

CHAPTER 6

MANAGING THE PROJECT DURING THE TESTING AND START-UP PHASE

The Testing and Start-up Phase provides the necessary linkage between the Construction and Revenue Service Phases. The purpose of this phase is to accept the newly constructed or modernized transit project. Acceptance follows verification that the project meets the contractual specifications by performing system, performance, and integration testing. In addition, a period of pre-revenue service is required to familiarize the grantee (or contractor) management and O&M personnel with the new system prior to beginning, resuming, or extending revenue service. Issues of safety certification, procedures development, training, emergency preparedness, and customer interface are addressed during this phase. Discussion is oriented to the requirements of a fixed guideway system that serves the public. Other transit capital projects should also follow this guidance, recognizing that the customers may only be the transit agency employees, e.g., a maintenance facility.

Although testing and start-up is the bridge between construction and revenue service, its planning must begin in the Design Phase. The requirements for system, performance, and integration testing, as-built drawings, O&M manuals, training, acceptance, and warranty requirements must be specified in the implementation contracts. The contractor's responsibilities and participation requirements during testing and start-up need to be clearly described in the contract. This phase actually overlaps with construction since component, subsystem, and installation verification tests are performed during construction.

As a supplement to the management principles presented in Chapter 3, Chapter 6 contains project management guidelines specifically related to the Testing and Start-up Phase of a transit construction project.

6.1 Test Program Planning

An element of the PMP is a Test Program Plan (TPP). This plan should:

- Establish the process for conducting, monitoring, and coordinating the test program.
- Define the test organization and specify its authority and responsibilities.
- Describe the administrative requirements of the test program.

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The TPP should be developed to ensure that management and technical resources are applied in a coherent and organized manner to achieve the test program objectives. The test program should include the following elements:

- *Identification and definition of test requirements* – Contract specifications should define those tests necessary to ensure that equipment meets performance requirements.
- *Identification of system integration tests* – In addition to contractually required tests, system integration tests should be identified and performed to ensure that necessary compatibility has been achieved among all elements of the new system and with the existing system.
- *Establishment of a test program administration system* – Administration of the test program on larger projects will be a major undertaking and should be managed through computerization, using a system to monitor, control, document, and report on program status. A test numbering system should be established to assist in the administration and retrieval of testing documents.
- *Development of testing sequence and schedules* – The test schedule should conform to and support the overall project schedule. The initial test schedule, developed when planning the test program during the Design Phase, should be updated regularly during the Construction and Testing and Start-Up of the project. A test management team established within the overall project organization should administer the test program. A test engineer should be assigned responsibility for managing the test program. This engineer should be assisted from consultants and grantee staff, as appropriate.

6.2 Test Program Elements

6.2.1 Contractually Required Testing

Contractually required testing should begin during the Construction Phase and continue through the Testing and Start-Up Phase. The following categories of tests should be considered:

- The contractor at the component and subsystem levels should conduct design qualification tests during contractor engineering to demonstrate compliance to the specifications.
- The contractor at the component and subsystem levels should conduct production verification and construction inspection tests during production in the shop and construction in the field to ensure that the product performs in accordance with design.

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- The contractor at the subsystem level should conduct installation and verification tests to ensure proper installation.
- The grantee's representatives should conduct acceptance tests at the system level to verify that all delivered and installed equipment performs as specified.
- The grantee's representatives should conduct demonstration tests to demonstrate the performance and reliability of the system equipment in the Testing and Start-up and Revenue Service Phases. An Incident Evaluation Committee, chaired by the test engineer should evaluate the relevance of all failures to the demonstration test program and require corrective action to be taken where and when necessary.

Contractors should be required by contract to prepare plans and procedures for tests they are contractually responsible for performing. The contractor should be required to submit the test plans and procedures for review and approval. A grantee representative (agency staff or consultant) should perform a thorough review of the test plans and then authorize the contractor to proceed with testing. The contractor should be required to prepare test results and reports, which should be promptly reviewed by grantee representatives. The grantee representative's review should result in providing the contractor with written approval or rejection of the tested component or subsystem.

Grantee representatives should develop plans, procedures, and reports for acceptance and demonstration tests. Tests should be scheduled, conducted, and documented in accordance with the approved schedules, plans, and procedures and should be monitored by grantee representatives. Formal reports on the status of the test program should be issued not less than monthly to project management.

Requirements for testing of materials should be defined in the construction contract for both construction materials and materials used in the fabrication of equipment. In addition, testing of products for which fabricators submit material certificates or certificates of compliance should be conducted on a random basis or when the validity of the materials or products, or documentation is questionable. Contract-specific inspection and test plans should identify the products or materials that require testing.

6.2.2 System Integration Testing

System integration testing should be conducted upon completion of the contractually required acceptance tests. The system integration testing should be performed to demonstrate the ability of various subsystems and facilities to work together as a system and for the new or modernized system to function with an existing system. The system integration testing should be performed by the

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grantee's staff with support, as required, from consultants. The test engineer should administer and be responsible for the performance of the tests.

Each system integration test should be documented in a formal report prepared by the grantee representatives who conducted the test. A Safety Certification Review Team (SCRT) should independently review tests that affect system safety to ensure that identified hazards have been controlled or eliminated. During performance, reliability, and system integration testing, equipment suppliers should be required to participate in tests of 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.

6.2.3 Pre-Revenue Testing

A period of full system operation prior to initiating revenue service for the public is required to both familiarize grantee management and O&M employees with the new system and to complete testing requirements that are beyond the contractually required responsibilities of individual contractors. The types of tests that might be appropriate during the pre-revenue phase include the following:

- Train braking tests – Can a car/train stop in the distance required in every possible situation?
- Signals tests – Do the signals operate as expected in every possible situation? What happens when one car/train is close behind another?
- Power tests – Do the substations supply the voltage and current as expected in every situation? What happens when the maximum number of cars is on the line and accelerating?
- Power (car) tests – Will a car/train still operate properly when the voltage falls to its minimum?
- Speed tests – Do the cars/trains ride properly at maximum speed? Is there always a good power contact at maximum speed? Can a car/train operate through a switch at maximum (switch) speed without problems?
- Clearance tests – Do cars/trains clear fixed objects properly (above and below as well as on the sides)? Can cars/trains pass one another everywhere they are supposed to?
- Wheelchair devices – Do the devices interface with the cars properly?
- Tests of emergency equipment and systems – Are specified emergency equipment and systems for ventilation and exhaust, generation of electricity, water removal, fire detection and suppression, intrusion

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detection, detection of weapons of mass destruction (WMD), communications, and lighting installed and properly operating.

The following section describes additional detail on preparing for O&M activities.

6.3 Preparation for Operations and Maintenance

The following sections describe elements to be accomplished in preparation for O&M activities. They should be established prior to beginning pre-revenue service and modified, as required, based on the experience of pre-revenue service. The creation of a Start-Up Committee comprised of the following functions should be considered:

- Operations Director (chair)
- Transportation Manager
- Maintenance Manager
- Control Center Manager
- Training Manager
- System Safety Director (includes Fire and Life Safety Committee)
- Project Manager

6.3.1 Agreements

Agreements need to be negotiated with all affected jurisdictions and agencies that have jurisdiction over the operation of the transportation system. These organizations and their requirements should be identified earlier in the project development process to assure that their requirements are accommodated, to the extent possible, in the design and construction phases. Prior to initiating pre-revenue service, additional required agreements could relate to:

- Utilities that directly support the improvement
- Operating permits from the local municipality
- Police, fire, and emergency response liaison
- Shared R/W owners, e.g., streets, highways, railroads, utilities
- Local traffic management interfaces (especially with light rail)
- Adjacent major ridership generators, e.g., university, airport, stadium, and other developments (especially with shared stations).

6.3.2 Establishment/Modification of Operating Organization

The grantee must establish an organization to perform or oversee the management, operations, maintenance, and supporting functions required for the implementation of the transit capital project. If housed in the same organization responsible for implementing the project, a transition will be required from the organization used to direct and oversee the project development to a more

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operations-oriented organization. In larger organizations separate capital project and O&M functions can continually co-exist.

6.3.3 Procedures, Rulebooks, and Manuals

Operations and maintenance procedures and rulebooks need to be developed or modified by the transit agency to address all areas affected by the transit capital improvement. O&M manuals should be finalized and turned over to the operating organization by the contractor prior to completing the Testing and Start-up Phase. They should incorporate all lessons learned from start-up.

6.3.4 Recruitment of Personnel

The operating agency must assess the labor required to operate and maintain the transit capital improvement project and recruit personnel with the skills required in time to support the testing and start-up phases, as well as revenue service phases. This will be directly related to the operating plan developed in conjunction with the capital improvement's implementation. Vehicle maintenance requirements will be a function of the fleet utilization and the inspection and maintenance standards established.

6.3.5 Training

Plans for a comprehensive training program for all O&M personnel should be in full operation during the start-up period and may include a period of joint operation by contractor and grantee personnel. A major aspect of pre-revenue service is the hands-on training of all O&M personnel.

For a new rail service, rail transportation training should be developed for all operators, supervisors, and dispatchers. Maintenance training should be provided for the following areas:

- Electrical systems
- Signal systems
- Track
- Shop equipment
- Revenue vehicles
- Fare collection systems
- Vertical transportation systems (escalators and elevators)
- Normal and emergency communications systems
- Security systems
- Non-revenue vehicles

The proficiency of all employees receiving training should be tested and verified, and all persons' training should be documented in their employee files. In addition, there may be a requirement for local certification as an operator.

6.3.6 Pre-Revenue Operations

Successful completion of system integration tests usually constitutes “substantial completion” and leads to the start of pre-revenue operations and testing. Sufficient time must be allocated to complete all testing and operations training prior to the date established to begin revenue service. These operations should be designed to mimic revenue operations and maintenance activities, except that passengers will not be carried. The following items may be considered in the evaluation of pre-revenue operations:

- Notification procedures
- 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
- Assumption of authority
- Rescue train
- Simulated public notification
- “On the line” vehicle troubleshooting
- Simulated emergency training

6.4 Safety Oversight

Safety oversight of transit is provided as follows:

- The FTA requires states to designate an agency to oversee the safety of any fixed guideway transit (non-commuter rail) system within the state. This is referred to as the State Safety Oversight Agency (SSOA).
- The Federal Railroad Administration (FRA) has safety jurisdiction over transit operating on the general railway system (commuter rail).
- In certain circumstances, a waiver from FRA safety oversight is negotiated to permit FTA oversight of transit fixed guideway operations that share the right-of-way with the general railway system, e.g., light rail operating with temporal separation.
- Except for a few Federal (e.g., Federal Motor Carrier Safety Standards (FMCSS) and FTA bus testing) requirements related to bus vehicles and

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Occupational Safety and Health Administration (OSHA) and FTA Drug and Alcohol regulations related to bus operations, bus safety oversight is limited to a variety of different state requirements. In general, there is little oversight related to the safety of bus capital projects.

State Safety Oversight (SSO) requires the SSOA to prepare System Safety Program Standards (SSPS) that are governed by FTA requirements that include:

- Transit agency to prepare and implement a System Safety Program Plan (SSPP) and a System Security Program Plan
- Safety review of fixed guideway transit systems at least every three years
- Accident and incident investigation procedures
- Internal safety audit process
- Designation of an unacceptable hazardous condition, if warranted
- Developing and reporting on a corrective action program
- Safety monitoring
- Safety reporting

☞ *Implementation Guidelines for State Safety Oversight of Rail Fixed Guideway Systems* [Ref. 21]

In recent years the SSO program has encouraged the safety and security oversight of the transit capital project development process including Safety and Security Certification by the grantee. The SSOA may oversee the Safety Certification process from design through testing and start-up, and conduct a pre-revenue service assessment prior to the initiation of revenue service.

☞ [Handbook for Transit Safety and Security Certification](#) [Ref. 19].

6.5 Safety and Security Certification

Safety and Security Certification (SSC) is a process by which an agency self-certifies satisfactory compliance with a formal list of safety requirements of a transit capital project. Note that the word “safety” is used to deal with hazards (due to unintentional acts) and “security” to deal with vulnerabilities (due to intentional acts). The SSC program typically encompasses the following three categories:

- Systemwide Elements – May include the passenger vehicles, catenary, traction power, train control, voice and data communications, Closed Circuit Television (CCTV), grade crossing and traffic control, intrusion detection system, central instrument houses, track, fare collection, supervisory control, fire protection and suppression systems, and auxiliary vehicles and equipment.

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- Fixed Facilities – May include stations and shelter stops, pedestrian bridges, yards and shops, structures, and the control center. Equipment installed in stations or shelter stops such as Heating Ventilation and Air Conditioning (HVAC), escalators, elevators is also considered part of the facility.
- Plans, Procedures, and Training – May include items such as emergency preparedness plans, security plans and procedures, training programs, rulebooks, and standard operating procedures.

When properly scoped, the SSC program will:

- During Design
 - Develop, document, and communicate safety and security criteria to guide design, engineering, and specification for the transit project.
 - Identify safety and security critical issues and develop practical and cost-effective requirements to support their resolution.
 - Use hazard and vulnerability analysis to evaluate the impact of all deviations introduced into the system in the form of engineering change proposals, construction change orders, work-arounds, and other temporary measures prior to the initiation of revenue service.
 - Develop management mechanisms to track and control the incorporation of safety and security into the transit project.
 - Identify certifiable items
 - Develop safety and security design criteria
 - Develop and complete design criteria conformance checklist
 - Perform construction specification conformance
 - Identify additional safety and security test requirements
- During Construction
 - Perform testing and validation in support of the SSC Program
- During Testing and Start-Up
 - Manage integrated tests for the SSC Program
 - Manage “open items” in the SSC Program
 - Verify operational readiness
 - Conduct final determination of project readiness and issue SSC.

While SSC should begin early in the project development process to influence design in order to overcome hazards, threats, and vulnerabilities, intensive effort should occur during construction and concludes during the testing and start-up phase. The SSC process should be guided by an SSC Plan, the development

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and implementation of which is directed and overseen by a Safety Certification Review Committee (SCRC) comprised of the following grantee representatives:

- Director of System Safety (Chair)
- Director of Security
- Director of Engineering or General Engineering Consultant (GEC)
- Director of Operations
- Director of Maintenance

The SCRC should be supported by the grantee staff and consultants involved in managing the implementation of the project, in addition to following functions or committees:

- Fire-Life Safety Committee (FLSC) – Serves as a liaison between the grantee, fire jurisdictions, and emergency response agencies. The FLSC reviews standards and safety-related designs and tests to verify fire-life safety code and regulatory compliance. In addition, the FLSC addresses preparedness issues and reviews variances.
- System Change and Operations Review Committee (SCORC) – Serves as a liaison to the grantee's O&M functions and departments related to operations planning, rules and procedures, training, pre-revenue service, and review and approval of changes to the system and fixed facilities that impacts O&M.

The chief executive of the grantee should sign the Safety and Security Certificate based on the recommendation of the SCRC.

6.6 Emergency Preparedness

The transit agency should establish strong ties with emergency response agencies and resources to provide for mutual assistance in support of transit emergencies and for transit to provide its resources to respond to community emergencies. Emergency preparedness requires working with local emergency management groups to develop procedures and contingency plans. As part of the start-up of the new transit project, there should be specific plans developed to address the site-specific nature of the capital project. Prior to revenue operations, specific drills should be performed depending on the nature and scope of the project. If two drills are warranted, one could be a tabletop exercise and one could be an on-site drill to simulate an emergency situation. The goal of the drills is to validate the emergency coordination between emergency personnel and grantee emergency procedures.

Examples of emergency readiness drills include:

- Bomb threat
- Simulated fire and smoke on a railcar
- Grade crossing collision with injuries

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- Underground toxic chemical release
- Patron evaluation on aerial structures and in tunnels

Important aspects related to an emergency drill include:

- Defining the roles and responsibilities of the people involved
- Having observers to critique the drill
- Having a drill debriefing to obtain feedback
- Producing a drill summary
- Closing out the drill as an SSC item through an SSC test certificate

6.7 Public Relations and Marketing

Throughout the capital project development process, there should be a public outreach and information program. Where the project directly relates to transit customers, especially for new or expanded service, this effect should expand to an intensive marketing campaign to encourage the public to utilize the improved service. This also needs to include specific information on how to use the new service including reoriented feeder bus service and park-and-ride facilities.

PMO [Lessons Learned #5:](#)

Bus – Rail Integration (1/95)

Introduction of a light rail system into an area where public transit was comprised of only buses requires extensive planning, coordination, and careful execution. Bus patrons and automobile commuters need to be educated about how to use the rail system. It is essential that all potential patrons of the light rail system feel comfortable and confident when the new system opens. The St. Louis Light Rail Project, known as MetroLink, developed a public information program to win the confidence of bus patrons and future rail patrons. The program consisted of two parts: Bus Buddies and Rail Ambassadors. The success of these efforts was apparent: the ridership exceeded all expectations by over 100 percent on rail and by more than 8 percent on the bus system.

PMO [Lessons Learned #29](#):

Commuter Rail Safety-Educating the Public (9/97)

On September 29, 1997, the Massachusetts Bay Transportation Authority (MBTA) reinstated commuter rail passenger service on the Old Colony Line. For a period of approximately 38 years, residents of the South Shore area have gradually become accustomed to driving across highway-rail grade crossings and accessing the right-of-way without concern for high-speed passenger train traffic. The MBTA recognized early in the design process that the revenue service phase would require a comprehensive safety awareness program. The MBTA created the "Office of Old Colony Communications" with the responsibility to reach out to the cities and towns affected by the new rail passenger service. The MBTA began educating the public utilizing the "Operation Lifesaver" program more than two years prior to the scheduled revenue operation date.

6.8 Initial Revenue Service

Transit capital project management concerns typically end at the conclusion of the Testing and Start-up Phase, except for the management of warrantee claims. The grantee should pay close attention to the following during the Revenue Service Phase to maintain a high level of system performance:

- A continuous quality improvement or lessons learned program
- A configuration management and change control process
- A system capital replacement and modernization program