



## Module 6: QUALITY MANAGEMENT FOR CONSTRUCTION PROJECTS

### Submodule 1: Introduction

**Objectives:** After completing this submodule, you will be able to:

- Define the function and importance of Construction Quality Assurance.
- Define the function and importance of Contractor Quality Control
  - for construction contracts
  - for design-build contracts

A. **Quality Assurance:** The primary function of quality assurance is to obtain completed construction that meets all contract requirements. Assurance is defined as a degree of certainty. Quality assurance personnel continually assure--or make certain--that the contractor's work complies with contract requirements.

B. **Quality Assurance Personnel:** The role of quality assurance personnel is to assure that the CQC system is functioning properly. To do this, QA personnel:

- Examine the quality control methods being used to determine if the contractor is properly controlling design activities in design-build contracts.
- Examine the quality control methods being used to determine if the contractor is properly controlling construction activities.
- Make certain that the necessary changes are made in the contractor's QC system, if excessive construction deficiencies occur.
- Assist the contractor in understanding and implementing the contract requirements.
- Examine ongoing and completed work.

- Review QC documentation to assure adequacy.
- C. **Contractor Quality Control:** The primary function of CQC is the successful execution of a realistic plan to ensure that the required standards of quality construction will be met. In CQC, the contractor defines procedures to manage and control his own, designer of record, consultant, architect-engineer, all subcontractor and all supplier activities so that the completed project complies with contract requirements. For design-build contracts this includes providing and maintaining a Design Quality Control plan as a part of the overall contract QC plan. This plan, as a minimum, must assure that all documents are reviewed by a technically competent, independent reviewer specifically named in the plan. This review cannot be performed by the same designers that produced the product. The design QC plan shall be managed by a Design QC Manager who has verifiable engineering or architectural design experience or is a registered engineer or architect. The Design QC Manager is under the supervision of the QC Manager.
- D. **Quality Control Personnel:** As stated previously, CQC is a contractor responsibility. This includes:
- Produce the quality specified in the plans and specifications, and for design-build contracts in the Request for Proposal, as well as the contractor's accepted proposal,
  - Develop and maintain an effective CQC system,
  - Perform all control activities and tests, and
  - Prepare acceptable documentation of CQC activities.

The contractor also is required to place a competent representative onsite to oversee the CQC system. He must have full authority to act for the contractor on CQC matters. His responsibilities include workmanship, methods, and techniques to ensure that all work is performed properly by qualified and careful craftsmen. For design-build contracts, responsibility also includes design quality and the performance of constructibility, operability and environmental review of the design.



## **EXERCISE**

### **Submodule 6.1**

1. What is the primary function of QA?
2. What is the role of QA personnel?
3. What is the primary function of CQC?
4. What are the roles of QC personnel?

5. For design-build contracts what additional requirements must be included in the QC plan?







## Module 6: QUALITY MANAGEMENT FOR CONSTRUCTION PROJECTS

### Submodule 2: Three-Phase Control System

**Objectives:** After completing this submodule, you will be able to:

- Define the purpose of control of onsite construction through the Three-Phase Control System.
- List the responsibilities of QC personnel regarding the three-phase control system.

#### A. **Purpose:**

The primary purpose of the Three-Phase Control System is to require the contractor to plan and schedule the work to ensure that he is prepared to start each new definable feature of work. **The three phases of control (preparatory, initial, and follow-up) are the core of the Construction Quality Management System. When they are performed as outlined in the specifications, success in completing the work to comply with requirements of the contract is enhanced.** In Module 3, Submodule 1, the three-phase control system was mentioned as a required part of the contractor's quality control plan.

#### B. **Three-Phase Control Responsibility:**

- Develop, schedule and implement procedures for tracking control phase meetings for definable features of work in the QC Plan.
- Notify appropriate personnel of time, date and agenda.
- Conduct Meetings (preparatory and initial).
- Safety considerations and Activity Hazard Analyses (AHAs).
- Document actual discussions and provide minutes to attendees.

- Monitor work in place through follow-up phase.
- Conduct additional control phase meetings, as needed.

### C. **The Three-Phase Control System:**

1. **Preparatory Phase:** This phase shall be performed prior to beginning work on each definable feature of work. Perform this work as detailed below:
  - A review of each paragraph of applicable specifications and references.
  - A review of contract plans.
  - A check to assure that all materials and/or equipment have been tested, submitted, and approved.
  - A check to assure that provisions have been made to provide required control inspection and testing.
  - Examination of the work area to assure that all required preliminary work has been completed.
  - A physical examination of required materials, equipment, and sample work to assure that they are on hand and conform to approved shop drawings or submitted data.
  - A review of the appropriate activity hazard analysis.
  - Discussion of procedures for constructing the work including the review of repetitive deficiencies.
- The Government shall be notified in advance of beginning any of the required action of the preparatory phase as required in the QC specifications.
- This phase shall include a meeting conducted by the QC Manager and attended by the superintendent, other CQC personnel (as applicable), and the foremen responsible for the definable feature. The results of the preparatory phase actions shall be documented by separate minutes prepared by the QC Manager and attached to the daily CQC report.



2. **Initial Phase:** This phase must be accomplished at the beginning of a definable feature of work. The “Initial Phase” will verify that control for the work developed in the “Preparatory Meeting” is implemented and the work is performed to the level of workmanship mutually agreed to. Perform this work as detailed below:

- Review minutes of Preparatory Meeting.
  - Check preliminary work.
  - Verify adequacy of controls to ensure full contract compliance.
  - Establish level of workmanship.
  - Resolve all differences.
  - Check safety to include compliance with the safety plan and activity hazard analysis. Review the activity hazard analysis with workers.
- The Government shall be notified in advance of the beginning of the Initial Phase as required in the CQC specifications.
  - The QC Manager is in charge of the Initial Phase Meeting. Separate minutes of this phase shall be prepared by the QC Manager and attached to the daily CQC report. The initial phase shall be repeated for each new crew to work onsite, or any time established level of workmanship is not being met.

3. **Follow-up Phase:** Daily checks shall be performed to assure continuing compliance with contract requirements, including safety and control testing, until completion of the particular feature of work. The checks shall be made a matter of record in the CQC documentation. Final follow-up checks shall be conducted and all deficiencies corrected prior to the start of additional features of work. QC personnel should continually refer back to the standards set in the “Preparatory and Initial Phases.”

D. **Cautionary Note:** QC personnel, in the midst of day-to-day duties, can easily fall into the trap of only working to detect deficiencies when in fact their role is to prevent deficiencies.

# 3 Phases of Control

Using a simplified Schedule

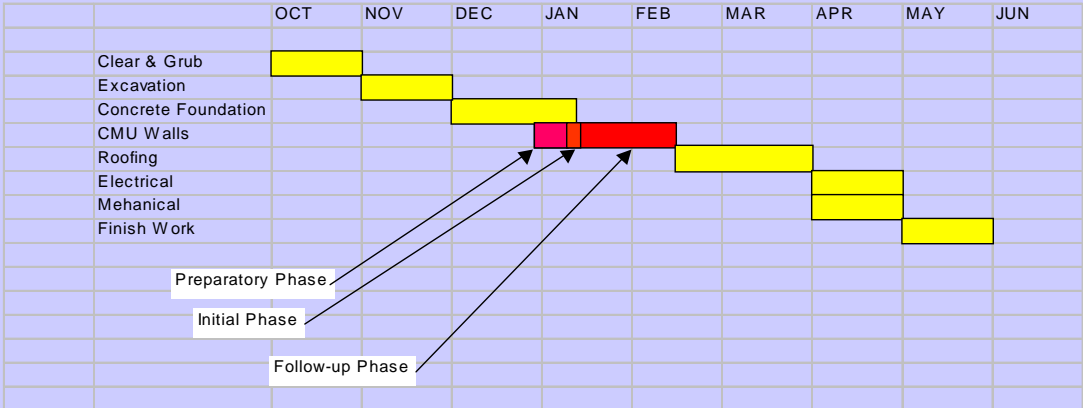


Figure 1

### 3 Phases - What is involved?

#### Preparatory Phase:

- Review Plans and Specs
- Verify submittal approval
- Review test plan
- Check preliminary work
- Examine materials
- Discuss construction methods
- Review Safety

#### Initial Phase:

- Establish quality required
- Resolve conflicts
- Ensure testing is performed
- Review Safety

#### Follow-up Phase:

- Ensure contract compliance
- Maintain quality
- Ensure testing report is submitted
- Ensure rework is completed



Figure 2

### 3 Phases - Who is involved?

#### Preparatory Phase:

- QC Manager
- QC Specialists
- Superintendent
- Subcontractor Foreman
- QA Representative

#### Initial Phase:

- QC Manager
- QC Specialists
- Superintendent
- Subcontractor Foreman
- QA Representative

#### Follow-up Phase:

- QC Manager
- QC Specialist
- Superintendent
- Subcontractor Foreman
- QA Representative

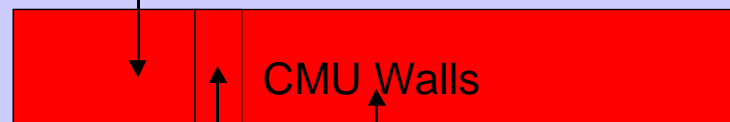


Figure 3



## **PRACTICAL EXERCISE**

### **Submodule 6.2**

#### **PREPARATORY PHASE MEETING EXERCISE**

You are involved in the construction of a \$22,000,000 two-bay hanger at March Air Force Base in California. Included in the project is 2,000 feet of 24-inch diameter storm drainage pipe. Manholes are to be installed every 300 feet. Storm drainage pipe is listed in the Quality Control Plan as a definable feature of work. The contractor plans to use reinforced concrete pipe and pre-cast manholes.

**SCOPE:** Install 2,000 feet of 24-inch storm drainage pipe. Pre-cast manholes shall be installed every 300 feet.

**Task:** Prepare to attend preparatory meeting to begin the work. Use the checklist included as a guide.

**Assumptions:**

- Pipe is on site
- Submittals are approved
- Excavation permit is issued
- Safety plan covers the work and is satisfactory
- Layout work is complete

**You are:** Resident Engineer or ROICC/SGE

Project Engineer or AROICC/AREICC

Onsite Quality Assurance Person

TEAM 1

## **PRACTICAL EXERCISE**

### **Submodule 6.2**

#### **PREPARATORY PHASE MEETING EXERCISE**

You are involved in the construction of a \$22,000,000 two-bay hanger at March Air Force Base in California. Included in the project is 2,000 feet of 24-inch diameter storm drainage pipe. Manholes are to be installed every 300 feet. Storm drainage pipe is listed in the Quality Control Plan as a definable feature of work. The contractor plans to use reinforced concrete pipe and pre-cast manholes.

**SCOPE:** Install 2,000 feet of 24-inch storm drainage pipe. Pre-cast manholes shall be installed every 300 feet.

**Task:** Perform preparatory meeting to begin the work. Use the checklist included as a guide.

**Assumptions:**

- Pipe is on site
- Submittals are approved
- Excavation permit is issued
- Safety plan covers the work and is satisfactory
- Layout work is complete

**You are:** Project Superintendent

Quality Control Manager

Site Work Subcontractor's Superintendent

Storm Drainage System Second Tier Subcontractor's Foreman

Safety Engineer

TEAM 2

# SAMPLE

## Preparatory Phase Checklist

Contract No.: \_\_\_\_\_ Date: \_\_\_\_\_

Definable Feature: \_\_\_\_\_ Spec Section: \_\_\_\_\_

Government Rep Notified \_\_\_\_\_ Hours in Advance Yes \_\_\_\_\_ No \_\_\_\_\_

### I. Personnel Present:

	<u>Name</u>	<u>Position</u>	<u>Company/Government</u>
1.	_____	_____	_____
2.	_____	_____	_____
3.	_____	_____	_____
4.	_____	_____	_____
5.	_____	_____	_____
6.	_____	_____	_____
7.	_____	_____	_____

(List additional personnel on reverse side)

### II. Submittals

1. Review submittals and/or submittal log 4288. Have all submittals been approved?  
Yes \_\_\_\_\_ No \_\_\_\_\_

If No, what items have not been submitted?

- a. \_\_\_\_\_  
b. \_\_\_\_\_  
c. \_\_\_\_\_

2. Are all materials on hand? Yes \_\_\_\_\_ No \_\_\_\_\_

If No, what items are missing?

- a. \_\_\_\_\_  
b. \_\_\_\_\_  
c. \_\_\_\_\_

3. Check approved submittals against delivered material. (This should be done as material arrives.)

Comments \_\_\_\_\_  
\_\_\_\_\_

III. Material storage

Are materials stored properly? Yes \_\_\_\_\_ No \_\_\_\_\_

If No, what action is taken? \_\_\_\_\_  
\_\_\_\_\_

IV. Specifications

1. Review each paragraph of specifications.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

2. Discuss procedure for accomplishing the work.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

3. Clarify any differences.

V. Preliminary Work and Permits

Ensure preliminary work is correct and permits are on file.

If not, what action is taken? \_\_\_\_\_  
\_\_\_\_\_

VI. Testing

1. Identify test to be performed, frequency, and by whom.

2. When required? \_\_\_\_\_

3. Where required? \_\_\_\_\_

4. Review Testing Plan. \_\_\_\_\_

5. Has test facilities been approved? \_\_\_\_\_  
\_\_\_\_\_

VII. Safety

1. Review applicable portion of EM 385-1-1. \_\_\_\_\_

2. Activity Hazard Analysis approved? Yes \_\_\_\_\_ No \_\_\_\_\_

VIII. Corps of Engineers comments during meeting.

\_\_\_\_\_  
QC Manager









## **Module 6: QUALITY MANAGEMENT FOR CONSTRUCTION PROJECTS**

### **Submodule 3: Documentation**

**Objectives:** After completing this submodule, you will be able to:

- Explain the purpose and importance of the Contractor Quality Control (CQC) Report.
- List the components of the CQC Report.
- Explain the purpose and importance of the Government Quality Assurance (QA) Report.
- Discuss the review and use of quality management reports.

#### **A. Quality Management Record Keeping:**

A comprehensive record keeping and information exchange system is an indispensable quality management tool. In addition to identifying specific deficiencies, careful report analysis will also detect patterns in the team's performance. If these patterns are detrimental, early detection and correction will save time, effort, and money for both the Government and the contractor.

#### **B. The Contractor Quality Control Report:**

- The requirement for the contractor to submit daily QC reports is established in the QC specification. As discussed previously, the Coordination Meeting or the Mutual Understanding Meeting (Navy) should include a detailed discussion of reporting procedures, information required in the reports, and the importance of the reports. The QC Report is to be submitted at a prescribed time every day, and all information relating to QC activities is to be included in the report.
  - There is no form specified for the QC Report. Note: For contracts using RMS/QCS, QCS does mandate a specific form. However, there are sample forms included in the contract and

they are highly recommended to be used. Regardless of the form and format used, it must include the information outlined in the QC specification. (A sample QC Report is located in the sample section of submodule 3.2.)

- Major elements of information required in the QC Report include, but are not limited to the following:
  - Contractor/subcontractor and their area of responsibility.
  - Operating plant/equipment with hours worked, idle, or down for repair.
  - Work performed each day, giving location, description, and by whom. When a Network Analysis System (NAS) is used, identify each phase of work performed each day by NAS activity number.
  - Test and/or control activities performed with results and references to specifications/drawings requirements. The control phase should be identified (Preparatory, Initial, Follow-up). List deficiencies noted along with corrective action.
  - Quantity of materials received at the site with statement as to acceptability, storage, and reference to specifications/drawings requirements.
  - Submittals reviewed, with contract reference, by whom, and action taken.
  - Off-site surveillance activities, including actions taken.
  - Job safety evaluations stating what was checked, results, and instructions or corrective actions.
  - Instructions given/received and conflicts in plans and/or specifications.
  - Attach QC Specialists' and Design QC Manager's reports.
  - Contractor's verification statement.
- When activities are completed, they must be so noted on the daily QC Report. The Government conducts a final follow-up inspection for completed activities.

- The QC Manager may attach separate reports for subcontractor work, or these reports may be combined into one consolidated report.
- The QC reports must present an accurate and complete picture of QC activities. QC reports should not concentrate only on work items that have been completed, but also must provide evidence of control activities. They should be precise, factual, legible, as objective as possible, and emphasize QC actions.
- QA personnel evaluate QC reports as they are received. If statements are discovered in the report that are contrary to QA personnel's knowledge of the work, action will be taken to resolve the differences. The contractor may be asked to submit a supplemental report containing corrections.

**C. The Government Quality Assurance Report:**

The QA report is the Government's record of project-related events and is prepared for each visit day. The QA report is not intended to duplicate information contained on the QC report.

**D. Deficiency Tracking System/Rework Items List:**

Included as a part of the CQC program is a requirement for a formal deficiency tracking system. As outlined in the accepted QC plan, it shall consist of a cumulative list of job deficiencies/rework items. This includes items identified by QA personnel, QC staff, testing failures, etc. This list shall be continually maintained with dates of corrective action. The system is subject to review by the government. If the QCS Module (Contractor Module-RMS) is used/required there is a deficiency tracking system in it.



documentation of activities, his comments were, "Insulation of duct work being done in accordance with specifications, vapor barrier was ripped in a couple of places and insulator was a little light in use of staples." Rewrite the contractor's comments to make them acceptable.

- c. The Paw Power Construction Company has a contract for construction of a high-rise administration building. Work was in early stages of construction and a subcontractor had just completed backfilling sanitary sewer lines. The utilities sub foreman had been designated as QC Manager for this portion of the work. His report was attached to the main report. A preparatory and initial phase have been performed and recorded earlier. This report stated, "All work completed in accordance with directions received at preparatory phase."

(1) Is it permissible to accept sub-reports attached to the Daily Report?

(2) Is it permissible to reference the preparatory phase?

(3) Is anything missing?

d. Results of Surveillance: Bowers installed base of manhole #2 approximately 10 ft. east of its correct location. Pipe between manholes #6 and #2 is being removed and the pipe between manholes #3 and #2 is being extended to a new location for manhole #2.

(1) What does this report say?

(2) Rewrite the report so that it states clearly what is intended.

e. You are the QC Manager. You are to begin installation of ceramic floor and wall tile. Both the floor and the wall are to receive a setting bed. The floor has floor drains, and waterproofing has been completed. The wall has electrical receptacles.

(1) Who would you want at the initial phase of the work?

(2) What would you check?



- (3) What items should be contained in the QC Report covering the Initial Phase?







## **Module 6: QUALITY MANAGEMENT FOR CONSTRUCTION PROJECTS**

### **Submodule 4: Testing**

**Objectives:** After completing this submodule, you will be able to:

- Discuss the objectives of contractor and Government testing.
- Describe contractor testing procedures.
- List testing requirements.

#### **A. Importance of Testing:**

Testing is an extremely important part of CQM. If tests are not performed properly, there are many construction procedures and materials that cannot be confirmed as adequate. Visual observation alone is insufficient.

#### **B. Types of Tests:**

1. QC Testing: The contractor performs control testing to determine whether construction procedures and materials are producing the desired contractual product.
2. QA Testing: The government performs assurance testing to verify that the contractor's control testing is adequate.

#### **C. Procedures:**

1. The contractor must outline proposed "testing procedures" as defined in Section 01451A and/or Section 01450N in the QC Plan. These proposed procedures must be discussed at the Coordination Meeting or the Mutual Understanding Meeting (Navy). Any disagreement regarding testing procedures must be settled before construction begins.
2. The contractor must provide a list of required control tests and specify whether the tests are to be performed by an independent, approved testing

laboratory, or through the use of his own personnel and facilities. For CORPS contracts “approved testing laboratory” means laboratories that have been validated by the Materials Testing Center (MTC) at Waterways Experiment Station in Vicksburg, MS.

3. Regardless of which method of testing the contractor uses, he is required to assure that specified laboratory procedures are used and that laboratory facilities are certified.
4. QC testing is verified in a random manner by QA testing. QA tests are unannounced sporadic tests that repeat QC tests. QA testing can be performed by :
  - a. Government personnel using the contractor's equipment and facilities,
  - b. An independent testing laboratory, or
  - c. A field office, district, or division government laboratory.
5. QC personnel must be knowledgeable concerning laboratory and testing procedures. They must be able to visually recognize proper and improper testing procedures. All involved personnel should become aware of the methods to be used for and the extent of QC testing.
6. Before testing begins, the following questions should be answered and verified against the approved QC Plan:
  - a. Has all required testing been identified?
  - b. Are test reporting requirements understood?
  - c. Have laboratory facilities and testing equipment been verified as acceptable?
  - d. Are laboratory personnel qualified?
  - e. Has the calibration of equipment been verified as accurate?
  - f. Is there a procedure for documenting corrective steps?
7. After QC testing has begun, a thorough examination must be made of the test reports submitted to ascertain that:

- a. Reports are being submitted for all tests performed,
- b. Reports are complete and accurate, and
- c. Failing tests must be retested and cross referenced to the original failing test.

D. **Test Tracking System:** In accordance with Section 01451A and Section 01450N, the contractor must establish and maintain a system to track verification, control and acceptance tests. Each planned test type and frequency must be entered into the tracking system prior to beginning work. Results and dates of individual tests are to be added to the system as they are performed. Any failing test results will have retests performed, entered into the system and cross referenced. The tracking system must be reviewed frequently to assure that any activity underway is having all planned tests performed as scheduled.



## **EXERCISE**

### **Submodule 6.4**

1. Define QC testing.
2. Define QA testing.
3. Who performs QC tests?

4. Who performs QA tests?

5. What questions should be answered before testing begins?









## **Module 6: QUALITY MANAGEMENT FOR CONSTRUCTION PROJECTS**

### **Submodule 5: Completion of Work**

**Objective:** After completing this submodule, you will be able to:

- Describe project completion procedures.

#### **Quality Management Completion Procedures:**

- **Testing of Completed Systems:** Testing of completed systems shall be performed as required by the technical specifications of the contract.
- **Contractor Punch-Out:** Near the completion of all work or any increment thereof, the contractor prepares a punch list and makes corrections. Quality Assurance personnel will not prepare the contractor's deficiency list. The contractor should correct deficiencies promptly so that project schedules are met. All major deficiencies noted during this contractor's punch-out inspection must be corrected prior to the pre-final inspection.
- **Pre-Final and Final Inspections:** Participating in the pre-final and final inspections will be QA personnel and QC personnel. The QC Manager will assure that all deficiencies noted during the pre-final inspection are corrected prior to the final inspection, and report the status of corrective actions to the Government. The client/customer is invited to the final inspection. Any deficiencies noted at these inspections by client/customer personnel, whether design or construction related, will be examined by the Government and the contractor notified if corrective action is required under the terms of the contract. All significant deficiencies must be corrected prior to turnover.
- **Complete As-Built Drawings:** As-built drawings are updated continually throughout the project. During the final stages of construction, the QC Manager will review and complete these drawings. While the status of as-built drawings is a concern throughout the project, it is of particular significance, as the project comes to an end, to prevent any loose ends.

- Operations and Maintenance (O&M) Manuals: The QC Manager will assure submittal of all required operation and maintenance data in accordance with scheduled submittal dates.
- Instruction and Training Procedures: If the contract requires operation and maintenance training of client/customer personnel, the QC Manager will make certain all specified training has been conducted by qualified instructors.
- Materials Turnover: The QC Manager will verify that all required keys, spare parts and materials have been sorted, identified, and demonstrated to be usable prior to final inspection.
- Warranty: The QC Manager will ensure that all warranty information is provided. Procedures for warranty notification and correction should be in place. FAR Clause 52.246-21 Warranty of Construction, states the general warranty period for construction work is one year from the time of acceptance by the government unless stated otherwise in the specifications. If the manufacturers of individual components provide a longer warranty, this extended warranty period accrues to the government. If the contractor repairs or replaces a component of the project during the warranty period then this component is warranted for one year from the repair or replacement date.



## **EXERCISE**

### **Submodule 6.5**

What is the appropriate chronological order for the quality management completion procedures listed in this submodule? Explain.



