments and change order values.

Sponsors should consider training project team members—both staff and consultants—in the unique aspects of the project undertaken. For example, if all project team members are required to use a certain collaboration platform to communicate, store, and exchange documents, they should be trained to use the platform. Additionally, specific staff management capabilities and training requirements should be included in the contract documents.

2. Project Management Plans and Subplans

Overview

The sponsor uses a PMP to plan project implementation and to establish and disseminate policies and practices that govern requisite project activities. The PMP is an overarching document that spans the project from no later than PD completion through the planned capital grant project closeout. The PMP identifies specific administrative and technical procedural documents that the sponsor develops to implement the project successfully as envisioned and approved in FTA grants.

Applicability

To receive federal financial assistance from FTA for an MCP, the sponsor should prepare a PMP for FTA review. PMPs for MCPs must be approved by FTA prior to grant award. Periodic PMP updates by the sponsor—especially related to project budget and project schedule, financing, and ridership estimates—are required per 49 U.S. Code 5327. Additionally, the sponsor should carry out the project in accordance with the PMP. Failure to follow the PMP can trigger intensified oversight by the FTA PMOC (see FTA *Oversight Procedure 25 – Recurring Oversight and Related Reports*). A PMP is also recommended for non-MCPs.

FTA requires that recipients of federal grants have project management policies and procedures in place, as well as adequate staff skilled in, but not limited to, project controls, quality, cost estimation, scheduling, procurement, transit operations, safety and security, and public outreach throughout the project life cycle. FTA uses a triennial review process to periodically assess grant recipient performance and adherence to current FTA requirements and policies, including project management capabilities.

The sponsor should require that all project participants and interfacing stakeholders comply with the PMP requirements. These conditions should be included in contracts involving contractors, consultants, and stakeholders on the project.

Timing

The PMP is an evolving document that should be expanded and updated as necessary throughout project implementation. Project management concepts are initially developed and documented in the PMP during PD. Per 49 CFR 633, the PMP should be updated and resubmitted “if the project is at a new phase or if there have been significant changes identified.”

For large, multi-segment projects, FTA encourages sponsors to modify the PMP to reflect the unique characteristics of each segment, and include specific SOW and resources (e.g., project staff, budget, and schedule).

The PMP and its subplans are controlled documents; each version is developed and approved by the sponsor under project document control and configuration management policies and procedures. Revisions should be distributed to ensure requisite parties have the latest version.

Content

Minimum FTA PMP requirements are defined in 49 U.S. Code 5327 – Project Management Oversight (Title 49 – Transportation, Subtitle III, General and Intermodal Programs, Chapter 53 Public Transportation, Section 5327) and in 49 CFR 633 – Project Management Oversight. Requirements include the following:

- Adequate recipient staff organization with well-defined reporting relationships, statements of functional responsibilities, job descriptions, and job qualifications.
- A budget covering the project management organization, appropriate consultants, property acquisition, utility relocation, systems demonstration staff, audits, and miscellaneous payments the recipient may need to justify.
- A project construction schedule.
- Document control procedures and a recordkeeping system.
- A change order procedure that includes a documented, systematic approach to handling construction change orders.
- Organizational structures, management skills, and staffing levels required throughout Construction.
- QA and QC functions, procedures, and responsibilities for construction, system installation, and system component integration.
- Materials testing policies and procedures.
- Internal plan implementation and reporting.
- Criteria and procedures for testing the operational system or its major components.
- Periodic updates of the plan related to the project budget and schedule, financing, ridership estimates, and the status of local efforts to enhance ridership where ridership estimates depend, in part, on the success of those efforts.
- The recipient's commitment to submit a project budget and project schedule quarterly to FTA, or more frequently if the sponsor fails to meet the requirements of the PMP and the project is at risk of materially exceeding its budget or falling behind schedule.
- Safety and security management.
- Management of risks, contingencies, and insurance.

The PMP should also adhere to requirements in FTA *Circular 5010* Sponsors should also consider consulting FTA *Oversight Procedure 20 – Project Management Plan Review*, which provides an understanding of the information PMOCs review in the PMP. Appendix B of *OP 20* provides a table of contents for the PMP that is based on a traditional DBB procurement approach. Note: PMP components and content should be modified to address alternative delivery approaches.

FTA operating procedures listed below provide sponsors with FTA requirements for each subplan. For large projects, the following elements of a PMP should be developed as separate subplans:

- Management Capacity and Capability documents (see *OP 21*)
- Safety and Security Management Plan (see *OP 22*)
- Real Estate Acquisition and Management Plan (see *OP 23*)
- QA/QC Review (see *OP 24*)
- Bus Fleet and Rail Fleet Management Plans (see *OP 37*)
- Risk and Contingency Management Plan (see *OP 40*)

The PMP should ensure that performance is qualitatively and quantitatively measurable through sound design and engineering and that comparable industry practices are readily identifiable, credible, and consistently applied. The plan should demonstrate that all project life cycle characteristics have been thoroughly considered, including methods used to execute the project and interfaces created among various participants.

The PMP should define project objectives and the methods and resources proposed to meet those objectives; an overall risk-informed, performance-based management approach, including technical and administrative means and methods for project control; and the responsibilities, authorities, and measures to gauge the performance of all parties involved.

The PMP should recognize FTA in its role of project oversight and independent project review. PMOCs are assigned by FTA to MCPs as an extension of staff to monitor and assess the technical aspects of the project. FTA also engages FMO contractors to review finance and accounting issues related to a sponsor or project, including specific methods and systems.

Communications Overview

Complex transportation projects require a strong communication network between agencies funding the project, key stakeholders, and the public. This network provides for open and continuous communication among participants across all project functions.

Affected groups should be represented on the project team either directly or through advisory committees. Effective internal communication and coordination established through standardized project organizational reporting and a central reporting office facilitate the flow of external information necessary for public participation. An effective communications program requires that information provided to all parties be accurate, timely, and relevant. The communication program should also ensure that relevant information is reaching its intended party.

Policies and procedures should be established for project progress and grant reporting. When a PMOC is assigned to a project, FTA may instruct that communications related to oversight, submittal, and review of the PMP and required plans be directed to the PMOC.

Sponsors should maintain solid working relationships with the FTA regional office and with the PMOC. The FTA and PMOC are interested in the project's success and can assist the sponsor in complying with federal grant requirements and in identifying project management best practices. Sponsors should also keep the FTA informed of the status of interfacing capital projects, upcoming projects that may seek federal funding, and significant events affecting revenue service or the grant project before the information is made public.

The communications program should establish schedules for periodic meetings and reports, determine critical program interfaces, identify affected audiences, designate staff responsible for information flow, and establish a public information and participation program.

Communications programs should target project partners and stakeholders, as well as communities affected by the project. These relationships may be governed by agreements, memoranda of understanding, or formal requirements associated with funding or environmental impact commitments. Regular communication supports effective project delivery by minimizing disputes that could disrupt or delay the project.

Project Coordination

An effective communications program and implementation strategy support project functions (e.g., existing management control, real estate, design, construction, and operations). Major interfaces within a project structure should be established when coordination is critical to project performance. These interfaces exist between companies under contract, functional units, project locations and phases, project and governmental regulatory agencies, and private and public interests. Formalizing written project coordination means and methods enables project organization members to work together efficiently.

To enhance interface management, the following should be clearly defined:

- Responsibility of each agency, department, and team member.
- Authority and accountability for each agency, department, and team member.
- Interfaces between project functions.
- Inputs and outputs in terms of content, schedule, and project status.
- Lines of, and procedures for, communication to facilitate informed decisions.

Third-party real estate acquisitions and utility agreements are frequent causes of project delay and cost growth. Communication with agencies having jurisdiction over the project and with utility companies that have infrastructure in the project ROW should begin during PD and continue throughout the project.

Operating Plan

The sponsor should include a BFMP or an RFMP in the PMP that documents how the sponsor will fund and operate the proposed project and existing transit system (see FTA *Oversight Procedure 37 – Fleet Management Plan Review* for sponsor requirements to operate and maintain the proposed project while retaining existing transit service levels).

The operating plan should include the following information:

- The operating agency and indication as to whether the sponsor or a separate agency will be responsible for operations, whether O&M services will be contracted to a service provider, and the extent of such contracting, if planned.
- The system, including type of service (e.g., LRT, HRT or rapid rail, commuter rail, BRT, etc.); ROWs; stations, including platform lengths; and signal and traction power systems, if any. For systems with a rail component, indications as to whether there are joint operations with freight, intercity rail, or other rail carriers.
- A vehicle and accessibility plan for individuals with disabilities.
- Operating characteristics of the proposed vehicles.
- For opening day and design year (for new systems only):
    - proposed hours of operation and service frequency for peak and off-peak hours, weekends, and holidays;
    - ridership levels for peak and off-peak hours, weekends, and holidays;
    - proposed operating schedules and simulation studies, if any, that support operating schedules;
    - projected peak ridership loading compared to vehicle loading standards;
    - parking plans; and
    - planning horizon.
- Travel times end to end and between stations/stops; station/stop dwell times and maximum operating speed.
- Operating crew plan, central control, and dispatching plan.
- Passenger fares and fare collection methodology; daily, weekly, monthly, multi-trip, peak and off-peak, senior, disabled, and promotional fares; the fare collection system and enforcement method.
- Vehicle storage and maintenance facilities.
- Vehicle and ROW maintenance plans; facility, equipment, and staffing required to carry out the plans.
- FRA rules and regulations or other federal regulations that apply to the system.
- An operating plan for special events.
- An SSP, including staffing requirements, and whether security services will be contracted to a service provider or provided by existing municipal security forces.

FTA determines whether the sponsor has the financial capacity to fund these additional expenses without reducing existing service levels, deferring maintenance, or causing significant adverse impacts to the current service. The operating plan should clearly identify the following:

- The effect on existing operations of the proposed project.
- The impact the project will have on existing operations, revenues, and O&M costs.
- Bus routes that will be realigned or removed.
- New planned feeder routes.

Early in PD, the sponsor may lack a sophisticated simulation model to evaluate the proposed project. This can cause the sponsor to understate or overstate ridership demand and power requirement capacities, leading to an ineffective, inefficient layout of critical elements of the project's physical plant and equipment.

Before approving project entry into Engineering, the FTA may request that the PMOC perform a transit capacity analysis. FTA has assisted in financing studies under the TCRP that address transit capacity analyses (see *TCRP Report 165: Transit Capacity and Quality of Service Manual,* Third Edition [January 2013] for information on providing this analysis).

Operation and Maintenance Costs

Transit system O&M expenses should be addressed in the operating plan. These expenses often increase after a transit project goes into revenue service and typically require additional subsidies to operate and maintain the system.

O&M cost changes have three components: 1) inflation for labor and materials; 2) service/operating changes; and 3) productivity changes. The plan should include inflation and productivity assumptions and system-wide operating and service characteristics. Accompanying text should document the O&M cost estimation methodology—preferably resource cost buildup— and describe service plans for the proposed project and existing transit system. The cost estimation documentation should provide details regarding operating, maintenance, and security labor; fuel and supplies; administration; and other relevant categories to calculate annual O&M costs. The output of this plan is an estimate of operating statistics that include vehicle miles and hours, peak vehicles, etc.; these become inputs to calculate O&M costs.

Fixed and variable O&M costs are relative to service levels. A fixed cost (e.g., station lighting) remains constant and is based on the physical facilities of the fixed guideway system, regardless of the service level. A variable cost is an expense linked to the service characteristic to which it is most closely tied (e.g., traction power for an electrified system). A standard system of accounts should be used for the cost model consistent with FTA NTD requirements. More information on O&M costs is available on the NTD website.

When outside contractors operate, maintain, and/or finance a project, contracting fundamentals should be incorporated in the analysis of O&M costs for the new project and for the balance of operations, facilities, and services.

3. Scope Control

The project scope describes the minimum requirements to deliver project objectives in compliance with the environmental review process. When a transit agency undertakes a capital project, the sponsor is responsible for establishing change policies and procedures to control scope, cost, and schedule.

Scope Life Cycle

During PD, the project scope is defined and finalized by the ROD at the end of the environmental review process. In PD, a broad range of needs includes service and operations parameters; community, third-party, ROW, and funding requirements; utility relocation; environmental impacts; and project delivery options. The sponsor defines the requirements and conceptualizes and studies options during the environmental review to arrive at an LPA that defines the complete project scope.

The sponsor should make an early decision on the contracting approach as it directly influences the design SOW. Contract package size and scope are selected with regard for management and financial resources available to the sponsor to obtain the greatest resource efficiency and economy. Sponsors should carefully review all proposed project scope changes to avoid jeopardizing grant agreement provisions or compromising the project definition in the FEIS or in FEIS-associated programmatic agreements.

Important to Know

✓ Scope changes after PD should be avoided as they may trigger an environmental reevaluation and/or a grant amendment and cause project delays and cost overruns.

✓ Reduced service, delayed construction, or reductions in project scope are not acceptable contingency plans to address cost overruns.

✓ Scope changes impact cost and schedule and may compromise environmental approvals.

At the end of PD, the project scope should be more accurately determined with a value-engineered design at approximately 30% completion. After PD, changes in project definition or scope that have potential and consequential impacts on the project budget and schedule should be allowed only for compelling reasons (e.g., substantial economies achieved through additional VE, constructability reviews, or accommodation of changed conditions due to construction planning, etc.).

Firm funding commitments in grant agreements are not made until sponsors have demonstrated that the project scope, cost, benefits, and impacts are final. The grant agreement defines the project in detail (i.e., scope and description).

After a grant is signed, the sponsor is responsible for fulfilling the terms of the grant. Reduced service, delayed construction, or reductions in project scope are unacceptable contingency plans for cost overruns unless preapproved by the FTA and amended in the grant agreement.

Controlling Project Configuration

Project definition describes both physical and technical components of the project. During design and Construction, project definition confirms that the project's original concept is followed and that the completed system functions as designed. Consistency is crucial in defining and recording the physical and technical aspects throughout the project life cycle. Physical and technical component definitions are as follows:

Physical. The total system in detail sufficient to permit the preparation of preliminary design concepts. Details include location, trackage layouts, facilities, interfaces with existing systems, proposed passenger vehicle configuration, above- and below-ground segments, landscaping, crossings and overpasses, and other physical system definitions that provide awareness of the overall suggested system characteristics.

Technical. Interrelationships and functions of the system in detail sufficient to guide construction. Details include design and construction considerations and techniques, systems, connections/interfaces with existing systems and utilities, maintainability of fixed facilities, system operations and characteristics, and other data that details system operations and performance.

Important to Do

✓ Conduct VE studies and a constructability review of design packages before entry to Engineering or before 30% design.

✓ Check scope changes against the environmental document to assure compliance.

✓ Review and address impact of scope changes on cost and schedule before approval.

Project definition may evolve throughout the PD process. To arrive at a firm definition, design criteria and the desired performance characteristics of the completed project should be developed early in the project. Design and performance criteria should exist for the following elements:

- *System-wide*. Capacity, safety, security, emergency procedures, system dependability, vehicle availability, ride quality, accessibility, comfort, convenience, aesthetics, environmental, etc.
- *Subsystem*. Vehicles, control, communications, power distribution, fare collection, support equipment, etc.
- *Fixed Facilities*. Guideway; stations and station amenities; access/egress; parking; intermodal features; central control, maintenance and storage, and administration facilities; etc.

Once project definition is established during design, the definition becomes the standard for accomplishing construction. The definition also serves as a "blueprint" for describing the look of the system and its functionality. The project's physical configuration provides specification details for the project definition. The configuration baseline includes drawings, lists, calculations, specifications, and reference documents that describe the project in its entirety.

Controlling Changes to Project Configuration

There are two types of change in scope: scope creep and scope development. Scope creep involves a substantive change in scope; scope development defines the original scope in detail.

Configuration management consists of the evaluation, coordination, and approval or disapproval of changes in the configuration of a component, system, or process after its baseline has been defined. As noted above, the project is baselined at completion of PD. This allows accurate and comprehensive monitoring of any changes that follow and establishes the basis for determining the project cost estimate.

4. Schedule Management

Overview

As part of the federal grant-making process, FTA places explicit requirements on sponsor funding control for major transit projects. The requirements include preparing and submitting an IMPS to FTA in support of project funding requests. An IMPS contains a high-level summary of information from all project schedules currently developed and maintained on the program. The IMPS is comprehensive, includes activities from PD through final closeout, and is managed by the sponsor.

Important to Know

✓ An IMPS is a high-level schedule from PD through final closeout and summarizes all other project schedules on the program.

✓ FTA reviews sponsor's schedules to verify that project activities represent the complete scope and are consistent with the project definition and cost estimate.

✓ For high-risk projects, sponsors should use probabilistic risk techniques to determine time contingency as 25% of the remaining project duration or P65 level of probability, whichever is later.

Schedule management throughout a project cannot be overemphasized. Schedule development enables the sponsor and contractor to carefully consider how the project will be built, as well as problems that may arise during the project. The resulting schedule is used as a coordination tool to inform subcontractors, utilities, code enforcement officers, stakeholders, and the owner when specific scope elements are to be built.

If delays occur, the schedule can be used to determine acceleration or mitigation strategies. If delays are not mitigated, the schedule can allocate responsibility and prove entitlement to a time extension. It is in everyone's best interest to have an accurate and reliable schedule throughout the project.

Sponsors should develop a work breakdown structure (WBS) during PD to monitor and control progress and to compare performance to the baseline. The *Project Management Body of Knowledge* (*PMBOK*) defines a WBS as follows:

> "a hierarchical decomposition of the total SOW to be carried out by the project team to accomplish the project objectives and create the required deliverables. Each level down in the hierarchy represents a greater level of detail of the deliverable and work required to produce it." (*PMBOK Guide*, 7th ed., Project Management Institute [PMI], 2021).

The WBS generally subdivides the scope geographically (e.g., segments, buildings, etc.), and by trade breakdown CSI codes, work packages, contracts, etc. at the discretion of the sponsor. The WBS should be structured to facilitate reporting to FTA by associating each task, activity, or deliverable with one of the Standard Cost Categories (SCC). The WBS can be revised as scope definition evolves.

Developing the Integrated Master Project Schedule

Schedule development, updating, and analysis should be performed by qualified schedulers who have experience using the selected software on similar projects. The sponsor should develop an initial baseline IMPS during PD concurrent with the development of its project budget. Budget and schedule activities should be coded to a common WBS. Activity codes should be assigned to schedule activities to facilitate sorting and filtering the schedule.

The sponsor should use critical path method (CPM) software to develop the IMPS. The IMPS should show a rational critical path—from inception to revenue service—to manage the project. The critical path is the longest path of logically connected schedule activities that drive project completion. The IMPS critical path may cross activities on several individual contracts throughout the project duration.

Schedule activities on the critical path have total float values of zero. Total float is the difference between when an activity *can* start (early dates) and when it *should* start (late dates) to avoid overall project or milestone completion delays. A delay to a zero-float critical path activity immediately delays project completion. Activities not on the critical path have positive float equal to the number of days that can be used before the completion date is impacted. The sponsor's designation or recognition of critical project elements is important in the project control process.

In the early stages of the project, the amount of information available dictates the level of detail in the schedule. The Association for the Advancement of Cost Engineering International (AACE) *Recommended Practice 37R-06 Schedule Levels of Detail* lists five levels of schedule detail (see Table 7.1).

Table 7.1 AACE Schedule Levels of Detail

Level	Detail	Level of Detail	Developer	End Usage
1	Executive Summary	One-page bar chart with key milestones and summary activities by projects or phases	Sponsor	Provide high-level overview Go/No Go decision
2	Management Schedule	Expansion of Level 1 showing high level interfaces between scope (buildings, track, utilities)	Sponsor	Identify issues for corrective action
3	Project Coordination Schedule	Expansion of Level 2 to CSI level (concrete, steel, etc.) to show interfaces between third parties, subcontractors, deliverables	Sponsor or Contractor	Identify critical path
4	Execution Schedule	Expansion of Level 3 to show interfaces between project elements (form, rebar, place).	Contractor	Coordinate work between trades
5	Detail Schedule	Temporary schedules expanding detail (i.e., three-week look ahead)	Contractor	Plan and schedule resources

During PD, the sponsor may not have input from vendors who will perform the work. However, the sponsor is expected to develop a carefully considered Level 3 schedule that establishes key milestones and details to discern a rational critical path from planning and design through Construction, testing, and Commissioning. At the end of PD, the sponsor's IMPS is reviewed by FTA to determine whether the project can move into Engineering. The IMPS is again reviewed prior to grant execution, at which time the schedule is considered the official baseline to measure the sponsor's performance. The baseline IMPS should accurately depict a logical project implementation process requiring minimal revision as the project progresses.

The sponsor should develop and integrate its schedule activities into the IMPS when the sponsor performs work or supports contractor work with sponsor resources (force account activities).

The sponsor should consider 1) cost loading the IMPS to provide an accurate cash flow table and better estimation of vendor progress payment percent complete and 2) using earned value techniques to measure effectiveness and increase the ability to monitor the status of a contract, specifically the progression of work and corresponding expenditures. The contract completion date and cost to complete can also be monitored. Larger contracts derive greater benefits through this useful and practical process. On smaller projects, the benefit of a cost-loaded schedule should be weighed against the cost to prepare, maintain, and administer the cost loading.

Depending on the detail of the WBS, a cost breakdown structure (CBS) may be needed to support the schedule and budget earned value and cost forecasting reporting. The CBS should reflect the FTA SCC numbering scheme for federal cost reporting. The CBS is typically a more detailed WBS that contains a cost account classification to support the sponsor's financial management system, consultant and contractor progress payments, FTA recordkeeping requirements, and the means for maintaining a historical record. A combination of the WBS or CBS supports budget and schedule fund management, cash flow reporting, and commitment curve projections. Work packages should be identified using a coding system compatible with the project accounting system to facilitate establishing a computerized cost-tracking and reporting system.

Important to Do

✓ Submit an IMPS accompanied by a basis of schedule.

✓ Provide time contingency of at least 25% of the remaining contract duration when establishing a project revenue service date.

✓ Update the IMPS monthly with actual start and finish dates as the project progresses.

FTA requires that sponsors provide contingency of at least 25% of the remaining duration when establishing the project's RSD. For high-risk projects, sponsors should develop a risk register with qualitative or quantitative risk rankings established in a risk workshop with project participants. To determine if more than the 25% minimum contingency is needed, FTA recommends that sponsors use probabilistic schedule software that performs a Monte Carlo simulation to determine the 65% probability completion date (see the Risk Management section for further explanation).

Updating the IMPS

The sponsor should revise the IMPS periodically and each time a vendor submits an acceptable detailed schedule for each major project milestone (e.g., NEPA requirements, FTA reviews and anticipated actions, real estate program, permitting or other approvals by third parties, bidding and procurement, system integration, testing, and start-up) or when significant changes to sequencing (e.g., greater than one month) occur.

The sponsor should incorporate the vendor schedule—or a summary if the schedule is too detailed—to produce a true IMPS. As lower-tier activity schedules are integrated, the schedules may show where the IMPS requires changes to eliminate inconsistencies and meet external schedule requirements.

The sponsor should update monthly the IMPS with actual start and finish dates as the project progresses. The activity remaining duration or percent complete should be entered for in-progress schedule activities on the data date—the date the schedule is updated, generally the last day of the reporting period.

Sponsors should perform regular reviews of schedule progress against the baseline to identify developing trends and identify potentially significant problems so corrective action can be taken quickly. Timely alerts to work package managers should be sent when schedule changes impact other work packages. The sponsor should perform vendor project schedule reviews, provide comments, and verify comments were incorporated for each vendor schedule update.

When significant changes occur in how the project will be performed, the sponsor's vendors should revise their schedule logic accordingly. However, the sponsor should not allow vendors to revise schedule activity ID numbers as this causes difficulty when comparing schedule versions. This becomes important if a vendor submits a delay claim to the sponsor later in the project.

When major schedule changes occur, the sponsor should re-baseline its IMPS to accurately depict when scope items will be performed. Such revisions need to be clearly documented and explained to the FTA. FTA recommends that the sponsor develop and submit with its PMP a configuration management subplan that defines the process and authority to revise the baselines. Sponsors are also encouraged to establish a change control board to confirm that issued change orders have contractual merit and are priced in accordance with the contract. This process provides important checks and balances on change orders issued by a project team and helps avoid budget overruns.

Schedule Basis Report

The IMPS should be accompanied by a schedule basis report that establishes procedures for schedule control and explains the basis of activity durations, schedule logic, and assumptions. The schedule basis should address topics listed in FTA *Oversight Procedure 34 – Project Schedule Review*.

The schedule basis report should include an organization chart for the sponsor's project controls department. The sponsor should demonstrate that it has coordinated management of primary project control functions (e.g., budget/funds management, cost estimating, cost control, document, risk, and change control/configuration). The sponsor should also describe project scheduling staff interactions and integration with engineering and construction management organizations and staff. The basis of schedule should include project controls team résumés that demonstrate that the sponsor's project controls team has the experience and qualifications to manage the proposed program.

Vendor Schedules

Throughout the project life cycle, sponsors generally hire professional service consultants and contractors to perform sections of the project scope. The sponsor's contract documents should require that these vendors submit and regularly update detailed schedules for their portion of the scope. FTA provides guidelines for coordinating and monitoring contractor schedules; sponsors should incorporate these into their contract specifications.

The sponsor should summarize and integrate individual detailed contractor schedules into the IMPS after confirming each accurately represents the sponsor's plan for the project. The most common schedules used on a transit project are listed below:

1. *NEPA*. Generally prepared by environmental consultants for activities performed during early planning.
2. *ROW*. Developed by real estate professionals to address real estate acquisition of partial and full takes, easements, potential condemnation process, etc.
3. *Design*. Prepared by in-house design staff or consultants for design phase work.
4. *Preliminary Construction*. Usually developed by the sponsor's GEC, project manager, or CM consultant. May include one or more construction contract according to contract delivery methods and packaging.
5. *Vendor/Supplier*. Developed and maintained by major vendors or suppliers for rolling stock, fare collection equipment, substations, etc.
6. *Construction*. Submitted by a construction contractor in accordance with CPM schedule specification requirements. The sponsor or its representative should perform a compliance review of all contractor schedule submissions, issue comments to contractors, and ensure comments are incorporated.
7. *Commissioning*. Typically required for commissioning facility buildings, control centers, vehicle maintenance facilities, etc.
8. *Start-up and Testing*. Developed and maintained by the sponsor, system integration consultant, or contractor. Note: This schedule is required for all projects.
9. *Time Impact Analysis (TIA)*. Typically prepared by a construction contractor seeking a time extension. The sponsor or its representative should prepare an independent TIA to verify the validity of and negotiate a contractor's request for a time extension.
10. *Schedule of Record (also referred to as as-built record)*. Documents actual dates and sequence of events at the completion of a design, construction, or other vendor contract.

The sponsor should require that the software utilized by vendors in developing their CPM schedules be compatible with that of the sponsor. The sponsor should also require that contractors provide electronic copies of all schedule submittals in native format (not in PDF) to facilitate integrating contractor CPM schedule submittals and updates into the IMPS.

Receiving timely vendor initial CPM submittals and updates is important to developing and maintaining the sponsor's IMPS. Enforcement provisions within contract scheduling specifications help agencies to ensure the flow of the information necessary to keep the IMPS current and useful for managing the project.

The most common enforcement provision gives sponsors the option to withhold progress payments pending submittal of acceptable CPM schedules and updates in accordance with the contract. The information needed to evaluate vendor progress should be specified in the contract bid documents.

All activities should be updated and reported on the same date as the IMPS data date, usually the last day of the reporting period. The vendor's narrative report should discuss completed activities, revisions of the logical sequence of the activities, and the critical path of activities based on the current update. Supporting data for the updated schedule should include a listing of actual start dates for each activity in progress and actual start and completion dates for completed activities. An analysis of changes to expected completion dates should identify activities that contributed to the changed completion date and why. Supporting data should also contain all information needed to indicate the status of the project.

If critical path activities fall behind by a specified number of calendar days of meeting a milestone or the contract completion date, the contractor should submit either a TIA justifying a time extension or a recovery schedule that establishes a plan for accelerating or adjusting the schedule sequence to meet the milestone or contract completion dates.

Sponsors should consider specifying that contractors bid a time-related overhead (TRO) daily rate for use in compensating excusable, compensable delays. This avoids accounting exercises to calculate a fair rate after contract award and delays paying contractors for compensable time.

Sponsors should establish liquidated damages when critical contract milestone completion dates are not achieved. Liquidated damages—when calculated before contracting as a reasonable pre-estimation of the sponsor's expected damages—are enforceable even if actual damages were not incurred. For more information, please see the References section of these *Guidelines*.

Schedule Best Practices

The following schedule best practices are recommended:

- *Performance Measurement System*. Establishes key performance indicators (KPIs) with approval from senior management and tracks them on an accessible dashboard that automates alerts to management.
- *Variance Reporting*. Compares schedule key milestone baseline planned dates to prior-month and current-month forecast dates; reports negative variances on a dashboard monthly with an explanation of why they occurred.
- *Earned Value*. Used to calculate SPI, which, if less than 1, indicates the contractor's schedule is not progressing as planned; alerts management that corrective action is necessary. Proper use of earned value requires accurate and timely calculation of actual cost with comparison to planned values in the same time period.

Cost-Loaded CPM Schedules. Provides an accurate cash flow table and estimation of vendor progress payment percent complete; uses earned value techniques to measure effectiveness; and increases the ability to monitor the status of a contract, specifically the progression of work and corresponding expenditures. Completion dates for the contract and for the cost to complete can be monitored in the schedule. The larger the contract, the more useful the process and the greater the benefits derived. On smaller projects, the benefit of a cost-loaded schedule should be weighed against the added cost to prepare, maintain, and administer the cost loading.

- *Liquidated Damages.* Should be established for failure to achieve critical contract milestone completion dates. If calculated before contracting as a reasonable pre-estimation of the sponsor's expected damages, damages are enforceable even if actual damages were not incurred.
- *Time-Related Overhead*. Specifies that contractors bid a daily overhead rate used to compensate for excusable, compensable delays. This avoids accounting exercises to calculate a fair rate after contract award and delays paying contractors for compensable time.
- *Delay Management*. Specifies that contractors submit a prospective time impact analysis within an indicated time period after a delaying event occurs; enforces the provision in the field, works collaboratively with the contractor to allocate responsibility, and pays contractors for excusable, compensable delays in a timely manner.
- *Cost and Schedule Integration*. Depending on the detail of the WBS, a CBS may be needed to support the schedule and budget earned value and cost forecasting reporting. The CBS should reflect the FTA SCC numbering scheme for federal cost reporting purposes. The CBS is typically a more detailed WBS that contains a cost account classification necessary to support the sponsor's financial management system, consultant and contractor progress payments, FTA record-keeping requirements, and the means for maintaining a historical record. A combination of the WBS or CBS supports budget and schedule fund management, cash-flow reporting, and commitment curve projections. Work packages should be identified using a coding system compatible with the project accounting system to facilitate establishing a computerized cost-tracking and reporting system.

5. Cost Management

Overview

FTA requires that sponsors submit a cost estimate with a basis of cost report for each major milestone in the project life cycle. The report should include a description of how contingency was calculated and how contingency will be used. Contingencies should be determined by a risk analysis.

In early PD, the cost estimate can be conceptual and parametric and include contingencies that reflect scope uncertainties. The conceptual cost estimate can be used for the financial plan that sponsors submit to FTA. At the end of PD, the project scope should be accurately determined and the budget revised to match the current project description and design basis. At this time, the cost estimate should be based on quantity takeoffs from plans that are at approximately 30% design.

FTA has determined—from historic project information and an FTA risk-tolerance level at P65 for DBB project delivery—that a minimum of 33% cost contingency (the aggregate of allocated and unallocated cost contingency) is prudent at the nominal 30% design level. Recommended generalized contingency percentages for other design or construction complete levels are identified in *OP 40*.

The sponsor's project budget should be entered into the current FTA Standard Cost Categories (SCC) for Capital Projects workbook format. The SCC workbook summarizes the sponsor's project budget into a consistent format for reporting, estimating, and managing transit capital projects using federal funds.

From the outset of capital cost estimating, sponsors should prepare their estimates using the SCC format. The top-level FTA SCCs are as follows:

10 Guideway & Track Elements

20 Stations, Stops, Terminals, Intermodal

30 Support Facilities: Yards, Shops, Administration Buildings

40 Sitework & Special Conditions

50 Systems

60 Right of Way, Land, Existing Improvements

70 Vehicles

80 Professional Services

90 Unallocated Contingency

100 Finance Charges

Important to Know

✓ After a grant is signed, the sponsor is responsible for any cost increases.

✓ When applying for a grant and at each phase of the project life cycle, FTA requires that sponsors prepare the project cost estimate in the FTA SCC workbook format.

✓ The FTA website offers a Capital Cost Database with as-built project cost data for sponsor reference when preparing conceptual analogous estimates.

✓ The Government Accountability Office's Cost Estimating and Assessment Guide Best Practices for Developing and Managing Program Costs provides best practices for sponsor reference when preparing estimates.

Each cost category is further broken down. One such breakdown is shown as follows:

50 SYSTEMS

50.01 Train control and signals

50.02 Traffic signals and crossing protection

50.03 Traction power supply: substations

50.04 Traction power distribution: catenary & third rail

50.05 Communications

50.06 Fare collection system and equipment

50.07 Central Control

Terms of FTA MCP grant agreements specify that expenditures be presented in the SCC format. If the sponsor uses a cost coding system that neither tracks actual expenditures nor forecasts costs to FTA SCC codes, the sponsor is required to translate its cost code into FTA grant management system categories to meet FTA reporting requirements. These reporting and SCC format requirements should be taken into consideration when developing cost reporting schemes for the project.

The SCC workbook provides clear descriptions for each cost category entry. The sponsor should keep in mind that the budget format should directly correlate and be accurately represented in SCC format. Care should be taken to correctly enter the budget for each category since beta range factors applied in the FTA cost-risk model are used to determine the project cost contingency amount.

Because MCPs often span multiple years, allowance for inflation should be included. Inflation allowances should be defined and applied to specific cost categories (e.g., construction labor, materials, services, ROW acquisition general price inflation, etc.). The workbook requires that the sponsor enter the project budget in present-day dollars. These costs are then escalated to the year of expenditure (YOE) using the SCC Inflation worksheet tab. The workbook calculates YOE costs based on project cash flow and on sponsor-selected annual inflation forecasts.

Over time, budget estimates should be refined as more detailed engineering information becomes available. All sponsors—and MCP sponsors, in particular—should submit their project budget in SCC format at the following points in the project life cycle:

- Request to enter PD
- Request to enter Engineering
- Rating requests
- Request for FFGA or SSGA
- Submission for annual New Starts evaluation
- FFGA and SSGA amendments

- During Construction at regular intervals
- At revenue operations
- Annually, with the last update due either with the before-and-after study submission or at project closeout after claims are resolved

Cost Estimates

SCC workbook costs should be backed by a detailed quantity takeoff and unit price cost estimate. Depending on the amount of design information available, the following types of estimates are used:

- *Parametric (Statistical)*. A cost estimating methodology using statistical relationships (also known as top-down estimating); appropriate during PD.
- *Analogous (Comparison)*. An estimate of costs based on historical data of a similar (analog) item; appropriate during PD.
- *Bottom-Up Estimating (Detailed Engineering)*. An estimate using a detailed WBS, quantity takeoffs, and unit pricing for each work package; generally required during Engineering.
- *Extrapolation (Earned Value)*. Estimates that are based on actual project costs and that can be used by sponsors during Engineering and Construction to determine appropriate consultant or contractor work performance costs.

The design team should include an estimate in each design milestone package. Before the 30% design estimate is completed, sponsors should conduct a VE and constructability workshop by a team not involved with the original estimate to verify major cost drivers.

The 30% estimate should be finalized based on the results of the independent VE and constructability reviews. These reviews should be considered at major subsequent design package review milestones.

Sponsors should be mindful of SCC categories prone to cost growth (i.e., SCC 20 Stations, Stops, Terminals, Intermodal; SCC 40 Sitework & Special Conditions; and SCC 80 Professional Services). Additionally, sponsors should consider having real estate professionals estimate costs for ROWs and for real estate acquisition programs. Staffing plans should be used for SCC 80 rather than percentages of costs for items such as project and construction management.

FTA recommends that the sponsor consider the following sources when preparing estimates:

- U.S. Government Accountability Office *Cost Estimating and Assessment Guide. Best Practices for Developing and Managing Program Costs* (GAO-20-195G, 2020) establishes a consistent 12-step methodology used across the federal government for developing, managing, and evaluating program cost estimates. The guide presents best practices associated with developing a reliable, high-quality cost estimate and best practices associated with effective management of program costs using earned value management (EVM).

- Sponsors should consider the FTA Capital Cost Database when preparing conceptual, rough project estimates when adequate design information is unavailable. This database contains historical as-built costs for numerous federally funded transit projects. Sponsors should compare the historical cost data in this database to the sponsor's more detailed cost estimate and reconcile differences by considering the unique characteristics of each project.
- Construction cost indices to consider for inflation and escalation adjustments:
    - *RSMeans Construction Cost Indexes*
    - *Engineering News-Record* Construction Cost Index
    - U.S. Bureau of Economic Analysis Producer Price Index for Transportation, State, and Local Index (line 38)
    - Dodge Reports
- Local cost data published by state agencies and association publications.

Contingencies

Project budgets submitted to FTA should provide contingencies against the risk of cost increases caused by unanticipated inflation, changed site conditions, design revision, and estimating uncertainties during PD. In the SCC workbook, each base-year line-item cost is marked with an allocated contingency in a separate column. SCC 90 is used to capture unallocated contingency, which should be maintained at the project level.

FTA refers to allocated and unallocated contingency together as "total contingency" in MCPs. Additionally, though contingencies are driven by risk assessment, rules of thumb exist for establishing contingencies. Unallocated contingency should address and overcome increases in costs due to potential risks (uncertainties) and for which no mitigation measure is available. These contingencies should be identified separately in the project's financial plan and included in the capital cost estimates. As a project moves through Engineering and design processes, cost increases due to the refinement of design are less likely. Consequently, the contingency should be reduced. Table 7.2 shows FTA recommended contingencies at nominal project design or construction completion levels for DBB projects (see *OP 40*, Appendix M).

Table 7.2 FTA Recommended Contingencies for DBB CIG Projects

Phase	% Complete	Recommended Contingency
PD	At nominal 15% design At nominal 30% design	40% 33%
Engineering	At nominal 60% design At nominal 95% design At nominal 100% design (post bid, Construction start)	26% 20% 13%
Construction	At nominal 20% Construction complete At nominal 50% Construction complete	9% 7%
RSD	At RSD	1%

Ranges shown in Table 7.2 are generalized contingency levels that should be used as a point of reference. Sponsors should use risk-based techniques to calculate project contingency specific to the risks associated with each project's unique conditions and per FTA guidelines stated earlier in this section. Please refer to AACE International *98R-18 Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Road and Rail Transportation Infrastructure Industries* for additional reference.

When alternate delivery methods are used, some portion of sponsor risk associated with design and Procurement 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 Table 7.2. A breakdown of these risk elements and an analysis of the actual design, bid, or construction progression are necessary to determine the amount of risk transferred and the resulting contingency percentage.

As a subplan of the PMP, the sponsor submits a project-specific RCMP that describes processes for risk management and mitigation. At a minimum, the RCMP should include a risk register, risk assessments, established contingency levels, and the sponsor's policies for contingency management. The contingency management section should include drawdown curves that define minimum levels of cost or schedule contingency to be preserved as a function of project advancement. The RCMP should also describe the system for determining and distributing the contingency funds. Strict controls should be established over the disposition of funds from these accounts. Budget transfers should be documented. If a line item is projected to underrun its budget, funds should be moved into the contingency account first even if the funds are reallocated to another line item later.

Important to Do

✓ Perform VE and constructability reviews before completion of 30% design and cost estimate.

✓ Add appropriate cost contingency to all estimates following federal guidelines.

✓ Establish a hierarchical WBS that subdivides the scope into increasing levels of detail and incorporates FTA SCC.

✓ Use staffing plans to estimate SCC 80 professional services bottom up rather than relying on percentages.

When the project budget is revised, the financial plan should be updated. Sponsors are subject to financial spot reviews by FTA and its PMOCs to confirm that the sponsor has the financial capacity to complete the project according to the terms of the FFGA, as well as to operate and maintain the existing transit system and service levels.

If allocated and unallocated contingency funds are insufficient—typically through FTA's risk process or due to higher-than-expected bids—the sponsor is responsible for securing additional funding. Reduced service, delayed construction, or reductions in project scope are not acceptable contingency plans unless they are preapproved by the FTA and the terms of the FFGA are amended.

The scope section of these *Guidelines* discusses the difference between scope definition and scope change. Since scope changes can trigger environmental reassessments and/or grant amendments that could delay the project or change the federal grant amount, scope changes should be discussed with FTA as soon as they are under consideration.

Force Account

Sponsors should prepare a detailed estimate for the cost of in-house forces to support the capital project work of private contractors. FTA *Circular 5010 Award Management Requirements* classifies this as "force account" work, which is eligible for federal funding if properly documented and warranted in terms of:

- cost savings;
- exclusive expertise;
- safety and efficiency of operations; or
- union agreement.

Sponsors may be required to submit a justification to undertake force account work or a force account plan, depending on the amount of force account work per FTA *Circular 5010.1E* (Rev. 2, 2018). The sponsor should monitor the costs and provide the necessary focus for coordinating force account and contractual work.

Controlling Costs

After a grant is signed, the sponsor is responsible for cost increases and for fulfilling the terms of the grant. Cost estimator participation throughout the life of the project is prudent. A system should be established for measuring earned values, forecasting variances, developing recovery plans, and assuring funding cash flows are adequate.

EVM techniques are effective at forecasting the expected final cost based on a contractor's historical EVM performance. EVM measures the value of work accomplished in a given period and compares it with the planned value of work scheduled for that period and with the actual cost of work accomplished. GAO recommends comparing estimates at completion (EAC) from EVM to the EAC forecast from a probabilistic risk analysis.

Authorization levels should be established and documented for capital expenditures, issuance of work orders, and additional work orders. Procedures should be established to verify merit and requested payment amounts; process partial payments, if necessary; and make final payments.

Work Breakdown Structure

The sponsor should establish a hierarchical WBS that subdivides the scope with each descending level of the WBS representing an increasingly detailed definition of the scope. The planned work contained within the lowest-level WBS components (work packages) should be scheduled, cost estimated, monitored, and controlled.

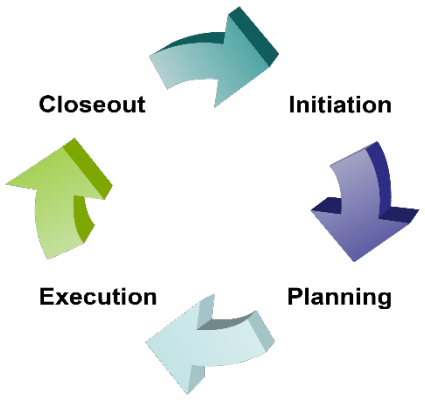
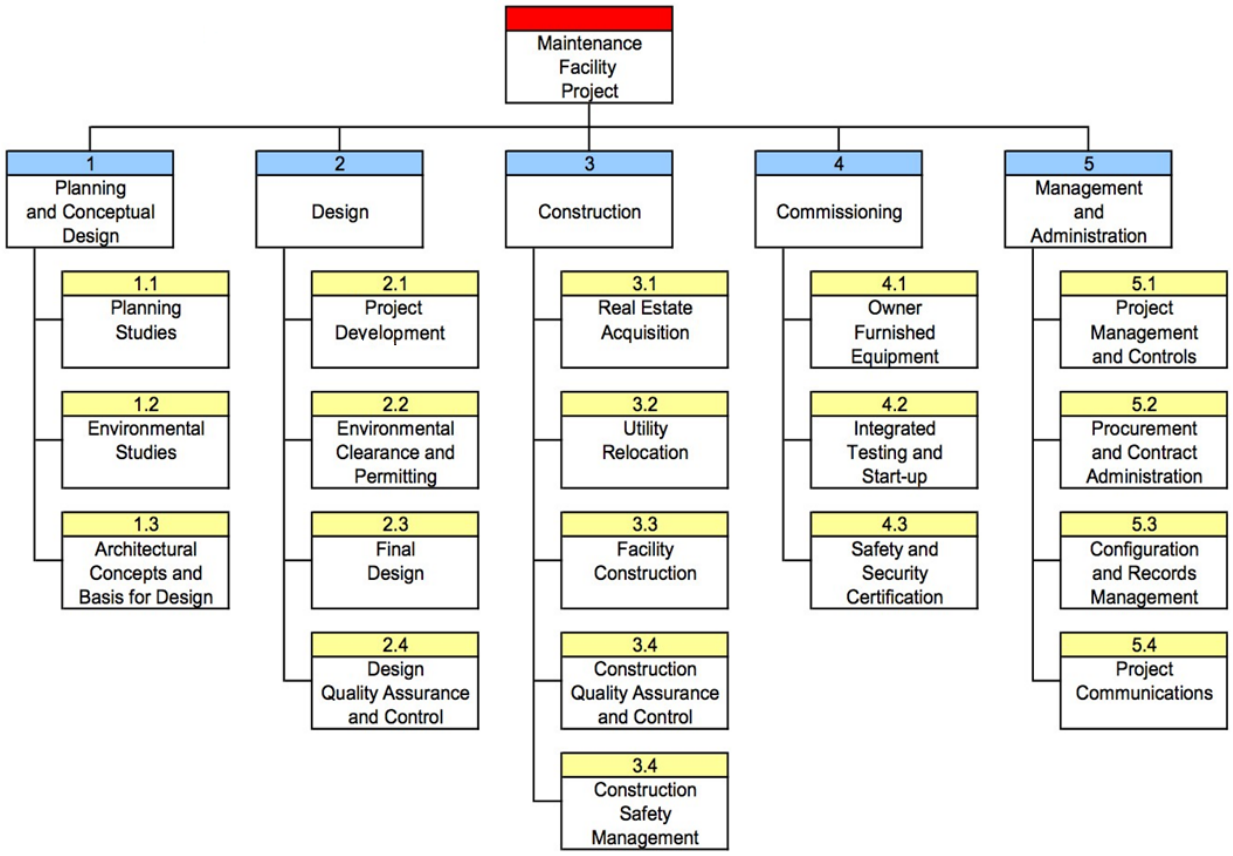


Figure 7.2 Project Life Cycle

The WBS should include all project management life-cycle periods, from project initiation to project closeout. Likewise, the WBS should tie back tasks to an organizational breakdown structure (OBS) for work required of all parties in the program. A chart of accounts should be established using WBS and OBS information. Parties include the owner; supporting federal, state, and local agencies; and consultants, contractors, and vendors. All FTA requirements, guidelines, and deliverables should be clearly established in the WBS, especially permits, environmental documents, deliverables, and critical items that require third-party review and approval. Figure 7.3 demonstrates a WBS example.



In a complete WBS the above work elements would be broken down into more detailed work packages. For example: WBS 1.1 Planning Studies could be broken down further into 1.1.1 Functional Studies, 1.1.2 Site Selection, and 1.1.3 Technical Studies; and WBS 2.3 Final Design broken down further by design package into 2.3.1 Utility Relocations, 2.3.2 Facility Structure, and 2.3.3 Major Equipment Procurement and Installation.

Figure 7.3 WBS Sample

6. Financial Management

Overview

Capital costs for transit projects are generally funded by a combination of FTA and matching funds provided by state and local governments. Operating costs have traditionally been funded by farebox revenues with other major support from federal, state, and local government taxes or dedicated revenue sources. A viable project should have a realistic scope, cost estimate, and schedule. The sponsor should have a credible financial plan for financing capital and O&M costs.

7. Regulatory Compliance

The sponsor responsible for a transit capital project possesses the legal authority to carry out the requirements necessary to effectively plan and implement the project. Statutory authority may be required to perform the following functions:

- Planning, design, construction, ownership, operation, and maintenance of public transit facilities, equipment, and rolling stock.
- Local financing, including use of public funds; taxation; and issuing bonds.
- Receipt of federal and state grants.
- Procuring and awarding contracts.
- Real estate acquisition and condemnation.
- Construction in a public ROW, including relocating utilities.
- Project SSC, including a hazard analysis.

Important to Know

✓ The sponsor responsible for a transit capital project possesses the legal authority to carry out all requirements necessary to effectively plan and implement the project.

✓ The sponsor and its representatives are expected to have a full understanding of the federal legislation, codification, regulation, and guidance that govern projects using federal funding.

The sponsor should review relevant statutes to increase its understanding of its authority and legal constraints that may affect the project. The sponsor's review should also identify requirements and constraints and address them in an orderly and timely manner as the project advances. This is especially critical for projects built in a public ROW or in a ROW belonging to railroads or state highway agencies.

Failure to recognize and accommodate legal requirements may jeopardize the project or severely affect the subsequent grant approval process, project schedule, and project costs. The sponsor should be cognizant of changes in the legislative/regulatory environment that may impose future constraints on a project. The ability to anticipate and deal with those potential issues in PD and Engineering may save considerable time and effort during Construction.

Important to Do

✓ Review relevant statutes to increase understanding of legal constraints that may affect the project.

✓ Meet with permitting agencies early in design to determine their design review and approval requirements.

✓ Determine that the selected procurement method is compliant with local, state, and federal regulations.

✓ Include applicable requirements in the invitation to bid documents.

The sponsor should comply with state and local requirements, specific federal statutes, rules, regulations, and circulars listings. The sponsor and its representatives are expected to have a full understanding of the federal legislation, codification, regulation, and guidance that govern projects using federal funding. Following is a partial list of compliance references:

- Americans with Disabilities Act, as amended (42 U.S. Code 12101 et seq.)
- Brooks Act qualifications-based procurement method (40 U.S. Code Chapter 11)
- Buy America (49 CFR, Parts 661 and 663)
- Build America, Buy America (BABA, Act 41 U.S. Code § 8301)
- Davis-Bacon Act, wage rates, and labor provisions (40 U.S. Code § 3141 et seq.)
- Disadvantaged Business Enterprise, DBE (49 CFR, Part 26)
- Equal Employment Opportunity (EEO), EEO (49 U.S. Code § 5332b)
- Land Acquisition and Relocation (49 CFR, Part 24)
- National Environmental Policy Act, NEPA (42 U.S. Code 4321 et seq.)
- National Historic Preservation Act (NHPA) of 1966 (16 U.S. Code 470)
- Occupational Safety and Health Regulations (29 U.S. Code Chapter 15)
- Rail Safety Improvement Act of 2008 (49 U.S. Code § 20101)
- *Safety and Security Management Guidance for Major Capital Projects* (FTA *Circular 5800.1*)
- State Safety Oversight Rule (49 CFR, Part 674)
- PTASP (49 CFR, Part 673)

8. Risk Management

FTA requires that sponsors implement a risk management program to evaluate project scope, cost estimates, and project schedules at various stages of the project life cycle to improve project delivery reliability. FTA places special focus on managing uncertainty, risks, contingencies, and associated risk treatment and response efforts. Sponsors should assign a qualified risk manager to establish a risk management program for their transit capital projects and major transit projects.

The risk management program should provide a multidisciplinary overview of the project and its elements and determine how risks affect the organizational, technical, legal, political, social, and financial aspects of the project from beginning to end in accordance with FTA *Oversight Procedure 40 – Risk and Contingency Review*.

Risk and contingency review assessments quantify uncertainties, systemic and project-specific risks, and escalation. These reviews forecast project costs and schedules and compare forecasted variability with the project baseline. Reviews apply to projects using all project delivery methods. Sponsors should perform risk and contingency reviews following these sequential steps:

1. Establish a project baseline that is stripped of cost and schedule contingency.
2. Hold a risk identification review.
3. Perform a schedule risk analysis.
4. Perform a cost risk analysis.
5. Hold a risk treatment and response review; include ex-ante and ex-post actions to address risks.

FTA works closely with the sponsor during the FTA risk review to facilitate the process and to encourage sponsor acceptance and support of the assessment and its outcome. FTA provides the sponsor with the background necessary to incorporate risk review recommendations into its PMP and RCMP.

The type of FTA CIG determines the timing for the risk review process. At a minimum, sponsors should perform risk and contingency reviews prior to entering Engineering and to receiving a grant award (see Figure 7.4, from FTA *Oversight Procedure 40 – Risk and Contingency Overview*, Appendix B). FTA may require additional risk and contingency reviews.

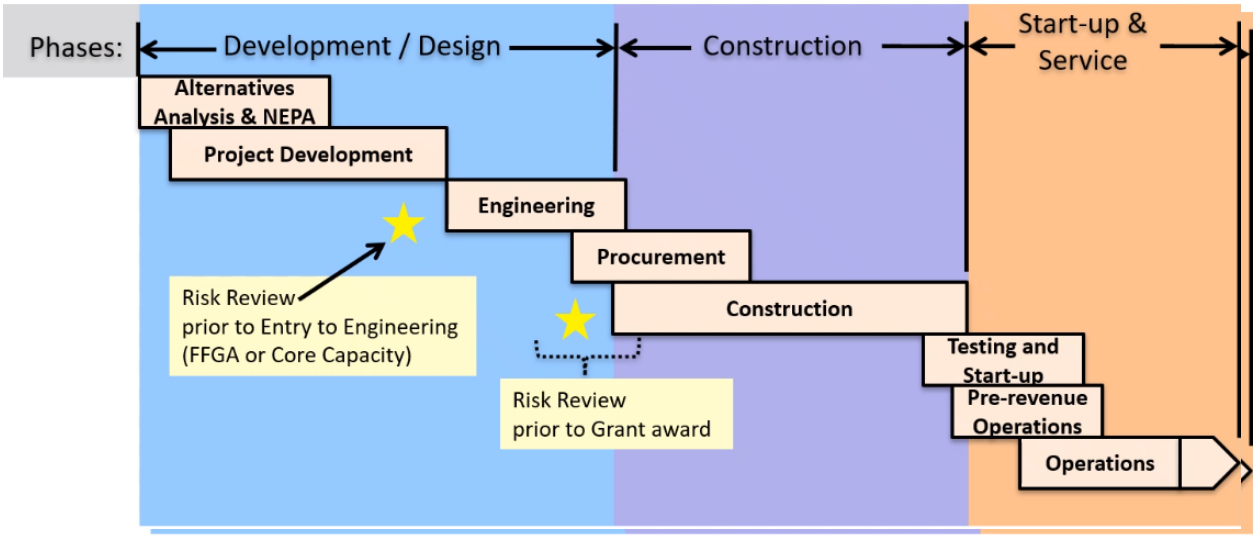


Figure 7.4 Risk Review in the Project Life Cycle

Core documents used in an effective risk and contingency review include the following:

- PMP and project delivery plan
- Design documents (plans and specifications)
- Approval letter, Letter of No Prejudice (LONP), or Early Systems Work Agreement (ESWA) issued by FTA
- RCMP and risk register
- Basis of estimate and basis of schedule
- Project capital cost estimate and project schedule
- Permit status
- VE report
- Escalation studies
- Transit capacity and operating plan, ROW plan (RAMP), and contracting plan
- Documentation of changes to scope that occurred since the last milestone
- Third-party agreements and their statuses

Establish a Project Baseline

FTA assesses the sponsor's core documents to set the project baseline following the guidelines provided for scope, cost, and schedule reviews noted above; and the applicable FTA oversight procedures (e.g., *OP 32c* for scope, *OP 33* for cost, and *OP 34* for schedule; see Figure 7.5 from *OP 40 Risk and Contingency Overview*, Appendix B). This assessment may include recommending adjustments to the SOW, cost estimate, and project schedule.

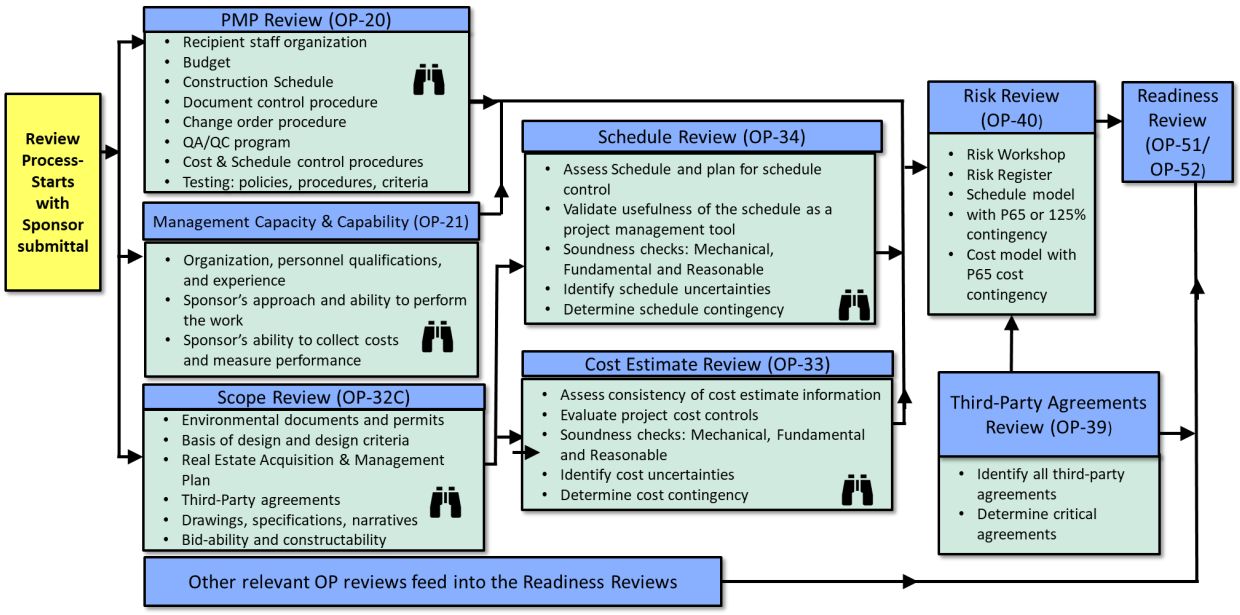


Figure 7.5 Risk Review Process

Establishing the project baseline produces two work products as follows:

1. *Stripped and Adjusted Base Cost Estimate (SABCE)*. The SABCE results by stripping all sponsor contingency funds included from the base-year cost estimate and adjusting the SCC cost elements as needed. The base-year stripped and adjusted cost estimate is then inflated to the YOE.
2. *Stripped and Adjusted Base Schedule (SABS)*. The SABS results by stripping all sponsor-allocated schedule contingency and adjusting activity durations, logic, and sequence of work.

Risk Identification

The FTA definition of risk identification includes examining the elements of project definition and project processes to uncover risks, uncertainties, and their root causes. Risks and uncertainties may prevent the project from being delivered within the constraints of the intended scope, cost, and schedule given the sponsor's management capability and capacity.

The sponsor should identify the following types of risks:

- *Systemic*. An artifact of the sponsor's organization, culture, strategy, complexity, technology, or similar overarching characteristics. Systemic risks have 100% probability of occurring and are typically found in the issues log.
- *Project-specific*. Related to positive and negative events (i.e., threats and opportunities); actions; and other conditions specific to the scope of a project (e.g., site and environmental conditions, vehicle delivery, etc.). Project-specific risks have less than 100% probability of occurring.
- *Uncertainty*. Represents background variability distinct from the variation caused by systemic and project-specific risks. Uncertainty is caused by inherent variability of the work not caused by identified risks, estimating error or error of prediction, and bias in estimation or prediction.
- *Escalation*. A provision in costs or prices for uncertain changes in technical and economic circumstances and in market conditions over time. One component of escalation is inflation.

The four categories FTA uses to assess risks for CIG projects, depending on the project phase, are requirements, design, market, and construction. A requirements risk pertains to uncertainties surrounding identifying and fulfilling environmental needs and goals. It is typically associated with the earliest stages of the project and may not be fully resolved even after completion of the environmental assessment process. Design risk is linked to changes in design-related assumptions that may occur due to unforeseen circumstances.

Market risk refers to challenges associated with procuring project management, materials, and services within the established timeline and budget. It can be influenced by factors such as supply and demand, inflation, contractor perceptions, and pricing strategies. Finally, construction risk includes a range of risks that may arise due to unpredictable environmental conditions, unexpected construction contractor failure, or the need for operational workarounds.

Sponsors should hold a formal risk workshop and provide final results three to six months before the PMOCs hold their *OP 40* risk review workshops. While FTA/PMOCs hold risk and contingency review workshops prior to entering Engineering and prior to receiving a grant award, these workshops can occur at other times in the project life cycle. Sponsors should employ various risk elicitation techniques for risk identification (e.g., risk questionnaires, interviews, brainstorming, checklists, etc.). Using a combination of these techniques is beneficial as it allows collecting risks based on historical data and subject matter expert input; this process also promotes collecting risk input from all participants.

Sponsors should use a risk register to capture and document risk characteristics, including their probability of occurrence and potential impacts, proximity date, SCCs, risk ratings, potential treatment actions, risk owner, and risk status.

As sponsors identify risks and collect potential cost, schedule, quality, and benefit impacts, they should consider whether inherent biases exist in stakeholder or team member responses that could affect probability and impact values. Several techniques can be used to identify and reduce bias in responses provided by subject matter experts. These techniques include structured elicitation and calibration assessments and are part of the Association for the Advancement of Cost Engineering International (AACE) recommended practices.

Schedule Risk Analysis

Schedule risk involves events that can cause potential delays to the project's critical path or that may reduce schedule float, require use of schedule contingency, and threaten the achievement of key interim and completion milestones. Schedule risk may create time-related cost impacts that have to be accounted for by sponsors. FTA works with the sponsor to develop a schedule risk model for calculating project schedule risk. This model facilitates the risk analysis process and helps communicate the effect of project risk to the project team and to other stakeholders.

The schedule risk model is based on the stripped and adjusted base schedule. It should be a logically correct, CPM schedule that adequately reflects the relationships among its activities to reproduce the effect of risk impacts on any activity or group of activities. The number of activities modeled should be commensurate with an adequate expression of risk and level of detail available in the sponsor's schedule at the time of the risk and contingency review.

Sponsors should use scheduling risk software that can perform critical path scheduling and stochastic modeling for probabilistically described activity durations (often referred to as Monte Carlo simulations). The scheduling risk software should also be capable of capturing and reporting assessments for uncertainty and for project-specific and systemic risks. The analysis provides a histogram of potential completion dates, along with the percentage likelihoods (i.e., confidence levels) of those completion dates (see Figure 7.6). FTA compares dates at P40, P50, P65, and P80 confidence levels against targeted completion dates for the project; FTA also provides comments and recommendations from this comparison.

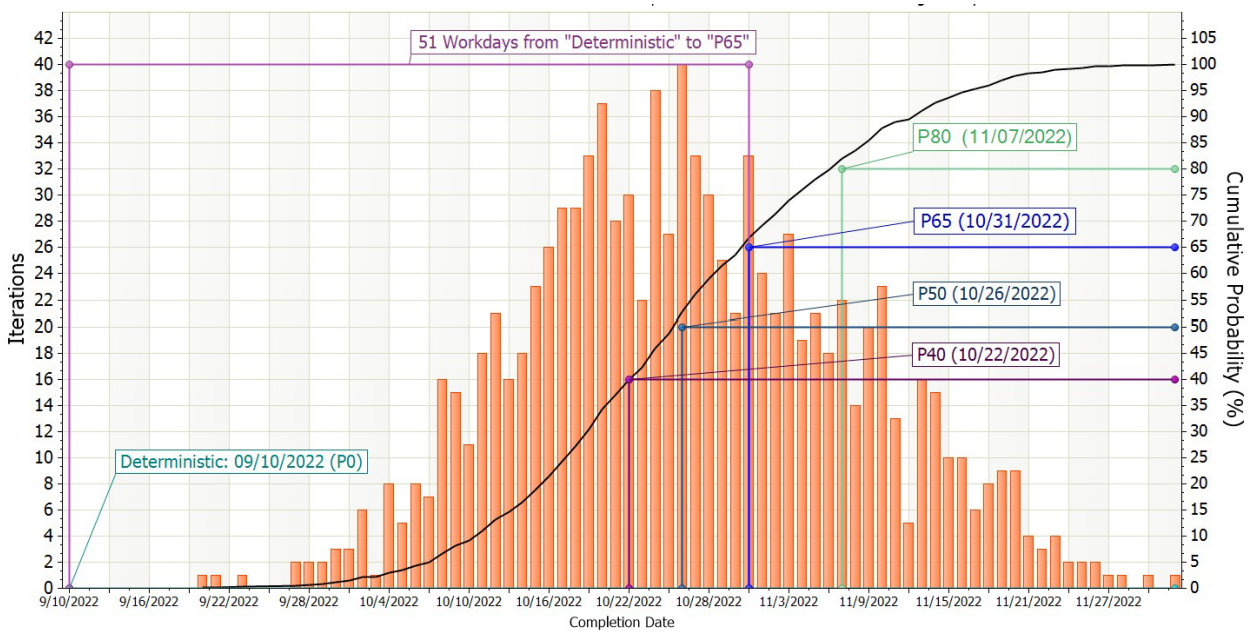


Figure 7.6 Sample Probability Distribution of Completion Date

Sponsors should add a schedule contingency activity to the stripped and adjusted base schedule. FTA guidance recommends a risk-adjusted schedule of 125% of the stripped and adjusted base schedule remaining duration of the critical path (i.e., a schedule contingency of at least 25% of the SABS remaining duration). This 125% value is derived from historical data and applies at any time in the project life cycle.

FTA recommends a schedule contingency resulting from the larger between the 125% of the SABS or the P65 duration from the histogram. Figure 7.7 demonstrates a comparison between the SABS, the sponsor's risk simulation results, the PMOC's risk simulation results, and the FTA's 25% contingency.

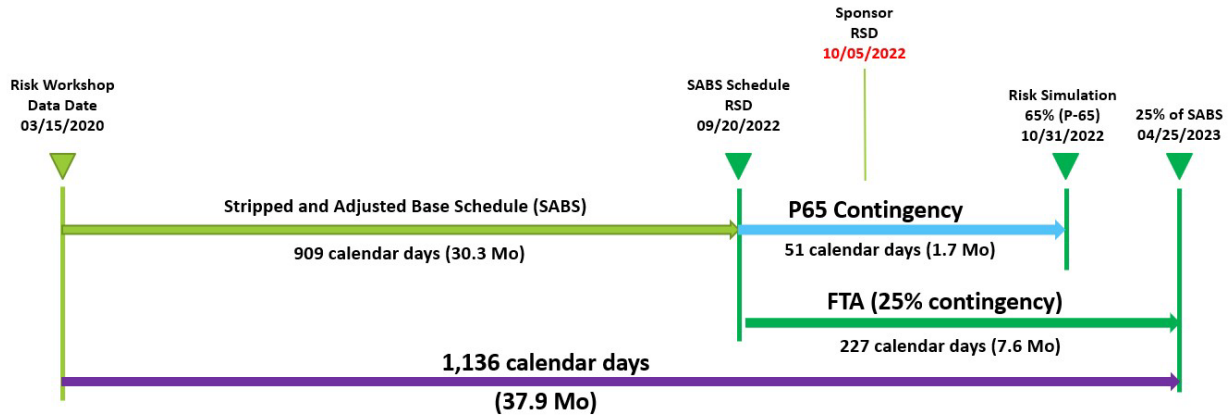


Figure 7.7 Sample Comparison of Schedule Risk Analysis Results

Cost Risk Analysis

Cost risk refers to potential cost overruns and their corresponding effects on project delivery as scoped and approved within an established budget and schedule. Uncertainty, escalation, and risks concerning the potential for cost overruns arise from the underlying technical uncertainty of achieving project objectives or from requirements, design, market, and construction risks. Uncertainty is also associated with the ability of sponsors in demonstrating MCC to mitigate technical and management risks within an acceptable range.

A cost risk analysis is based on risk adjustments made to the SCC cost elements of the SABCE. These adjustments recognize general uncertainty in the form of beta range factors. Beta range factors are the sum of risk category factors for requirement, design, market, and construction risks and factors derived from project-specific risks. FTA developed a top-down risk parametric model using beta range factors and based on historical data of FTA-funded projects. The cost risk quantification is modeled using an Excel-based FTA *Cost-Risk Model Workbook*. FTA uses these risk range calculations to establish a baseline and adjusts the beta range factors to reflect actual project conditions demonstrated in the project risk register.

Project delivery methods—whether traditional (e.g., DBB) or an alternate (e.g., DB, P3)—can affect the timing and scope of risk sharing but not necessarily the magnitude of risk nor the sequence of risk mitigation. Regardless of the delivery method, existing risks will affect project cost and schedule. Sponsors should consider the extent and effectiveness of risk transfer and risk sharing inherent in alternative project delivery methods when developing recommendations for risk assignment.

When using the Excel-based FTA *Cost-Risk Model Workbook*, sponsors may need to perform base-year adjustments as a result of schedule risk analysis findings. These adjustments may include an extension of time-related (e.g., construction overhead) and project management costs.

The workbook contains tables showing confidence levels and cost probability charts that list a sponsor's estimated project costs, adjusted YOE cost estimates, and assessment data. The risk assessment workbook also includes the variability determined in the risk assessment and its overall effect on the budget.

FTA analyzes and comments on sponsor cost contingencies to confirm the minimum amounts of contingency to be included in the sponsor's supporting documents, RCMP, and PMP. The current policy requires sponsors to provide cash funding at the 65th percentile (i.e., P65), as per the FTA cost risk model. FTA advises on cost adjustments that align with the SABCE and recommends a cost contingency that equals the difference between the modeled P65 cost and the SABCE. Figure 7.8 depicts a probability distribution comparison of the sponsor's risked cost estimate and the FTA's risked cost estimate.

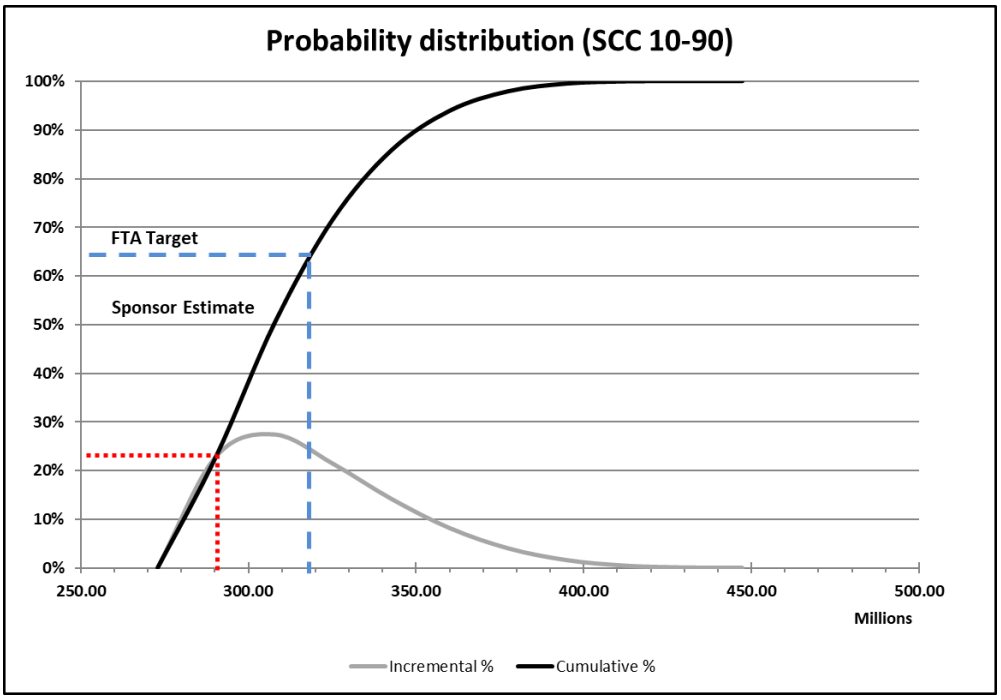


Figure 7.8 Sample Probability Distribution of Completion Cost

Risk Treatment and Response Review

FTA identifies risk treatment and response recommendations that sponsors may adopt to supplement their treatment and response efforts in their RCMP. Seen as a highly effective practice, FTA categorizes risk mitigations by SCC, risk category, and treatment type. FTA organizes risk treatment and response actions by treatment structure (i.e., primary treatment, secondary treatment, and contingencies).

Primary treatment activities are scheduled at the earliest time during which the treatment activity may occur (e.g., requirements, design, Procurement, or Construction). These activities are expected to be completed on a timely basis to achieve cost-risk and schedule-risk parameter targets at the end of that major milestone.

Secondary treatment activities consist of preplanned, potential scope, or process changes that may be triggered when risk events occur that require a reduction of contingencies below minimum levels. Secondary risk treatment is fundamentally different than VE as VE is a formal, systematic, multidisciplined process designed to optimize the value of each dollar spent.

Contingencies are estimated amounts added to cost estimates and schedules to account for uncertain conditions and events and that potentially result in additional cost and time for a project. Contingency amounts may be associated with a particular activity or cost category (e.g., allocated contingency) or may be set aside in a general fund (e.g., unallocated contingency). The contingency amount assigned for a project decreases as the project progresses over time.

9. Quality Management

Quality management should be involved in all stages of a project. Quality management is an integral component of the transit agency's management organization, independent of project management. Quality does not start or stop with the projects themselves. Individual elements and subcomponents of a quality management system are introduced into projects at different stages (see Figure 7.9).

Figure 7.9 Quality and Project Life Cycle Integration

When planning or implementing projects with FTA grants, FTA requires that sponsors undertaking an MCP prepare a PMP that includes a quality plan. The sponsor should develop a quality plan that complies with FTA *Quality Management System Guidelines* during PD (see these guidelines for a comprehensive review of quality management principles); the plan should be updated in Engineering and for subsequent major milestones. FTA *Oversight Procedure 24 – Quality Assurance/Quality Control Review* provides additional guidance for developing quality plans. Both FTA quality documents are based on the *ISO 9001:2015* quality standard.

Important to Know

✓ FTA requires that sponsors prepare a PMP that includes a quality plan.

✓ FTA *Quality Management Systems Guidelines, FTA OP24 - Quality Control/Quality Assurance Review, and ISO 9001:2015* provide guidance on developing a quality plan.

Table 7.3 from the FTA *Quality Management System Guidelines* introduces terms used in the quality field.

Table 7.3 FTA Quality Terminology

Quality Policy	The overall quality intentions and direction of an organization with regard to quality are determined by top management. The *ISO 9001:2015* quality standard specifies that a quality policy be appropriate for the purpose of the organization, provide a framework for establishing quality objectives, and be communicated and understood within the organization.
Quality Objectives	Objectives or goals related to quality. *ISO 9001:2015* specifies that objectives should be measurable and consistent with the quality policy.
Quality Management System (QMS)	The American Society for Quality (ASQ) defines a QMS as, "A formalized system that documents the structure, responsibilities and procedures required to achieve effective quality management."
Quality Management	ASQ defines quality management as, "The application of a quality management system in managing a process to achieve maximum customer satisfaction at the lowest overall cost to the organization while continuing to improve the process."
Quality Procedures	Written instructions for implementing various components of the QMS. Procedures should identify what is to be done; who should do it; and how, where, and when it should be done.
Quality Plan	The typical form of the main document used in developing and implementing a QMS. The Quality Plan should contain the Quality Policy, objectives, and written procedures. In larger properties, there can be more than one Quality Plan. For example, there could be a corporate quality plan, divisional quality plans, and specialized quality plans for design, procurement, construction, operations, and maintenance activities, with each prepared by those responsible for the work.
Quality Program	The coordinated execution of applicable quality plans and activities for a project.
Quality Control	Techniques that are used to assure that a product or service meets requirements and that the work meets the product or service goals. Generally, QC refers to the act of taking measurements, testing, and inspecting a process or product to assure that it meets specification. It also

	includes actions by those performing the work to control the quality of the work. Products may be design drawings/calculations or specifications, manufactured equipment, or constructed items. QC also refers to the process of witnessing or attesting to and documenting such actions.
Quality Assurance	QA involves all those planned and systematic actions necessary to provide adequate confidence to the management that a product or service will satisfy given requirements for quality. It emphasizes planned and systematic actions and are necessary to provide adequate confidence that preventive/continual improvement actions at a management level will result in a product or service that meets requirements. QA includes ensuring the project requirements are developed to meet the needs of all relevant internal and external agencies, planning the processes needed to assure quality of the project, ensuring that equipment and staffing is capable of performing tasks related to project quality, ensuring that contractors are capable of meeting and carrying out quality requirements, and documenting the quality efforts.
Quality Oversight	Oversight can be defined as watchful care or general supervision. Quality oversight can range from an informal process of keeping in touch with the QA organization to a second layer of QA activities, depending upon the circumstances. Quality oversight verifies the execution of the Quality Program.
Quality Audit	A documented activity performed in accordance with written procedures or checklists to verify, by examination and evaluation of objective evidence, that applicable elements of the QMS have been developed, documented, and effectively implemented in accordance with specified requirements. An audit should not be confused with an inspection or QC check. It is a primarily QA activity that involves some QC.

Quality and safety are at the core of any project activity during the project life cycle, including in PD and planning. Quality does not start or stop before and after design and Construction; it is a continuous process.

The FTA *Quality Management System Guidelines* identify and describe 15 elements that should be considered when developing a QMP. They are as follows:

1. Management responsibility
2. Documented quality management system
3. Design control
4. Document control
5. Purchasing
6. Product identification and traceability
7. Process control

8. Inspection and testing
9. Inspection, measuring, and test equipment
10. Inspection and test status
11. Nonconformances
12. Corrective action
13. Quality records
14. Quality audits
15. Training

The sponsor should designate a quality manager to lead the development, implementation, and monitoring of the quality plan. The quality manager should report to the sponsor at or above the level of the project manager to provide checks and balances in meeting cost and schedule objectives while ensuring that work products satisfy quality objectives. The quality manager should preferably be certified by a nationally recognized quality professional organization and be supported by adequate staffing to meet project needs.

The quality manager reviews and approves QMPs submitted by the consultants and contractors. and leads the audit of quality activities. Outside consultants may be engaged to assist with developing and implementing the quality plan. Independent auditors will also need to be engaged if the quality plan will be certified to international standards (e.g., ISO 9001). The sponsor should perform periodic audits of QMPs and seek timely closure of observations and nonconformances identified during audits.

QC procedures should include formal documentation of nonconformances with quality objectives or requirements. Nonconformance reports should be resolved expeditiously. Recurrent nonconformances may require a root-cause analysis to identify lessons learned, make recommendations for improvements, and communicate best practices to all parties to reduce recurrent quality issues.

Important to Do

✓ Develop a quality plan in association with the PMP in the early stages of PD.

✓ Assign a quality manager who reports to senior management; the quality manager is responsible for developing and managing the quality plan.

✓ Create a quality culture in the organization through leadership, training, and communication.

Quality management is facilitated by implementing a robust and user-friendly PMIS to retain quality records, manage workflows, and hold responsible parties accountable for quality.

Effective quality management requires engaging internal staff at all levels, as well as consultants and contractors. Consultants, contractors, and their subconsultants and subcontractors should assign their own quality managers to develop quality plans in accordance with the sponsor's quality plan. Before work is submitted by consultants and contractors for review, the work should be subjected to a quality review process as defined by the governing QMP. The sponsor's quality management processes are intended to provide oversight and should not replace the QA and QC required by the entities performing the work.

Continuous improvement is fundamental to quality management. Continuous improvement is achieved through formal staff and leadership training and through proactive management of quality processes.

10. Safety and Security Management

The SSMP—required by FTA *Circular 5800.1 Safety and Security Management Guidance for Major Capital Projects*—is the roadmap for managing all aspects of safety and security. This plan is part of a project's PMP and should be updated for each major milestone of the project.

Important to Know

- ✓ FTA requires an SSMP for MCPs.
- ✓ SSMPs are prepared in PD and updated for each subsequent major project milestone.
- ✓ SSRC focus is internal with no regular outside participation.
- ✓ FLSSC focus is external and includes key outside stakeholders.

The circular provides detailed instructions for developing and maintaining the project's SSMP. Chapter I, Section 5 provides definitions of terms, committees, and documents. Chapter II outlines required safety and security management activities and explains FTA evaluation criteria. This chapter also reviews the requirements for establishing and managing an SSI policy (see *Guidelines* Chapter 3).

Circular Chapters III and IV are crucial to creating an SSMP that meets FTA criteria. Chapter III explains the process for preparing each of the SSMP's 11 sections and subsections. Chapter IV describes items that should be included in the 11 sections. An appendix contains an SSMP checklist used to approve the document. The SSMP may be reviewed by FTA, its PMOC, or by the project's SSOA (see 49 CFR, Part 674 State Safety Oversight for a description of the SSOA's role). The SSOA and FTA approve and audit many of the project's safety and security documents, policies, and procedures. The SSOA should also be invited to participate in briefings and meetings at the earliest stages of a project.

The sponsor should assign qualified safety and security professionals with experience on FTA-funded projects to prepare the SSMP. The sponsor is encouraged to avoid common errors and inconsistencies such as the following:

- The SSMP does not include a policy statement signed by the project's executive officer endorsing a sponsor's commitment to safety and security. While this statement fulfills the requirements of Section 1, subsection 1, *Safety and Security Policy Statement*, the statement will not be approved if it is unsigned. This policy statement is generally placed at the beginning of the document immediately after the table of contents.
- The SSMP chapter order does not conform to the order presented in *Circular 5800.1*; not all 11 sections are discussed. The order of the SSMP chapters should conform to the circular. Any section not applicable to a project should be included with the notation "Not Applicable." This commonly applies to Section 10 documenting coordination with the FRA.
- Although a PHA (or an HA) need not be labeled as SSI, a sponsor may decide to label it SSI if safety analysis closely aligns with security considerations. While not mandated by *Circular 5800.1*, a sponsor should confirm that for any completed analysis, sections marked "Prepared by," "Reviewed by," or "Approved by" include the signee's full name, his/her affiliation, and the date. Because many projects take years to complete, instances have occurred during a review when a sponsor was unable to identify the person involved in the analysis.
- The two major safety and security committees do not separate internal and external members or establish committee rankings. While the circular refers to a Safety Review Committee (SRC) and an FLSC, the FTA now recommends that "security" appear in each committee name.

Important to Do

✓ Assign qualified safety and security professionals with FTA experience to prepare the SSMP in PD.

✓ Update the SSMP for each subsequent major project milestone.

✓ Form SSRC and FLSSC in PD; begin meeting with increased regularity as project enters into engineering and construction.

The SSRC is a decision-making group that includes only personnel from the project and from the transit agency who will operate the project. Reporting directly to executive leadership and chaired by the safety/security or certification manager, the SSRC addresses risk-related issues, approves certification activities, and resolves issues among the project team and executive leadership.

The FLSSC serves as the eyes and ears of the SSRC in reviewing safety and security elements. The FLSSC should include project and transit agency operations, safety, security, training, construction and design, and media staff. This committee is designed for interacting with non-project personnel, including members of local, county, or state police, fire, and emergency response agencies; hospitals; and highway, building, or environmental personnel.

The FLSSC helps ensure compliance with local laws, fire-life safety codes, and other regulations. By way of an example, designers on a project learned from the fire department that the emergency ROW onto the tracks was too narrow for department trucks and that the steep slope was hazardous for the size and weight of the equipment. In later stages of a project, the FLSSC plays a large role in developing tabletop exercises and full-scale safety/security drills that are key portions of the certification process.

The following are relevant references on the topic of safety and security management:

- FTA *Circular 5800.1 Safety and Security Management Guidance for Major Capital Projects* (2007)
- *Handbook for Transit Safety and Security Certification* (2002)
- *Hazard Analysis Guidelines for Transit Projects Final Report* (January 2000)
- *The Public Transportation System Security and Emergency Preparedness Planning Guide* (2003)
- *Designing and Operating Safe and Secure Transit Systems: Assessing Current Practices in the United States and Abroad* (2005)
- U.S. Code of Federal Regulations Title 49, Subtitle B, Chapter VI, Part 674 – State Safety Oversight Document Control

Per 49 U.S. Code 5327, sponsors are required to have a document control procedure in the PMP subplan and a recordkeeping system prior to entering Engineering. Document control is also one of the 15 elements in an effective quality program project per FTA QA/QC guidelines.

Important to Know

✓ Sponsors are required to have a document control procedure and record-keeping system.

✓ Configuration management is an important part of document control.

✓ The system implemented should facilitate workplace collaboration.

Sponsors should have an electronic document management system (EDMS) to facilitate document sharing and distribution. A centralized document repository stores, archives, and retrieves documents relevant to sponsor business processes. A document management system improves collaboration by allowing multiple users to work on the same file simultaneously. Changes are tracked per user and document iterations can be easily accessed. The sponsor should consider the following methodology [1] to establish requirements for a document control system:

- Organize the resources necessary to set up and maintain the EDMS.
- Develop an effective policy/ies, practices, and procedures for cybersecurity, access rights, data retention, file naming, workflow, and collaboration.
- Develop workflows for documents that need reviewing, approval, or a response.
- Implement the policies, practices, and procedures. Provide training for individuals who will access the system. Maintain policies, practices, and procedures. Note: Due to changes in regulations, technology, personnel, and other program aspects, effective document management requires regular monitoring for project team compliance.
- Develop and implement an effective redress and audit system to effectively address noncompliance and provide corrective training.

Configuration management is an important part of document control. Document control measures should ensure that all relevant documents are current and available to authorized users. Plans submitted to FTA should have a revision history box before the table of contents and be signed by an authorized manager. A procedure for documenting revision distributions should be included to ensure requisite parties have the latest revision.

Important to Do

✓ Establish an EDMS at project commencement.

✓ Follow the recommended methodology for system set up.

Before purchasing an EDMS and collaboration system, the sponsor should create a functional requirements matrix for inclusion in the bid documents, evaluate a variety of vendors, and request a system demonstration.

[1] US Department of Transportation Privacy Impact Assessment (PIA) - Electronic Document Management System

11. Project Management Information System

Sponsors should adopt a PMIS to collect, share, and report information on project health and progress. PMIS tools should be selected and implemented at project onset to capture project data early on. The PMIS should include cost, schedule, and progress monitoring; document storage and collaboration; and financial reporting with capabilities that allow the sponsor to make timely decisions. All potential users should participate in developing the reporting system to ensure that project needs are met.

PMIS software tools should have functionality for project planning and scheduling, resource management, cost estimating, contract administration, configuration and change order management, project and construction management, document control, and reporting. The sponsor should define technology requirements and make the requirements mandatory for contractors and consultants. This facilitates cross-platform collaboration and consistent data collection across the entire capital program.

No one system can meet all project management reporting needs. Most sponsors use different specialty systems for specific functions (e.g., project budgets and actual costs are in an accounting system, construction costs are forecasted in project management tools, schedule information is produced in scheduling software, etc.). Typical software in common, robust project management software tools include the following:

- *Scheduling*. Timescales project activities and logically ties them to preceding and successive activities to determine the project's critical path. Stores actual start and finish dates and percent complete in periodic updates. Compares actual progress to the baseline and calculates variance. Integrates cost and schedule to generate cash flow cost. Allows resource loading (e.g., workers, equipment, material, and cost) of activities and resource leveling to recalculate dates based on availability constraints. Calculates earned value, cost, and schedule performance indices. Activities can be coded to the program or to the project WBS. Generates standard and custom graphs and plotted reports.
- *Project Management*. Manages multiple vendor contracts with detailed budget and milestone dates. Tracks contracting goals; processes payment and change order requests; auto generates cost worksheets with budget actual and forecast comparison; creates commonly used project documents (e.g., change orders, record of negotiation, meeting minutes, RFIs, daily reports, letters, etc.) from standard templates; routes documents through a workflow for approval; auto generates logs for each document type (e.g., change order logs with cost data, RFI logs with turnaround times, etc.); auto generates alerts, ball-in-court reports, dunning letters, variance reports, and printed standard and customized documents and reports; auto generates standard dashboards.

- *Risk Management*. Generates risk registers; models cost and schedule data; maps risks to models; runs simulations and generates probabilistic cost and schedule ranges; autogenerates graphic curves and tables. FTA has developed its own beta range cost risk model using historical completion data from project oversight that can be used by sponsors to determine required cost contingency. An Excel beta range model workbook can be downloaded from the FTA website under the Document drop-down menu.
- *Financial Management*. Sponsors apply for grant funding in TrAMS. Sponsors should have their own financial management system that allocates multiple funding sources to specific elements of a project budget to avoid misuse of earmarked funding.
- *Cost Estimating*. Allows quantity takeoffs, develops historic unit prices or integrates with industry unit pricing data, generates markups and contingency, etc. Estimate line items can be coded to the program or project WBS. The WBS should incorporate FTA SCC coding (see https://www.transit.dot.gov/funding/grant-programs/capital-investments/standard-cost-categories-capital-projects workbook links under Related Documents) and cost line-item numbers.

In addition to reporting, these systems are key communication and collaboration tools that bring accuracy, transparency, and accountability to the capital program when properly configured.

While most sponsors have modern enterprise resource planning accounting systems that compare budget to actual costs, these systems lack tools to perform forward-looking tasks (e.g., cost forecasting and cash flow) accurately. Project management differs from accounting by its prospective focus on timely identifying potential issues so issues can be mitigated or avoided. Sponsors are encouraged to supplement enterprise resource planning with a PMIS to manage programs and projects and facilitate required reporting.

Using a PMIS

The PMIS selected should be used consistently across the sponsor's entire capital program. Multiple sources of similar project data can lead to inaccuracies and to reconciling and standardizing inconsistent data; these additional steps slow reporting processes. One source should exist for each data point (e.g., a central master schedule system containing all capital projects that each sponsor's department uses to develop and update project schedules and the project cost forecast).

Important to Know

✓ Sponsors can find reporting requirements in FTA *OP25 - Recurring Oversight and Related Reports*.

✓ Effective reporting systems forecast variances from the planned baseline data in time for sponsors to make decisions that can avoid or mitigate a potential cost or schedule impact.

✓ Effective reporting systems can tap into sources that create data to provide access to data that is accurate and current.

✓ Multiple sources of similar project data maintained by different stakeholder groups should be avoided.

To foster communication and collaboration, system features should be shared externally with contractors and consultants. In a centralized contract management system, vendors can enter their budget schedule of values, progress payment requests, change order requests, and time extension requests. When vendors use this type of system on projects and sponsor costs are captured, capital program budget and actual costs are depicted in real time in a single environment; data entry is also distributed between users.

More importantly, a system that allows vendors to enter potential cost and schedule impacts in a change order trend log before the impact occurs creates a bottom-up program cost forecast with full detail visibility.

During Construction, transparency and accountability are greatly improved using construction management software. Sponsors should consider setting performance metrics and adopting earned value techniques. To enhance transparency, dashboards should be used, and the same system should be shared by the sponsor, its CM, and the contractor.

Licenses and training should be provided to managers and project staff. These systems allow users to drill down to details, such as reviewing the justification for a change in the record of negotiation or identifying the number of days a contractor used to resubmit a document after comments were provided.

Accountability is enhanced if project management software can produce and automatically log documents (e.g., RFIs, submittals, daily field reports with photographs, noncompliance notices with corrective action reports, change order requests, change directives, contract modifications, records of negotiation, progress payments, design revision logs, transmittals, letters, meeting minutes, etc.). Since producing several of these documents—notably submittals, RFIs, and change orders—can delay a project, using this software for contract and document control can improve the probability of project success.

Project management software systems create accountability in a workflow. These systems can track when users create, route, and work in a document; display the amount of time spent in each process; generate an alert when a document dwell time is exceeded; and produce standard ball-in-court reports sorted by reviewer name and a “dunning” letter. A dunning letter prompts a user to follow up on overdue items, conduct a workload analysis, and make adjustments. Document turnaround charts on a dashboard can identify endemic issues that need resolution; the system can also generate high alerts for overdue items. The status of contractor progress payments can be traced through the workflow to expedite payment as well.

To further accountability, sponsors should periodically evaluate the performance of their contractors, consultants, staff, or third parties. Periodic contractual and procedural compliance and performance audits should be conducted by the sponsor’s staff. Evaluations, audit findings, and recommendations should be shared with vendors and used as potential selection factors in future procurements for the same services.

Reporting

Effective reporting systems tap into sources that create data and provide greater accuracy and access to the most recent data. Program and project reporting become challenging when multiple data sources exist and are not on a common server. An integrated cost, schedule, and progress reporting system provides prompt, accurate data on costs, budgets, and progress of organization entities.

To avoid manual data manipulation from different systems when producing reports, sponsors can select an existing system and write code to pull data from other native systems or create a data warehouse.

Successful reporting tools provide stakeholder access to data; can group, sort, and filter the data; and customize standard reports. Effective reporting systems forecast variances from planned baseline data so sponsors can make timely decisions to avoid or mitigate potential cost or schedule impacts. An early warning system can provide sponsor decision-makers with email alerts, avoiding the need to search for the data in a reporting system. Additionally, dashboards disseminate information to stakeholders and managers, facilitate issue identification, and provide management with a visual tool to make timely decisions.

FTA Reporting

FTA requires that sponsors of MCPs submit recurring progress reports to the FTA and to its PMOC. These status reports should include the following:

- A completed core accountability dashboard
- A quarterly safety and security checklist
- Grant status
- Rolling stock vehicle status report
- Risk register updates
- Awarded contracts matrix
- A real estate acquisition and relocation matrix
- Third-party agreements and utilities matrix

FTA *Oversight Procedure 25 – Recurring Oversight and Related Reports* outlines the content the PMOC should report to FTA and a prescribed format for most of the reports listed. In general, detailed and summary-level reports should provide periodic and cumulative costs, a comparison of actual-to-planned costs for each element of work, analyses of variances from planned costs, cost relationships with schedule and progress, and variations in the defined SOW. The system should include engineering and administrative cost reporting, as well as construction and procurement costs. The system should also forecast the expected costs of work packages at completion and the expected total project costs.

To collect information for FTA reporting during Construction, sponsors should consider establishing a contractor performance measurement system. The system should include KPIs that can be tracked on a dashboard and send alerts to management when performance is below established limits. The system should also include variance reporting that compares schedule key milestone baseline planned dates to previous-month and current-month forecast dates. The sponsor should report negative variances monthly on a dashboard with an explanation as to why the variances occurred.

The reporting system should include an exceptions report that focuses on current issues, an explanation for variances, and proposed solutions. The exceptions report should indicate perceived changes in cash flow and identify anticipated areas of concern. Recommendations to mitigate or resolve areas of concern should be presented to management and discussed with FTA.

Choosing a PMIS

The sponsor should define its requirements for each system and compare products. After discussing its needs with other recipients, managers should consider software costs, capabilities, user friendliness, training requirements, flexibility, and available technical support. Sponsors should also ensure that requisite software specifications and RFPs, or requests for bids, identify process requirements; specify the requirements in the contract; and enforce the requirements to realize desired functionalities.

When choosing an enterprise PMIS, a list should be created of the systems and reports used by project stakeholders. The sponsor should study the reports and map the systems to identify duplicate data sets, reporting inaccuracies, function overlap, and inefficiencies. From this exercise, the sponsor should develop a functional requirements matrix and obtain stakeholder buy-in for a centralized PMIS with one data source that feeds various reporting needs. Using this matrix, the sponsor can contact software vendors to identify the best fit with minimal gaps requiring customization.

Important to Do

✓ Select and implement PMIS tools as soon as possible so all data is captured as early as possible in the project timeline.

✓ Configure forward-looking systems that identify potential cost and schedule impacts in time to potentially mitigate the issue.

The sponsor should conduct a procurement effort for the software and for an expert consultant to configure and roll out the system. Sponsor staff in each stakeholder group can be assigned to the system implementation team. As part of the vendor team, sponsor staff can promote internal advocacy by providing comments and feedback on the software configuration to ensure the system is tailored to the sponsor's needs. When sponsor staff train their departments to use the new PMIS, adaptation and acceptance are likely. Choosing and implementing a new PMIS system take time. Sponsors are, therefore, encouraged to begin developing or enhancing their systems before entry into PD, or, at the latest, in PD.

12. Advanced Digital Construction Management Systems

Advanced digital construction management systems (ADCMS) solutions are available to the transit industry. These systems transform capital construction projects by integrating advanced tools and technologies throughout the project life cycle and include O&M. The solutions provide enterprise-wide integration across processes and functions and leverage cutting-edge technologies to streamline processes, improve outcomes, and enhance transparency.

ADCMS solutions incorporate program management tools, online document management/workflows, BIM for cohesive design, and construction coordination to ensure a seamless flow of information across all areas of a project. These solutions also use Internet of Things (IoT)-based monitoring to track equipment, materials, and environmental conditions in real time, enhancing visibility and control. Artificial intelligence (AI)-powered analytics enable automated updates and data-driven decision-making while advanced data analytics digitize workflows to optimize efficiency.

Additionally, digital twin technology facilitates continuous monitoring and advanced simulation capabilities that offer precise insights and predictive capabilities by extending foundational BIM elements and integrating real-time data from sensors, IoT devices, and other sources to create a live, real-time operational and optimizable 3D replica of the physical asset (e.g., a light rail extension, heavy rail station, or BRT running way).

Unlike traditional PMIS, ADCMS includes integration across the functions and processes of the program lifecycle, enabling real-time collaboration among diverse stakeholders, automation of routine tasks, online repositories, and enhanced efficiency through predictive analytics. An ADCMS enterprise-wide solution covers the entire project lifecycle, from design and planning to implementation, maintenance, and asset management to ensure comprehensive management and minimize construction disruptions.

Key goals of ADCMS solutions include:

- Applying digital systems throughout the lifecycle of transportation infrastructure.
- Facilitating timely and productive information sharing among stakeholders.
- Enabling and leveraging digital technologies for process improvement.
- Increasing technology adoption and deployment across projects.
- Providing technology training and workforce development opportunities.
- Updating regulations and creating standards to support digital data reporting to maximize integration and benefits.
- Reducing the environmental footprint of construction projects.
- Enhancing project worker and pedestrian safety through increased project transparency.

By adopting and accelerating the use of ADCMS solutions, transit construction projects can achieve substantial improvements in accuracy, integration, efficiency, and safety while reducing cost overruns and delays compared to traditional project management solutions. These advanced solutions not only optimize construction processes but also contribute to more environmentally sustainable and safe infrastructure development.

FTA has an active ADCMS research program. To access information about the latest results of the program, please see https://www.transit.dot.gov/grant-programs/accelerating-advanced-digital-construction-management-systems-program.

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APPENDIX A. COST ESTIMATION METHODOLOGY

Introduction

Cost estimation is a process that provides progressively more accurate information as a project moves from conceptual through final design, award of construction and/or equipment/materials contracts, and is updated as estimates to complete throughout such contracts until close-out. It establishes initial budget limits and is the crucial element of a project management/control system. FTA relies heavily on a sponsor's ability to develop, monitor, trend, and update an accurate project budget. Over time, budget estimates are refined as more detailed engineering information is available.

Budget Development

Creating a project budget requires the allocation of all costs associated with completing a project. Project budgets are built from the "bottom up" by use of work breakdown structures (WBS). The WBS provides a means for defining program/project scope, both what is to be built (i.e., hard costs) and what is to be designed and all management/administrative costs (i.e., soft costs).

Development of an "order of magnitude" estimate marks the beginning of the budget and project management process. Sponsor staff (or, often, contracted design consultants) prepare "order of magnitude" estimates using models or templates developed by a professional engineering association having detailed knowledge of a particular field or industry. In rail transit, for example, a frequent starting place would be manuals published by the American Railway Engineering and Maintenance Association (AREMA) with adjustments reflecting unique features of the sponsor's fixed guideway project. Another source is the *RSMeans Estimating Handbook*. In rough order of magnitude estimates, higher levels of reserves or contingencies are normal.

Hard costs are the probable costs of construction and procurement of equipment (and materials) and are first prepared as "order of magnitude" estimates. From this point the sponsor engineering staff and retained design consultant is instructed to "design to budget", an exercise that relies on budget limits to control scope expansion. No construction contingencies are included at this level of detail. Sponsors do not release design contingencies at this stage of design, usually reserving these funds for added design work needed at a later time. In some circumstances an architect/engineer instructed to "design to budget" may be required to redesign a project, at no cost to the sponsor, if construction bids exceed final design estimates. At the preliminary design, design development and final design stage, construction cost estimates should be verified at key milestones of progress to confirm that project costs are being managed with respect to the available funds.

Value engineering (VE) is encouraged by FTA throughout the design process, particularly in the early stages where there is the greatest opportunity to affect the cost of construction with minimal impact to project goals. VE assesses products and systems and provides recommendations for a more economical solution. The process also considers long-term operations and maintenance practices and costs.

Construction planning and constructability review are two other steps encouraged by FTA and ideally occur before the end of PD. It is essential to involve construction personnel, along with the designers, cost estimators and schedulers, and to do so early, and at least once again, before the end of Engineering. It is also useful to invite construction and equipment contractors to "industry review" workshops to address both of these subjects.

- Construction planning involves a broad assessment of the environment and conditions in and under which a particular construction contract (or the furnishing of a fixture or structure from an equipment contract) will be advanced. It seeks to understand the work site and adjacencies that are to be (or may be) impacted, the means and methods for essential site access, and associated constraints that are likely to be encountered. These elements can and will influence contractor interests and the bids, as well as the potential for disruptions, delays, claims, and community disruption.
- Constructability review is a process whereby the plans and specifications are reviewed toward the goal of ensuring the project (contract package) is both "biddable" and "buildable." It seeks to bring experienced construction personnel together with the designer to evaluate the scope of the work to be bid, with attention to three major categories of concern: (1) can it be constructed using standard methods, materials and techniques as it is detailed in the plans and specifications; (2) can the bid documents made available to the contractor permit a competitive and cost-effective bid; and (3) can the finished work be built according to the plans and specifications and meet the cost-effective maintainability envisioned by the sponsor over its useful life.

There are a number of sources for further information on these topics, among them: American Association of State Highway and Transportation Officials' (AASHTO) *Constructability Review Best Practices Guide* (August 2000); and the Association for the Advancement of Cost Engineering (AACE).

FTA requires its sponsors to escalate construction costs to reflect anticipated inflation and to report this amount as a separate budget line item. This requirement acknowledges that, over time, materials and labor costs may rise due to general inflation. Escalation may be calculated by applying an assumed fixed annual percentage to probable construction costs through the mid-point of construction.

During Engineering, the more sophisticated approach should be used to apply escalation by either individual construction contract or by trade item (e.g., bridge, track, signal, etc.) and adjust to the anticipated year of expenditure.

Large, complex projects that encompass many construction contracts should add a program contingency over and above design and construction contingencies consistent with the results of the programmatic risk assessment. A program contingency addresses interfaces between and among construction contracts as well as uncertainty (risks) associated with system start-up, testing, and commissioning. FTA participates in reasonable startup costs that directly support activation and pre-revenue operations (PRO). These costs should be accounted for in the project estimate.

Recommendations

1. **Government Accountability Office (GAO) GAO-20-195G *Cost Estimating and Assessment Guide*** – FTA encourages project sponsors to consider applying the GAO 12-step methodology when developing a project cost estimate. GAO's *Cost Guide* outlines best practices pertaining to cost estimation principles, presenting 12 steps to create high-quality estimates. These steps are generally applicable in a variety of circumstances. Application of these principles should result in reliable and valid cost estimates that Sponsor management can use to make informed decisions. The 12 steps and their associated best practices are as follows:

   Step 1. Define the estimate's purpose. Best Practice: The cost estimate includes all life-cycle costs.

   Step 2. Develop the estimating plan.

   Step 3. Define the program. Best Practice: The technical baseline description completely defines the program, reflects the current schedule, and is technically reasonable.

   Step 4. Determine the estimating structure. Best Practice: The cost estimate WBS is product-oriented, traceable to the statement of work, and at an appropriate level of detail to ensure that cost elements are neither omitted nor double-counted.

   Step 5. Identify ground rules and assumptions. Best Practice: The estimate documents all cost-influencing ground rules and assumptions.

   Step 6. Obtain the data.

   - Best Practice: The estimate is based on a historical record of cost estimating and actual experiences from other comparable programs.
   - Best Practice: The estimate is adjusted properly for inflation.

   Step 7. Develop the point estimate.

   - Best Practice: The cost model is developed by estimating each WBS element using the best methodology from the data collected.
   - Best Practice: The estimate contains few, if any, minor mistakes.
   - Best Practice: Major cost elements are cross-checked to see if results are similar.

- Best Practice: An independent cost estimate is conducted by a group outside the acquiring organization to determine whether other estimating methods produce similar results.

Step 8. Conduct sensitivity analysis. Best Practice: The cost estimate includes a sensitivity analysis that identifies a range of possible costs based on varying major assumptions and parameters.

Step 9. Conduct risk and uncertainty analysis. Best Practice: A risk and uncertainty analysis is conducted that quantifies the imperfectly understood risks and identifies the effects of changing key cost driver assumptions and factors.

Step 10. Document the estimate.

- Best Practice: The documentation shows the source data used, the reliability of the data, and the estimating methodology used to derive each element's cost.
- Best Practice: The documentation describes how the estimate was developed so that a cost analyst unfamiliar with the program could understand what was done and replicate it.
- Best Practice: The documentation discusses the technical baseline description and the data in the technical baseline are consistent with the cost estimate.

Step 11. Present the estimate to management for approval. Best Practice: The documentation provides evidence that the cost estimate is reviewed and accepted by management.

Step 12. Update the estimate to reflect actual costs and changes.

- Best Practice: The cost estimate is regularly updated to confirm that it reflects program changes and actual costs.
- Best Practice: Variances between planned and actual costs are documented, explained, and reviewed.

See GAO-20-195G, *Cost Estimating and Assessment Guide: Best Practice by Developing and Managing Program Cost* to review the complete guide.

2. **Resolution of Variations in Cost Estimates** – During PD, FTA and the sponsor should agree on a method to resolve variances between estimates. While there are no standards specifically for resolving variations between estimates on the same project, the sponsor could set aside funds equal to estimating differences as a contingency if differences cannot be resolved by fact and assumption checks.

3. **Project Management Information System** – Sponsors should implement a project management information system (PMIS) to operate within the framework of the grant requirements and provide the sponsor with reliable cost information every step of the way along the PD continuum. Greater visibility to cost information will permit the timely implementation of alternative solutions. The PMIS will encompass a database of all project costs organized within the WBS.

   Reporting categories within the PMIS should be as explicit as possible so as to be able to measure performance of each participant organization (e.g., sponsor, third parties, each professional services consultant, construction contractors, equipment, or other supplies/services contractors, etc.) and should include:

   - Baseline budget authorization
   - Contract commitments
   - Actual cost
   - Pending contract changes
   - Forecast to complete
   - Estimate at completion
   - Budget variance
   - Earned value (cost and time relative to major milestones and logical interim milestones)

   Sponsors can manage the program/project contingency by evaluating commitments to budget estimates and tracking potential changes as soon as they are identified. Further, the sponsor should establish a change order control system that identifies and records the cause of the changes. Increases/changes in scope or “scope creep” are a common occurrence on large-scale as well as small-scale projects. Individual changes should be logged and recorded with the appropriate funding source. The change procedures should be formalized, and all changes should be reviewed by the cost estimator(s) and scheduler(s) for the project, not just the design management team.

4. **Cost Recovery** – In association with the change order control system, sponsors are encouraged to develop and utilize a cost recovery procedure. Several larger projects have successfully implemented procedures that allow for the potential recovery of costs due to “errors and omissions” that cause rework of a portion of the project. It is a requirement of all design contracts for the architect/engineer to maintain professional and general liability insurance to cover these items. Regardless of how much is recovered through this process, it is an effective negotiation tool.

APPENDIX B. PROJECT CONTINGENCY (GENERAL OVERVIEW)

Definitions

Congress has directed that funds sufficient to meet "project contingencies" be included in all budgets. Contingency levels vary depending on the complexity of the project, the experience of the sponsor with similar projects, the contract packaging, the project schedule, and, of course, how well the project has controlled costs (and schedule) during development and is defined through engineering plans and specifications at the time bids are solicited.

For the two most common contract choices employed by sponsors—design-bid-build (DBB) and design-build (DB)—the burden of risk is very different. In either case, how the sponsor identifies and distributes risks among the parties also will influence contingencies required. Contingency is typically broken into allocated and unallocated contingencies. Total project contingency is the sum of the two and almost always expressed as a percentage of the overall estimated cost of the project.

Design-Bid-Build

DBB projects demand a larger percentage for contingency in relation to the overall project budget because the owner is assuming the majority of risk. Total project contingency for DBB contracts typically average around 10% or higher of the overall project budget at the 100% bid point. Consequently, higher contingency is required prior to bidding any of the work so as to reflect realities of the design phases and the potential market conditions upon bidding. For traditional DBB projects, the owner provides the contractor with plans and specifications, and the contractor provides a bid to build the project. Any changes to the project become the sole responsibility of the owner and may impact schedule and budget. Changes on DBB construction projects are most often the result of changed conditions, design errors, or additional requirements.

Typically in a DBB contract, the design consultant maintains a significant manpower level in order to review contractor submittals and perform design activities associated with any errors, differing site conditions and/or new program requirements. Most changes add cost to the project budget. Generally, the amount of contingency assigned to a project budget declines as a project nears completion. There are exceptions, particularly if a large number of change orders and claims are outstanding.

Design-Build

In a DB contract, design activity is integrated into the construction contract. There is only a limited need to transfer data across contract boundaries, particularly for approval on a day-to-day basis. Since the DB contractor is responsible for design and construction, it has assumed most, if not all, of the risks for differing site conditions and design errors. Whenever changes are ordered or new requirements are established by the sponsor or by third parties, risks and costs are normally assigned to the owner. The presence of a third party with authority to order change has the potential to increase costs; this situation should, therefore, be carefully managed. The owner will normally control internally generated changes and limit financial risk. During design, contingency can be lower versus DBB because the design-builder has assumed much of the risk. With primarily sponsor or third-party changes to plan for, construction contingency can be closer to 10% when the design is complete.

Construction Manager/Guaranteed Maximum Price

In a construction manager/guaranteed maximum price (CM/GMP) project, a cost is negotiated prior to 100% design; added risk can be assigned to the CM/GMP contractor. Construction may also start prior to 100% design, which increases the recommended contingency over 10% at the start of construction.

Phased and/or Progressive Design-Build

In phased and/or progressive design-build (PDB), project construction starts and costs are negotiated in phases as parts of the design complete. Contingency needs to be evaluated throughout the process; it should not be expected to approach 10% until design is near completion.

Other Related Issues

Project endeavors such as ROW purchase/relocation, vehicles acquisition, project management, construction management and miscellaneous construction, utility and start-up efforts for design/build contracts typically have nearly the same risks as a DBB contract, but rarely have exceeded one third of the total project costs. Co-location of the owner and DB contractor, as compared to the traditional arrangement in which project participants are often located in separate facilities, has proven to speed resolution of questions and improved project execution.

Managing Risk

The amount of project contingency is directly related to the risk associated with completing a particular scope of work. This is true in design as well as in construction and other procurements. When bidding on a project, contractors evaluate risk and incorporate its potential cost into their bid. If a contractor’s contingency is not used, it will become profit to the contractor.

Appendix B. Project Contingency (General Overview)

If bid documents or a request for proposal (RFP) is ambiguous, bids higher than expected will be the likely result. Bid documents or an RFP that clearly defines the project, its operational/quality requirements, and explicitly states how the bids or proposal will be evaluated generally results in a bid or proposal that will best meet the needs of the owner. This minimizes the risk of changes, and the cost associated with those changes, and reduces the amount of contingency needed by the contractor.

The FTA OP 40 Cost-Risk Model Workbook is structured to provide a comprehensive framework for assessing risks from a top-down perspective—overarching risks at the organizational or project level are assessed first, as well as their impact on various components of a project. The approach is systematic and standardized, allowing for consistent risk assessment practices across different projects, and ensures that all potential risks are considered from the highest levels first. The top-down approach of the OP 40 model facilitates a broader, faster initial risk identification and prioritization, which can be particularly effective on large-scale transportation projects where strategic oversight is crucial.

In contrast, a bottom-up risk assessment model begins with individual components or specific tasks within a project and builds to an overall risk profile. This method focuses on the details and specifics of each element and gathers detailed data at the micro-level to identify and mitigate risks as they arise during operational phases. Bottom-up approaches are typically more granular and sensitive to the nuances of specific project challenges, potentially leading to more tailored risk management strategies. However, this approach may require more time and resources due to the depth of analysis required at every level of the project.

Analysis of historical project data recommends specific contingency levels expressed as a percentage of the current estimate at completion, excluding contingency itself (see Table 7.2). These figures are calculated based on a P65 risk-tolerance level and may be interpolated linearly for intermediate stages. Adjustments to these guidelines are necessary when contracts are issued before design completion, a common scenario in DB and other similar methods. Also, projects with various risk profiles or phases require individual analysis, integrating over time to produce a comprehensive contingency drawdown curve.

In cases where alternative delivery methods are used, risks typically held by the sponsor in design and Procurement can be transferred to the contractor and often influence the contractor's pricing at different project stages than originally planned. A thorough review of the design, bid, or Construction phases is essential to assess the degree of risk transfer and to tailor the contingency needs accordingly.

APPENDIX C. UTILITY RELOCATION AGREEMENTS

Introduction

The utility and transportation industries are often linked through shared ROW, state and federal safety oversight, and a measure of economic regulation. Transit New Starts frequently require the relocation of utilities just as federally supported highway construction has for many years. In recognition of this long standing interaction, “utilities” are defined in 23 CFR, Part 645, Subpart B, Section 645.207 as a “privately, publicly, or cooperatively owned line, facility, or system for producing, transmitting, or distributing communications, cable television, power, electricity, light, heat, gas, oil, crude products, water, steam, waste, storm water not connected with highway drainage, or any other similar commodity, including any fire or police signal system or street lighting system, which directly or indirectly serves the public.” The term utility shall also mean the utility company inclusive of any wholly owned or controlled subsidiary.

A “utility agreement” is a legally binding document between a utility company and a transit agency that defines the scope of a relocation, including reimbursement, liability, right of entry, insurance, and schedule to complete the work. Such an agreement is essential to properly identify the parties involved and to ensure that all parties have a complete understanding of the scope, schedule, and reimbursement issues relating to the relocation. Utility agreements have long been the means by which a transit agency arranges for a Utility to relocate its facilities from within the footprint or that is considered for safety or other tangible reason considered too close to the proposed operation of a proposed transit project.

Policies and Practices

It is extremely important that utility agreements be thoroughly reviewed by in-house counsel and engineering staff to ensure that all necessary information is included. For this review to occur the agreement must be completed well in advance of the start of construction. Cost and schedule penalties can be severe when construction activities and utility relocations occur concurrently.

Development of the Utility Agreement

The first step required for any utility relocation is to solicit utility maps from all known utility companies in the area under consideration. It is helpful to have a master list of utility companies and mail letters of intent to all of them asking for maps of any known utilities in the project limits. Subsurface utility engineering (SUE) is the process of accurately and comprehensively mapping all underground utilities. This method should be utilized, as budgets allow, assisting in locating all utilities. After this preliminary effort, the utility locator company in the area is contacted and a request is made for all of the utilities to be marked in the field. This information is used, along with the preliminary survey information collected, to ensure that all utility locations are known, and are accurately identified on the field survey.

Appendix C. Utility Relocation Agreements

After all affected utilities have been identified, a determination of the most desirable location for their relocations should then be performed. Begin discussions with the Utility and determine if the utility has a policy of relocating its own utilities or if it wants the relocation performed under the relocation activities of the project. Determine who is responsible for the relocation costs. A general review of existing license agreements will be necessary to make this determination. If costs are to be covered by the sponsor, determine what these costs are up front, and begin negotiations.

As design of the transit project continues, and project alignments become known, initial work on the utility agreement should begin and increased coordination and negotiations with the affected utility should follow. The ideal situation is to have signed agreements and all utilities relocated prior to the general contractor receiving an NTP on its construction contract. If this is not possible, all affected utility facilities need to be shown in the project documents and relocation will be made concurrent with the construction activities. Coordinating the availability of the construction site with the general contractor and the utility will be very important. Ensuring each has access to the site as promised will help to avoid any future litigation.

The next steps involve setting up a utility preconstruction meeting, monitoring the relocation work of the utility, and providing oversight of their progress. Any slip in the schedule of the utility relocation will have the same detrimental effect as any slip in the schedule of the individual construction contract. Finally, the sponsor should inspect the utility relocations to ensure that all work is performed according to the sponsor's expectations.

Utility Relocations During the Project Design

Utility relocation must be properly coordinated with PD, ROW acquisition, and Construction in order that conflicting utilities are removed or adjusted prior to Construction or in a manner that will not interfere with the construction scope of work or its schedule. The scope of the utility relocation must be determined as well as the responsibility for costs of the relocation. Of particular importance is the avoidance of what are known as "betterments" in the scope of work, as these are ineligible for FTA funding participation.

The costs of the relocation are not always borne by the sponsor. In many instances, utilities are located in public ROW under what is effectively a "franchise" agreement, and often such agreements require the utility to relocate at its own expense. If the former is not the case, cost sharing must always be considered as a feasible alternative to the project being charged. A review of the project plans must be made, relocation estimates checked, agreements prepared, and relocation costs negotiated and agreed upon. The scheduling of the relocation must be made to coincide and agree with all other impacted contractors on project right-of-way.

Numerous contractors on the project, all performing work independently, will often present scheduling issues, the potential for claims is increased, and the real possibility of contractor disputes may arise.

It is the responsibility of the sponsor utility staff to coordinate utility relocations on proposed projects with other phases of ROW acquisition and with construction in order that conflicting utilities are removed or adjusted prior to construction or in a manner that will not interfere with construction. The staff must determine the scope of utility relocation required as well as the responsibility for costs of the relocation. Utility designers must secure, review, and process plans. Also, they must review estimates and reimbursement agreements covering the relocation or removal of conflicting utilities.

23 CFR 645.109 considers the application of value engineering to utility relocations. In one particular case, under a lump sum utility agreement, a utility later proposed a cost-saving alternate solution. The utility identified this as a value engineering savings and proposed that it share in the savings. The net impact would be to provide cash to the utility. Value engineering incentives are supported in the customary sponsor-contractor relationship. However, VE incentives should not be applied to the typical sponsor-utility relationship for utility work where the utility is the "owner" and, therefore, the organization responsible for setting up the means for rewarding creative ideas. In no case should the relocation or adjustment of facilities result in a cash windfall to the utility.

Scheduling Agreements

It is never too early to negotiate and execute utility agreements. Usually, however, the status of the design and the requirements of the utility will control when the agreement can be negotiated. The DEIS/FEIS phase usually aids in identifying utilities that are affected by the proposed transit project. As early as is economically feasible, the sponsor must contact all affected utilities to inform them of the proposed improvements and obtain their criteria for relocating or protecting their respective facilities. Some utilities insist on performing their own design, while others insist that firms prequalified by the utility perform the design and the actual relocation work.

Utility Agreement Language/Content

Utility agreements should contain a detailed description of the scope of work to be accomplished. Providing design drawings that accurately depict the existing conditions and the post-construction conditions contributes extensively to describing the scope of work. The extent of the relocations must be clearly shown.

Many utility companies have their own design staff and are capable of designing the relocation themselves. If this is the case, the parameters of the relocation must be clearly identified in the agreement so that the designers have all the necessary information needed to conduct their design. Design reviews, constructability reviews, and continual coordination are essential with each utility to ensure that all relocations are performed as expected.

Many utility companies are also capable of performing their own relocation. Again, this should be referenced in the utility agreement and the schedule becomes very important because the utility often has priorities that are not the same as the construction project. The sponsor should, in such instances, also seek in the agreement provisions for both cost and schedule accountability from the utility so as to offset any schedule delay and associated costs if and when a project construction contractor is negatively impacted and that contractor seeks relief (delay claim). Progress monitoring is essential for relocation work performed by the utility.

It is important that all relocated utilities are moved, protected, and constructed to meet all applicable codes. Whether the utility is relocated by the utility or by the sponsor's general contractor, proper inspections must be performed to ensure adequate construction. The party responsible for this vital function needs to be identified in the agreement.

Ideally, the relocation costs are negotiated up front before the relocation work takes place. This enables the sponsor to properly budget all costs related to relocation. The lump sum method of payment is beneficial because it reduces the administrative and record-keeping costs associated with documenting payment for completed work. However, these savings may be offset by inaccuracies in the cost estimating process. The lump sum payment method should only be used where the end product, in this case the utility relocation, can be clearly and concisely defined. The cost estimate in support of the lump sum agreement must be accurate, comprehensive, verifiable, and in sufficient detail to give a clear picture of the work involved and the cost of the individual items.

If reimbursement is to be made on a cost reimbursement basis, this too must be determined and necessary line items and unit costs developed before the relocation work is performed. A method for settling claims and a conflict resolution method should also be included in the agreement.

Finally, the schedule must be specified and completely understood by all parties. If multiple contractors will have access to the site, this must be identified and agreed to in the agreement. It is ideal to have the relocations substantially completed prior to the general contractor receiving NTP. However, this is not always possible, and when it is not, extensive coordination and written documentation must clearly define the expectations of all parties involved.

Appendix C. Utility Relocation Agreements

Agreements and authorizations, as identified in 23 CFR 645.113, state that the agreement should be supported by plans and/or drawings that show:

- The location, length, size and/or capacity, type, class, and pertinent operating conditions and design features of existing, proposed, and temporary facilities, including any proposed changes to them, using appropriate nomenclature, symbols, legend, notes, color-coding.
- The project number, plan scale and date, the horizontal and, where appropriate, the vertical location of the utility facilities in relation to the highway alignment, geometric features, stationing, grades, structures, and other facilities, proposed and existing ROW lines, and, where applicable, the access control lines.
- The limits of ROW to be acquired from, by, or on behalf of the utility, where applicable.
- The portion of the work to be accomplished, if any, at the sole expense of the utility, using appropriate notes or symbols.
- The agreement should also include a cost estimate for the proposed work. The cost estimate should set forth the items of work to be performed, broken down by the estimated costs of the following:
    - Direct labor
    - Labor surcharges
    - Overhead and indirect construction charges
    - Materials and supplies
    - Handling charges
    - Transportation
    - Equipment
    - ROW
    - Preliminary engineering
    - Construction engineering
    - Salvage credits
    - Betterment credits
    - Accrued depreciation credits

The estimate should include sufficient detail to provide the sponsor with a reasonable basis for analysis. Factors included in the utility's overhead and indirect construction charges should be set forth. Materials should be itemized where they represent relatively major components or cost in the relocation. Unit costs, such as broad- gauge units of property, may be used for estimating purposes where the utility uses such units in its own operations. Typically, a utility uses its own forces or those of a utility contractor to accomplish the needed adjustments to its facilities. Records of actual costs incurred should form the basis for reimbursement.

Negotiation and Reimbursement

Only actual allowable, allocable, and reasonable costs are reimbursable. Where the work is to be performed by the public utility's forces, no profit is allowed and reimbursement is limited to the amount necessary to relocate and/or rearrange the facilities to affect conditions equal to the existing utility facilities. Generally, reimbursement would not provide for greater capacity, capability, durability, efficiency or function, or other "betterments," except for meeting current state and local codes. The cost estimate should contain, at a minimum, the labor type along with hours and hourly rate, equipment type and rates, material quantities and costs, and engineering costs.

If a utility elects to improve, change, rearrange, or otherwise enhance its facilities beyond what currently exists, the sponsor should obtain separate estimates to identify the cost difference between the improved adjustment and the adjustment that is comparable to the existing facility.

Utility agreements must accurately reflect the costs of the activities involved. Acceptable methods for developing relocation costs include:

- Actual direct and related indirect costs accumulated in accordance with a specified work order and in accordance with a jointly approved procedure for documenting those costs
- An agreed upon fixed amount (lump sum) payment
- An agreed unit cost method of payment

When the sponsor is obligated to reimburse a utility for the removal or alteration of its facility, all parties should understand that the adjustment is to be undertaken in the most economical manner consistent with good engineering practice and in compliance with applicable codes and permit regulations. The sponsor should only reimburse the utility for comparable facilities. If the utility elects to improve its facility during the adjustment (i.e., a utility betterment), the sponsor should strive to only reimburse the company for the cost of a comparable facility. No cost for "betterments" are reimbursable with FTA funds.

Conclusion

The most important element to successfully negotiate every utility agreement is to begin the process early. By accurately locating all utilities through surveys, SUE and general inquiries early in the design process, more time is available to negotiate and coordinate the content of the utility agreements. Coordinating and meeting often with the affected utilities ensures that the entire process is progressing and the eventual outcome has a greater chance of being successful. Proper oversight of the utility activities is essential to maintaining the project schedule and ensuring that utilities are relocated in a manner that meets the transit project objectives.

It is important to employ people who have experience and are adept at all aspects of utility relocation. Many things can delay the relocation of an important utility. It is essential that management of the utility relocation efforts be given the same amount of manpower as design and construction oversight activities. Simply signing a utility agreement and then allowing the utility to monitor itself is not an effective plan for the sponsor. Constant oversight and coordination is essential. Knowledgeable staff is also better prepared to estimate relocation costs and successfully negotiate with the utility.

Utility companies often operate at their own pace and under their own set of rules. For these reasons, it is more important than ever that the sponsor do everything within its capability to effectively evaluate the work to be done, oversee, negotiate, and monitor all of the utility relocations performed by utilities, just as the grant must do with its other construction contracts.

Also please refer to the “Utility Relocation - Challenges and Proposed Solutions” (March 2022) white paper from the FTA Project Management Oversight Program.

APPENDIX D. SYSTEMS INTEGRATION & PRE-REVENUE OPERATIONS PROCESS

Activity/Phase	Project Development	Engineering	Start Construction	50% Construction	90% Construction		Pre-Revenue Operations Revenue	Revenue Service
Project Management Plan (PMP)								
Update PMP & Subplans	Develop Outline	Finalize Plans			Update			
Quality Controls Procedures	Develop	Develop	Finalize		Update			
Safety & Security								
SSMP	Develop Outline	Finalize Plan			Update			
Design Criteria	Develop	Finalize						Update
Preliminary Hazard Analysis		Finalize	Update					
Threat & Vulnerability Assessment		Finalize	Update					
Safety & Security Certification Plan	Develop Outline	Finalize Plan						
Safety Certifiable Items List (SCIL)	Develop	Finalize						
Operations Hazard Analysis					Develop		Finalize	
System Safety Program Plan (49 CFR 659)		Develop					Finalize	
SCIL Documentation		Safety & Security Certification Activities and Documentation						
System Integration Test (SIT) Planning								
SIT Plan			Develop	Finalize			Update	
Schedule for SIT Activities				Develop	Finalize		Update	
Test Procedures				Develop	Finalize		Update	
Testing								
Pre-Revenue Operations (PRO) Planning								
PRO Plan & Schedule								
Emergency Preparedness Plan				Develop				
Update Rule Book					Finalize/Update			
Standard Operating Procedures					Finalize/Update			
Training Program					Conduct Training			
Public Awareness Plan					Develop			
PRO					PRO is typically 3-4 months after substantial completion			
Final Safety & Security Certification								
Safety & Security Certification Verification Report							Finalize	
SSO Approvals (as applicable)							Complete	
Revenue Service								