

SECTION 16

CONSTRUCTION PROCEDURES

AND SPECIAL REQUIREMENTS

16.1 DEFINITIONS AND CHARACTERIZATIONS

16.1.1 Quality

For the purposes of this manual, quality is defined as the totality of features, attributes and characteristics of a facility, product, process, component, service or workmanship that bear on its ability to satisfy a given need: fitness for purpose. It is usually referenced to and measured by the degree of conformance to a pre-determined standard of performance. In simple terms, quality is meeting the requirements. Quality is obtained if the stated requirements are adequate and if the completed project conforms to the requirements. Quality in the constructed project is obtained by conscious application of a thoroughly planned quality assurance program implemented through a quality control procedure. Quality can be characterized as: meeting the requirements of the owner as to functional adequacy; completion on time and within budget; life cycle costs and operation and maintenance; meeting the requirements of the design professional as to provisions of well-defined scope of work; use of a qualified trained and experienced staff; obtaining adequate field information prior to design; provisions for timely decisions by the Operating Division and others; meeting the requirements of the contractor as to provisions of the contract plans, specifications and other documents prepared in sufficient detail to permit a good competitive bid, timely decisions by the Construction staff and Design Section on authorizing and processing of change orders; fair and timely interpretation of contract requirements from field design and inspection; allowance for a reasonable schedule of work performance which permits a reasonable profit; meeting the requirements of regulatory agencies as to public safety and health, environmental considerations; protection of public utilities and public property; and conformance with applicable laws, regulations, codes and policies. Quality in the constructed project is also characterized by complete and open communications among project parties, change orders in less than 5% of the bid amount (except in cases of change of scope or changed construction conditions), and a rapid resolution of conflicts and disagreements in absence of litigation.

16.1.2 Lack of Quality

Lack of quality invariably results in a higher total cost. Though the initial cost may be less through the use of minimal design functions, substandard materials or unskilled workmanship, the total cost to the user over the life of the project will be greater. Since lack of quality inevitably results in frequent repairs, breakdowns and shorter useful life of the facility, resources are improperly allocated. Lack of quality damages and degrades the quality of life for the project's users, may result in injury to people and property, and frequently leads to conflict in litigation.

16.1.3 Resident Engineer

The term Resident Engineer as used in this document shall mean either the Resident Engineer or the Resident Construction Inspector appropriately assigned to the project by the Construction Section. The Resident Engineer is one of the most critical persons in establishing and maintaining the quality control process on the site. Quality control is directly related to contractor integrity and how much observation the City is willing to perform (pay for). A Resident Engineer is the employee of the City whose duties, responsibilities, and limitations of authority are made a part of the construction contract documents. The Resident Engineer is required to: Review progress and shop drawing submittal schedules; consults with the designer about acceptability of the work, attends conferences and meetings with the contractor and prepares and circulates minutes, serves as the designer's liaison with the contractor; logs shop drawings and samples; logs interpretations and clarifications as well as substitute proposals and field orders; reviews work performed; disapproves defective work and verifies that tests and start up procedures as required by the contract documents are accomplished; accompanies the City's personnel or representatives of agencies having jurisdictional interests during site visits and receives requests for information from the contractor and transmits the designer's interpretations of the contract documents back to the contractor; considers and evaluates the contractor's suggested modifications to the contract drawings or specifications and reports to the designer; maintains orderly files of all job records; keeps a diary or log book of the weather conditions with names, addresses and telephone numbers of all contractors, subcontractors and major suppliers; submits to the appropriate designer or Construction Section personnel advice concerning major inspection and tests, draft change orders, field orders and work directive changes; reviews payment requests with the

contractor before sending them on for City processing. Submits to the contractor, before Notice of Completion is issued, a punch list of items that remain to be completed or corrected and conducts a final inspection with the designer or appropriate Construction Section or Operation and Maintenance Division staff; verifies that all items on the final punch list have been completed or corrected; determines if certificates, operating and maintenance manuals and other required data have been assembled by the contractor and forwarded to the designer of Operating Division as appropriate; prepares record drawings and specifications as required.

The Resident Engineer for the City of Sacramento operates under a number of limitations of authority which are as important as the authorizations listed above. The Resident Engineer has no power or right to: authorize any deviation from the contract documents or substitutions of materials and equipment except as specifically authorized by the designer or Operating Division; exceed the limitations of the City's authority outlined in the contract documents; assume any of the responsibilities of the contractors, subcontractors or their superintendents; advise on or issue instructions concerning the contractor's technique, sequences or other procedures of construction unless specifically required by the contract documents; advise, issue directions concerning, or take control over safety precautions and programs; accept shop drawings or samples from anyone other than the prime contractor, authorize the City to occupy the project in whole or in part as specified in the construction contract.

The above guidelines outline the Resident Engineer's conduct in construction administration and inspection and specifically state the Resident Engineer's position with respect to the designer, construction and owner team. For any team to function successfully all team members must focus on the project's goals. If the Resident Engineer observes the contractor using a method that will not produce an acceptable result, the Resident Engineer may inform the contractor's superintendent and log the event. One should never wait until faulty work is completed before reporting it. Delays in passing information, processing payment applications or similar actions invariably lower the quality of any project.

The above guidelines for the Resident Engineer apply to almost all situations except a catastrophe or imminent disaster. The Resident Engineer should report any unsafe method that he observes, but the Resident Engineer must never recommend or supervise corrective measures. Any member of the team that is aware of the

unsatisfactory methods is expected to promptly respond to avoid or minimize serious consequences. When authority is given to the City's Resident Engineer, that authority should be respected during the administration of construction. Changes affecting overall safety and structural integrity should be reviewed by the design professional.

16.1.4 Superintendent

According to the contract documents, the contractor is responsible for providing a competent Superintendent. This individual supervises the construction work and has authority to act on the contractor's behalf. The Superintendent's competency and skill are critical elements in a quality construction team. All communications given to the Superintendent are binding upon the contractor. A Superintendent should fulfill the contractor's obligation to supervise and direct the work competently and efficiently and insure that proper techniques and procedures are used. Quality in construction is greatly assisted when a competent construction schedule is used and when the Superintendent and the Resident Engineer work well together. Any sign of a serious conflict among team members should be investigated promptly and resolved.

16.1.5 Testing and Inspection

Additional on-site personnel include representatives from the independent testing and inspection firms responsible for examining and testing various materials, procedures and equipment. Since they provide an unbiased evaluation of the materials or equipment, their evaluations and suggestions should be accepted and respected. If the Resident Engineer finds that a particular shipment of material or piece of equipment does not meet a certain quality level, that shipment shall be removed from the site immediately. The City retains the testing firms to assure compliance during construction. The testing firms should be under the direction but not under the control of the Resident Engineer. The City is responsible for quality assurance testing and inspection on the project.

16.1.6 Subcontractors

Most projects have a substantial number of subcontractors and each is responsible for only certain activities. On some private development projects the general contractor will only provide management and supervisory personnel and virtually all trade and craft work is done by subcontracted firms. The City staff does not deal directly with

subcontractors. Regardless of the business relationships established among the prime contractor and the various subcontractors, the prime contractor is responsible for the quality of the work and meeting quality control specifications in the contract documents. The responsibility for meeting those specifications cannot be delegated.

16.1.7 Suppliers

Suppliers are key members of the construction team. On any given project there may be many materials and equipment suppliers. Some supply basic raw materials for the construction process such as concrete, lumber, steel, asphalt and fencing. Others provide finish products and equipment which are installed as they arrive at the site with no significant modification. The suppliers are responsible for the quality of their materials and equipment. Inferior materials and equipment should be rejected and removed from the site. If materials and equipment are delivered to a subcontractor, the subcontractor is responsible to the prime contractor for assuring that the items meet the specifications stipulated in the contract. Questions or disputes should be directed to the prime contractor's supervisory personnel.

16.1.8 Others Who Influence the Construction Process

There are other professionals who influence the construction less directly than the ones mentioned above. Especially important are the sections and individuals charged with the financing and accounting for the City, the insurers, the bondsmen, utility officials, government regulators or grant agencies, and attorneys.

16.2 GOAL OF CONSTRUCTION TEAM

The primary goal of the construction team, which consists primarily of the City's Design and Construction Sections and the Operation and Maintenance Divisions, is to build a quality project within budget, on time, and with little or no litigation.

16.3 PLANNING AND MANAGING CONSTRUCTION ACTIVITIES

16.3.1 Introduction

There are many ways to plan and manage construction activities. However, certain responsibilities may not be altered without threatening quality in the constructed project. These are:

1. The City, through the Construction Section, is responsible for activity coordination, contract enforcement, and stopping work (in emergencies).
2. The Design Engineer is responsible for design changes and interpretation of contract documents and submittal review and approval.
3. The prime contractor is responsible for construction methods, direction of labor, job safety and the construction related quality assurance and quality control program.
4. Essential elements of planning and managing construction include clear communications through planned reporting, scheduled meetings, memos, shop drawing processing and review of progress payment requests. Project management tools include formulating and regularly updating the construction plan and schedule, estimates and the quality control program.

16.3.2 Pre-Construction Meeting

The pre-construction meeting will be held at the Construction Section's office in most instances and should include key project team representatives from the City, the Design Engineer and the contractor. Representatives from principal subcontractors should also attend. Representatives of management with the authority to make decisions should be present to resolve problems. A meeting agenda is prepared by the Resident Engineer and accurate minutes are kept. The minutes are distributed to all attendees. Typical agenda items for a pre-construction meeting include introductions; lines of communications and submittals, including correspondence; site rules and regulations; procedures for issuing and revising design information and authorizing changes, survey information, constructor's designated area; methods of payment; security, clean up, safety and first aide; temporary facilities and services, project scheduled program, material handling; labor compliance; City's role and responsibilities; specific State and local laws and regulations; dispute procedures; claims; subcontractors' approval; community relations; critical specification status; and quality control.

Depending on the size and nature of the City's project, weekly coordination meetings by the construction team are also recommended. The agenda would be similar to the pre-construction meeting but would focus on immediate project needs.

16.3.3 Construction Plan

When construction begins, most of the planning should have been completed by the contractor. A well planned construction phase is essential if the contractors are to work efficiently and safely. A realistic plan and schedule will avoid schedule problems that could lower a project's quality. The Resident Engineer should thoroughly review the contractor's initial and updated construction schedules. Duration of work items and a completion date should be reasonable. During the construction phase the schedule may be refined and expanded. The type, style and level of detail must be specified in the contract documents. Schedule updates must be re-analyzed for their impact on the critical path.

16.3.4 Coordination and Communication

A successful construction project requires coordination between the designer, the Construction Section and the contractor. The Construction Section is responsible for providing this coordination. Coordination and communications are enhanced if clear communication is established. Some basics are:

1. Only the contractor should direct labor.
2. Only the contractor should coordinate subcontractors.
3. The contractor should receive direction only from the Resident Engineer under terms of the construction contract.
4. Coordination among the project team members is based on a realistic plan and schedule developed in the pre-construction phase and reviewed during the pre-construction meeting.

16.4 CONTRACT ADMINISTRATION PROCEDURES FOR CONSTRUCTION

There are at least two parties to every construction contract and each party has contract administration responsibilities. For the purposes of this discussion, the Resident Engineer is the City's representative who is responsible for cost control and quality assurance and progress reports of the constructed project. There are certain professional mandates, management principles and communication imperatives that apply to contract administration procedures for all construction projects. These are: quality commitments, payment and cost control, progress reports, timely and acceptable receipt of contract deliverables, liaison requirements, communication skills and record keeping and retrieval functions.

16.4.1 Quality Commitments

This section discusses the Resident Engineer's responsibility to implement procedures for documenting the review and evaluation of quality requirements. Construction quality generally involves two broad aspects: specified properties for materials and workmanship.

16.4.2 Materials

In situ (natural or original) materials typically include native soils and rock, and often require independent laboratory testing and engineering evaluation of material properties to determine their acceptability for project needs. Such laboratory reports and engineering evaluations should become part of the Resident Engineer's file. Re-testing and other necessary follow up analysis should also become part of the file.

Procured materials are manmade items and they can be evaluated and accepted by several considerations. The procurement specifications should outline the level of quality and the manner of qualification, if any, that will be required. For example, a manufactured product such as a light bulb may be accepted based totally on the verification of brand name and catalog number, whereas a material such as a paint primer may require a whole series of physical and chemical analysis to verify that specified requirements have been met. The Special Provisions or the Standard Specifications must outline the minimum standards accepted for compliance. It is the responsibility of the Resident Engineer to verify if the procurement qualification requirements are met. The Resident Engineer should determine if the results of such tests were properly evaluated for specified acceptance standards by qualified individuals. If the results of all tests were properly recorded they should be documented in file. Each procured item of material or product should be represented by a file listing the qualification procedure and minimum requirements and include the type of test performed, the date the test was performed, the signature of the person performing the test, test results, any non-conformance reports and, if required, the location in the structure where the tested material or product is incorporated. Products are often purchased with performance warranties and certifications instead of specific qualifications or test requirements.

16.4.3 Workmanship

It should be understood that most specified properties and workmanship are identified with implied tolerances. It should be

clearly stated in the contract specifications if the property or workmanship being specified is "nominal" to which tolerances may be applied or a specified minimum where tolerance consideration has already been included. The practices for determining compliance with the "minimum acceptable standards" definition are more varied than for specified properties. Where more subjective judgments such as with the standard of workmanship for concrete wall finish, then common sense and experience should suffice. However, standards of measurements have been developed for virtually every conceivable physical product of construction. If minimum levels of acceptance for specified properties and workmanship are not identified, then the Resident Engineer should rely on typical industry standards.

16.4.4 Requests for Substitutions

Requests for substitutions of materials is common in contract administration. Such substitutions may be proposed by either party to the contract to save time, money, or improve quality. It is necessary to obtain approval from the designer for all but minor items change requests. In all situations, the Resident Engineer's role is to verify that the substitution is comparable in quality and utility to the original item. Requests for substitution should be responded to in a timely manner. Substitution of a specified item requires a formal letter by the Resident Engineer authorizing such a change. It is usually the contractor's right to offer substitutes and if they meet the specified criteria the owner should allow them or pay the cost differential to upgrade to the brand name originally specified. As with all factors bearing on quality, it is essential that the job record accurately reflect the items substituted, the original item, the reason for substitution, date of action, and whether a price adjustment was negotiated as a result of the change.

16.4.5 Cost Control, Payments and Estimates

Reliable estimates of cash requirements to maintain construction are vital to the City and the contractors. Providing timely and correct payment for work accomplished is critical for contractors. One significant task of project administration is predicting, monitoring and controlling cash flow. Costs are divided into two broad categories: payment to the contractor and payment to others. Payment to the contractor is further divided into regular and periodic payments of originally contemplated work and extra work or change orders. Payments to others fall into several categories such as real estate payments for right of way acquisitions, payment to utility companies for relocation of various lines so construction can begin, testing

laboratory fees and outside inspection laboratory fees and other construction related costs. A complete record of all change orders indicating the percentages of both change order costs to each contract and the total change order cost to the total project should be maintained. Periodic payments usually mean monthly payments to the contractor based on the amount of work accomplished. There are occasions when a payment is made only once, when the project is completed. However, for the majority of City construction contracts, monthly progress payments are normal. Under provisions of the 1989 City Standard Specifications, the Resident Engineer is responsible for preparing the estimated value of the monthly pay estimate and the contractor reviews and acknowledges the amount due.

16.4.6 Types of Contracts

There are three principal types of contracts: unit price, lump sum and cost plus (force account).

16.4.6.1 Unit Price Contracts

Unit price contracts are common in public works projects where the quantities of various kinds of materials and work segments are approximated and not precisely known. Under such a contract it is simple to measure the quantities involved for each item completed over the given period of time and record them for payment with the understanding that any errors will be automatically corrected in the next payment period. However, determining an accurate estimate on many unit priced contract is sometimes difficult. However, the two parties should agree before work begins on a reasonable, responsible estimating parameter for interim periods. Normally, the City Standard Specifications will only allow for payment of material incorporated into the work. However, it is sometimes necessary to pay for materials that were delivered but not yet incorporated into the work provided the Special Provisions authorize such. The value of the material is usually determined by requesting copies of invoices of the materials. Occasionally a situation arises that necessitates changing a unit price. Unforeseen circumstances, such as unknown soil conditions or changes which greatly increase or decrease the amount of materials to be used, may require a renegotiation. As soon as the scope of the change is known, a revised material quantity should be calculated. If this change is

over the preset limit (20% in accordance with City Standard Specs) a unit price change may be necessary. The new price may be more or less than the original price but it should reflect such factors as restocking charges, overhead amortization and suppliers' discounts. A contract duration change may also be necessary. A frequent cause of disputes on unit price contracts involves the estimated value of incomplete items. The important point to remember is that all work has value and estimating and paying for that value is a fundamental responsibility of the Resident Engineer. The Resident Engineer is responsible for recommending payment only for the stated value of the completed item less the cost to complete it. If there is any question on this, consult with the Senior Construction Engineer or the Construction Manager.

16.4.6.2 Lump Sum Contracts

In lump sum contracts, quantities of material are determined by the contractor. The contractor submits a single lump sum price for the completed structure. Typically, the successful contractor divides the contract into various components similar to a unit price contract. In such breakdowns it is important that mobilization or contract initiation costs be recognized and paid for. The Resident Engineer's responsibility is to determine if the various items of work included in the lump sum breakdown are properly balanced to avoid overpayment for completion of early items. Once the proper balance of items and cost has been agreed upon by the Resident Engineer the lump sum contract is similar to the unit price contract discussed above. When calculating the quantities in either case it is important to tabulate in each pay period the total quantity consumed or completed to date from the beginning of the project to the subject date. From this the total previously paid is subtracted. This process involves constantly reviewing the total quantities used and any errors in estimating are automatically discovered and corrected. Merely tabulating the amount added on each month usually results in compounding errors.

16.4.6.3 Cost Plus Contracts (Force Account)

In cost plus contracts the contractor is reimbursed for actual cost plus an agreed upon rate for overhead and profit. Because the contractor is compensated for cost rather than for completed work, the emphasis on record keeping shifts from the amount of work completed to the cost for completing the work. Under this type of contract record keeping is more important and it is necessary to record each worker (direct, indirect and supervisory), the hours worked, the type of work and the wages paid. Moreover, methods must be established to record and file the large quantity of material invoices, delivery slips and other records required to verify the costs of the contractor to complete the work. This also includes equipment used in the project and the time the equipment was actually used. Further difficulties can occur when cost plus work is performed within a unit price contract such as when extra or unexpected work is encountered for which no unit price has been established. In such situations the mixed use of personnel and equipment can cause problems. For example, the cost involved in maintaining a superintendent on the project may be amortized among various unit priced items. If the same superintendent is engaged in supervising extra items, then a fair and reasonable determination of that time and effort may need to be added to the cost of performing the work. Similarly, equipment brought on to the project to perform unit priced items may be used for extra work. Again, a fair and reasonable allocation should be made.

16.4.7 Retainage

Retainage is withholding funds, usually a percentage of the work completed to date, in case an error in estimating, a lapse in meeting quality standards, or a construction error is discovered. It is important to understand that retainage is neither a penalty nor a license to alter the contract. In many areas retainage is used as an inducement to assure timely completion. However it is used, retainage is a temporary assessment against earned funds and it is recommended to reduce such withholding promptly after the cause of the assessment has been satisfactorily addressed. On the other hand, failure to withhold sufficient retainage in the event of an error, default, bankruptcy, or a similar event can be a serious matter. Premature

payment of the contract funds by overpayment or premature release of retained funds can result in loss of the owner's rights under the performance bond in the event that the contractor fails to perform his contractual obligation and is in default. In such a situation the amount retained indicates project management's professional skill and judgment. Releasing earned funds fully and promptly while withholding all unearned funds is a constant challenge to a competent Resident Engineer.

16.4.8 Liquidated Damages

Liquidated damages are a pre-determined value placed on a completed element of work, usually expressed in dollars per day. Liquidated damages, unlike retainage, generally are not related to contracted costs. Liquidated damages are intended to compensate the owner for additional costs incurred and loss of income because the project is not complete and the owners must retain staff and absorb redundant costs. Liquidated damages can be assessed only when the cause for the delay on a project can be attributed to acts or omissions by the contractor. If a project is delayed for reasons beyond the control of the contractor, then sufficient extensions of time should be granted to avoid the need for assessing liquidated damages.

16.4.9 Change Orders

Construction involves creating custom made products in the field. Consequently, the variety of foundation types, the weather and the abstract nature of materials, design fabrication and erection frequently dictates some deviation from the original plan. Quickly recognizing this will save both owners and contractors from unnecessary costs increases and schedule delays. All quality construction projects should have contingency for unforeseen circumstances. Ideally, changes should be recognized in sufficient time for materials, designs, fabrications and installations to be altered, estimated and performed, received and fair prices negotiated. Often this is not possible and the work must proceed before reasonable prices have been agreed upon. This latter case is somewhat common and neither the contract plans nor a particular individual is necessarily to blame. Changes do occur and there is often disagreement as to their value. Reaching a reasonable agreement is the prime responsibility of the Resident Engineer. In addition to changes to the original materials design and fabrication, it frequently becomes necessary or desirable to perform extra work on a project. This may entail providing more or less of an

item than originally intended and utilizing the skills and resources of the contractor to perform work or implement a concept not originally planned. In such situations a change order is necessary.

Whether it is a change order or an extra work order the document should be clearly and promptly initiated and accurately reflect its nature and reason for the revision. The document should be signed by the contractor and the Construction Manager and forwarded to the appropriate City offices for completion. All change orders shall be numbered, dated, and include relevant information such as a revised plan sheet, sketches, specifications and quotations. The document should address impacts of the changed work on the project schedule when appropriate. Additionally, change orders frequently are used to acknowledge changes in progress factors even where no physical change is evident.

16.4.10 Non-Contractor Invoices

The certification and recommendation for payment of various vendors' invoices is an important element in effective project cost management. All such invoices whether for utility relocations, purchase of equipment by the construction organization or testing of construction components must show the date that the purchase was made or the work was performed, the unit cost or prices involved, and the specifications or other quality criterion used in performing the work. Each vendor's invoice should be considered a separate contract and should provide the same information as in the construction contract.

16.4.11 Construction Progress

All major construction projects require the pre-commencement submittal of a progress schedule by the contractor. Such schedules remind the contractor to consider carefully the timing required for the various elements of the work. The schedules are important to the Resident Engineer in establishing cash flow requirements, assessing personnel demands and coordinating contract work with adjacent activities. There are numerous ways to communicate the intent of progress. The most common kinds of schedules are bar charts, net work analysis such as the critical path method, and S curves which relate progress to cumulative costs.

Bar charts are the simplest schedules to prepare and evaluate because they show time on the horizontal axis and various items of work on the vertical axis. Bar charts can become more detailed and

complex simply by defining the time scale. The number of elements on the vertical scale also increases the complexity.

On the other hand, network analysis, in addition to the passage of time, recognizes the interrelationships of various construction elements. The elements of work are represented by an arrow symbol which is generally un-dimensioned. The nodes representing the tail and head of the arrow can be tabulated for early or late start or early or late finish to represent a realistic picture of the variability that is common to construction. As with bar charts however, network analysis is not inherently simple or complex. The complexity derives from the number of elements chosen to be reflected in the various nodes.

16.4.12 Progress Reports

The three common types of construction reports are detailed reports, summary reports and subjective reports. Regularly scheduled progress or coordination meetings should be established and minutes taken. These minutes constitute a report and all team members should be involved. Detailed reports should be prepared on a scheduled basis, usually daily and involve tabulation of each item of work accomplished (equipment, materials and manpower used) during the defined period. Detailed reports form the substance of the Resident Engineer's file and are the most important resource for paying requisitions, resolving disputes and recreating the job history. A preparation and review of detailed reports is one of the most significant tasks for the Resident Engineer.

Summary reports contain information from each detailed report and relate that information to project goals. Normally most City projects do not require a summary report.

Subjective reports need not be made periodically but should be filed when unusual or significant events occur during construction. An example would be an accident report or a letter describing an unusual incident or problem.

16.4.13 Records

The Resident Engineer is responsible for maintaining a complete and orderly file of all aspects of the contract. In addition to the reports mentioned previously, the entire correspondence file of memos and minutes and meetings is an important part of that record. Other

important records not previously discussed are part of the job records. These are the shop and shop drawing logs, job photographs, video tapes, certified payroll records, and record drawings. Other documents such as change orders and field orders also must be maintained and filed. All job diaries and bidding documents are included as part of the permanent contract record.

16.4.14 Notice of Completion

When the project is completed, acceptance is recommended to the City Council and following their acceptance a Notice of Completion shall be filed.