

<b>SAN FRANCISCO PUBLIC UTILITIES COMMISSION INFRASTRUCTURE CONSTRUCTION MANAGEMENT PROCEDURES</b>	
<b>SECTION: SFPUC INFRASTRUCTURE CONSTRUCTION MANAGEMENT</b>	<b>APPROVED:</b> 
<b>PROCEDURE NO: 018</b>	<b>DATE: 6/7/2019</b>
<b>TITLE: SYSTEM TESTING AND START-UP</b>	<b>REVISION: 1</b>

**1.0 Policy**

The two major areas of particular importance for facility testing and start-up process are;

- Reliability and integrity of the transmission and collection systems,
- Reliability and operations of the communications, data transmission, power, instrumentation and control systems.

This SFPUC Infrastructure Construction Management (CM) Procedure focuses on pre-testing, training, testing and start-up of the communications, data transmission, power, instrumentation and control systems, after the completion and acceptance of mechanical and installation tests.

This CM Procedure applies to all personnel working on the SFPUC Infrastructure projects during construction to the extent that their Work is affected by these CM Procedures and does not conflict with specific San Francisco Public Utilities Commission (SFPUC) Policies or the Contract under which the Work is executed.

**2.0 Description**

This CM Procedure defines the tasks, requirements, sequence and responsibilities for execution of system testing and start-up of a new system or facility during the construction phase of the SFPUC Infrastructure projects.

This CM Procedure also describes how issues identified during the process will be managed and resolved. It will be necessary to adapt this procedure to the actual scope and content of each project. This is particularly important when the

system consists of multiple facilities linked by remote telemetry and controls that must operate in an integrated manner. The facility shutdown process detail description is provided in SFPUC Infrastructure CM Procedure No. 019, Shutdown/Specific Condition Coordination.

## **2.1 Testing and Start-up Sequencing**

A typical facility testing and start-up process consists of the following sequential activities:

- Approved Testing Submittals
- Factory Testing
- Pre-Start-up Coordination Meeting,
- Field and Shop Mechanical and Conveyance Inspections,
- Functional Testing for components, subsystems and systems,
- Communication System Functional Tests for SCADA or DCS.
- Performance Test for subsystems and systems,
- Control System Functional Tests,
- Pre-Start-up Test activities,
- System Disinfection (sequence to be confirmed for water facilities),
- Start-up Test activities,
- Performance Run,
- Post-Performance Run, corrective actions if required.

## **3.0 Definitions**

### **3.1 Construction Management Information System (CMIS)**

The CMIS is an on-line management tool for the processing of contract documents based on established SFPUC Infrastructure CM Business Processes. It serves as a tool for effective storage and retrieval of various documents generated during a construction project. Contractor RFI submittals and associated RE submittal responses should be entered directly into the CMIS.

### **3.2 Control Systems Functional Acceptance Test (FAT)**

The Control Systems FAT demonstrates the proper interaction of the facility Programmable Logic Controller (PLC) and the related equipment individual control system.

3.2.1 The System Integrator (SI) will be responsible for this test.

3.2.2 The Contractor Testing Coordinator shall coordinate tests and activities to support the control system FAT.

### **3.3 Electrical Testing (ET) Firm**

The ET Firm is the testing entity responsible for performing functional and performance tests on all Division 26 Electrical equipment, components and materials in the Contract Documents.

3.3.1 The ET Firm shall coordinate scheduling work, testing, training of SFPUC personnel, and documentation with the Contractor Testing Coordinator.

### **3.4 Field Tests**

The Field Tests denotes all field testing including functional, performance, pre-start-up and start-up tests.

### **3.5 Functional Test**

The Functional Testing is required to determine, if installed equipment, subsystem or system will operate in a satisfactory manner and as specified.

3.5.1 The Functional Test is a point-by-point test to confirm that all components associated with the equipment, subsystems or systems are operating properly. All non-operating adjustments, cold alignment checks, equipment installation and status servicing, other specific tasks recommended by the manufacturers, and/or cleaning shall be completed prior to Functional Test.

### **3.6 In-Factory Tests and Source Inspections**

The In-Factory Tests and Source Inspections are the verifications that specific equipment components conform to the performance criteria specified in the Contract Documents. In-Factory and Source Inspections occur before the equipment is delivered to the construction site.

3.6.1 Prior to delivery of equipment to the work site, it may have been designated for independent Third-Party Supplier Quality Surveillance (SQS) activities. If SQS exceptions were accepted by SFPUC until equipment delivery and installation, then these exceptions must be tested for compliance during component testing. The equipment SQS Reports (with exceptions) are distributed to the RE, Project Engineer and Program CM Manager.

### **3.7 Performance Test**

The Performance Test is the field test required to demonstrate the individual equipment, subsystem or system meets all the Contract performance requirements. Successful Performance Testing is a requirement of Substantial Completion.

3.7.1 After equipment or system start-up, a Performance Run will be conducted for the entire facility in compliance with Contract Documents.

### **3.8 Pre-Start-Up Test**

A Pre-Start-Up Test is a test of portions and all systems (or specific groups of systems) operating together to demonstrate satisfactory performance of the facility as a whole, as it performs connected to the SFPUC system, for the specified Pre-Start-Up Test period without failure and to the satisfaction of the Contractor and the SFPUC.

3.8.1 The test procedures for both the Pre-Start-Up Test and Start-Up Test shall be the same. Any Start-Up Test requirement applies to the Pre-Start-Up Test. The Pre-Start-Up phase allows the Contractor to make final adjustments and troubleshooting before Start-Up Testing. Successful completion of Pre-Start-Up Test shall ensure that the Contractor is ready to demonstrate satisfactory operational performance of the entire facility.

### **3.9 Supervisory Control and Data Acquisition (SCADA)**

3.9.1 The SCADA is a supervisory control system that monitors and coordinates the process.

3.9.2 The Remote Terminal Units (RTUs) are subsystems connecting to sensors in the process, converting sensor signals to digital data and sending digital data to the supervisory system.

### **3.10 Distributed Control System**

3.10.1 A Distributed Control System (DCS) is a control system for a process or plant, wherein control elements (controllers) are distributed throughout the system. In a DCS, a hierarchy of controllers is connected by communication networks for command and monitoring.

### **3.11 Start-Up Test**

The Start-Up Test is the final commissioning test of all systems operating together to demonstrate satisfactory performance of the entire facility, as it performs connected to the SFPUC system, for the specified Start-Up Test period, without failure and to the satisfaction of the SFPUC.

### **3.12 Test Procedures**

The test procedures shall include detailed testing methods and equipment, pre-test checklist, acceptance criteria, procedures, details of all necessary adjustments and personnel, component testing, sub-system testing, performance testing, and test data forms for functional performance and start-up tests.

3.12.1 If any portion of a test fails, the Contractor shall correct the problem and repeat the test to the satisfaction of the SFPUC Infrastructure CM Inspectors.

3.12.2 If any component or system failure occurs during Pre-Start-Up or Start-up Testing, then the entire test protocol shall be restarted.

3.12.3 After the completion of the Start-Up testing, the test data forms should be bound and turned over to facility Operations & Maintenance Department for future reference.

#### **4.0 Responsibilities**

A typical System Testing and Start-up Team Organization, including direct lines of communication, field communication/coordination and “as needed” support is presented on Attachment 18 – 1.

##### **4.1 Resident Engineer (RE)**

The RE, with assistance from the CM Team, is responsible for reviewing the testing and startup requirements included in the Contract Documents for each project.

4.1.1 Testing and Start-Up Team direct reports to the RE are;

- Project Engineer,
- ITS / SCADA Specialist,
- Electrical, Instrumentation & Controls Inspectors,
- Mechanical Inspectors,
- CM Consultant Test & Start-up Engineers,
- CM Consultant Electrical & Mechanical Inspectors (as needed).

##### **4.2 Project Engineer (PE)**

The SFPUC PE, in collaboration with the Operations Representative (OR), is responsible for defining the testing, start-up and commissioning requirements to be included in each construction contract.

4.2.1 The PE provides the interface with the Engineer of Record (EOR) who develops the engineering design and contract requirements. The PE may be the EOR in some cases.

4.2.2 The PE reports to the RE during facility testing, start-up and commissioning activities.

4.2.3 The EMB Design Engineers report to and provide support to the PE.

##### **4.3 CM Test & Start-Up Engineers (T&SE) – CM team**

4.3.1 The T&SE report to the RE and functions as the project interface with SFPUC Operations for the City’s responsibilities during project testing, training, commissioning, start-up and acceptance activities.

4.3.2 The RE designates one T&SE personnel as the responsible “lead” that coordinates the field activities with the Contractor Testing Coordinator.

4.3.3 The T&SE reviews the Contractor's test and start-up plans and coordinates with SFPUC Operations to minimize impacts to existing operating facilities and systems.

#### **4.4 Inspectors – CM team**

4.4.1 On each project, one Inspector will be designated a "Lead" Inspector for the CM team members to assist the RE in planning for and coordinating all inspection activities. The Lead Inspector is responsible for compiling, reviewing, and approving all Daily Inspection Reports.

4.4.2 The inspectors assure that the construction work is performed and completed in accordance with the Contract Documents; conduct periodic observation and inspection of the work, monitor Contractor's quality progress, coordinate field sampling and verification testing for quality.

4.4.3 The various specialty discipline Inspectors will be assigned as needed for the specific work activities to assist with start-up and commissioning activities. Specific Inspector needs for facility start-up may include mechanical, communications, electrical, control systems and instrumentation expertise.

#### **4.5 Electrical Testing (ET) Firm – Contractor**

4.5.1 The ET Firm is the independent third-party testing organization responsible for performing functional and performance test on all Division 26 Electrical equipment, components and materials.

4.5.2 The ET Firm is a Sub-Consultant provided by the Contractor and works directly with the Contractor Testing Coordinator.

4.5.3 The Electrical Testing firm shall coordinate scheduling work, testing, training of City personnel, and documentation with the Contractor Testing Coordinator.

#### **4.6 System Integrator (SI) - Contractor**

4.6.1 The SI is the responsible party for interfacing the facility Programmable Logic Controller (PLC) and Controls to the Local Operator Interface (LOI) and the SFPUC's established San Francisco Water Department (SFWD) Supervisory Control and Data Acquisition (SCADA) System.

4.6.2 The SI duties include, but not limited to, performing all work necessary to design, select, furnish, customize, debug, supervise installation, connect, calibrate, field modify existing control and instrumentation wirings and place into operation all hardware, communication lines and equipment, and coordinate the programming of all software.

4.6.3 The SI provides the "As-Built" Programmable Logic documentation to the RE.

- 4.6.4 The SFPUC SCADA System may be programmed by the City. Depending on the specific contract, the Contractor may be requested to provide additional support services. The SI shall coordinate scheduling of work, testing, training of City personnel, and documentation with the Contractor Testing Coordinator.
- 4.6.5 The SI is provided by the Contractor and reports to the Contractor Testing Coordinator.

#### **4.7 Contractor**

- 4.7.1 The Contractor is responsible for developing and submitting proposed test procedures, test schedules and Facility Testing and Start-Up Plan in accordance with the Contract Documents, refer to Attachment 018 - 4.
- 4.7.2 Depending on the extent of the work and the requirements of the Contract, the Contractor may be required to provide a full-time Contractor Testing Coordinator, SI and ET Firm to prepare plans, accomplish the test and commissioning work, and submit testing reports.
- 4.7.3 The Contractor Testing Coordinator is the Contractor lead for the facility start-up and commissioning activities and coordinates the activities with the RE or designated Lead Test & Start-up Engineer.
- 4.7.4 The Contractor shall make the Electrical Subcontractor available as part of the facility start-up team to perform corrective actions.

#### **4.8 Contractor Testing Coordinator**

- 4.8.1 The Contractor Testing Coordinator is a testing and commissioning expert (not the Contractor's Superintendent) responsible for overseeing, organizing, planning, coordinating, assembling, compiling, and administering all field testing including the functional, performance, and start-up tests for the overall project.
- 4.8.2 The Contractor Test Coordinator is responsible lead for the Contractor testing and commissioning activities.

#### **4.9 Communications/SCADA Specialist - Contractor**

The Contractor Communications/SCADA Specialist coordinates and performs all Contract work associated or connected to the SFWD SCADA with the ITS/SCADA Coordinator.

#### **4.10 ITS/SCADA Specialist - City**

The ITS/SCADA Coordinator coordinates all work associated or connected to the SFPUC SCADA system with the Contractor's Communications/SCADA Specialist. The ITS/SCADA Specialist completes all final connections to SCADA system.

#### **4.11 Operations Representative (OR)**

4.11.1 The OR assists the facility testing and start-up team and coordinates the activities of the Operating Divisions.

4.11.2 The OR is responsible to coordinate the activities of the Operations Disinfectant Team and the CM team. The Operations Disinfectant Team implements the method and parameters specified by the Water Quality Bureau.

4.11.3 The OR participates on facility "Punch List" inspection, facility acceptance and closeout activities.

#### **4.12 EMB Design Engineers - City**

The SFPUC Engineering Management Bureau (EMB) Design Engineers shall provide field support as determined by RE and Project Engineer relevant to each project. Design Engineering support can include witness testing, reviewing field calculations or responding to technical Requests for Information and submittals.

### **5.0 Implementation**

The overall procedure for system testing and startup is defined by the activities described below and as shown in Attachment 18-2.

#### **5.1 Submittals**

5.1.1 The Contractor shall submit all the required submittals in accordance with the Contract Documents for the City's review and approval;

5.1.1.1 Confirmation of submittal requirements from vendors and Electrical subcontractor.

5.1.1.2 List of all in-factory and source testing, and all field tests.

5.1.1.3 Proposed Testing personnel and firms' qualifications.

5.1.1.4 Manufacturer's representative qualifications and scope.

5.1.1.5 Test procedures for all field tests.

5.1.1.6 Facility Testing and Start-Up Plan based on project technical specifications, refer to Attachment 018 – 4.

5.1.1.7 Comprehensive Testing Schedules for Functional Testing, Performance Testing, Pre-Start-up Testing, Start-up Testing and Performance Run.

5.1.1.8 Daily Test Reports

5.1.1.9 Final Field Test Reports

5.1.1.10 Device Settings for all field adjustable devices.

5.1.1.11 Field Test Manual



- 5.1.2 Submittal approval process: The RE is responsible for distributing the submittals to the PE, and T&SE; all of whom shall review and comment within a reasonable period, or, if applicable, within the time specified in the Contract Documents. All review comments shall be returned to the RE.
- 5.1.3 The Contractor shall provide missing submittals or resubmit corrections to the RE.
- 5.1.4 System Testing, Start-up and Post Performance Run submittals and records summary are presented in Attachment 18 – 3. The summary list does not indicate every test data submittal required as required in each equipment or item project technical specification.

## **5.2 Field Testing Coordination Meetings**

- 5.2.1 The Contractor schedules and conducts the weekly testing coordination meetings for the Start-up Team;
  - City Personnel: RE, PE, ITS/SCADA Specialist, Instrumentation & Controls Inspector, and OR.
  - CM Consultant Personnel: Test & Start-up Lead, Test & Start-up Engineer(s), Electrical and Mechanical Inspectors.
  - Contractor Personnel: Contractor Testing Coordinator, Electrical Testing Firm, System Integrator, Communications/SCADA Specialist, and Electrical Subcontractor.

The actual composition of the Testing and Start-Up Team will be based on specific project needs.

- 5.2.2 Items for discussion: The purpose of the field testing coordination meetings are to clarify the requirements in the Contact Documents, to discuss the overall test scheduling, procedures, plans, strategy, and preparations for the forthcoming testing.
  - 5.2.2.1 Agreement for the removal of Lock-out/Tag-out barriers to safely energize the electrical systems, refer to Section 5.12.
  - 5.2.2.2 The PE will confirm if Supplier Quality Surveillance exceptions were accepted at the equipment supplier fabrication facility. The RE upon consultation with Senior CM will decide if additional surveillance is necessary.
- 5.2.3 Facility Disinfection: RE, OR and Water Quality Representative will decide when and where to implement facility disinfection, if required; refer to Technical Specification Section 01 35 55, Sanitary Work Practices, Disinfection, and Other Regulatory Requirements.

### **5.3 Mechanical and Conveyance Inspections and Tests**

- 5.3.1 Roles and Responsibilities: The Contractor Testing Coordinator shall lead the equipment and conveyance inspection and testing activities with assistance from the CM Testing and Start-Up Engineers, if required.
- 5.3.2 The Contractor shall perform mechanical inspection and testing process in accordance with the Contract Documents and manufacturer's recommended practice.
- 5.3.3 The Contractor shall perform conveyance system inspections and testing process in accordance with the Contract Documents.
- 5.3.4 CM Witness and Documentation: Field tests shall be witnessed and documented by CM inspectors,

### **5.4 Functional Tests**

- 5.4.1 Roles and Responsibilities: The Contractor Testing Coordinator shall lead Functional Test activities with assistance from the CM Testing and Start-Up Engineers, if required.
- 5.4.2 Testing shall not proceed until the City has received and approved the following: Interconnection and Loop Diagrams, all Factory Tests, Manufacturer's Certificate of Installation, Equipment or System Test submittals, Spare Parts and Tools, and Draft Operations & Maintenance Manuals.
- 5.4.3 Functional Testing: Functional Testing is the verification that each component complies with the Contract Documents. These tests may include Communication System Functional Test, Calibrations, Loop Checks, Electrical Commissioning, Installation Checks, Operations Check, Controls Checks, Alarm Checks, Run Checks, and other functional test requirements as specified in the Technical Specifications or by the equipment manufacturer.
- 5.4.4 Contractor Testing Coordinator confirms performance of installed components.
- 5.4.5 CM Witness and Documentation: Functional Tests shall be witnessed and documented by SFPUC Infrastructure CM Inspectors.

### **5.5 Communication System Functional Test (for SCADA or DCS)**

- 5.5.1 Roles and Responsibilities: The Contractor Testing Coordinator is responsible for coordinating the Communications System Contractor, SI, and independent ET Firm to test the fiber optic communications to the RTUs and fiber optic or microwave communications to the existing SFPUC network.
- 5.5.2 Test Requirements: All communication systems test requirements are specified in Division 27 of the Contract Technical Specifications.

- 5.5.3 Facility Telecommunications: The SF Department of Telecommunications and Information System (DTIS) is responsible for the installation of equipment and cable and the testing, service, documentation and operational acceptance of the facility telecommunication system. The RE coordinates the contract work associated with the installation of conduit and other communication related facilities with DTIS.
- 5.5.4 CM Witness and Documentation: ITS/SCADA personnel, DCS Staff, Inspector, and OR verify proper installation of all communication systems.
- 5.5.5 The instrumentation and control communications testing shall not proceed until all related systems have been completely installed and tested (including loop checks, leased telephone (ADN) data communication tests, spread spectrum and MAS radio, and VSAT) as required by the respective technical sections, and all systems are ready for operation.
- 5.5.6 If the project scope is limited to new input to (E) DCS, this test is limited to electrical subcontractor coordinating with City staff to verify signal reception to (E) DCS.

## **5.6 Performance Test Requirements**

- 5.6.1 Roles and responsibilities: The Contractor Testing Coordinator shall lead Performance Test Requirements activities with assistance from the CM Testing and Start-Up Engineers, if required.
- 5.6.2 Prerequisites and Documentation: Prior to proceeding with the Performance Tests, the Contractor shall successfully complete factory and field functional test of electrical component results that have been accepted by SFPUC.
- 5.6.3 Performance Tests: Verification of equipment or system that meets all specified performance requirements described in the individual Technical Specifications.
- 5.6.4 CM Witness and Documentation: Witness and documented by Lead T&SE and Inspectors.

## **5.7 Control System Functional Acceptance Test (FAT)**

- 5.7.1 Roles and Responsibilities: The Contractor Testing Coordinator is responsible for coordinating the Control System Functional Acceptance Test with Instrumentation and Electrical Subcontractor, Independent Electrical Testing Firm, Electrical CM Inspector and other designated SFPUC personnel.
- 5.7.2 Prerequisites and Documentation: Prior to proceeding with the Control System FAT, the Contractor shall completely install and successfully test all systems (including loop checks and the instrumentation and control communication system tests) as

required in the Contract Documents, and all systems shall be ready for operation.

5.7.3 Test requirements: Contractor System Integrator with the Testing Coordinator conducts a formal FAT's to demonstrate proper performance of each process sub-system control modes (local manual/automatic, remote manual/automatic) from all interface locations prior to energizing or operating major systems components. If required in the Contract Documents, California State Certified electrician shall be provided by the Contractor to resolve potential conflicts between the control systems and other equipment or systems installed under the Contract.

5.7.4 CM Witness and Documentation: Witness and documented by CM Inspectors and other designated personnel.

## **5.8 Pre-Start-Up Test**

5.8.1 Roles and Responsibilities: The Contractor Testing Coordinator shall lead the Pre-Start Up activities with assistance from the CM Testing and Start-Up Engineers, if required.

5.8.2 Prerequisites and Submittals Review: Prior to Pre-Start-Up demonstration, Contractor shall complete the following: approval of all factory, functional, and performance test records and draft Operations & Maintenance Manuals by the City, training of City personnel, all facility equipment and lines tagged and labeled, City's approval of near final As-Built Drawings, and approval of Start-Up Test procedure and Start-Up Plan by the City.

5.8.3 City Personnel Training: All City operations and maintenance personnel shall be instructed on facility equipment and system and documented, refer to Section 5.13 for details.

5.8.4 Systems Tests: Pre-Start-Up Test duration shall be specified in the Contract Documents. The test shall be completed without failure.

5.8.5 Witness and Documentation: Witness by Lead T&SE, CM Inspectors, RE, and other designated project stakeholders.

## **5.9 Start-Up Run**

5.9.1 Roles and responsibilities: The Contractor Testing Coordinator shall lead the Pre-Start Up activities with assistance from the CM Testing and Start-Up Engineers, if required.

5.9.2 Prerequisite: Completion and acceptance of corrective actions discovered during Pre-Start-Up Test Run, successful completion of Pre-Start Up Test accepted by SFPUC, and completion of system disinfection.

5.9.3 Start-Up Process: The approved Start-Up Plan developed, implemented, and lead by the Contractor Testing Coordinator.

5.9.4 CM Witness and Documentation: Witness and documented by Inspectors, RE, OR, PE and other designated project stakeholders.

## **5.10 Performance Run**

5.10.1 Roles and Responsibilities: The Contractor Testing Coordinator, CM T&SE, PE and CM team members shall perform the final commissioning.

5.10.2 Prerequisite: Successful completion of Start-Up Test and activities.

5.10.3 Performance Run: Performance Run is the verification step that the operation of all facilities provided or modified by the Work is successful and reliable on an extended basis without failure as defined in scope and duration by the Contract Documents. Successful performance testing is a requirement of Substantial Completion.

5.10.4 CM Witness and Documentation: All facility functions are completed and witness tested per plan during final commissioning.

5.10.5 Facility Substantial Completion: Full and successful operation of all components and systems of the Work, including acceptance of satisfactory completion of all testing and start-up requirements and completion of all Work in accordance with the Contract Documents for Substantial Completion.

## **5.11 Post-Performance Run**

5.11.1 Correct All Deficiencies: Contractor shall correct all deficiencies discovered during Performance Run period to the acceptance of RE.

5.11.2 Facility Restoration: After successful completion of Facility Performance Run, the Contractor shall recheck all machines for proper alignment, remove all temporary equipment, and return facility to service.

5.11.3 Remaining Documentation: All remaining or revised contract submittal documents shall be provided to RE including final "As-Built" Drawings, "As-Built" Programmable Logic, Final O&M Manuals and Warranties.

5.11.4 Facility Turnover: After successful Performance Testing, submittal and approval of all outstanding documents, and clean-up/restoration, the facility shall be turned over to SFPUC Operating Division.

5.11.5 Proceed to Project Final Completion Phase: The RE will proceed to Final Completion activities.

### **5.12 Lock-out/Tag-out**

As part of system start-up, the RE, OR and Contractor shall follow the Lock-out/Tag-out removal process as defined in Attachment 018 – 3, SFPUC Lock-out/Tag-out Program, November 1, 2015.

### **5.13 City Personnel Training**

Prior to Pre-Start-up Test activities, all equipment training of City Personnel shall be provided in accordance with the Contract Documents.

5.13.1 Contractor shall submit names and qualifications of individual trainers for approval by RE.

5.13.2 Contractor shall submit list of operational training topics and session durations for approval by RE.

- Facility training session topics may include:
- Functional Testing,
- Performance Testing,
- Major Equipment Operations, Maintenance and Safe Practice,
- Review of Equipment O&M information including Data Sheets and recommended spare parts list.

5.13.3 SFPUC EMB is responsible to compile information, provide process description and procedure for the Facility O&M Manuals for City furnished equipment. Information which may be used in Contractor Training Sessions are:

- Facility Process Description – What it does and How it works,
- Facility Background – Explanation of systems and components,
- Facility Normal Operation, Normal Shutdown, Emergency Shutdown, Start-up Modes.

## **6.0 Other Procedural Requirements**

The following activities are not specific to the subject SFPUC Infrastructure CM procedures, but are necessary to complete the testing and start-up process:

- No. 004      Record Documents and Drawing Control
- No. 005      Submittals

## **7.0 References**

### **7.1 Technical Specifications & Other Documents**

- Section 01 35 55 Sanitary Work Practices, Disinfection, and Other Regulatory Requirements
- Section 01 75 60 Testing Coordination and Start-Up Testing
- Section 01 78 23 Operations and Maintenance Data
- Section 01 75 00 Manufacturer's and Contractor's Service

### **7.2 SFPUC Infrastructure CM Procedures**

- No. 019 Shutdown/Specific Condition Coordination
- No. 020 Project History / Lesson Learned
- No. 021 Contract Closeout (Substantial & Final Completion Certificate)
- No. 028 Construction Quality Management
- No. 030 Daily Inspection Reports
- No. 032 SQS Plan and Surveillance Process

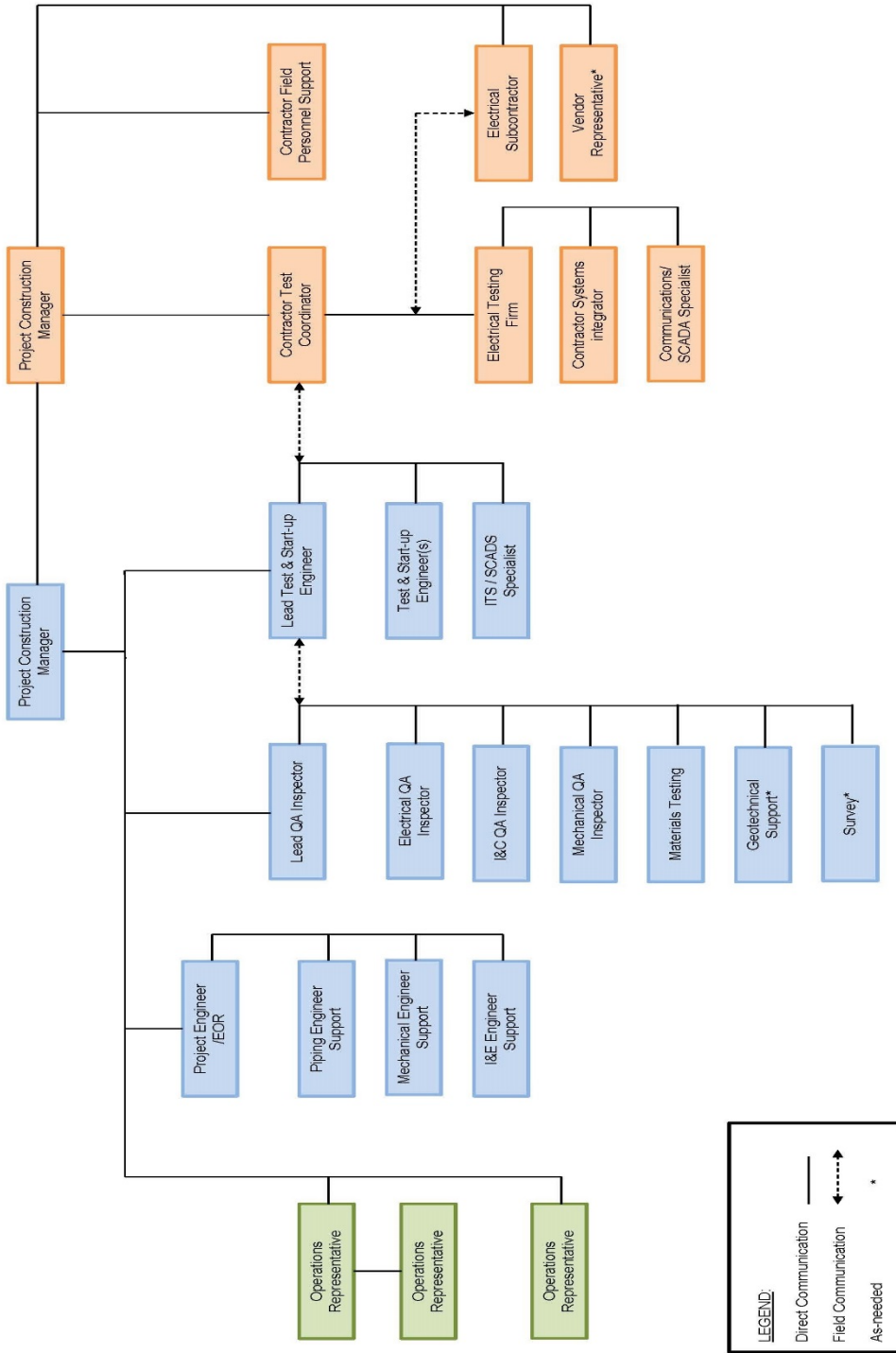
### **7.3 Other References**

- SFPUC Lock-out/Tag-out Program, November 1, 2015
- Lockout/Tag-out, OSHA Title 29. CFR Part 1910.147
- Cal/OSHA Title 8, Subsection 3314

## **8.0 Attachments**

- 018 - 1 Typical System Testing and Start-Up Team Organization (City/CM Consultant/Contractor)
- 018 - 2 Testing and Start-Up Submittal Forms and Records Summary
- 018 - 3 Facility Testing and Start-Up Plan – Table of Contents Sample
- 018 - 4 Documents Distribution List for CMP No. 018
- 018 - 5 Revision Control Log

# Attachment 018 – 1 Typical System Testing and Start-Up Team Organization (City/CM Consultant/Contractor)





## Attachment 018 - 2

Page 1 of 3

### Testing and Start-Up Submittal Forms and Records Summary

A summary of major facility systems testing and start-up submittal forms and records are presented below. The complete testing and start-up requirements and their submittal documentations shall be in accordance with Technical Specification No. 01 75 60, Testing Coordination and Startup; and other references provided in this procedure for Data submittals and Manufacturer's support services.

Specific Test Data and Information required for submittal by Contractor are presented in Technical Specification No. 01 78 23. Basic Test Information for each form should include the following:

- Date and Time of Test
- Test Participants: Names, Organization, Role
- Type of Test
- Purpose or Brief Test Description
- Estimated Duration and Actual Duration of Test
- Exceptions to Approved Test Plan, if applicable
- Reference to Test Change Notice, if applicable

#### I. MECHANICAL AND HYDROSTATIC PRESSURE TESTS

Facility Mechanical and Hydrostatic Pressure Tests shall be completed and accepted by RE before starting Functional Testing, refer to Procedure Section 5.3.

1. Mechanical Tests, in-situ installation inspection and tests in accordance with applicable Technical Specifications; i.e. pumps, HVAC Systems, etc.
2. Valves and Piping Systems Hydrostatic Pressure Tests, in-situ installation inspection and tests in accordance with applicable Technical Specifications.

##### Submittals for Post Mechanical and Hydrostatic Pressure Tests

- a. Contractor's Certification of Proper Installation and Readiness for Testing Sheet; i.e. mechanical, valves and pipes.
- b. Hydrostatic Pressure Test Diagram for Piping Systems; show boundary limits of hydrostatic test pressure in accordance with technical specification requirements.

#### II. FUNCTIONAL TEST REQUIREMENTS

Functional Tests shall not proceed until the Project CM has received and approved the following items listed below;

1. Electrical Interconnection and Loop Diagrams
2. All factory test reports
3. Manufacturer's Certificate of Proper Installation (where required)

## Attachment 018 – 2

Page 2 of 3

### Testing and Start-Up Submittal Forms and Records Summary

4. Equipment or System Test Submittal
5. All specified Spare Parts and Special Tools
6. Draft Operations & Maintenance Manuals (Final O&M Manuals to have test results and data forms incorporated into them.)

Functional Tests shall be performed in accordance with Procedure Sections 5.4 and 5.5; and Technical Specification No. 01660.

#### Submittals for Post Functional Tests

- a. Test Log Summary and Test Forms
- b. Test Hold Log and Test Exceptions Log
- c. Test Change Notice
- d. Project Test Package Endorsement Record

### III. PERFORMANCE TEST REQUIREMENTS

Performance Tests shall not proceed until the Functional Tests have been successfully completed and accepted by the Project CM.

Performance Test requirements shall be performed in accordance with Procedure Sections 5.6 and 5.7; and Technical Specification No. 01 35 55.

#### Submittals for Test

- a. Test Log Summary and Test Forms
- b. Test Exceptions Log
- c. Test Change Notice
- d. Project Test Package Endorsement Record

### IV. PRE-START-UP AND START-UP TEST REQUIREMENTS

The Pre-Start-up Test shall use the approved Start-up Test Procedure for the purposes of the Pre-Start-up Test. These tests verify the installation completion and systems operation mode.

The Start-up Test shall not proceed until the following have been completed;

1. All factory, functional and performance test records have been approved and available.
2. All draft O&M Manuals completed and approved.
3. City personnel trained in accordance with the individual technical specifications
4. All equipment, piping and systems component identities are tagged and labeled in accordance with contract documents.
5. All near final As-Built Drawings have been completed and approved.

**Testing and Start-Up Submittal Forms and Records Summary**

6. Start-up Test Procedure has been approved.

**V. PERFORMANCE TEST RUN**

The Performance Test Run is the verification step that the complete work functions on an extended basis as defined in scope and duration of the Contract, refer to Procedure Sections 5.10 and 5.11.

Submittals for Post Performance Test Run

- a. Start-up and Performance Log Summary
- b. Start-up and Performance Exceptions Log, if applicable
- c. Start-up and Performance Change Notice, if applicable
- d. Start-up and Performance Package Endorsement Record
- e. Final “As-Built” Drawings
- f. “As-Built” Programmable Logic
- g. Final Operations & Maintenance Manuals
- h. Equipment Warranties

**Attachment 018 – 3**  
*Page 1 of 2*  
**Facility Testing and Start-Up Plan**

**Table of Contents Sample**

1. **Introduction**
  - Purpose
  - General Over View
  
2. **Testing, Start-Up and Acceptance Plan Description**
  - Implementation
    - Testing – Hydraulic Transmission
    - Testing – Mechanical Components
    - Testing – Instruments, Electrical and SCADA
    - Facility Start-Up
    - Facility Performance Run
  
  - Definitions and Acceptance Criteria
    - Functional Test
      - Performance Test
      - Test Acceptance Criteria and Documentation
      - Test Rejection Criteria and Documentation
      - Retest for Acceptance Criteria and Documentation
      - Notice of Substantial Completion
      - Notice of Completion
  
3. **Roles and Responsibilities**
  - Contractor Start-Up Team (Names & Qualifications)
  - Equipment & Materials Supplier Start-Up Assistance (Names & Qualifications)
  - CM Consultant Team
  - Owners (SFPUC) Team
  
4. **Scope of Work & Technical References**
  - Scope of Work
    - Equipment Testing based on Specifications & Manufacture's Procedure
    - Transmission System and Piping Tests
    - Components Testing
    - Instrumentation & Electrical Systems Testing
    - Automation Systems Testing with Owner
    - System Testing
    - Facility Testing
    - Facility Start-Up
    - Facility Performance Run
  
  - Contract and Technical References
    - Contract Specifications
    - Manufactures' Guidelines for Installation and Start-Up
    - Industry Practices, Methods and Guidelines

**Attachment 018 – 3**  
*Page 2 of 2*  
**Facility Testing and Start-Up Plan**

**Table of Contents Sample**

5. **Other Work Requirements per Contract**
  - Safety – Emergency Contingency
  - Risk Analysis for Start-Up
  - Environmental – Emergency Contingency; SPCC Plan
  - Permits – Water Discharge / storm Water Control Plan
  - Permits – Air Discharge
  - Restricted Materials Handling Approval & MSDS
  - Waste Minimization and Recycle Plan
  
6. **Pre-Testing Submittals and Activities**
  - Testing and Start-Up Plan
  - Test Acceptance Form Format
  - Test Procedures & Methods
  - Facility Training Plan and Course Implementation
  - Draft Operations & Maintenance Manuals
  - Spare Parts List - Recommended
  - Contractor Secured Start-Up and Operating Permits
  - Agencies and Community Notifications
  
7. **Schedule**
  - Pre-Start-Up Activities
  - Equipment and Mechanical Tests
  - Transmission and Piping Tests
  - Component Tests
  - Instrumentation and Electrical Tests
  - Automation and SCADA Tests
  - System Tests
  - Start-Up
  - Performance Run
  - Demobilization
  
8. **Post Start-Up Deliverables**
  - Spare Parts List and Spare Parts
  - Equipment Warranties
  - As-Built Drawings Submittals
  - Final Operations & Maintenance Manuals
  - Certified Test Samples and Lab Analyses
  - Final Punch List with Corrective Actions Complete
  - All Acceptance Forms Signed
  
9. **Attachments**
  - Contractor Start-Up Team Organization Chart (Names & Positions)
  - Testing, Start-Up and Performance Run Schedule
  - Contractor Start-Up Team Check List (Detailed)
  - Work by Others - Draft List of Major Activities
  - SFPUC Owner/Operations
  - CM Consultant Team

**Attachment 018 – 4**  
**Documents Distribution List for CMP No. 018**

The following personnel listed (by project position or responsibility) for Documents Distribution is a general guideline for specific CM Procedure. It is the responsibility of the ADCS to confirm and as necessary revise this list as appropriate for the specific project needs. The OE shall approve these distribution changes.

The guideline for hard copy document distribution is follows:

1. Individual, without CMIS access, who attended a specific meeting
2. Individual, without CMIS access, who was mentioned or designated for action in a specific project meeting
3. Individual, without CMIS access, who has management oversight responsibilities to ensure the implementation or completion of project action.

**SPECIAL REPORTS:**

- **Notification of Facility Acceptance**
- **Final Start-Up and Test Report**

**DISTRIBUTION:**

**Project Field Personnel – Information Only, Not Distribution**

- RE, Field Contracts Administrator, Lead Inspector, OR

**Construction Management Bureau**

- Senior CM

**Program CM Consultant**

- Program CM Consultant Advisor

**Project Management Bureau**

- Senior PM
- Project Manager

**Engineering Management Bureau**

- Project Engineer

**Attachment 018 - 5  
Request for Information Log**

<b>Revision No.</b>	<b>Revision Date</b>	<b>What changed?</b>
Rev 1	6/7/19	<ul style="list-style-type: none"><li>• Minor format changes;</li><li>• Attachments revised;</li><li>• Revision Control Log updated.</li></ul>
Rev 0	11/14/16	Signed