DIVISION OF CONSTRUCTION

Construction Quality Assurance Program Manual

State of California
Department Of Transportation

Caltrans

MAY 2023

CALIFORNIA
DEPARTMENT OF TRANSPORTATION

Construction Quality Assurance Program Manual

Issued by
Division of Construction

GAVIN NEWSOM
Governor

TONY TAVARES
Director, Department of Transportation

MICHAEL KEEVER
Chief Deputy Director

DONNA BERRY
Chief Engineer

RAMON HOPKINS
Chief, Division of Construction

RAYMOND TRITT
Assistant Chief, Division of Construction

JOSEPH DONGO
Chief, Office of Construction Standards

Construction Quality Assurance Program (CQAP) Manual

Issued by
Division of Construction

This manual provides quality assurance guidance on testing and inspection to verify the quality of materials used in highway construction on Federal-Aid Projects.

Approved By:

Raymond Tritt
Assistant Chief
Division of Construction
California Department of Transportation

7/3/2023
Date

Christopher S. Long
Infrastructure Team Leader
Federal Highway Administration

7/3/2023
Date

CONTENTS

Introduction

For many years, departments of transportation (DOTs) performed testing and inspection to verify the quality of materials used in highway construction. During those years, DOTs were the sole testing and inspection authority. Later, as some of the testing duties were shifted to the contractor, the DOTs continued performing tests for acceptance or verification. The contractor testing was then referred to as quality control, while the DOT testing and inspection were termed quality assurance.

In the past two decades, the use of alternative project delivery methods challenged the traditional quality management approach where the contractor performed quality control while the owner conducted quality assurance. This caused a shift in perspective regarding quality assurance. For the Federal Highway Administration (FHWA), construction quality assurance is not a slogan. It is a systematic approach to attain the constructed quality of each Federal-aid project. As Figure 1 illustrates, a complete Quality Assurance Program includes the six core elements of:

- Contractor Quality Control
- Agency Acceptance
- Independent Assurance
- Dispute Resolution
- Laboratory Qualification and Accreditation
- Personnel Qualification and Certification

Figure 1. FHWA Six Core Elements of Quality Assurance Program

Quality construction is fundamental to meeting the mission of the California Department of Transportation (Caltrans), and quality assurance is the primary means by which Caltrans confirms the quality of constructed highway projects.

Quality assurance encompasses all materials and construction activities on a project and directly affects the service life of a transportation facility. The elements of an acceptable quality assurance program include quality control by the contractor, acceptance testing and inspection by Caltrans, independent assurance, qualified personnel, accredited laboratories, and a dispute resolution process. These elements work together to assure an effective quality assurance program. Any elements missing from the program increase the risks associated with the project, such as a reduced service life.

The Construction Quality Assurance Program (CQAP), developed by Caltrans for highway construction projects, adheres to the quality assurance requirements outlined by the Federal Highway Administration (FHWA) in the Code of Federal Regulations, Title 23, Section 637 (23 CFR 637), “Construction Inspection and Approval”; 23 CFR 637 Subpart B, “Quality Assurance Procedures for Construction,”; 23 CFR 637.205, “Policy,” and 23 CFR 637.207, “Quality Assurance Program.”

The role of the CQAP is to provide confidence that the quality of the materials and work quality incorporated into all highway construction projects conforms to the requirements of the plans and specifications.

Construction Quality Assurance Program Manual Overview

Purpose

Completed projects are tangible products by which Caltrans is measured in the delivery of its programs. The public ultimately defines the success of Caltrans' performance based on these projects.

Caltrans requires consistent quality construction in all its projects. As a result, over the years, Caltrans has developed procedures and methods to make sure that every construction project achieves the desired level of quality for both materials and work. The responsibility for construction quality has been shared by various functional groups, resulting in the distribution of quality-related policies, procedures, and guidelines throughout Caltrans, with no single, consolidated document available as a guide for all quality-related requirements.

Scope

This manual documents the CQAP by identifying existing quality related requirements from all applicable Caltrans policies, procedures, and guidance documents. See Appendix A, "Caltrans Quality Assurance Documents." This manual also demonstrates compliance with 23 CFR 637.

The provisions of this manual apply to design-bid-build projects and projects under a construction manager general contractor (CMGC) or a job order contracting agreement. The provisions do not apply to projects for which Caltrans has entered into a public-private partnership or a design-build agreement. The Caltrans document, "Design-Build Quality Manual Template," provides guidance to design-builders regarding quality assurance. For alternate project delivery methods, Caltrans retains responsibility for acceptance. The implementing agency may use its own program when authorized by Caltrans; however, Caltrans retains authority for the project and performs independent quality assurance to make sure that the implementing agency's quality assurance activities result in projects being developed in accordance with Caltrans standards, policies, practices, and the quality control plan provided by the project sponsor.

This manual does not repeat information contained in other manuals but references where the inspection, acceptance testing, and independent assurance requirements are found for materials used in highway construction.

Organization of This Manual

- Chapter 1, "Construction Quality Assurance Program," describes the CQAP activities Caltrans performs to achieve the specified quality for constructed highway facilities. These activities include control of documents and records, management responsibilities, resource management, process control, inspection and testing, control of nonconforming work, control of testing and measuring equipment, and project materials certification.
- Chapter 2, "Construction Quality Assurance Roadmap," describes the six major components of the CQAP; presents the route to developing quality assurance specifications for materials, work quality, products, and services; summarizes the various quality assurance methods Caltrans uses; and provides guidance to determine which quality assurance methods are needed to achieve a level of quality assurance appropriate to the application of a contract item of work, and severity of the consequences of its failure.
- Chapter 3, "Construction Quality Assurance Long-Range Plan," recommends and describes a potential long-range plan for improvements to the CQAP. The long-range plan includes establishing a construction quality assurance database, adopting a system-based acceptance process, implementing performance specifications, and adopting risk-based

acceptance criteria based on use of performance-related specifications, risk-based acceptance, and system-based acceptance. Development and implementation of a materials management system construction quality assurance database is the primary recommendation to improve the efficiency and quality of the CQAP.

Process for Updating

The Division of Construction issues Quality Assurance Program Bulletins (QAPBs), as shown in Appendix B, “Caltrans Quality Assurance Program Bulletin” to communicate procedure and policy changes. From time to time, QAPBs are incorporated into this manual. QAPBs supersede any conflicting information, guideline, or instruction in the manual. If a policy contained in this manual is unclear or has been superseded, and a QAPB has not been issued covering the changed policy, notify the Division of Construction, Publications Unit.

Chapter 1
Construction Quality Assurance Program
Overview

The Construction Quality Assurance Program (CQAP) includes an acceptance program for materials and work quality, an independent assurance program, and preparation of a project materials certification. Consistent with the Code of Federal Regulations Title 23, Section 637 (23 CFR 637), "Construction and Inspection Approval," the CQAP assures "that the materials and workmanship incorporated into each federal-aid highway construction project on the National Highway System are in conformity with the requirements of the approved plans and specifications, including approved changes." The CQAP is also applicable to all California Department of Transportation (Caltrans) projects on the State Highway System. However, the CQAP is not applicable to projects for which Caltrans has entered into a public-private partnership or a design-build agreement.

Chapter 1 describes CQAP-related organizational roles and responsibilities, and the policies and procedures designed to assure that specified construction materials and work quality incorporated into each project are acceptable and in conformance with the contract documents. The chapter is organized into 10 sections:

1. Definitions and Abbreviations
2. Specified Level of Quality—Materials and Work Quality
3. Document and Record Control
4. Management and Staff Responsibilities
5. Resource Management
6. Process Control
7. Inspection and Testing
8. Control of Nonconforming Work and Materials
9. Control of Inspection, Measuring, and Testing Equipment
10. Project Materials Certification

Section 1 addresses the definitions and abbreviations associated with the specialized vocabulary in quality assurance programs.

Sections 2 through 10 are based in part on the International Organization for Standardization (ISO) 9001, "Quality Management Systems." ISO 9001 lists 20 quality management elements that must be addressed in a quality assurance program. These sections demonstrate the CQAP's conformance with the ISO 9001 elements applicable to transportation construction. Some ISO 9001 elements are not addressed in the CQAP because they reflect the manufacturing-related origins of the ISO 9000 series and a literal application to transportation construction is not appropriate.

1.1 Definitions and Abbreviations

The terms related to the Caltrans quality assurance program are defined in this section.

1.1.1 Definitions

acceptance: The process of deciding if the material and work quality meet contract requirements.

acceptance program: All factors that comprise Caltrans' determination of the product's quality as specified in the contract requirements. These factors include verification sampling, testing, and inspection, and may include results of quality control sampling and testing. Refer to 23 CFR 637, Subpart B, "Quality Assurance Procedures."

acceptance tests: Defined in Section 6-102, "Types of Sampling and Testing," of the *Construction Manual* as "tests performed on samples from the materials that will be incorporated into the work."

acceptance sampling and testing: Sampling, testing, and assessing test results to determine whether the quality of produced material or construction meets the terms of the specifications.

accredited laboratories: Laboratories that are accredited by Caltrans in accordance with the requirements of the Caltrans *Independent Assurance Manual* (IAM), Section 2.4, "Laboratory Accreditation," for performing tests on aggregates, asphalt concrete materials, embankment and soils, and cementitious concrete materials.

authorized laboratories: Independent testing laboratory: (1) not employed or compensated by any subcontractor or subcontractor's affiliate providing other services for the contract, and (2) authorized by Caltrans. Refer to the *Standard Specifications*. This includes laboratories accredited in accordance with Section 2.4 of the IAM, as well as laboratories authorized using other methods.

construction manager or general contractor: A project delivery method in which the contractor is selected during the design process and makes input to the design regarding constructability, cost engineering, and value analysis reviews. Once the design is complete, the same entity may build the project as the general contractor. The construction manager or general contractor delivery method assumes the contractor will perform a significant amount of the construction work.

construction manager-at-risk: A project delivery method similar to the construction manager or general contractor method, except the construction manager does not perform any of the construction work.

design-bid-build: A project delivery method for which the design phase and the construction phase are done by separate entities.

design-build: A project delivery method for which the design phase and construction phase of the project are both awarded to a single entity.

documentation: Proof in the form of detailed records or charts supporting the effectiveness of a quality control system.

fabricated: Custom-made under controlled conditions to Caltrans specifications.

implementing agency: The entity charged with the successful completion of each project component as defined in California Government Code Section 14529 (b). Refer to Deputy

Directive 090-R1, “Funding of Quality Management Work on State Highway Projects,” December 21, 2018, included in Appendix C.

independent assurance program: Activities that are an unbiased and independent evaluation of all the sampling and testing procedures used in the acceptance program. Refer to 23 CFR 637.

independent quality assurance: The activities performed by Caltrans at a project level to verify that the implementing agency’s quality assurance activities result in projects being delivered in accordance with Caltrans standards, policies, and practices, and the quality control plan provided by the project sponsor. Refer to Deputy Directive 090-R1, “Funding of Quality Management Work on State Highway Projects,” December 21, 2018, included in Appendix C.

job order contracting: Also known as indefinite delivery or indefinite quantity contracting provides for an indefinite quantity of construction services whose performance and delivery scheduling are determined by issuing work orders with the contractor during a fixed period of time. It is an on-call construction contract through a master agreement, not a purchase order or service contract.

manufactured: Mass-produced under controlled conditions to standard industry specifications.

process control: The method for keeping a process within boundaries; the act of minimizing the variation of a process. Refer to American Society for Quality, “Quality Glossary.”

public-private partnership: Comprehensive lease agreement between Caltrans, or regional transportation agencies, and public or private entities for transportation projects.

qualified laboratories: Laboratories that are capable as defined by appropriate programs established by Caltrans. As a minimum, the qualification program must include provisions for checking test equipment and the laboratory, and must keep records of calibration checks. Refer to 23 CFR 637. Caltrans uses “accredited laboratories” as an equivalent to the term “qualified laboratories.”

qualified sampling and testing personnel: Capable personnel, as defined by appropriate programs established by Caltrans. Refer to 23 CFR 637.

qualified tester: Personnel qualified by successfully completing the process in the *Independent Assurance Manual,* Section 2.3, “Tester Qualification,” or as defined in the plans and specifications.

quality: (1) the degree or grade of excellence of a product or service, (2) the degree to which a product or service satisfies the needs of a specific customer, and (3) the degree to which a product or service conforms to a given requirement.

quality assurance: All planned and systematic actions necessary to provide confidence that a product, facility, or service will satisfy given quality requirements. Refer to 23 CFR 637.

quality control: Actions and considerations necessary to assess and adjust production and construction processes to control the level of quality produced in the end product or facility, and to fulfill specified requirements.

quality control plan: Contractor's plan to confirm quality control. Refer to Caltrans *Standard Specifications* glossary.

specifications: Caltrans *Standard Specifications*, revised *Standard Specifications*, and special provisions.

verification: The process of determining or testing the truth or accuracy of a test result by examining the data and providing objective evidence. Caltrans applies this process as part of the acceptance program by inspection, sampling, and testing to determine the accuracy of the contractor's test results.

verification sampling and testing: Sampling and testing performed to validate the quality of the product. Refer to 23 CFR 637.

1.1.2 List of Abbreviations

The following abbreviations and their definitions are used in this manual.

Abbreviation	Description
AASHTO	American Association of State Highway and Transportation Officials
AFAL	Authorized Facility Audit List
AISC	American Institute of Steel Construction
ASTM	American Society for Testing and Materials
BCRP	*Bridge Construction Records and Procedures* Manual
CAPE	Contract Administration Process Evaluation
CFR	Code of Federal Regulations
CQAP	Construction Quality Assurance Program (Caltrans)
DES-SC	Division of Engineering Services, Structure Construction
DIME	Data Interchange for Materials Engineering
DOT	Department of Transportation
FHWA	Federal Highway Administration
FSR	Feasibility Study Report
HMA	Hot Mix Asphalt
IAM	*Independent Assurance Manual* (Caltrans)
JMF	Job Mix Formula
METS	Materials Engineering and Testing Services
MPQP	Material Plant Quality Program
OCL	Office of Central Laboratories
OMMIA	Office of Materials Management and Independent Assurance
OQASI	Office of Quality Assurance and Source Inspection
PaveM	Pavement Management System (Caltrans)
PBS	Performance-Based Specifications
PRS	Performance-Related Specifications
QASI Manual	Quality Assurance and Source Inspection Manual
QMS	Quality Management System
SIAD	Statewide Independent Assurance Database

1.2 Specified Level of Quality—Materials and Work Quality

The CQAP includes specifications and plans that describe the quality requirements for all material and work to be incorporated into a project, and the acceptance criteria by which Caltrans will verify conformance with the quality requirements. Material and work quality requirements are established in the design process and reflect the standards necessary to make sure that the material or item will function as designed. During construction, tests and inspections evaluate the acceptability of the material and work based on the acceptance criteria.

1.2.1 Materials

The quality requirements for materials are contained in the: (1) Caltrans *Standard Specifications* and project special provisions; (2) contract plans, and (3) change orders. These documents include or reference the acceptance criteria for determining if the prescribed quality for materials has been met. For example, Section 19-3.02C, “Structure Backfill,” of the 2022 *Standard Specifications*, requires that structure backfill complies with the grading requirement of 100 percent passing the 3-inch sieve.

1.2.2 Work Quality

The requirements for work quality are contained in the Caltrans *Standard Specifications*, project special provisions and in the plans or change orders. For example, Section 73-3.03, “Construction,” of the *Standard Specifications*, requires that “The finished surface must not vary more than 0.02 foot from a 10-foot straightedge …”

1.3 Document and Record Control

Activities affecting quality are prescribed by and accomplished in accordance with documented instructions, procedures, and drawings. These documents also include appropriate quantitative or qualitative acceptance criteria for determining that the activities have been satisfactorily accomplished.

The following types of documents are used in the CQAP:

- Documents that provide consistent information, both internally and externally, about Caltrans' CQAP. Such documents are referred to as quality manuals.
- Documents that describe how the CQAP is applied to a specific product, project, or contract. Such documents are referred to as quality plans.
- Documents stating requirements. Such documents are referred to as specifications.
- Documents stating recommendations or suggestions. Such documents are referred to as guidelines.
- Documents that provide information about how to perform activities and processes consistently. Such documents include documented procedures, work instructions, and drawings.
- Documents that provide objective evidence of activities performed or results achieved. Such documents are referred to as records.

1.3.1 Document Control

The CQAP includes procedures to control the issuance of documents, including changes, that prescribe all activities affecting quality. These procedures assure that documents, including changes, are: (1) reviewed for adequacy, (2) approved for release by authorized personnel, and (3) distributed for use where the prescribed activity is performed.

Preparing, issuing, and updating or revising documents that specify quality requirements or prescribe activities affecting quality are controlled processes that assure that correct, up-to-date documents are used. The document control system assures distribution and availability of the latest authorized documents to all required users before the start of work.

- Program level documents, such as the Construction Manual and changes to it, are reviewed for adequacy and authorized for release by appropriate division personnel. For example, the Division of Construction makes changes in policy to the Construction Manual as need arises. Policy changes are incorporated into the Construction Manual and announced in manual change transmittals, which the Division of Construction reviews and controls. Another useful guide is the Quality Assurance and Source Inspection (QASI) Manual, which is controlled by the Office of Quality Assurance and Source Inspection (OQASI) (see Appendix A for reference link).
- Project level documents, such as plans and specifications, are controlled and issued by district office engineers as part of the construction contract for a project. Changes to these documents after project award are controlled by a change order process.

Table 1.3.1. lists supporting documentation.

Table 1.3.1. Document Control References

Title	Chapter/Section	Description
Construction Manual	Chapter 1, Section 0	Construction Manual Overview
Construction Manual	Chapter 5, Section 1	Project Records and Reports
Construction Manual	Chapter 5, Section 3	Change Orders
Construction Manual	Chapter 9	Projects Sponsored by Others
QASI Manual	Sections 5, 6, 11, 40, 47, 49, 50, 52, 55, 75, 86, 90, 99	Quality Control Plan Review
QASI Manual	Sections 1, 5, 11, 40, 46, 47, 49, 50, 51, 52, 55, 56, 59, 60, 65, 75, 83, 86	Shop Drawing Review
BCRP Vol. 1	Bridge Construction Memo C-6	Required Documents to be Submitted During Construction

Note: See Appendix A for the reference manuals

1.3.2 Records Control

The CQAP includes procedures that verify that sufficient records are maintained to furnish evidence of activities affecting quality. At a minimum, inspection and test records must identify the inspector, tester, or data recorder, the type of observation, the results, the acceptability, and the action taken in connection with any deficiencies noted. Records must be identifiable and retrievable. Records retention requirements, such as duration, location, and assigned responsibility, are established. Refer to Section 5-104C, “Disposition of Construction Project Records” of the *Construction Manual* for the details.

Quality records describe the work involved and contain evidence that work items met the requirements of the plans and specifications; sampling and testing personnel, procedures and equipment were properly certified or accredited, and corrective action was taken for any nonconforming conditions. Records generated for the project by Caltrans, consultants, contractors, subcontractors, and suppliers represent an important and integral part of each construction project. Contractors are required to maintain quality records as evidence of their activities and those of their subcontractors and suppliers.

Resident engineers and structure representatives maintain records at the projects during the construction phase. After project closeout, those records are transferred to district archives and retained in accordance with record retention schedules. As-built plans for all projects on the State Highway System are submitted to the document retrieval system (DRS) unit at the Division of Design. The official as-built plans are stored in DRS. Structure-related documents are submitted to headquarters Structure Construction for distribution to other pertinent units for record keeping. Refer to *BCRP*, Vol. 1, Bridge Construction Memo C-6, “Required Documents to be Submitted During Construction.”

Required quality records are indexed, filed, readily retrievable for authorized personnel, maintained, stored to minimize deterioration and prevent damage or loss, and archived according to applicable written procedures. Refer to Table 1.3.2 for examples of quality records indexed and filed in the uniform filing system.

Table 1.3.2. Records Control File Categories

File Category	File Description	File Category	File Description
9	Welding	39	Materials Testing Qualification of Employees
11	Information Furnished at Start of Project	40	Field Laboratory Assistant Reports to Resident Engineer
29	Materials Information and Preliminary Tests	41	Report of Inspection of Material
30	Basement Soil Test Results	42	Material Plants
31	Notice of Materials to Be Used	43	Concrete and Reinforcing Steel
32	Notice of Materials to be Inspected at the Job Site	45	Resident Engineer's Daily Reports
34	Treated Base	46	Assistant Resident Engineer's Daily Reports
35	Hot Mix Asphalt	47	Drainage Systems
36	Concrete, other than structure items	49	Change Orders
37	Initial Tests and Acceptance Tests	63	Project Completion Documents
38	Quality Control		

Most project records are distributed to the project field office for current projects, or the district archives for completed projects for recordkeeping. An example of a document review would be to determine if qualified testers were used to perform tests. The first step would be to sample records from Category 37, "Initial Tests and Acceptance Tests," to obtain the names of testers. Then review records from Category 39, "Materials Testing Qualification of Employees," and the Statewide Independent Assurance Database (SIAD), to determine that testers are qualified. For more information, refer to the *Construction Manual*.

Table 1.3.3. lists supporting documentation.

Table 1.3.3. Required Documents to be Submitted During Construction

Title	Chapter/Section	Description
Construction Manual	Chapter 5, Section 1	Project Records and Reports
BCRP Vol. 1	Bridge Construction Memo C-6	Required Documents to be Submitted
QASI Manual	Section 1-A.07.2	OQASI Uniform Filing System for Project Specific Documents

Note: See Appendix A for the reference manuals

1.4 Management and Staff Responsibilities

1.4.1 Quality Objective

Caltrans' strategic goals include:

- Safety first
- Cultivate excellence
- Strengthen stewardship and drive efficiency

1.4.2 Quality Commitment

Caltrans is committed to providing adequate technical, administrative, and managerial services to support each construction project so that it is completed to the specified level of quality, and when placed in operation, provides a safe, reliable, easily maintained facility that fulfills the intended function, and meets all applicable statutory and regulatory requirements.

1.4.3 Responsibility and Authority

Caltrans' key organizations and management positions responsible for managing, performing, and verifying work affecting quality are described in Chapter 1, "Caltrans Construction Organization," of the *Construction Manual*.

1.4.3.a Division of Construction

- The chief of the Division of Construction, located in headquarters, leads the CQAP to deliver quality transportation products and services.
- Headquarters Construction office chiefs and staff, and Construction field coordinators assist with contract administration processes and reviews.

1.4.3.b District Construction

- The district and regional Construction division chief or district Construction deputy director is responsible for implementing the CQAP in each region or district.
- District Construction engineers are responsible for making sure resident engineers are adequately trained, verifying that materials and work comply with plans and specifications, and maintaining project quality records.
- District materials engineers are responsible for district and field materials laboratories.
- The resident engineer assigned to each project is the onsite Construction representative and is responsible for contract administration, construction engineering, and the acceptance of all materials and work quality on each assigned project. The resident engineer makes sure that contractor and state staff whose test results are used in the acceptance decision are certified in accordance with the Independent Assurance Program.

1.4.3.c Division of Engineering Services

- The Division of Engineering Services, Structure Construction (DES-SC) is responsible for technical control of structure work and has ultimate responsibility and authority for decisions relating to the structural adequacy of contract work on structures. DES-SC engineers are assigned to all districts to provide field engineering for structures. The district may request that the assigned structure representative act as the resident engineer on projects where structure work predominates.

- Materials Engineering and Testing Services (METS) conducts specialized laboratory and field testing, provides source inspections, audits suppliers and fabricators, and gives expert advice on all phases of transportation engineering involving materials and manufactured products. METS also provides technical expertise for the development of statewide standards, procedural guidelines, and manuals. Furthermore, the independent assurance program has been centralized and is administered by METS.

1.4.3.d Other Divisions

The Divisions of Maintenance and Design are available to support the resident engineer in implementing the CQAP. Figure 1.4.1 reflects the many support services available to the resident engineer.

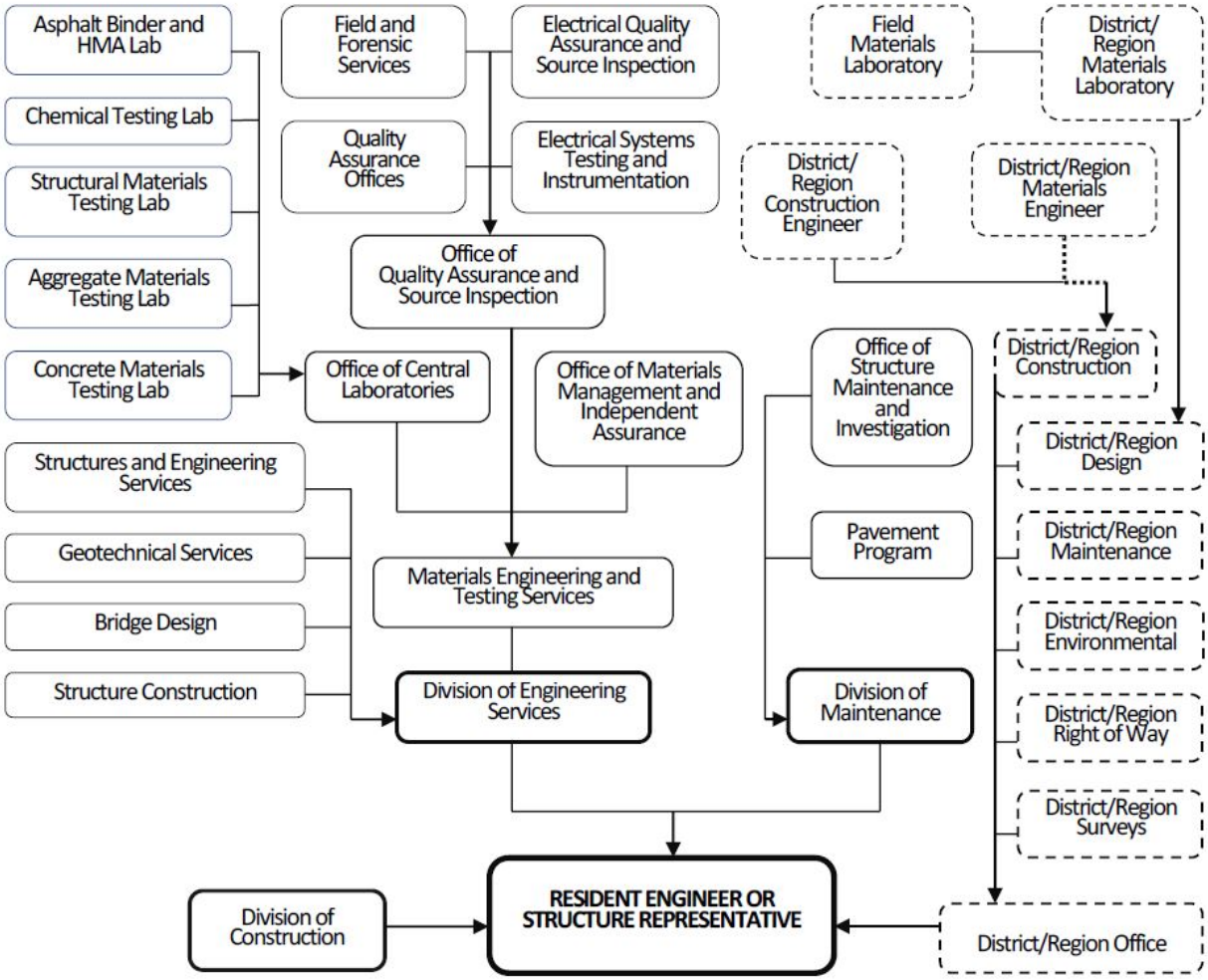

Figure 1.4.1. Support Services Available to Resident Engineer

Caltrans staff responsible for implementing the CQAP and for verifying that activities affecting quality are properly performed have sufficient authority, access to work areas, and organizational freedom to:

1. Identify quality problems.
2. Initiate, recommend, and provide solutions to quality problems through designated channels.
3. Verify implementation of solutions.
4. Make sure that further processing, delivery, construction, and use are controlled until proper resolution of a nonconformance, deficiency, or unsatisfactory condition has occurred.

Responsible Caltrans staff have direct access to the management level at which appropriate action can be taken, with sufficient independence from cost and schedule considerations unduly influencing those decisions.

Table 1.4.1. lists supporting documentation.

Table 1.4.1. Organization Reference

Title	Chapter/Section	Description
Construction Manual	Chapter 1, Section 1	Construction Organization

Note: See Appendix A for the reference manuals

1.4.4 CQAP Process Evaluation

Evaluations are conducted routinely to determine the effectiveness of the various CQAP processes. When deficiencies are found, corrective actions are taken by the appropriate division. The following are examples of Caltrans' annual CQAP process evaluations.

The Division of Construction compiles an annual Contract Administration Process Evaluation (CAPE) report. Three to six elements of the contract administration process are evaluated for strengths, weaknesses, recommendations for improvements, and district corrective action plans. The CAPE is described in the Caltrans Division of Construction Charter: Contract Administration Process Evaluation (CAPE). Refer to Appendix D.

The Office of Materials Management and Independent Assurance (OMMIA) performs annual audits of each Office of Quality Assurance and Source Inspection (OQASI) Branch to make sure that the branches are using consistent practices and procedures.

DES-SC management conducts an annual project record review for each structure representative. If inadequacies are found, the reviewer conducts another review within 1 month to verify that the noted problems have been corrected.

Table 1.4.2. lists supporting documentation.

Table 1.4.2. Process Evaluation References

Title	Chapter/Section	Description
METS Quality Manual	Chapter 9	Quality Assurance and Source Inspection (QASI) Branch Audits
BCRP, Vol. 1	Bridge Construction Memo E-2	Structural Construction Project Record Review

Note: See Appendix A for the reference manuals

1.5 Resource Management

The CQAP includes guidance for Caltrans to provide necessary resources to implement, maintain, and continually improve the program's effectiveness. Adequate personnel and technological and environmental resources are provided to support project delivery in conformance with regulatory requirements. These provisions are consistent with 23 CFR 637.205, "Policy," requirements that adequate, qualified staff be maintained to administer the CQAP. Caltrans also maintains the Transportation Laboratory, or Translab, a central transportation laboratory in Sacramento, which is accredited by the American Association of State Highway and Transportation Officials (AASHTO) Accreditation Program for the testing of aggregate, asphalt binder, asphalt concrete, cement, concrete, and soils.

1.5.1 Competence, Awareness, and Training

The CQAP includes procedures to make sure the training of personnel performing activities affecting quality and to confirm that suitable proficiency is achieved and maintained. Managers of activities affecting quality are responsible for determining the personnel competencies required and assessing needs; making sure that actions such as training are taken to satisfy those needs; and evaluating the actions to confirm that personnel are adequately trained and qualified to manage and perform assigned work activities.

Lists of available training courses and seminars are periodically provided to senior management for distribution to managers who review the education and experience of employees to determine whether additional training is required to perform specific tasks. Managers are periodically requested to select personnel for scheduled safety training and other employee development training, such as project management and field inspection. Classes provided to the resident engineer or the structures representative are listed at the following link:

https://construction.onramp.dot.ca.gov/division-construction-training-unit

Alternatively, contact the Division of Construction at: Construction.Publications@dot.ca.gov.

Table 1.5.1. lists supporting documentation:

Table 1.5.1. Training Policy Reference

Title	Chapter/Section	Description
Deputy Directive 75R1, 05/27/2015 (see Appendix C)	Training	Establishes policy for training

1.6 Process Control

The CQAP includes process control procedures, based on specifications, drawings, process parameters and approvals, and other appropriate methods, to control contractor construction processes that affect material and work quality. Typical elements of construction process control addressed throughout this manual include, but are not limited to:

- Approved material sources
- Work quality standards
- Quality control requirements
- Acceptance criteria
- Inspection and testing

1.6.1 Proposed Source of Materials

The contractor must notify the resident engineer of the sources of all materials obtained for incorporation into the work. Such notification is required before the preconstruction conference. The contractor must submit Form DOT CEM-3101, “Notice of Materials to Be Used,” to list all materials to be used on the project.

1.6.1.a Material Identification and Traceability

The CQAP includes procedures to assure that contractors maintain identification, control, and traceability of materials and components, from point of production through material incorporation into the project. These procedures specify the methods and extent of material identification and traceability to assure that only correct and acceptable items are incorporated into the project. The procedures specify that item identification is maintained by heat number, part number, serial number, or other appropriate means either on the item or on records traceable to the item throughout fabrication, erection, delivery, installation, and use of the item. The *Standard Specifications* specify the identification requirements for different materials. For example, Section 49-2.02B(1)(d), “Markings,” requires the contractor to provide steel pipe piling with markings showing the heat number. Commercial-quality items are not required to be traceable.

The following methods are applicable:

- Contractor quality control plan. When applicable, the contractor is required to maintain the traceability of materials.
- Certificate of compliance. These certificates are required to show a unique shipment number or a serial number traceable to a specific silo, bin, lot, or heat number.
- Source inspection. Inspected materials meeting specifications are identified by lot numbers. The METS inspector enters the lot number, a description, and the quantities of materials inspected on Form TL-0029, “Report of Inspection of Material.”

Table 1.6.1. lists supporting documentation.

Table 1.6.1. Control of Work and Materials References

Title	Chapter/Section	Description
Standard Specifications, 2022	6, 19, 20, 21, 37, 39, 40, 41, 47, 49, 50, 51, 52, 55, 57, 59, 74, 75, 80, 82, 84, 87	Quality Control, Materials
Construction Manual	Chapter 3, Section 5	Control of Work
Construction Manual	Chapter 3, Section 6	Control of Materials
Construction Manual	Chapter 6, Section 2	Acceptance of Manufactured or Fabricated Materials and Products
BCRP Vol. 1	Section A, Memo A-1	Communicating Staff Responsibilities
QASI Manual	Section 5	Control of Work
QASI Manual	Section 6	Control of Materials

Note: See Appendix A for the reference manuals

1.6.1.b Handling, Storing, and Transporting

The CQAP includes guidance to assure the contractor's control of handling, storage, shipping, cleaning, and preservation of material and equipment to prevent damage or deterioration. When necessary for special products, protective environments such as specific temperature levels are required. Examples of materials requiring such measures include hot mix asphalt, cement, asphalt emulsions, and prestressing steel. When no requirements are specified, manufacturer's requirements are followed.

Table 1.6.2. lists supporting documentation.

Table 1.6.2. Materials Handling Reference

Title	Chapter/Section	Description
QASI Manual	Section 50-B.03	In-process Inspection, Storage and Packaging of Prestressing Strands

Note: See Appendix A for the reference manuals

1.6.1.c Control of Special Processes

A special process is any production process that generates outputs that cannot be measured, monitored, or verified until after the resulting products have been used.

The CQAP includes procedures to confirm that special processes such as welding, non-destructive testing, structural steel coating, and masonry construction are controlled and performed by qualified personnel using procedures stated in applicable codes, standards, specification criteria, and other special requirements. For example, Section 11, "Welding," of the *Standard Specifications*, states the personnel requirements and procedures required by applicable codes.

Table 1.6.3. lists supporting documentation.

Table 1.6.3. Special Processes References

Title	Chapter/Section	Description
Standard Specifications, 2022	Section 11	Welding
BCRP, Vol 2	Section 55	Steel Structures
BCRP, Vol 2	Section 11	Welding
QASI Manual	Section 1-A.06	Roles and Responsibilities of OQASI Branch Staff
QASI Manual	Section 50	Prestressing Concrete

Note: See Appendix A for the reference manuals

1.7 Inspection and Testing

The CQAP includes procedures for inspecting activities that affect quality to verify conformance with the documented instructions, procedures, and drawings for accomplishing the work. Examinations and measurements are required for each work operation to verify quality. Procedures also specify that all required material or product testing is identified and performed in accordance with written test procedures that incorporate the requirements and acceptance limits in applicable construction documents.

1.7.1 Role of Resident Engineer

Inspection is an activity, using observation, measurement, testing, and judgment, that compares one or more characteristics of a product with specified requirements to determine if the product meets the requirements.

Caltrans resident engineers must review and monitor the technical inspection activities performed by the contractor and Caltrans personnel to make sure: (1) necessary inspections and testing are performed in a proper manner; (2) proper inspection techniques are used, and (3) contract requirements for quality control and acceptance of material and work are enforced.

Procedures and guidelines prescribe source and field inspection activities that collectively provide for the desired level of quality. Written inspection procedures provide guidance on: (1) characteristics to be inspected; (2) inspection methods; (3) acceptance and rejection criteria, and (4) methods for documenting inspection results.

Table 1.7.1. lists supporting documentation.

Table 1.7.1. Engineer Duties References

Title	Chapter/Section	Description
Construction Manual	Chapter 3, Section 5	Control of Work
Construction Manual	Chapter 4	Construction Details
QASI Manual	Section 1-A.06	Roles and Responsibilities of OQASI Branch Staff
BCRP, Vol. 1	Section A, Memo A-1	Communicating Staff Responsibilities

Note: See Appendix A for the reference manuals

1.7.2 Quality Control Inspection and Testing

The quality control function is the responsibility of the contractor. The contractor is responsible for establishing, implementing, and maintaining a quality control system to manage, control, document, and make sure that all work complies with the requirements of the plans and specifications. The quality control system must assure the adequate control and quality for materials, equipment, work, fabrication, and construction by the contractor and its subcontractors, suppliers, authorized laboratories, and consultants.

The purpose of quality control activities is to measure the quality characteristics and inspect the activities that affect production when corrective action can be taken to prevent nonconforming material from being incorporated into the project. Effective quality control tests allow results to be obtained during the process to allow adjustments to meet acceptance criteria.

Caltrans may use results from contractor quality control testing for acceptance. For acceptance of results, the following Caltrans activities must occur:

1. Authorization of the contractor's quality control plan

2. Accreditation of the contractor's laboratory
3. Authorization of qualifications of contractor's testing personnel
4. Evaluation of quality control sampling and testing
5. Verification that validates the quality of sampling and testing

Details for the production and placement of hot mix asphalt for projects under the statistical pay factor specification are provided in the Caltrans Division of Construction *Quality Control Manual for Hot Mix Asphalt Using Statistical Pay Factors.*

Table 1.7.2. lists supporting documentation.

Table 1.7.2. Quality Control References

Title	Chapter/Section	Description
Standard Specifications, 2022	Various	Quality Control
Construction Manual	Chapter 3, Section 6	Control of Materials
Construction Manual	Chapter 6, Section 107	Materials Acceptance Sampling and Testing
BCRP, Vol. I	Section A, Memo A-1	Communicating Staff Responsibilities

Note: See Appendix A for the reference manuals

1.7.3 Acceptance Inspection and Testing

Caltrans typically uses the design-bid-build method of project development, but sometimes also uses alternative contracting methods such as design-build, construction manager general contractor (CMGC), or job order contracting in accordance with California Streets and Highway Code, Section 143. Caltrans is responsible for the acceptance function on all its construction projects regardless of the contracting method used.

Acceptance includes inspecting the component materials upon delivery, placement or installation, and inspecting the work and quality of the finished product. The *Construction Manual* and the *BCRP* include guidance for activities to be conducted by the resident engineer or structures representative in the work and materials acceptance process. For example, Section 4-1903B (2), "Structure Backfill," of the *Construction Manual* requires the resident engineer to inspect the backfill to make sure that it is brought up uniformly and in the specified layer thickness. Records of this inspection would be filed in Category 46, "Assistant Resident Engineer's Daily Reports," of the project files.

1.7.3.a Quality Assurance Methods

Section 2.3, "Quality Assurance Methods," of this manual details the categories of quality assurance methods Caltrans uses to assure the quality of material and work. The listed methods can be used singularly but are generally used in combination or series to achieve the level of quality assurance desired. Decisions on the level of quality assurance required are based on the use or application of the item and the severity of the consequences of its failure. Table 2-2.7, "Quality Assurance Method Application Matrix," of this manual lists the use of each quality assurance method.

1.7.3.b Acceptance Criteria

The *Standard Specifications* and *Standard Special Provisions* provide acceptance criteria for all materials. Caltrans meets the 23 CFR 637.205(d), "Verification Sampling and Testing," requirements by performing acceptance inspection, sampling, testing, and measurement

activities to make sure the product's quality. When specified, the contractor's quality control sampling and testing may be used in the acceptance decision in accordance with 23 CFR 637.207, "Quality Assurance Program."

1.7.3.b (1) Manufactured and Fabricated Materials

For all manufactured and fabricated materials incorporated into the project, the acceptance program provides for:

- Acceptance sampling and testing of the materials at the site of manufacture or fabrication.
- Acceptance by the resident engineer upon delivery of the materials at the job site on the basis of a manufacturer-provided certificate of compliance.
- Acceptance based upon these materials or the source of these materials listed on the Caltrans authorized materials list.

1.7.3.b (2) Job Site-Produced Materials

For all job site-produced materials incorporated into the work, the acceptance program contains:

- Frequency schedules for acceptance sampling and testing that give general guidance to personnel responsible for the program and allow adaptation to specific project conditions and needs.
- Identification of the specific location in the construction or production operation where random acceptance sampling and testing is to be accomplished.
- Identification of the specific attributes to be inspected that reflect the quality of the finished product.

All incoming material or equipment items require documentary evidence that they conform to specified quality and contractual requirements before use, processing, or installation. This documentary evidence is retained at the job site or central file (upon project completion) and is sufficient to identify specific requirements, such as codes, standards, or specifications, that the material or equipment meet.

Table 1.7.3. lists supporting documentation.

Table 1.7.3. Materials Acceptance References

Title	Chapter/Section	Description
Standard Specifications, 2022	Various	Quality Control and Assurance, Materials
Construction Manual	Chapter 4	Construction Details
Construction Manual	Chapter 6	Sampling and Testing
BCRP, Vol. 1	Section A, Memo A-1	Communicating Staff Responsibilities
California Tests		
AASHTO Test Methods		
ASTM Test Methods		

Note: See Appendix A for the reference manuals

1.7.4 Independent Assurance

The Caltrans Independent Assurance Program, documented in the *Independent Assurance Manual*, is a system-based process that qualifies laboratories, testers, and equipment used to provide test results for material acceptance decisions on construction projects. In the system-

based process, Caltrans independent assurance staff administer written and practical examinations to ascertain a technician's qualifications. Additionally, independent assurance staff annually inspect laboratories for equipment availability, condition and calibration. The Independent Assurance Program is applied to testing on project-produced materials including aggregates, hot-mix asphalt, embankment and soils, and cementitious concrete materials in conformance with 23 CFR 637.

The Caltrans Independent Assurance Program includes:

- Evaluation of laboratories' testing equipment.
- Evaluation of testing personnel.
- Annual proficiency checks of laboratories and technicians using controlled samples.
- Annual reporting to FHWA.

The Independent Assurance and Associated Programs include the following:

- Joint Training and Certification Program: Caltrans, local agencies, and industry have established a joint training and certification program to make the certification process more efficient and to ultimately obtain consistent, reliable, quality testing through joint training.
- Inertial Profiler Certification Program: Caltrans has adopted the inertial profiler for determination of pavement smoothness for some of the smoothness specifications as identified in the *Standard Specifications*.
- Reference Sample Program and Corroboration Sample Program: These programs evaluate tester and laboratory proficiency by comparing individual tester and lab performances to reference samples.

Regarding the Independent Assurance Program and Associated Programs, or to request a copy of the *Independent Assurance Manual*, Independent Assurance Manual Amendments, and Annual Reports, go to the Independent Assurance Program website at:

https://dot.ca.gov/programs/engineering-services/independent-assurance-program

Table 1.7.4. lists supporting documentation.

Table 1.7.4. Independent Assurance References

Title	Chapter/Section	Description
IAM, 7/2005	Section 2.1.	Independent Assurance Program Overview
IAM, 7/2005	Section 2.2.	Independent Assurance Staff Certification
IAM, 7/2005	Section 2.3.	Tester Qualifications
IAM, 7/2005	Section 2.4.	Laboratory Accreditation
IAM, 7/2005	Section 2.4.2.2.	Calibration of Test Equipment
IAM, 7/2005	Section 2.4.3.	Proficiency Testing
IAM, 7/2005	Section 2.5.	Dispute Resolution
IAM, 7/2005 Amendment	IAP 2005-001	Two-Year Qualification for Testers
IAM, 7/2005 Amendment	IAP 2005-002 Rev.1	Joint Training and Certification Program

Note: See Appendix A for the reference manuals

1.8 Control of Nonconforming Work and Materials

The CQAP includes procedures to control nonconforming work and materials. Nonconformance is a deficiency that may render work and materials unacceptable, including failures, malfunctions, deviations, and defective material and equipment. CQAP procedures identify, segregate, and track all nonconforming work and materials until a resolution is made to prevent their inadvertent use or installation. Nonconformances are reviewed and rejected, reworked, or accepted in accordance with change order or other documented procedures. An example of a nonconforming item that would be rejected is a pre-cast girder with a missing strand. An example of a nonconformance that could be accepted based on repair would be damaged cast-in-place concrete pipe. Nonconforming materials can be accepted when the material is deemed to be "fit for purpose" on a case-by-case basis. This process is referred to as "blue tag" release. Nonconforming materials may also be accepted by applying a specified pay factor adjustment, such as for hot mix asphalt pavement when compaction test results indicate that the density is outside the specified limit, but is suitable for the intended purpose. Any nonconforming condition that results in a change to the technical requirements of the original contract or previously authorized shop drawing requires documented engineering review and acceptance.

Table 1.8.1. lists supporting documentation.

Table 1.8.1. Nonconforming Work and Materials References

Title	Chapter/Section	Description
Standard Specifications, 2022	Section 5-1.30	Noncompliant and Unauthorized Work
Construction Manual	Chapter 3, Section 514	Noncompliant and Unauthorized Work
Construction Manual	Chapter 6, Section 2	Acceptance of Manufactured or Fabricated Materials and Products
QASI Manual	Section 5-A.03	Quality Assurance Non-Conformances
DOT TL-0015	METS Form	Quality Assurance Nonconformance Report
DOT TL-0016	METS Form	Quality Assurance Nonconformance Resolution
QASI Manual	Section 6-A.15	Tagging Procedures
QASI Manual	Section 6-A.15.1	Blue Tag Material Release Procedures

Note: See Appendix A for the reference manuals

1.8.1 Corrective and Preventive Action

Corrective action is defined as action to eliminate the cause of a detected nonconformity or other undesirable situation. Preventive action is defined as action taken to prevent nonconformity or an undesirable situation. Corrective action is taken to prevent recurrence whereas preventive action is taken to prevent occurrence.

The CQAP includes requirements for corrective and preventive action by the contractor to verify that conditions adverse to the quality of materials and work are identified, analyzed, and documented, and that corrective action is implemented when warranted to prevent recurrence. The processes outlined in these procedures include:

- Investigating the cause of nonconformance and the corrective actions needed to prevent recurrence.
- Analyzing processes to detect and eliminate potential causes of nonconformance.

- Initiating remedial actions to address problems to a level appropriate with the risks encountered.
- Making sure that effective corrective actions are taken, and implementing and recording changes resulting from the corrective action.

According to these procedures, the contractor is required to investigate the cause of the nonconformance and immediately take corrective action, including retesting repaired and reworked items. Items that require repair, replacement, or repeated testing are re-inspected for compliance with contract requirements only when the agreed upon corrective actions have been implemented. For example, in accordance with the *Quality Control Manual for Hot Mix Asphalt Production and Placement*, the contractor's quality control plan must include a daily inspection provision requiring that, if a single quality characteristic has two consecutive acceptance or quality control test results not in compliance with the specification, the contractor must stop production, notify the engineer, take corrective action, and demonstrate compliance with the specification before resuming production.

Table 1.8.2. lists supporting documentation.

Table 1.8.2. Corrective Work References

Title	Chapter/Section	Description
Construction Manual	Chapter 3, Section 611	Suspected Fraudulent Test and Inspection Reports
Construction Manual	Chapter 4	Construction Details
Construction Manual	Chapter 6, Section 105	Acceptance Records
QASI Manual	Section 5-A.03	Quality Assurance Non-Conformances
QASI Manual	Section 6-A.15	Tagging Procedures
TL-0015	METS Form	Quality Assurance Nonconformance Report
TL-0016	METS Form	Quality Assurance Nonconformance Resolution

Note: See Appendix A for the reference manuals

1.9 Control of Inspection, Measuring, and Testing Equipment

The CQAP includes procedures to assure that inspection, measuring, and testing equipment used for contract acceptance are properly identified, controlled, and calibrated by qualified technicians at specific frequencies to maintain accuracy within required tolerances. Records of calibration activity are maintained in sufficient detail to provide objective evidence of planned frequency of calibration, actual calibration, repair, or removal from service. In addition, Caltrans re-evaluates the validity of previous inspection and test results when equipment used previously for inspecting, measuring, and testing is found to be defective. When contractor quality control tests are used for acceptance, the contractor is required to have a calibration program for applicable test and inspection equipment.

Table 1.9.1. lists supporting documentation.

Table 1.9.1. Inspection and Testing References

Title	Chapter/Section	Description
IAM, 7/2005	Appendix H	Calibration of Materials Testing Equipment
MPQP, 10/2022	Appendix	Calibration and Production Error Limits
Construction Manual	Chapter 6, Section 304	Field Testing Equipment
Standard Specifications, 2022	13, 15, 20, 37, 40, 41, 46, 50, 55, 59, 61, 84, 90, 92, 93, 94	Various
California Tests		
AASHTO Test Methods		
ASTM Test Methods		

Note: See Appendix A for the reference manuals

1.10 Project Materials Certification

The CQAP includes procedures to make sure the resident engineer prepares and submits a project final materials certification. Upon project completion, the resident engineer must prepare Form DOT CEM-6302, “Final Materials Certification.” The resident engineer must certify that, other than for the exceptions listed on the form, the results of tests performed on acceptance samples indicate the materials incorporated in the construction work, and the construction operations controlled by sampling and testing were in conformity with the authorized plans and specifications. This certification is consistent with 23 CFR 637.207(a) (3) requirements that each acceptance program include the preparation and submission of a project materials certification.

Examples of exceptions to be listed on the certification form include:

- Materials accepted by applying specified pay factor.
- Materials out of “operating range” but within “contract compliance” for which a specified payment deduction was made.
- Materials not in compliance with the plans or specification for which a change order was authorized to accept the material.
- Materials that require certificates of compliance but one or more have not been submitted.

Table 1.10.1. lists supporting documentation.

Table 1.10.1. Materials Certification Reference

Title	Chapter/Section	Description
Construction Manual	Chapter 6, Section 106	Project Materials Certification

Note: See Appendix A for the reference manuals

Chapter 2
Construction Quality Assurance Roadmap
Overview

This chapter provides guidance to Division of Construction, Materials Engineering and Testing Services (METS) staff, Geotechnical Services, specification owners, and others involved in determining quality assurance requirements for materials and work in highway construction contracts.

The chapter discusses the primary elements of the quality assurance program, provides a guide for developing quality assurance specifications, and discusses methods to verify the quality assurance standards in the plans and specifications are met.

The specification owner has the primary responsibility for the specification content, including the quality control requirements and acceptance criteria. This document provides guidance for selecting quality assurance requirements and methods, but specification owners must apply engineering experience and judgment when making the final selection.

2.1 Quality Assurance Elements

The essential elements of an acceptable quality assurance program are quality control by the contractor, verification inspection and testing by Caltrans, independent assurance, a dispute resolution process, use of authorized laboratories, and use of qualified personnel. If any elements are missing, the program as a whole is significantly weakened and risk is increased. These elements must be included in the specifications for all items that use contractor quality control test results in the acceptance decision.

2.1.1 Contractor Quality Control

Contractor quality control is designed to monitor, assess, and adjust the production or placement processes of specific materials to assure that the final product will meet the specified quality level. Quality control testing is different from acceptance testing discussed in Section 2.1.2 of this manual. Quality control testing measures quality characteristics and inspects activities when corrective action can be taken, if needed. The efforts and testing defined and performed by the contractor should be able to identify nonconforming material and prevent its incorporation into the final product. It also identifies proper control and provides a level of confidence that the work is being completed according to the specifications.

Quality control by the contractor evolved primarily for two reasons. First, if Caltrans controls the contractor's process, then Caltrans implicitly accepts responsibility for the product and must accept it, regardless of the quality. Secondly, because the contractor's production equipment and personnel are used to produce the material and construction, the contractor is the best entity to control these items.

The contractor is responsible for establishing, implementing, and maintaining a quality control plan to manage, control, document, and make sure that work complies with the requirements of the contract documents. The minimum contractor quality control activities are defined in the construction contract. The contractor's quality control plan should address the following elements for each contract item:

- Managing the work to make sure that both onsite and offsite work complies with the contract requirements, including the work of subcontractors, suppliers, and testing laboratories.
- Managing submittals, such as supplemental quality control plans, qualification and certification documents for laboratories and testing personnel, certificates of compliance, shop drawings and proposed methods for fabrication and construction activities, mix designs, inspection reports, and test results.
- Providing the necessary inspection to verify effective quality control and assurance of quality for acceptance of materials and workmanship, such as inspections of fabrication, sampling and testing, production, storage, delivery, construction, and placement.
- Identifying, controlling, and documenting materials and work that do not meet the specified level of quality. Documentation should include the nature of the non-conformance, location, extent, and disposition, such as removed and replaced, reworked, accepted based on engineering judgment. The final disposition of non-conforming materials or work quality must be authorized by Caltrans.
- Training to assure that proficiency is achieved and maintained by personnel performing activities that affect quality.

- Assuring that the equipment used in the production and testing of the materials provides accurate and precise measurements in accordance with the applicable specifications.
- Maintaining records of inspections that include date of inspection, results of inspection, and any subsequent corrective actions taken.

While the primary purpose of quality control activities is to provide timely information for the contractor to monitor and guide each production or placement process, quality control data for certain quality characteristics may also be used in the final acceptance decision. If the data is used in the acceptance decision, it must be validated by independently obtained verification data. Caltrans is responsible for conducting verification sampling and testing to provide an assessment of product quality that is independent of the contractor's quality control process. Not all characteristics that are monitored by quality control are required to be verified, such as those used for process control. Contractors will often perform more than the minimum level of quality control, including testing of material properties beyond those critical quality characteristics that will be used in Caltrans' acceptance decision.

2.1.2 Department Acceptance Program

The Non-Regulatory Supplement for 23 CFR 637.207 requires that, "The State's acceptance program should provide a reasonable level of inspection to adequately assess the specific attributes which reflect the quality of the finished product. Verification inspection should include inspection of the component materials at the time of placement or installation, as well as the workmanship and quality of the finished product."

The Caltrans acceptance program activities of verification sampling, testing, and inspection provide a quality assessment independent of the contractor's quality control process. These activities enable Caltrans to verify that the product meets the quality specified in the contract requirements. In some instances, determining a quality-based pay factor for a given finished item is also involved. The acceptance program includes inspection schedules, lot sizes, sample sizes, testing frequency, quality measure, pay factors, and acceptance limits. When contractor data is used in the acceptance decision, the program also includes verification sampling and testing, and risk evaluations.

2.1.3 Independent Assurance

According to 23 CFR 637, "Construction Inspection and Approval," independent assurance activities provide an unbiased and independent evaluation of all the sampling and testing procedures used in the acceptance decision. Independent assurance provides a mechanism for formally evaluating the competency of personnel and testing laboratories to perform specific sampling and testing of construction materials. This process is designed to verify the accuracy and repeatability of test results, not the quality of the material, which is obtained during highway construction.

An overview of the independent assurance process, including detailed procedures and requirements, is included in the *Independent Assurance Manual (IAM)*. For more information including how to request a copy of the IAM, visit:

https://dot.ca.gov/programs/engineering-services/independent-assurance-program

2.1.4 Dispute Resolution

In accordance with 23 CFR 637.207, Caltrans' dispute resolution is a documented process used to resolve discrepancies between the Caltrans verification test results and the contractor's quality control test results when the contractor's results are used in the acceptance decision, and must not be confused with contract administration dispute resolution processes outlined in Section 5-1.09, "Partnering," of the *Standard Specifications*. Additional details on dispute resolution samples are presented in Chapter 6, "Sampling and Testing," of the *Construction Manual*. Disputes pertaining to Independent Assurance certification, tester qualification or laboratory accreditation are addressed in Section 2.5, "Dispute Resolution," of the *Independent Assurance Manual*.

2.1.5 Authorized Laboratories

In accordance with 23 CFR 637, each state must have a central laboratory accredited by the AASHTO Accreditation Program or a comparable laboratory accreditation program approved by the FHWA. In addition, any laboratory used by Caltrans to provide acceptance, verification, or independent assurance test results and all contractor or consultant laboratories that perform quality control testing included in the acceptance decision must be authorized by Independent Assurance personnel. The primary objective in establishing laboratory accreditation, qualification, and authorization requirements is to make sure the capabilities of the laboratories that provide test results and information used in the acceptance decision. Caltrans' central laboratory is Translab.

Authorization is granted on a test-by-test basis and is a means of formally recognizing the competence of testing laboratories to perform specific tests on construction materials. An authorized laboratory must also have a current accreditation for the test methods applicable to any test for which the laboratory will perform for acceptance consideration.

Laboratories that conduct quality control testing for process control purposes only are not subject to these authorization requirements.

2.1.6 Personnel Qualifications

In accordance with 23 CFR 637, materials sampling and testing used in the acceptance decision must be performed by Caltrans- Independent Assurance qualified sampling and testing personnel. All Caltrans, contractor, and consultant personnel performing quality control, acceptance, verification, or independent assurance sampling and testing included in the acceptance decision must complete the qualification process and obtain official certification for each test method they intend to perform. Personnel who perform contractor quality control sampling and testing for process control purposes only are not included in this requirement. However, test results generated by uncertified personnel may not be used for acceptance or for the purposes of disputing acceptance test results.

The primary objective in establishing technician qualification programs is to certify that the technician is capable of correctly performing the appropriate sampling and testing procedures. The qualification criteria include formal training, hands-on demonstration, written examination, proficiency testing, and periodic re-qualification.

An overview of the Caltrans tester qualification process, including procedures for written and practical examinations, proficiency testing, and re-qualification requirements, is presented in Section 2.3 of the *Independent Assurance Manual.*

Qualifications for production personnel at production facilities and for construction personnel at the job site are specified for certain critical fabricated and manufactured products, items

having a history of quality or workmanship issues, and items having a personnel qualification requirement mandated by building codes or state statutes. Qualification requirements of this type make sure that work performed by contractors and fabricators is executed by qualified personnel. Required qualification examples include American Welding Society certification for construction and inspection personnel, and American Society for Nondestructive Testing certification for nondestructive testing personnel.

2.2 Specifications

Quality assurance involves everything from project planning and design to construction materials, work quality, and durability of the finished product. Highway engineers see quality in a highway that conforms to certain design and construction standards while providing excellent long-term performance. The public sees quality in congestion relief, increased mobility, and safety benefits. Quality assurance is not one definition or a one-step process, but an end result that provides value to all.

Specifications tell the contractor what Caltrans wants. Caltrans must be able to describe the level of quality construction it requires regardless of the type of specifications it chooses to employ—method or quality assurance.

Under method specifications, the contractor follows Caltrans-specified methods while using Caltrans-authorized materials and equipment. The resulting construction quality depends on the methods, materials, and equipment described in the specifications. The resulting quality is the minimum quality level described in those specifications. The low-bid contractor has no incentive to use better methods or materials that will result in a higher quality than that corresponding to the specified methods and materials.

Conversely, the contractor working under quality assurance specifications typically does have an incentive, in the form of positive or negative pay adjustment provisions, based on a selection of weighted pay factors, to provide as high a level of quality as is possible. Thus, assuming use of the same specified minimum level of acceptable quality, properly developed quality assurance specifications can result in higher quality than method specifications. However, the nature of materials and construction may sometimes impede the use of statistical parameters to measure construction quality. For example, because of the diverse characteristics of in-place soils and embankments, it is often more difficult to use statistically based specifications for these materials than for plant-produced materials. Thus, there is typically greater reliance on the use of method specifications for these types of materials having wide variation in the quality characteristics to be measured.

The best indicator of the quality to be achieved on a project is the quality level being specified, not the type of specifications.

2.2.1 Deciding Between Method and Quality Assurance Specifications

A specification communicates a project's requirements and the criteria by which Caltrans will verify conformance with those requirements. In this respect, quality assurance specifications are similar to conventional method specifications. They differ in how they define and verify the desired quality level and how much latitude they extend to contractors to meet project requirements.

2.2.1.a Advantages and Disadvantages

Both method and quality assurance specifications hold unique advantages and disadvantages that should be carefully weighed when considering how best to specify requirements for a particular project or project element.

2.2.1.a (1) Method Specifications

Method specifications require contractors to use specific materials, equipment, and methods to complete the work. The prescribed requirements are typically based on materials and methods that have historically produced satisfactory results for Caltrans, thus minimizing risk associated with newer, less proven methods and risk associated with varying contractor performance.

Contractors are provided few, if any, opportunities to deviate from the specified requirements, allowing Caltrans to retain significant control over the work.

Under this traditional approach, Caltrans bases acceptance on the "reasonable conformance" or "substantial compliance" of the work with the specified requirements. If test results are a component of the acceptance decision, usually only individual or representative field samples are taken. Those individual results may fail to recognize the inherent variability in the material itself, potentially leading to disputes between the contractor and Caltrans over acceptance decisions. Also, because method specifications do not establish a range of quality levels, they generally do not include procedures for pay adjustments. The contractor, therefore, typically receives 100 percent payment for the work completed as long as it strictly adheres to the specified requirements. Table 2.2.1. summarizes the advantages and disadvantages of using method specifications.

Table 2.2.1. Advantages and Disadvantages of Method Specifications

Advantages	Disadvantages
· Method specifications are well established, easily understood, and applicable to a wide range of topic areas. · Caltrans can exert significant control over the work, although increased Caltrans inspection efforts may increase costs. · Requirements are based on materials and methods that have worked in the past, minimizing risk associated with newer or less proven methods or varying contractor performance.	· The contractor has little opportunity to deviate from the specifications and, provided that the specifications are met, is not responsible for performance deficiencies of the end product. · Method specifications lack built-in incentives for contractors to provide enhanced performance. · The prescribed procedures may prevent or discourage the contractor from using the most cost-effective or innovative procedures and equipment to perform the work. · Contractor payment is not tied to the performance or quality of the work. · Acceptance decisions based on test results of individual field samples can increase the potential for disputes.

2.2.1.a (2) Quality Assurance Specifications

In place of the explicit materials and construction requirements found in traditional method specifications, quality assurance specifications contain statements of required results that focus on the desired quality level of the finished product. Quality assurance specifications require contractor quality management and Caltrans acceptance activities throughout the production and placement of a product. Final acceptance of the product is usually based on a random, statistical sampling of the measured quality level on a lot-by-lot basis for key quality characteristics. Price adjustments are generally based on a mathematical assessment of the measured variability of the product. To the extent that Caltrans is willing to relinquish control over some aspects of the work, this approach can foster contractor innovation and improve the quality or economy, or both, of the product. The advantages and disadvantages of quality assurance specifications are identified in Table 2.2.2.

Table 2.2.2. Advantages and Disadvantages of Quality Assurance Specifications

Advantages	Disadvantages
· Quality assurance specifications promote contractor innovation. · The contractor assumes more performance risk. · Contractors have the flexibility to select techniques and procedures to improve the quality or economy, or both, of the product. · A quality assurance specification provides a more rational mechanism for adjusting payment on the basis of the quality or performance of the constructed facility. · The potential for disputes is reduced. · Less Caltrans staff is required.	· Caltrans has less control over the work. · Identifying all of the parameters critical to performance and establishing related thresholds is challenging. · Roles and responsibilities of the contractor and Caltrans often become blurred if not adequately defined in the specifications or contract documents.

The motivation for using quality assurance specifications may vary from project to project. Implementing quality assurance specifications has improved quality and long-term durability, encouraged innovation, accelerated construction, and reduced an owner's quality assurance inspection costs during construction.

2.2.1.b Choosing the Specification Type

The decision to use method or quality assurance specifications is often a matter of degree. The appropriate mix of requirements is generally driven by a project's scope and objectives, as well as the project delivery approach and risk allocation strategy. In practice, this means that the decision to use quality assurance specifications should be supported by evaluating the type and level of quality requirements appropriate for the project characteristics and delivery approach.

Table 2.2.3. summarizes the conditions for which method and quality assurance specifications can best be applied.

Table 2.2.3. Appropriate Conditions for Using Method Versus Quality Assurance Specifications

Method Specifications	Quality Assurance Specifications
· End-product quality characteristics cannot be easily defined. · End-product quality characteristics cannot be easily or economically measured and verified. · Limited methods exist that would satisfy Caltrans' minimum requirements. · Caltrans must retain performance risk because of permit requirements, maintenance considerations, the need to tie into existing or adjacent construction, and similar issues. · Pre-existing conditions would compromise the transfer of performance risk to the contractor.	· End-product quality characteristics can be defined in terms of desired outcomes or user needs. · Key quality characteristics can be measured and tested; the test methods are rapid, reliable, and economical. · Multiple approaches can achieve the desired results. · Contractors are willing to assume performance risk. · Caltrans is willing to relinquish control over some aspects of the work.

Quality assurance specifications are advantageous when the project goals allow the contractor to innovate and influence performance outcomes. This is often the case on complex projects involving major reconstruction or new capacity, multi-phased work zone management, major or nonstandard structures, and high traffic volumes requiring accelerated design and construction.

In contrast, minor resurfacing or restoration of the pavement surface, or use of standard structural components to match existing facilities are less likely project types to benefit from a quality assurance specification.

A well-drafted quality assurance specification is not sufficient to assure that Caltrans' quality requirements will be met. Caltrans and contractors must also support the implementation of quality assurance specifications across a wide spectrum of work and projects.

2.2.2 Specification Development Process

Each bid item must be covered by the *Standard Specifications* or the special provisions. If a work component is not covered by the *Standard Specifications,* add the appropriate standard special provision (SSP). If an appropriate SSP does not exist, create a non-standard special provision (nSSP).

The process for initially drafting a quality assurance specification consists of seven major steps:

1. Identify the tier level.
2. Identify the production mode.
3. Define the quality characteristics for quality control and acceptance.
4. Specify the quality control and acceptance test methods.
5. Specify the location and frequency of sampling and testing.
6. Define the acceptance criteria and acceptance limits.
7. Identify the quality assurance methods to be specified.

These steps are identified on Figure 2.2.1. and discussed in the following subsections.

Figure 2.2.1 Acceptance of work. Numbered steps are discussed in following subsections.

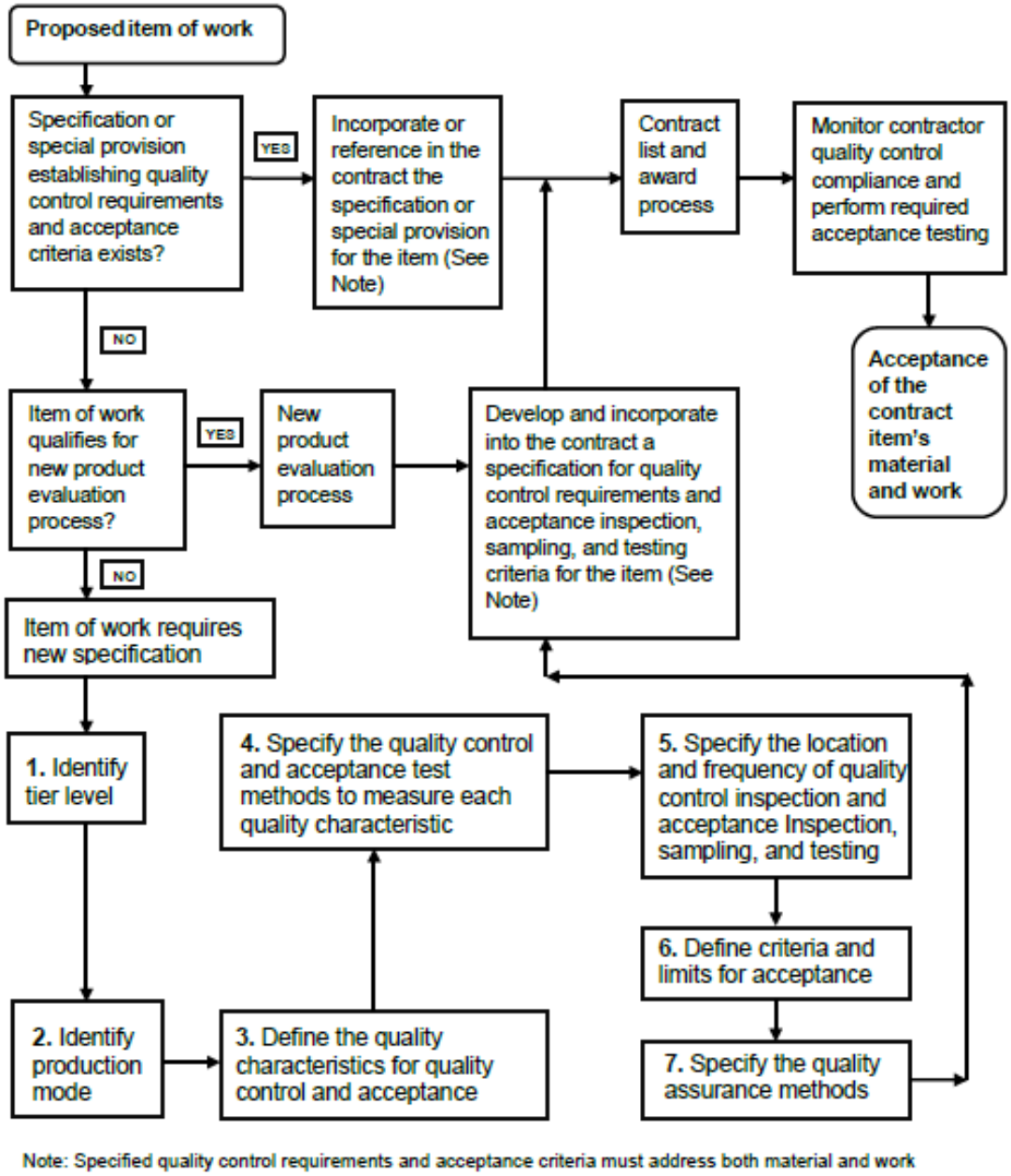

Figure 2.2.1. Quality Assurance Specification Development Process

2.2.2.a Step 1—Identify Tier Level

Caltrans' tier-level system is based on the consequence of failure of each item. For example, Tier Level 1 items have the greatest consequence of failure, while Tier Level 4 items have the least consequence. The appropriate level of inspection, sampling, and testing resources are assigned to each contract item based on the item's consequence of failure—the greater the

consequence of failure for the item, the greater the number of resources devoted to quality assurance for the item.

The tier levels described in Table 2.2.4. provide the specification owner guidance in determining the type and level of quality assurance requirements for each item. Table 2.2.5. lists the tier levels associated with the *Standard Specifications* sections.

Table 2.2.4. Tier Levels for Contract Items

Tier Level	Failure Category	Consequence of Failure	Example Items	Quality Assurance Requirements
1	Catastrophic	Greatest consequence of failure. Failure is likely to cause loss of life or serious injury.	Typically, fabricated structural-type products, such as structural steel, precast girders, pre-stressing.	Quality assurance methods designed to provide the maximum level of confidence in the quality control efforts of both the contractor and the producer.
2	Safety	Although not catastrophic, failure creates a safety hazard for employees or the public.	Manufactured and fabricated safety-related products, such as delineation, safety barriers, lighting, signal controllers.	Quality assurance methods designed to provide a high level of confidence in the quality control efforts of both the contractor and the producer through extensive use of pre-qualified materials from an authorized materials list.
3	Interrupt Service	Failure or repair may cause an interruption in service, or environmental impact.	Job site-produced base and pavement structure, embankment, and drainage items; and environmental items, including stormwater pollution prevention plan best management practice devices.	Quality assurance methods based on 23 CFR 637 requirements for job site-produced items, applicable rules and regulations included in the contract for the environmental items; and certificates of compliance from the contractor or producer combined with intermittent inspection, sampling, and testing of in-progress work for drainage items.
4	Monetary	Monetary loss only. Consequence of failure is considered minimal in terms of project performance.	Grass seed, drainage and irrigation products, fencing.	Quality assurance methods typically based on use of commercial quality products or extensive use of certificates of compliance from the contractor or producer combined with periodical random inspection of in-progress work.

Table 2.2.5. *Standard Specifications* Sections with Associated Tier Levels

Section	Description	Tier 1	Tier 2	Tier 3	Tier 4
12	Temporary Traffic Control		X		
15	Existing Facilities		X		
16	Temporary Facilities			X	
17	General				X
18	Dust Palliatives				X
19	Earthwork			X	
20	Landscape				X
21	Erosion Control				X
22	Finishing Roadway				X
24	Stabilized Soils				X
25	Aggregate Subbases			X	
26	Aggregate Bases			X	
27	Cement Treated Bases			X	
28	Concrete Bases			X	
29	Treated Permeable Bases			X	X
37	Bituminous Seals			X	
39	Asphalt Concrete			X	
40	Concrete Pavement			X	
41	Existing Concrete Pavement			X	
42	Groove and Grind Concrete		X	X	
46	Ground Anchors and Soil Nails	X			
47	Earth Retaining Systems	X			
48	Temporary Structures	X			
49	Piling	X		X	
50	Prestressing Concrete	X		X	
51	Concrete Structures	X	X	X	X
52	Reinforcement	X	X	X	
53	Shotcrete			X	X
53-2	Structural Shotcrete	X			
54	Waterproofing				X
55	Steel Structures	X	X		X

Table 2.2.5. *Standard Specifications* Sections with Associated Tier Levels (continued)

Section	Description	Tier 1	Tier 2	Tier 3	Tier 4
56	Overhead Sign Structures, Standards, and Poles		X		
57	Wood and Plastic Lumber Structures	X	X		X
58	Sound Walls	X			
59	Structural Steel Coatings			X	X
61	General			X	
64	Plastic Pipe			X	
65	Concrete Pipe			X	
66	Corrugated Metal Pipe			X	
67	Structural Plate Culverts		X	X	
68	Subsurface Drains			X	X
69	Overside Drains			X	
70	Miscellaneous Drainage Facilities			X	
72	Slope Protection				X
73	Concrete Curbs and Sidewalks				X
74	Pumping Equipment and Controls				X
75	Miscellaneous Metal		X		
80	Fences				X
81	Miscellaneous Traffic Control Devices				X
82	Signs and Markers		X		
83	Railings and Barriers		X		
84	Markings		X		
87	Electrical Systems		X	X	X

The elements in the table are not fixed but can change based on feedback and risk factors. For assistance in determining the appropriate tier level for any item contact your METS Representative listed at:

https://mets.dot.ca.gov/metsrepresentatives.php

2.2.2.b Step 2—Identify Production Mode

The production mode is classified as job site, fabricated, or manufactured.

- Job site—Products that are constructed, made, or produced at the project and subsequently subject to operations such as transport, mixing, placement, compaction, and curing that can substantively affect quality. Examples include pavement placement, cast-in-drilled-hole piles, batched concrete, imported borrow, and embankment fill.

- Fabricated—Custom-made under controlled conditions to Caltrans specification at a fabrication facility off the job site. Fabricated items include those produced to meet specific requirements of Caltrans plans and specifications and all material, such as paint, produced to meet a state specification. Other examples include structural steel, and precast, prestressed concrete members.
- Manufactured—Items mass-produced under controlled conditions to standard industry specifications at a production facility off the job site. These products are not unique to Caltrans. Manufactured items include those that are:
    - Produced to meet the specifications of such industry-wide organizations as AASHTO, American Society for Testing and Materials (ASTM), the American Wood-Preservers' Association, the American Institute of Steel Construction (AISC), and the United States Department of Agriculture.
    - Listed in an industry-wide catalog and available for timely delivery.
    - Shelf items available for purchase at supply houses.

Examples include polyvinyl chloride (PVC) pipe, cement, fly ash, electrical wire, and corrugated metal pipe.

2.2.2.c Step 3—Define the Quality Characteristics for Quality Control and Acceptance

The two critical aspects of developing quality assurance specifications are: (1) identifying the properties essential for good performance over the design life of a product, and (2) translating each of those properties into some related measurable quality characteristic that can be specified and tested to determine conformance with the desired product quality level.

The Transportation Research Board Circular, *Glossary of Highway Quality Assurance Terms,* defines quality characteristic as "that characteristic of a unit or product that is actually measured to determine conformance with a given requirement."

In terms of acceptance, several decisions must be made concerning each quality characteristic. These decisions include establishing acceptance criteria defining acceptable quality levels; and determining sample size, lot size, and sample location. Specific knowledge of each quality characteristic is necessary to make these decisions.

Measuring quality characteristics of in-service performance is preferred because it indicates that the properties being measured are meaningful. It is also important to select quality characteristics that can be measured by well-established and reliable test methods. This improves credibility in the selection of the quality characteristic. When selecting quality characteristics, consider the following:

- What quality characteristics are considered critical to performance?
- To what degree does each quality characteristic influence performance?
- How can these quality characteristics be tested and measured?
- What price adjustment, if any, should be applied to these quality characteristics?
- Are all factors associated with the quality characteristics within the contractor's control? For example, if the pavement contractor is not responsible for the subgrade conditions, there may be reluctance to accept responsibility for certain quality characteristics, such as structural deflection.

If payment adjustments are made based on the test results for these quality characteristics, performance-related results can be related to quality through some modeling process. This makes the payment adjustment process rational, and not arbitrary.

Article 625.4 (c) of 23 CFR 625, *Design Standards for Highways,* requires certain national reference standards to be applied to transportation materials in the geometric and structural design process for highways. Reference standards are specifications prepared by recognized trade associations, professional societies, standards-writing organizations, or agencies that provide national standards of performance or measurement and that have been proved over time to provide the desired quality.

These reference standards typically identify the properties essential to good performance over the design life of a product and the measurable quality characteristics that can be specified and tested to determine conformance with the desired standard of performance and quality.

To incorporate reference standards into a specification, they should be referred to by number, title, or other designation. Cross-referencing in this manner makes the standard a part of the specification, as if it were included in its entirety.

National reference standards commonly used in transportation specifications include:

- AASHTO standards for materials and methods of sampling and testing.
- ASTM standards for testing, materials, and work quality.
- American National Standards Institute product standards.
- Design standards from the American Concrete Institute and AISC.

Measuring some quality characteristics, such as slump test, are more ideally suited for the quality control function than for acceptance. On the contrary, 28-day concrete cylinder strength is not a good quality control characteristic, but does provide useful information for Caltrans and the contractor. By the time this quality characteristic is measured, too much production has occurred to make the strength results useful as a quality control tool. Table 2.2.6. lists commonly used quality characteristics measured for the quality control and acceptance of various job site-produced items.

Table 2.2.6. Typical Quality Characteristics for Quality Control and Acceptance

Material Type	Quality Characteristics Typically Measured for Quality Control	Quality Characteristics Typically Measured for Acceptance
Soils and embankment	Moisture content and compaction	Moisture content and compaction
Aggregate base and subbase	Gradation, compaction, and moisture content	Gradation and compaction
Hot mix asphalt	Asphalt content, gradation, compaction, air void, and smoothness	Asphalt content, gradation, compaction, air void, and smoothness
Concrete pavement	Air content, gradation, slump, and smoothness	Air content, thickness, modulus of rupture, and smoothness
Concrete structures	Gradation, slump, air content, and compressive strength	Gradation, slump, air content, and compressive strength

Throughout this manual, the term “quality characteristic” is used to refer to a value measured for quality control purposes or to assess acceptability of a material or product.

2.2.2.d Step 4—Specify the Quality Control and Acceptance Test Methods

The optimal material sampling and testing plan is driven by the criticality of the quality characteristic to be tested, Caltrans' resources, and the uniformity of the materials in question. The most desirable quality characteristics are measurable and testable. The specification must identify quality characteristics for both quality control and acceptance testing methods.

When selecting testing methods, consider the following:

- Are standardized tests available?
- Compared to other possible testing methods, is the sampling and testing economical, considering technician availability and the dollars for each test multiplied by the number of tests required based on the uniformity of the material?
- Can the test data be processed in a timely manner?
- Do the sampling and testing techniques require highly skilled technicians? Are special certifications necessary?
- Is specialized equipment necessary?

The combined cost of the specified sampling and testing effort for a quality characteristic should be consistent with the criticality of the performance benefit sought and the criticality of the contract item.

Possible test method references include AASHTO and ASTM test methods, and California Tests. Refer to Appendix A for the links to these test methods and tests.

2.2.2.e Step 5—Specify the Location and Frequency of Sampling and Testing

The sampling and testing frequency specified for quality control and acceptance of each quality characteristic should be consistent with the criticality of the performance benefit sought and the criticality of the contract item. Section 6-107, "Materials Acceptance Sampling and Testing," of the *Construction Manual* includes tables listing Caltrans' minimum sampling and testing requirements for materials acceptance including the sampling location and frequency.

2.2.2.e (1) Location of Sampling and Testing

The specific location in the construction or production operation for sampling and testing must be specified for each quality characteristic. Samples used in the acceptance decision should be taken as close as possible to where the material is incorporated into the project. Sampling and testing may be required before, during, or upon completion of the production process, or a combination, depending on the quality characteristic being measured.

California Test 125, "Methods of Test for Sampling Highway Materials and Products Used in the Roadway Pavement Structure Sections," describes the procedures for obtaining representative samples of various highway materials and products that are incorporated in roadway structural sections. This test method also addresses acceptable locations that are routinely used for sampling.

2.2.2.e (2) Quality Control Testing Frequency

A testing frequency must be established that creates a balance between enough tests to control the process but not so many tests as to be impractical. Operations with a history of quality control problems require more frequent sampling and testing than those with typically fewer problems. Sampling and testing frequencies may vary with the quality and uniformity of the material.

A key to achieving a balance in testing frequency is to relate the testing frequency to the rate and consistency of production. If the production tends to be continuous and consistent, less frequent testing may be permissible than if there are many interruptions. The testing frequency may also be reduced for materials with a history of accurate, uniform test results that consistently meet specification requirements.

The rate of testing should be higher on newly developed material sources, sources that furnish materials only on an intermittent basis, sources with questionable quality, sources with a wide range of test results, and sources with failing test results.

2.2.2.e (3) Acceptance Testing Frequency

Acceptance testing frequencies should be established by a random sampling from production and construction projects that represent different geographical areas of the state, different contractors with different operations, and projects of different sizes. If no sufficient historical data exists, data may be gathered from ongoing statewide projects. Once the new testing frequencies are implemented, data from projects should continue to be collected and monitored to verify that the assumptions made when developing the testing frequencies were appropriate.

Like any statistical procedure, the ability to determine with a low degree of risk the quality levels that the contractor is providing depends on several factors. One major factor is the amount of sampling and testing being performed—the greater the amount, the greater the ability of the procedure to identify statistically valid quality levels. A minimum Caltrans rate of 10 to 20 percent of the testing rate of the contractor has been commonly used.

2.2.2.f Step 6—Define the Acceptance Criteria and Acceptance Limits

Considerations involved in determining the acceptance criteria include the following.

2.2.2.f (1) Quality Measures

In quality assurance specifications, measure of quality refers to any one of several mathematical tools used to quantify the quality level of an individual quality characteristic. The measure of quality may quantify the average quality, the variability, or both. Percent within limits is the measure of quality that is most often recommended for use in quality assurance specifications.

2.2.2.f (2) Specification Limits

Specification limits refer to the upper and lower specification value limits placed on a quality characteristic, established preferably by statistical analysis, for evaluating material or construction within the specification requirements. For each quality characteristic, establish what the specification limits should be within which the material or work can be produced to verify good performance over the product's design life. Selection of the limits relates to determining the risks. The risk for the contractor or producer is the probability that good quality construction will be rejected. The risk for Caltrans is the probability that poor quality construction will be accepted. A well-written specification considers these risks in a manner

fair to both the contractor and Caltrans. Since too large a risk for either party undermines credibility, the risks should be both reasonably balanced and reasonably small.

2.2.2.f (3) Payment Adjustment Schedule

The payment adjustment schedule, in either tabular or equation form, is used to assign pay factors associated with estimated quality levels of a given characteristic for a submitted lot of material or construction. The pay factors are usually expressed as percentages of the contractor's bid price for each unit of work. The schedule provides payment equal to the quality provided. Often this includes sufficient incentive to produce the desired level of quality at the time of initial construction. The schedule also recoups at least part of the anticipated future costs that are likely to occur if poor quality is received. Effective payment schedules encourage contractors to apply appropriate quality control measures to make sure that the finished product will equal or exceed the desired level of quality a high percentage of the time.

Additional details related to acceptance criteria are presented in Chapter 6, "Sampling and Testing," of the *Construction Manual*.

2.2.2.g Step 7—Identify the Quality Assurance Methods to be Specified

Section 3 of this chapter details categories of quality assurance methods Caltrans uses to verify the quality of material and work. The listed methods can be used alone but are generally used in combination or series to achieve the desired level of quality assurance. Decisions on the quality assurance level required are based on the use or application of the item and the severity of the consequences of its failure.

Table 2.2.7., "Quality Assurance Method Application Matrix," relates the use of each listed quality assurance method to the production mode, tier level, specification type, and type of construction of any proposed item or item component. The "X" on the matrix indicates the specification owner should consider including the associated quality assurance method in the specification for the item or component. In addition, METS uses a risk assessment process to determine the level of inspection for each material. This method assigns a risk factor to each material by considering the effect of failure of a material (similar to tiers described in Section 2.2.2.a), as well as the probability of a material failing to meet the specification. Materials that rate for high in both categories (high risk of failing to meet specification and high risk of consequences if they do fail) should have the highest level of quality assurance inspection and testing. Additional information about the risk assessment process can be found in Section 6-A.14, "Risk Assessment," of the *QASI Manual*.

Table 2.2.7. Quality Assurance Method Application Matrix

Specification Section Heading	Quality Assurance Methods	Job site	Manufactured	Fabricated	Tier 1	Tier 2	Tier 3	Tier 4	Method Spec	Quality Assurance Spec	Structures	Roadway
Materials	Authorized Materials List		X	X	X	X	X	X	X	X	X	X
	Authorized to Deliver List		X			X	X		X		X	X
	Proprietary Product or Process		X			X	X		X		X	X
	Manufactured to National Quality Standard		X		X	X	X	X	X		X	X
	Commercial Quality		X					X	X			X
	Caltrans-Furnished Materials		X	X	X	X	X	X	X		X	X
Qualifications	Prefabrication Audit			X	X				X	X	X	
	Authorized Facility Audit Listing			X	X	X			X	X	X	
	Authorized Laboratory	X	X	X	X	X	X	X		X	X	X
	Authorized Laboratory List		X		X	X				X	X	X
	Contractor	X	X	X	X	X	X	X	X	X	X	X
	Installer, Applicator, Erector Personnel	X		X	X	X	X			X	X	X
	Fabricator			X	X	X				X	X	
	Fabricator Personnel			X	X	X				X	X	
	Plant (MPQP)	X			X	X	X	X		X	X	X
	Sampling or Testing Personnel	X		X	X	X	X	X		X	X	X
Submittals	Construction Method—Design	X		X	X	X	X		X	X	X	X
	Construction Procedures—Engineer	X		X	X	X	X		X	X	X	X
	Fabrication Method—Design			X	X	X			X	X	X	
	Fabrication Procedures—Engineer			X	X	X			X	X	X	
	Mix Design or Job Mix Formula—Engineer	X		X	X	X	X		X	X	X	X
	Product Data	X	X	X	X	X	X	X	X	X	X	X
	Quality Control Plan—Engineer	X		X	X	X	X			X	X	X
Meetings	Pre-Production Meeting	X	X	X	X	X	X		X	X	X	X

	Warranty (Materials and Work)	X	X		X	X	X	X	X		X	X
Warranty	Warranty (Performance) Warranty (Materials and Work)	X	X		X	X	X	X	X		X	X
	Warranty (Performance)	X				X	X				X	X
Mock-ups	Pre-Production Trial (Mock-up)	X	X	X	X	X	X	X	X	X	X	X
Quality Control	Inspection, Sampling and Testing (Job Site)	X	X	X	X	X	X	X	X	X	X	X
	Inspection, Sampling and Testing (Source) Inspection, Sampling and Testing (Job Site)	X	X	X	X	X	X	X	X	X	X	X
	Pre-Production Sampling and Testing (Initial, Stock) Inspection, Sampling and Testing (Source)	X	X	X	X	X	X		X	X	X	X
	Sampling and Testing for Acceptance Pre-Production Sampling and Testing (Initial, Stock)	X			X	X	X		X	X	X	X
	Sampling and Testing for Acceptance	X			X		X			X	X	X
	Certificate of Compliance with Test Results	X	X		X	X	X	X	X	X	X	X
	Inspection (Engineering) Certificate of Compliance with Test Results	X	X	X	X	X	X	X	X	X	X	X
Caltrans Acceptance	Inspection, Sampling and Testing (Job Site) Inspection (Engineering)	X	X	X	X	X	X	X	X	X	X	X
	Inspection, Sampling and Testing (Source) Inspection, Sampling and Testing (Job Site)	X	X	X	X	X	X	X	X	X	X	X
	Inspection, Sampling and Testing (Verification) Inspection, Sampling and Testing (Source)	X		X	X	X	X		X	X	X	X
	Payment Based on Quality Factor Inspection, Sampling and Testing (Verification)	X			X	X	X			X	X	X
	Test Samples Payment Based on Quality Factor	X	X	X	X	X	X	X	X	X	X	X
	Test Samples	X	X	X	X	X	X	X	X	X	X	X

Section 6, “Special Provisions,” of the *Ready to List and Construction Contract Award Guide* provides guidance for preparing project special provisions. The latest versions of the specification templates are available at:

https://design.onramp.dot.ca.gov/node/1466

The *Specification Style Guide,* also provides instructions for specification writers contributing to Caltrans’ construction specifications.

Information on developing quality assurance specifications is also available from a state planning and research pooled fund study, SPR-2 (199), “Optimal Acceptance Procedures for Statistical Construction Specifications,” conducted to investigate the use of quality assurance specifications, and provide recommendations for statistically sound quality assurance procedures and balancing of risks. The pooled fund study was administered by the FHWA and the results provided in FHWA-RD-02-095, “Optimal Procedures for Quality Assurance Specifications.” This publication provides a how-to guide for developing new or modifying existing quality assurance specifications and is available at:

http://www.fhwa.dot.gov/publications/research/infrastructure/pavements/pccp/02095/02095.pdf

2.3 Quality Assurance Methods

Caltrans uses a spectrum of quality assurance methods to make sure the quality of material and work depending on the material and construction activity. At one end of the spectrum are quality assurance methods that rely primarily on materials and methods provisions, such as soils and embankment items. At the other end are quality assurance methods that use contractor test results as part of the acceptance decision, such as hot-mix asphalt items. In between are various combinations of quality control and acceptance provisions. These methods can be as simple as relying on a certificate of compliance for a manufactured product, or as complex as a series of measures including audit, quality control plan, certification, and inspection.

The quality assurance methods are generally grouped into the following categories: material prequalification, qualification requirements for facilities and personnel, submittal requirements, materials sampling and testing, certificate of compliance, material and engineering inspection, and warranty. The methods can be used alone, but are generally used in combination or series to achieve the level of quality assurance desired. Decisions on the quality assurance level required are based on the use or application of the item and the severity of the consequences of its failure.

2.3.1 Material Prequalification

2.3.1.a Authorized Materials List

The listed materials are pre-qualified and authorized for use on Caltrans projects. These materials cannot be evaluated or tested within typical construction project timeframes and require extensive prequalification testing, which is not practical to repeat for every job. The strategy developed to make sure that quality for these types of products involves the manufacturer submitting prequalification samples to Caltrans or an accredited laboratory testing to confirm that specification requirements are met before entry of the material onto a web-based authorized materials list. Although pre-qualified, periodic testing and field performance evaluations of the materials are performed at a prescribed frequency to make sure that continued specified quality. Example materials include cementitious materials for use in concrete, concrete anchorage devices, safety, signing and delineation materials, post tensioning systems, and noise barrier systems. Materials from the authorized materials list should be specified for use whenever possible.

Refer to Table 6-2.2., “Materials Acceptance Based on Authorized Materials List,” of the *Construction Manual* for materials accepted on the basis of the authorized materials list.

Material lists are located at:

https://dot.ca.gov/programs/engineering-services/authorized-materials-lists

For further information on the authorization to deliver program, refer to the QASI manual.

2.3.1.b Aggregate Prequalification Program

The Aggregate Prequalification Program has been developed to provide aggregate suppliers with the ability to prequalify aggregate for use in portland cement concrete statewide before the award of a construction contract. The program is intended to reduce costs, delays, and additional liquidated damage payments to Caltrans associated with prequalification testing during the construction phase and allows Caltrans to achieve the goal of developing additional project delivery efficiencies. A list of approved aggregate suppliers and sizes can be found at the following website:

https://dot.ca.gov/programs/engineering-services/aggregate-prequalification-program

2.3.1.c Job Mix Formula Prequalification Program

The Job Mix Formula Prequalification Program has been developed to provide paving contractors with prequalified job mix formulas (JMFs) that have been verified by Caltrans using the *Standard Specifications* before the award of construction contracts. The Job Mix Formula Prequalification Program provides prequalified JMFs for the following mix types:

- Type A hot mix asphalt
- Rubberized hot mix asphalt gap-graded
- Bonded wearing course gap-graded
- Open-graded friction course

A list of preapproved JMFs can be found at the following website:

https://dot.ca.gov/programs/engineering-services/job-mix-formula-prequalification-program

2.3.1.d Proprietary Product or Process

Specifications that identify the desired products or processes by manufacturer name, brand name, model number, or other unique characteristic are considered proprietary. Trade names are usually the key to identifying patented or proprietary materials. Generally, products identified by their brand or trade name are not to be specified without an "or equal" phrase, and, if trade names are used, a minimum of three acceptable "equal" materials or products should be listed.

Use of specific brand or trade name items should be limited to applications in which the consequence of failure is low. See Public Contract Code Section 3400 and 23 CFR 635.411 for specifics governing the use of proprietary products, specifications, or processes. Refer to Section 6-1.05, "Specific Brand or Trade Name and Substitution*,"* of the *Standard Specifications,* and Section 6.10, "Proprietary Products," of the *Ready to List Guide* for further details.

2.3.1.e Products Manufactured to National Quality Standard

These products are manufactured to meet the specifications of such industry-wide organizations as AASHTO, ASTM, the American Wood-Preservers' Association, AISC, and the United States Department of Agriculture.

These industry-standard specifications typically include end-result requirements, criteria, and tests to meet national quality standards. They are prepared by recognized trade associations, professional societies, standards-writing organizations, or agencies that provide national standards of performance or measurement. They have proved over time to provide desired quality, and can be readily incorporated into the Caltrans specifications by referencing the number, title, or other industry-assigned designation for the product specification.

These types of products should be specified for all manufactured items whenever possible because the capability of incorporating time-tested and proven product specifications by reference provides a cost-effective alternative to the process of developing Caltrans-specific contract item specifications and test methods for manufactured items.

2.3.1.f Commercial Quality Products

Commercial quality products are products defined in the *Standard Specifications* as having "quality meeting the best general practices." These items are available for purchase at local

supply houses and are typically referred to as “off-the-shelf items.” Use of commercial quality items should be limited to Tier 4 items in which the consequence of failure is low.

2.3.1.g Caltrans-Furnished Materials

On all highway construction projects, the contractor must furnish all materials to be incorporated in the work, and is permitted to select the material sources. Caltrans may make exceptions to this requirement on federal-aid highway projects when there is a definite finding by Caltrans with FHWA concurrence that it is in the public interest to require the contractor to use Caltrans-furnished materials or materials from sources designated by Caltrans. Refer to 23 CFR 635.407 for specific guidelines pertaining to the use of Caltrans-owned, -furnished, or -designated materials.

Caltrans-furnished material is primarily material deemed to be “safety critical” and which directly controls traffic, such as traffic controller assemblies. This material undergoes quality assurance inspection by the Materials Engineering and Testing Services (METS) Electrical Quality Assurance and Source Inspection branch before being stored in the state’s Division of Procurement and Contracts warehouse for future use on Caltrans projects. Therefore, the contractor is not responsible for pre-installation quality assurance of this material.

2.3.2 Qualification Requirements for Facilities, Contractors, and Personnel

2.3.2.a Qualification Requirements for Facilities

2.3.2.a (1) Prefabrication Audit

Caltrans performs a prefabrication audit to evaluate if a fabricator has the processes and resources to fabricate products to the quality indicated in the specifications. This applies only to custom-fabricated materials for which adherence to specifications is critical and field rejection is costly to all parties. The onsite production facility audit provides a measure of assurance that the producer has the capability to perform. The contractor's fabricator must demonstrate adherence to prescribed standards of operation. By knowing that a periodic audit is required to supply certain materials to Caltrans, contractors and fabricators are more cognizant of their responsibility for quality control. Further details on the application of this audit are available in Section 11-A.05, "Prefabrication Meeting," of the *QASI Manual*.

2.3.2.a (2) Authorized Facility Audit Listing

Caltrans audits the facilities listed on the authorized facility audit list (AFAL) using a system-based approach to evaluate the fabricator's quality control process. The AFAL is available for items such as structural precast concrete, welded steel for overhead sign structures, welded steel poles for lighting and signal structures, and steel pipe piling. The audit process evaluates if the fabricator has the processes and the resources to fabricate the structural products to the quality specified in the contract documents. The AFAL is maintained by METS. Further information on the AFAL can be found at:

https://mets.dot.ca.gov/afl/AuditedFacilitiesList.php

2.3.2.a (3) Authorized Laboratory List

Caltrans maintains the list of independent laboratories authorized to perform testing on reinforcing steel splices. Example items requiring testing by laboratories on the authorized laboratory list include production tests for bar reinforcement splices and tensile tests for headed bar reinforcement. Further details on the qualification requirements for the authorized laboratory list are available at:

https://dot.ca.gov/programs/engineering-services/authorized-laboratory-list

2.3.2.a (4) Authorized Laboratory

An authorized laboratory must meet at least one of the following requirements:

- Be currently accredited by the AASHTO Accreditation Program, the Caltrans Independent Assurance laboratory accreditation program, or by a comparable accreditation body recognized by the National Cooperation for Laboratory Accreditation. According to 23 CFR 637.209, the laboratory accreditation must indicate that the laboratory was assessed according to the requirements in National Institute of Standards and Technology Interagency Report 7012 (NISTIR 7012), "Technical Requirements for Construction Materials Testing."
- Participate in laboratory assessment and proficiency sample services provided by the AASHTO Materials Reference Laboratory, the Cement and Concrete Reference Laboratory, American Association for Laboratory Accreditation, or other recognized agency providing comparable services for construction materials testing laboratories.

- Be recognized and accepted as a product safety testing and certification organization such as Underwriters Laboratories or other recognized agency providing comparable product testing and certification services.
- Be capable of performing specialized test methods developed by Caltrans.

A matrix relating authorization requirements for each category of laboratory to each test category is presented in Table 2.3.1.

Table 2.3.1. Laboratory Authorization Matrix

		Test Categories										
		California Test	Non-California Test	Pre-Production	Process Control	JMF/Mix Design	JMF Verify	Quality Control	Quality Control	Verification	Acceptance	Dispute Resolution
		X=Must be Caltrans-Authorized to Perform Test										
Laboratory Categories	Contractor	X	X	X		X		X	X			
	Contractor Fabricator/Manufacturer	X	X	X		X		X	X			
	Contractor Independent Third Party	X	X			X			X			
	Contractor Plant	X	X	X		X		X	X			
	Contractor Supplier	X	X	X				X				
	Caltrans Central Laboratory (Translab)	X	X				X			X	X	X
	Caltrans-Designated Agent	X	X				X			X	X	X
	Caltrans District or Region	X	X				X			X	X	X
	Caltrans Field Laboratory	X	X				X			X	X	X
	Independent Third Party (Dispute Resolution)	X	X				X					X
	Local Agency	X	X				X		X	X	X	

Any commercial laboratory seeking Caltrans' authorization to perform a specific test method on manufactured or fabricated construction materials must provide technical documentation to prove that the laboratory has the following:

- Proper facilities and necessary testing equipment capable of performing the test method.
- Competence in performing the test method as demonstrated by the following:
  - Supervisors of testing personnel have a minimum of 3 years of experience in testing highway construction materials.
  - Laboratory assessments routinely made on a 3- to 5-year cycle.

- Current training records and certifications that show testing personnel are properly trained, are routinely evaluated by observations and proficiency samples, and are qualified to perform the test method.
- Actual test results that show previous experience in performing the test method.
- A formal reporting procedure for test results including published test report forms.
- Two years of annual calibration records for required testing equipment. The calibration must be performed by an independent third party that has testing standards traceable to the National Institute of Standards and Technology.
- The documentation listed must also be submitted by laboratories seeking authorization for specialized test methods for which neither a recognized laboratory accreditation nor certification currently exists.

The use of an authorized laboratory is typically specified for Tier 1 and Tier 2 fabricated items, Tier 1 and Tier 2 complex or critical manufactured items, and for all job site-produced items. Example items include aggregate bases and subbases, asphalt and concrete pavement, and structural concrete.

2.3.2.a (5) Authorized Plant or Facility

An authorized facility or plant must be certified to a recognized standard. An example is plant authorization under the Caltrans Material Plant Quality Program covering inspection, calibration, dynamic testing, and acceptance for material plant weighing and measuring devices. All hot mix asphalt plants must be authorized before production. Specific details about the Caltrans Material Plant Quality Program requirements are available at:

https://dot.ca.gov/programs/construction/material-plant-quality-program

2.3.2.b Qualification Requirements for Contractors

Contractors are required to be certified to a recognized standard to assure that work performed is executed by qualified contractors. An example is the Society for Protective Coatings certifications—Society for Protective Coatings Qualification Procedures 1, 2, and 3—required for structural steel painting contractors.

2.3.2.c Qualification Requirements for Personnel

2.3.2.c (1) Sampling, Testing, and Inspection Personnel

Sampling, testing, and inspection personnel must be certified to a recognized standard so that all contractor, vendor, and Caltrans sampling, testing, and inspection data used in the acceptance decision is executed by sampling and testing personnel qualified through experience and technical training. Example certifications include American Welding Society Certified Weld Inspector, Precast Concrete Institute Quality Control Inspector Certification, Caltrans Independent Assurance Program Qualification, American Society for Nondestructive Testing certification for non-destructive testing personnel, and American Concrete Institute.

Table 2.3.2. relates the authorization requirements for each category of sampling and testing personnel to each test category.

Table 2.3.2. Sampling and Testing Personnel Authorization Matrix

		Test Categories										
		California Test	Non-California Test	Pre-Production	Process Control	JMF or Mix Design	JMF Verify	Quality Control	Quality Control	Verification	Acceptance	Dispute Resolution
		X=Must be Caltrans-Authorized to Perform Sampling and Testing										
Personnel Categories	Contractor Fabricator	X	X	X		X		X	X			
	Contractor Job Site	X	X	X		X		X	X			
	Contractor Laboratory	X	X	X		X		X	X			
	Contractor Plant	X	X	X		X		X	X			
	Contractor Supplier	X	X	X				X	X			
	Caltrans Central Laboratory (Translab)	X	X				X			X	X	X
	Caltrans-Designated Agent	X	X				X			X	X	X
	Caltrans District/Region Laboratory	X	X				X			X	X	X
	Caltrans Field Laboratory	X	X				X			X	X	X
	Caltrans Job Site	X	X							X	X	
	Independent Third Party (Dispute Resolution)	X	X									X
	Independent Third Party (Modified Emulsion)	X	X					X	X			
	Local Agency	X	X				X			X	X	

Qualifications for sampling, testing, and inspection personnel are typically required for Tier 1 and Tier 2 fabricated items, Tier 1 and Tier 2 complex or critical manufactured items, and for all job site-produced items, Tier 3. Example items include aggregate bases and subbases, asphalt and concrete pavement, and structural concrete.

The contractor is in charge of the process control and no authorization is required.

2.3.2.c (2) Installer, Applicator, or Erector Personnel

Production personnel must be certified to a recognized standard to assure that work performed by contractors and fabricators is executed by personnel qualified through experience and technical training. Required qualification examples include American Welding Society certification for construction and inspection personnel, and American Society for Nondestructive Testing certification for non-destructive testing personnel.

Qualifications for production personnel at the fabrication facility and for construction personnel at the job site are typically specified for:

- Tier 1 and Tier 2 fabricated item.
- Tier 1 and Tier 2 complex or critical manufactured item.
- Items having a history of quality issues.
- Items having a personnel qualification requirement mandated by building codes or state statutes.

2.3.3 Submittal Requirements

Submittals requiring Caltrans' response such as written and graphic information or samples are action submittals, as described in Section 5-1.23B, "Action Submittals," of the *Standard Specifications*. Action submittals include shop drawings demonstrating design adequacy, product data, test samples, quality control plans, work plans, and material source data. Submittals that are written information and not requiring Caltrans' response are informational submittals. Informational submittals include certificates of compliance and manufacturer instructions not associated with drawing submittals. Any submittal not specified as an informational submittal is considered an action submittal.

2.3.3.a Designer Review of Construction and Fabrication Working Drawings or Plans

Before the start of construction or fabrication, required drawings and plans submittals from the contractor that provide details on proposed methods of construction or fabrication are reviewed by project designers to assure conformance with design requirements. Typical drawing and plan features reviewed include weld details, nondestructive testing requirements, and constructability. Submittals detailing proposed methods of construction or fabrication are typically required for Tier 1 and Tier 2 fabricated items, and Tier 1 and Tier 2 complex or critical manufactured items. Examples include steel fabrication shop drawings, working drawings for mechanically stabilized earth structures, and working drawings for alternate piling systems.

2.3.3.b Resident Engineer Review of Construction and Fabrication Process Submittals

Required submittals from the contractor detailing proposed procedures for the construction or fabrication of an item are authorized by the resident engineer or representative before the start of construction or fabrication.

Submittals detailing proposed procedures for construction or fabrication are typically required for Tier 1 and Tier 2 fabricated items, Tier 1 and Tier 2 complex or critical manufactured items, and Tier 3 job site-produced items. Examples include proposed methods for construction of falsework, cast-in-drilled-hole piles, and proposed welding procedures.

2.3.3.c Resident Engineer Review of Proposed Job Mix Formulas or Mix Designs

Required submittals from the contractor detailing planned mix proportioning are reviewed by the resident engineer or representative before the start of construction or fabrication.

Submittals detailing planned mix proportioning are typically required for Tier 1 and Tier 2 fabricated items, Tier 1 and Tier 2 complex or critical manufactured items, and for all Tier 3 job site-produced items. Examples include hot mix asphalt pavement job mix formulas, and mix designs for structural and pavement concrete.

2.3.3.d Resident Engineer Review of Proposed Quality Control Procedures

Required submittals from the contractor detailing planned quality control procedures are reviewed by the resident engineer or representative before the start of construction or fabrication.

Submittals detailing planned quality control procedures are typically required for Tier 1 and Tier 2 fabricated items, Tier 1 and Tier 2 complex or critical manufactured items, and for all Tier 3 job site-produced items. Examples include quality control plan submittals for precast, structural, and pavement concrete, welding, paint, hot mix asphalt pavement, and sign panels.

2.3.3.e Engineer Review of Product Data

Required submittals from the contractor demonstrate the compliance of a manufactured product with contract requirements and may include the manufacturer's recommended installation or application instructions for the product. Examples of required product data submittals include the manufacturer's catalog cut sheets, performance data, and installation instructions for pumping equipment and controls.

2.3.3.f Contractor Submittal of Test Samples

Required test sample submittals from the contractor are used for quality verification testing by Caltrans before authorizing incorporation of the represented material into the project. Examples of required test sample submittals include epoxy-coated reinforcement bars, bonding materials and chemical adhesives for concrete structures, and fasteners for electrical systems.

2.3.4 Material Sampling and Testing

The optimal material sampling and testing plan is based on the criticality of the quality characteristic to be tested, Caltrans resources, and the uniformity of the materials in question.

2.3.4.a Pre-Production, Initial or Stockpile

Pre-production sampling and testing is performed by the contractor before job startup to determine whether proposed materials sources, proposed local materials, and products meet the specifications. Initial testing is typically specified for Tier 3 and Tier 4 items. Example items include the initial sampling and testing of borrow material sites and micro-surfacing aggregate.

Stockpile testing is typically specified for Tier 2, Tier 3, and Tier 4 manufactured and fabricated products that are identifiable by means of a serial number or other unique identifier. An example item is corrugated metal pipe.

2.3.4.b Quality Control Sampling and Testing

Quality control testing by the contractor, its representatives, or subcontractors is required during the production process to measure the quality characteristics that affect the production at a time when corrective action can be taken to prevent appreciable nonconforming material from being incorporated in the project.

Quality control testing at the point of production is typically specified for Tier 1, Tier 2, or Tier 3 fabricated or job site-produced items. Example items include aggregate bases and subbases, asphalt and concrete pavement, and structural concrete.

Quality control testing at the job site is typically specified for Tier 1, Tier 2, or Tier 3 job site-produced items whose quality is subject to change after production because of transporting or handling. Job site quality control testing may also be specified for manufactured or fabricated items whose quality is subject to change after production because of installation, placement,

assembly, application, or storage. Examples of this include required testing of drilling slurry properties during construction of cast-in-drilled-hole piles, required testing for chemical composition of steel performed at a steel plant, and the non-destructive testing of welds by a steel fabricator.

2.3.4.b (1) Quality Control Sampling and Testing for Process Control

Process control refers to a method for keeping a process within boundaries or the act of minimizing the variation of a process. Process control activities may include sampling, testing, inspection, and corrective action performed by a contractor in addition to quality control requirements to improve the likelihood that the final product will meet the specified level of quality. Sampling and testing requirements for process control are not included in the specifications because process control, although beneficial to the contractor's quality control efforts, is not essential to Caltrans' evaluation of the finished work product for acceptance and payment purposes.

2.3.4.b (2) Quality Control Sampling and Testing for Acceptance

An important step in the evolution of quality assurance programs occurred when 23 CFR 637 allowed contractor test results to be used in the acceptance decision. Research indicates that, with the checks and balances required in the CFR, more testing in the acceptance function is being done using this alternative than would have been done solely by Caltrans under traditional acceptance testing.

In accordance with 23 CFR 637.207, contractor quality control sampling and testing results may be used as part of the acceptance decision provided that:

- The sampling and testing were performed by qualified laboratories and qualified sampling and testing personnel.
- The quality of the material was validated by the verification sampling and testing process. The verification testing must have been performed on samples taken independently of the quality control samples.
- The quality control sampling and testing is evaluated by an independent assurance program.

Caltrans' dispute resolution process addresses the resolution of discrepancies between the verification sampling and testing and the quality control sampling and testing. The dispute resolution process is only applicable when the results from the contractor's quality control sampling and testing are used in the acceptance program.

2.3.4.c Verification Sampling and Testing

This form of sampling and testing uses a statistically based number of tests that Caltrans performs to verify contractor-performed quality control testing results used by Caltrans in the acceptance decision. In this form, both the contractor's and Caltrans' test results are used collectively to determine whether the material is acceptable.

Typically, the three sources of variability between contractor and Caltrans test results are derived from differences in the:

- Material quality
- Testing procedures
- Sampling procedures

Variability between the contractor's and Caltrans' sampling and testing procedures is minimized by extending the laboratory and testing personnel qualification requirements and the independent assurance program requirements to the contractor if the contractor's test results are to be used in the acceptance decision. Verification sampling and testing results are used to validate the quality of the material, thereby making sure that all sources of differences between test results are measured.

The type and extent of verifications that Caltrans performs as part of its acceptance program are outlined in the specifications. The frequency of verification sampling and testing depends on the risk implications from premature failures because of the acceptance of substandard or failing materials. For example, verification testing may be more frequent for structural concrete than for embankment materials.

Verification sampling and testing are applicable to all job site-produced items for which the contractor's quality control testing results are used in the Caltrans acceptance decision. Examples include hot mix asphalt using the quality control or quality assurance process, and concrete pavement. In terms of the acceptance program, verification sampling and testing performed by Caltrans is not required when the contractor quality control testing results are not used in the Caltrans acceptance decision.

2.3.4.d Programmatic Quality Assurance Inspection and Testing at the Job Site

The periodic inspection and testing are performed by Caltrans on random samples of manufactured products at the job site to confirm that a manufacturer continues to provide products meeting the desired standard of quality.

Inspection and testing requirements for programmatic quality assurance are not included in the specifications because, although an integral part of Caltrans' periodic review of product quality, programmatic quality assurance is not essential to Caltrans' evaluation of the finished work product for acceptance and payment purposes. This type of inspection and testing typically provides data to support continued use of a certificate of compliance and is not necessarily linked to specific projects.

2.3.4.e Programmatic Assessment

Caltrans evaluates Tier 3 and Tier 4 manufactured items to determine the reliability of the manufacturer's quality control process.

Requirements for programmatic assessment procedures are not included in the specifications because the procedures are not essential to Caltrans' evaluation of the manufactured product for acceptance and payment purposes.

A certificate of compliance is required for Tier 3 and Tier 4 manufactured items.

2.3.4.f Acceptance Sampling and Testing

Sampling and testing of manufactured or fabricated products are typically performed at the point of production. However, sampling can be performed at the job site under certain circumstances. Samples used in the acceptance decision of job site-produced materials should be taken as close as possible to where the material is incorporated into the project.

Sampling and testing responsibilities and requirements for the acceptance of job site-produced and miscellaneous materials are included in Section 6-1, "Sample Types and Frequencies," of the *Construction Manual*.

Sampling and testing responsibilities and requirements for the acceptance of manufactured or fabricated materials are included in Section 6-2, "Acceptance of Manufactured or Fabricated Materials and Products," of the *Construction Manual*.

Acceptance testing at the point of production is typically specified for Tier 1 and Tier 2 fabricated items, Tier 1 and Tier 2 complex or critical manufactured items, and any off-site production facilities for job site-produced items. Acceptance testing at the point of production does not preclude acceptance by the resident engineer at the job site. Example items include overhead sign structures.

Acceptance testing at the job site is typically specified for Tier 1, Tier 2, or Tier 3 job site-produced items whose quality is subject to change after production because of transporting or handling. Example items include hot mix asphalt and structural concrete.

Job site acceptance testing may also be applied to complex or critical manufactured or fabricated items whose quality is subject to change after production because of installation, placement, assembly, application, or storage. Example items include electrical systems, ground anchors, and soil nails.

2.3.5 Certificate of Compliance

Certificates of compliance are used for acceptance of products for which the industry has demonstrated a high degree of reliability in meeting contract specifications. The certificate of compliance is submitted before the material is incorporated into the work, for each batch or lot of the material identified on the certificate, and signed by the producer of the material stating that the material complies with the contract. The certificate of compliance informs Caltrans that the contractor has accepted the material and is confident that the material complies with the contract specifications.

2.3.5.a Certificate of Compliance from Producer

This written statement submitted by a producer affirms that a product meets specification requirements.

2.3.5.b Certificate of Compliance from Producer with Test Results

This written statement, accompanied by field or laboratory test data from a producer, affirms that a product meets specification requirements. Examples of field or laboratory data to be provided include mill test reports for steel, pressure treating reports for timber, and concrete test reports. The field or laboratory test data provided must:

- Address each of the product quality characteristics specified for measurement.
- Represent the same lot of material as the material to be incorporated in the work.
- For Tier 3 items, represent a test performed within the past 6 months.
- For Tier 4 items, represent a test performed within the past 12 months.

All materials and products accepted by certificates of compliance require periodic programmatic quality assurance testing of random samples with results that support the reliability of the certificate provider.

A certificate of compliance is not required for off-the-shelf commercial quality items, Caltrans-furnished materials, items subject to contract warranty provisions, and items for which material tests are not specified or feasible.

Refer to Table 6-2.3, "Materials Accepted by Certificate of Compliance," in the *Construction Manual* for a listing of applicable materials.

2.3.6 Material and Engineering Inspection

Inspection is one of the most important aspects of construction work. Inspection consists of careful reviews and critical examination of all the factors entering into the construction of transportation projects to assure the proper combination of materials and details of construction. The construction of any transportation project consists of several operations that must be integrated to produce a quality-finished product. Each operation influences the quality of the final product.

2.3.6.a Material Inspection

2.3.6.a (1) Quality Control Inspection

Quality control inspection must be performed by the contractor, its representatives, or subcontractors during the production process to assure that a material or product meets the contract requirements.

Quality control inspection at the point of production is typically required for Tier 1 and Tier 2 fabricated items, Tier 1 and Tier 2 complex or critical manufactured items, and for any off-site production facilities associated with job site-produced items.

Quality control inspection at the job site is required for all remaining project items. Examples include the required documentation of concrete placement during the contractor's construction of cast-in-drilled-hole piles, and required welding inspection for structural steel erected by the contractor.

2.3.6.a (2) Verification Inspection

Caltrans performs material and work inspection as well as quality procedures inspection as part of an independent assurance program to verify that the contractor quality control process complies with specified requirements, or as part of an acceptance program to verify that the contractor-provided product meets the specified work-related requirements. Verification inspection and acceptance inspection have the same underlying function—to validate the quality of the product.

2.3.6.a (3) Acceptance Inspection

Caltrans performs acceptance inspection to verify that a product is acceptable in terms of the specifications for a specific project. According to 23 CFR 637, acceptance inspection includes inspection of the component materials at the time of placement or installation, as well as quality of the finished product. As part of their acceptance responsibilities, Caltrans technicians and inspectors must monitor the contractor's quality control activities while retaining responsibility for acceptance sampling, testing, and inspection. The inspection is typically performed at either the point of production or the job site.

Material acceptance inspection at the point of production is typically required for Tier 1 and Tier 2 fabricated items, Tier 1 and Tier 2 complex or critical manufactured items, and for any off-site production facilities associated with job site-produced items. Material acceptance inspection at the point of production does not preclude acceptance by the resident engineer at the job site.

All remaining project materials require acceptance inspection at the job site by Caltrans personnel. Example items requiring job site acceptance inspection include aggregate bases and subbases, asphalt and concrete pavement, and structural concrete.

2.3.6.a (4) Pre-Production Meetings

To assure the contractor's means and methods produce the desired product with the specified quality, Caltrans may require meetings to discuss and familiarize those responsible for performing, controlling, and managing the work with the quality control requirements in advance of the start of work. Example pre-production meetings include pre-painting, pre-welding, pre-precast, and pre-grouting.

2.3.6.a (5) Pre-Production Trial Mockup

To verify that the contractor's means and methods produce the desired product with the specified quality or to use as a standard of comparison for accepting the finished product, Caltrans may require the functionality of items to be demonstrated, or prequalified, before use. Example items include test panels for structural concrete, shotcrete, textured or colored concrete surfaces, and prefabricated detectable warning surfaces; test strips for concrete pavement; mockups for self-consolidating concrete; and trial slabs for concrete pavement replacement.

2.3.6.b Engineering Inspection

Engineering inspection involves monitoring the contractor's construction processes to verify that the construction quality is in compliance with the plans and specifications. The resident engineers, structures representatives, and field engineers exercise engineering judgment and evaluate fitness for purpose when inspecting for work quality.

Caltrans manuals, including the *Construction Manual*, *Bridge Construction Records and Procedures* manual, *Foundation Manual*, and *Concrete Technology Manual*, provide guidelines for inspecting, measuring, and paying for contract item work. These guidelines describe the construction details and associated inspection requirements necessary to confirm that product work is acceptable. Also see Appendix A, "Caltrans Quality Assurance Documents."

The level of engineering inspection depends on the type of work being performed and is categorized into three basic levels:

- Continuous Inspection—Inspect 80 to 100 percent of the time work is in progress with assistants assigned only to one operation. Continuous inspection is typically required for Tier 1 and Tier 2 fabricated items, and Tier 1 and Tier 2 complex or critical manufactured items.
- Intermittent Inspection—Inspect 30 to 80 percent of the time work is in progress with assistants assigned to two or three operations simultaneously. Intermittent inspection is typically required for Tier 2 items that are non-complex and non-critical and for Tier 3 items.
- Benchmark Inspection—Inspect up to 30 percent of the time work is in progress. Construction operations can proceed without inspection until a predetermined critical activity point has been achieved. Benchmark inspection is typically required for Tier 4 items.

Critical activity points are hold points established in the contract documents to assure that the proper inspection and testing have been performed before starting, or before proceeding to the next phase or stage of that construction activity. No work can proceed beyond each critical activity point until approved by Caltrans.

2.3.7 Warranty Provisions

Warranty is a guarantee of the integrity of a product and the maker's responsibility for the repair or replacement of the deficiencies. A warranty specifies the desired performance characteristics of a particular product over a specified period and defines who is responsible for the product. Products that are good candidates have clearly definable, self-evident failure modes, are produced and designed by industries with proven quality control capabilities, are easily traceable through serial numbers or other identifying features and can prematurely fail without dire consequences. The use of warranties allows Caltrans to shift some of the post-construction performance risk of the warranted product to the contractor.

2.3.7.a Material and Work Quality Warranty

A material and work quality warranty holds the contractor responsible for correcting defects in work elements within the contractor's control during the warranty period. The contractor or manufacturer warrants that material complies with specifications, and agrees to repair or replace if, during the period of the warranty, the material fails, and tests prove it does not comply with the specifications. Material and work warranties may be specified for Tier 3 and Tier 4 manufactured items. Example items include LED lights, prefabricated detectable warning surface for Americans with Disabilities Act (ADA) ramps, batteries for electrical systems backup, materials for pumping equipment, and permanent pavement marking tape.

2.3.7.b Performance Warranty

A performance warranty holds the contractor fully responsible for product performance during the warranty period. The contractor or manufacturer warrants that material will perform to predefined standards or will be repaired or replaced if, during the period of the warranty, the material's performance falls below the standard. Contract language should specify the warranty period and the enforcement process, including a detailed description of the measures that will be used to determine warranty compliance. The requirements for warranties used on design-build projects are covered under 23 CFR 635.413, "Construction and Maintenance."

An example warranty provision is the 5-year manufacturer's warranty of replacement for defects in dome shape, color fastness, sound-on-cane acoustic quality, resilience, and attachment specified for prefabricated detectable warning surfaces.

2.3.7.c Guarantee

According to Section 5-1.47, "Guarantee," of the *Standard Specifications*, the contractor must guarantee that work remains free from substantial defects for 1 year after contract acceptance except for work portions relieved of maintenance and protection, which must be guaranteed for 1 year after the relief date. The guarantee excludes damage or displacement caused by an event outside the contractor's control, including normal wear and tear and improper operation. Refer to Section 3-526, "Guarantee," of the *Construction Manual* for the resident engineer's duties related to guarantees.

Chapter 3
Construction Quality Assurance Long-Range Plan
Overview

The following sections lay out a potential long-range plan for changes to the Caltrans Construction Quality Assurance Program. The objectives are broken down as follows: long-term objectives by functional units, establishment of a construction quality assurance database; adoption of a system-based acceptance process; implementation of performance specifications; and adoption of risk-based acceptance criteria.

3.1 Long-Range Objective—Construction Quality Assurance Database

3.1.1 Data Interchange for Materials Engineering, METS

Construction quality assurance databases are a key element of any construction quality assurance program because they enable highway departments to make sound, data-based decisions that lead to cost-effective construction. These databases improve data processing efficiency, minimize errors, unify data administration, and provide data security. They also provide the data source for a variety of analyses, such as construction quality monitoring, developing pay adjustments, and detailed statistical analyses.

A quality assurance database facilitates assessing the quality of materials production and placement and establishing pay factors, as defined by specifications. It also enables detailed analyses of quality, performance, and cost data that can help guide future improvements to standards and specifications, such as materials, techniques, and design strategies to use; quality characteristics and levels to use in acceptance; and incentive or disincentive plans.

While most highway departments have established and maintained construction-related databases for many years, only within the past decade have they realized the need for more integrated systems to accommodate the requirements of new quality assurance programs.

Caltrans has several database and software systems that serve specific quality assurance functions for different groups. However, these individual databases are not integrated. They were established with different architecture, purpose, and data collection and access procedures, leaving limited means to match all the collected data. While Caltrans may be able to calculate pay factors and make acceptance decisions from one database, data from that database cannot easily be linked to other databases to monitor effectiveness of specifications, correlate construction quality to field performance, or to perform life-cycle cost analysis. The result is that by continuing to focus primarily on entering data and not necessarily on retrieving data to draw valuable conclusions, Caltrans may become “data rich and information poor.”

While individual databases may address current needs of the multiple functional groups, a more efficient, comprehensive, user-friendly database system is needed that can link existing individual databases. Such a system would allow the more efficient analysis required to develop or refine system-based and risk-based acceptance processes, performance specifications, warranty specifications, and innovative contracting procedures.

METS’ mission is to provide quality material engineering solutions that are safe, sustainable, and efficient for California's transportation infrastructure. To achieve this mission, METS established a long-range plan that focuses on a set of strategic priorities. METS works to integrate and align project delivery and incorporate materials engineering products and services across Caltrans. METS strives to make sure that its operations and decision-making processes are effective, coordinated, and efficient across its offices.

3.1.1.a Construction Quality Assurance Database Requirements

Data Interchange for Materials Engineering (DIME) is a web application developed by the METS to allow material testing laboratories the ability to easily submit sample information and test data to Caltrans' database through the website:

https://dime.dot.ca.gov/

DIME's materials testing results are accessible for projects statewide, which negates the need to spend time and money retesting materials that may have been used for other projects. Results in DIME may be used for material acceptance decisions. METS has developed a statewide implementation plan to require Caltrans staff to adopt DIME into their workflow as of January 1, 2023. This effort requires training and participation of both districts and contractors.

3.1.1.b Team Culture and Innovation

To make sure that there is continuous and uninterrupted operation, METS seeks to sustain its materials engineering expertise and knowledge through teams rather than individuals. METS uses the Repository of Common Knowledge (ROCK) database to store and document its ongoing findings and efforts, and to make this knowledge accessible to its members. Examples of documents stored in ROCK include, but are not limited to METS Representative Reports, Reference Sample Program Reports, interlaboratoy studies reports, Corroboration Sample Program Reports, and Materials Innovation Reports. In addition, METS thrives to create a culture that sustains an energized and engaged workforce. METS works to foster innovation in materials engineering and science, by using state of the art and practice knowledge in Caltrans projects.

3.1.1.c Environmental Product Declaration

Another initiative in METS' long-term plans is to advance the Environmental Product Declaration program, which plays an important role in achieving California's goals in battling climate change. This requires collaboration with external agencies, and extensive data collection from manufacturers in variety of industries.

3.1.2 Construction Quality Assurance Database, Division of Construction

The Division of Construction Office of Performance and Innovation (OPI) maintains databases that contain information relating to contract payments, for example the Contract Administration System (CAS) and the Internet Extra Work Bill (iEWB) system. OPI also maintains a document management system called FalconDMS, contract administration milestone dates in CAS and the Construction Contract Information System, and potential claims in the Electronic Potential Claim Records System. OPI is currently developing additional databases that will track safety and contract time data. Information from these databases is shared throughout Caltrans to support statewide and district needs including contract management support, research, internal reporting, external stakeholder reports, and other data collection efforts. The data from these databases is also used in applications created and maintained by other Caltrans offices. The information is also used for data visualizations, primarily dashboards, that display various performance measures as well as manage the quality of contract management tasks.

The goal is to transition to a more modern and comprehensive Construction Management System solution in the future that incorporates the aforementioned information along with additional items including, but not limited to, Building Information Modeling for Infrastructure, automated workflows, and enhanced contract management tools. The databases setup to support any future systems will incorporate existing data needs and expand to include new reporting analytics through dashboards and reports.

3.1.2.a Contract Payments

OPI manages databases that contain data related to contract payments made using CAS, sometimes referred to as “the progress pay system.” The payment system also uses the iEWB system, which involves payments made to contractors on highway construction projects for work performed for contract change orders as well as emergency contracts. The primary purpose of CAS is to help administer Caltrans construction projects. Functional units within the Division of Construction update and maintain records on individual contracts in CAS from the award and approval of the contract through to the completion and final payment. Multiple reports can be generated directly in CAS and iEWB, but many of the data points are also maintained in a database that can be accessed via direct connections to the database or using the Discoverer Business Intelligence tool.

3.1.2.b Construction Document Management System

FalconDMS is the Electronic Document Management System currently utilized by Construction to manage and store all project records. The system was implemented and required for use on all construction contracts awarded on or after July 1, 2021. The electronic storage of project records in FalconDMS follows the uniform filing system identified in Section 5-102, “Organization of Project Documents,” of the *Construction Manual* to maintain consistency and assure auditability.

FalconDMS is a Windows-based document management application that stores and tracks any type of document. Falcon is accessible through a web-based application and a client-based application. The applications provide a standardized, user-friendly searchable interface in which documents can be filed, retrieved, shared, tracked, revised, and distributed. Users add metadata tags to each file upon upload which allows Falcon users to search the databases for specific documents based on criteria such as expenditure authorization number, postmile, document type, and keywords.

The management of files within FalconDMS will allow for a seamless transition of designated files as described and listed in Section 5-104, “Final Construction Project Records,” of the *Construction Manual* to the project history file in DRS at such time as outlined in the policy and retention schedule.

FalconDMS is currently being used in conjunction with other construction applications and tracking tools such as Tableau. OPI has integrated a feature that allows for the automatic filing of documents directly into FalconDMS from some of the applications once a document is ready to be filed, which reduces the need for users to upload some forms manually. Dashboards to track and monitor the status of key documents have been created for staff and manager use. The dashboards can serve as a reminder to upload key information in the contract folders so that it isn’t missed during the project.

3.1.2.c Data Visualization and Reporting Systems

The current data visualization tool OPI uses is Tableau to display, analyze and report on construction contract information. Dashboards are built and updated to help office and field staff track and manage multiple aspects of the construction phase including contract costs, milestone dates, document management and risk management. OPI has also incorporated a Data Quality Management Plan to manage the quality of the data in the databases and fully participates in statewide data governance efforts to continue to improve the quality and availability of Construction data. As a result of these efforts, OPI has created dashboards to track and monitor data quality throughout the databases.

The CAS and iEWB systems have pre-built reports that can be generated as needed and are used extensively by district staff. CAS and iEWB database information can also be accessed via direct database connections or using the Discoverer Business Intelligence tool.

3.1.3 Construction Quality Assurance Database—Pavement Program

Caltrans began collecting automated pavement condition data annually for every available mainline mile on the State Highway Systsem using an automated pavement condition assessment in 2011. When National Highway System automated condition reporting was expanded to include many local roadways, Caltrans extended the Automated Pavement Condition Survey (APCS) evaluation to include the outer lane in the primary direction of all locally owned National Highway System pavement. Data collected through APCS includes pavement type, profiles, distresses, and images.

Data collected through APCS considers several variables that affect pavement condition evaluation. Data from APCS are used in Caltrans' Pavement Management System (PaveM). PaveM is a software tool at Caltrans used to model pavement deterioration and prioritize pavement treatment priorities statewide. With the implementation of the PaveM system in 2015, Caltrans can analyze and predict SHS needs statewide based on distress conditions and evaluate funding scenarios. PaveM supports decision-making based on project optimization that analyzes benefit and cost considerations considering pavement condition, pavement type, climate, traffic, and project history to identify potential treatments that achieve the desired State Highway System Management Plan performance targets.

PaveM uses input from various data sources including APCS, pavement projects' as-built records, Transportation Systems Network, and funding programs such as the State Highway Operation and Protection Program and Highway Maintenance Funding. PaveM's optimization tool, known as Pavement Analyst, uses current condition, segmentations, and decision trees to maximize or minimize objectives (depending on the type of objective) while meeting funding constraint(s).

The approach to predicting pavement condition includes treatments types, effects on condition, and costs. The statewide approach to the management of pavements begins with preservation after initial construction of new pavement, followed by timely repeated maintenance and minor rehabilitation treatments until the pavement requires major rehabilitation or reconstruction. Unit costs for the treatments are based on historical project data and are updated as needed. Unit costs include materials, labor, traffic handling, and other required costs to construct pavement including mobilization, contingency, state furnished materials and supplemental work.

The results from PaveM provide District Maintenance engineers the recommended pavement needs for potential project development. Engineering analysis, judgment, and cost analysis are used to validate the needs and the preferred alternative that is advertised for construction. Project work plans are based on PaveM recommendations and district priorities for preserving, rehabilitating and reconstructing pavements to achieve legislatively mandated performance targets. Maintenance work is critical to overall system health and helps sustain the state of good repair.

3.1.4 Construction Quality Assurance Database—Structural Construction

3.1.4.a Project Data Management System (ProDMS)

ProDMS is a web-based enterprise solution for managing construction project data. It supports eConstruction in Caltrans by integrating data management needs across all of Caltrans Project Delivery in a unified, easy-to-use, and mobile-friendly environment that conforms with existing Caltrans business practices. It is built on a hub-and-spoke model, where the application's core hub provides simple extensibility and seamless integration between all its connected modules (the spokes). ProDMS also provides role-based authorization that is customizable at the project level to provide different levels of access and operational privileges for each user.

The daily reports module, which is used for creating and reviewing Form DOT CEM-4601, "Assistant Resident Engineer's Daily Report," is the first module developed for ProDMS and is one of the primary modules currently in use. Access to create a daily report for a project, as well as the ability to review and approve a daily report, are based on the role-based authorization rules. Below are several examples of how this module interacts with other modules and data sources:

- The project administration module allows users to manage data that is used by the daily reports module, such as bid items, locations, labor and equipment.
- As field engineers input data into the daily reports module, they can link source inspection and testing records directly from METS databases on materials delivered to the job site and provide additional data on when and where the materials were incorporated into the job. This detailed as-built data is then made available to materials engineers for any necessary post-construction follow up.
- Labor hours entered into the daily reports module is also made available to labor compliance officers in a format that facilitates verification against certified payrolls.

Using the reports module, users can pull a quantity summary sheet listing all quantities reported during a pay period and get a full force account summary for bid items, change orders, laborers or contractors.

3.1.4.b Future Development on ProDMS

- A native mobile app for tablets or smart phones that will allow complete offline use, for when cellular data is not available.
- Progress pay module that will generate qantity calculation sheets with detailed breakdown.
- Contractors portal that will allow contractors to submit documents and data for review.
- Enhanced reporting on project assignment status, and photos.

3.2 Long-Range Objective—System-Based Acceptance Process

Caltrans uses a system-based acceptance process for more efficient use of testing and sampling resources. System-based acceptance is the process by which a department of transportation performs tests and inspections on a system-wide basis, rather than on a project-specific basis. For example, in a system-based process only one verification sample would be tested for a particular heat of steel, whereas on a project-based system, several samples might be taken and tested for steel from the same heat delivered to multiple projects. System-based acceptance is most beneficial for off-site produced items but can be advantageous for on-site produced materials on a more limited basis.

The advantages of a system-based acceptance process include improved quality because problem areas can be more readily identified and corrected, and more efficient resource use by eliminating duplicate tests and inspections.

The following subsections discuss the system-based acceptance process.

3.2.1 Pre-Approved Source

Certain material sources consistently demonstrate the ability to supply acceptable products. Caltrans would periodically sample and test products from selected material sources and, if acceptable, would designate the source as approved and certified. Materials from such sources would be accepted for use upon delivery to the project site with proper documentation and no further sampling or testing would be required.

Materials from such sources might still be subject to source inspection before the release depending on the outcome of the risk assessment performed by the METS representative.

Pre-approved sources would be shown on a Caltrans approved list of sources for a specific time until a renewed approval was established by the Division of Engineering Services, Materials Engineering and Testing Services, Office of Quality Assurance and Source Inspection (OQASI). The current list would be available online at:

https://dot.ca.gov/programs/engineering-services/authorized-materials-lists

3.2.2 Unapproved Source

If a source listed on the contractor's Form DOT CEM-3101, "Notice of Materials to Be Used," is not on the Authorized Materials List, OQASI would contact the source and arrange for source approval or for the testing of a specific "lot" of material. A "lot" generally refers to an isolated quantity of specified material from a single source. The variability of the material to be supplied would become the determining factor for source approval. Lot approval would only apply to the defined quantity of material. Source and lot approvals for unapproved sources are as follows:

- Lot Approval—Sampling of a specific lot would be arranged and, in most instances, would be submitted with Form TL-101, "Sample Identification Card," and a DIME identification number. Necessary information is entered into DIME, which can be traced using DIME identification for project-level documentation and to support the project materials certification when the pay item is completed.
- Source Approval—Source approval would work like lot approval except the data used for approval would often include manufacturer quality control data and site inspection results by Caltrans materials personnel. A report for source approval would be issued similar to the report issued for the sampling of a specific lot. Lot and source approval reports are

essential because they initiate tracking of the material approval process through project implementation and project materials certification.

3.2.3 Laboratory Testing

Material samples for projects throughout the state would be routinely routed to the Transportation Laboratory, district, region, or field laboratories. The laboratory would enter test results and observations into DIME using the DIME Identification assigned to the sample at the time of sampling. DIME data would be available to all Caltrans districts and regions and their respective project personnel, who would track the material sample from the time it was received at a laboratory until the time project materials certification was needed for the item. Aside from Caltrans test results, DIME stores additional information, such as precast quality control test results, temperature monitoring information, and Environmental Product Declarations. If the resident engineer, contractor, producer, or manufacturer requested test status on a particular sample, Caltrans personnel could quickly access and provide the information.

3.2.4 Material Approval and Delivery

After materials were tested at a Caltrans laboratory, Caltrans personnel would evaluate the results in accordance with contract or standard specifications. If the material source or lot were approved, OQASI would notify the manufacturer or producer. The material corresponding to the tested sample is required to be released before shipping to the job site. Upon release, the manufacturer or producer is required to provide a Certificate of Compliance (COC) as minimum evidence of inspection to demonstrate delivered materials are from an approved lot or approved source. The resident engineer uses the COC to verify the delivered material.

3.2.5 Field Release of Manufactured Items

For materials identified by OQASI with Form TL-0028, “Notice of Materials To Be Inspected At Job Site,” the manufacturer is required to issue a COC, certifying compliance of the material with contract requirements. The resident engineer is responsible for field inspection and release of these materials based on the information provided in the COC.

3.2.6 Project-Level Documentation

With few exceptions, all off-site materials used in Caltrans construction would be tested and approved to meet the contract specifications before they were delivered to the project. The resident engineer would verify that project materials were delivered to the site with the proper shipping documents, which include the laboratory number as evidence of inspection. In addition, some materials would have additional inspection requirements and additional indicators for evidence of inspection. Materials without evidence of inspection would not be incorporated into the work.

The resident engineer has the final opportunity to observe project materials to detect any problems before they are incorporated in the project. If evidence of inspection is lacking (such as the material arrives at the job site without a proper orange tag), or minimum documentation is not received (such as the release documents are missing or incomplete), or if there is any doubt about a material’s acceptability (for example, there’s damage to the material during shipping), a METS representative for the project is immediately contacted before the material is accepted.

The assistant resident engineer or office engineer would be responsible for recording, on the daily report, the quantity of material delivered and placed and the acceptability of the material. If a manufacturer or producer delivered material to the site, the assistant resident engineer or

office engineer would again be required to verify the shipping document referenced the appropriate laboratory numbers.

3.2.7 Final Materials Certification

Section 6-106, “Project Materials Certification,” of the *Construction Manual* describes the process to certify that the results of tests performed on acceptance samples show that the materials used in the work controlled by sampling and testing conform to the approved plans and specifications. Section 6-107, “Materials Acceptance Sampling and Testing,” of the *Construction Manual* details the minimum sampling and testing requirements for materials acceptance. Once construction work is complete and materials acceptance has been verified, Form CEM-6302, “Final Materials Certification,” is completed and placed in the project files.

3.3 Long-Range Objective—Performance Specifications

The term performance specification can be used as an umbrella term to capture several types of specifications, including end-result specifications, quality assurance specifications, performance-related specifications, and performance-based specifications. The basic concepts of each subset of performance specifications are discussed below. More detailed descriptions on these various performance specification types can be found in "Major Types of Transportation Construction Specifications—A Guideline to their Evolution and Application," by AASHTO.

- End-result specifications assign to the contractor complete responsibility and flexibility in selecting the procedures and equipment for supplying a product or an item of construction. Agency's responsibility is to either accept or reject the final in-place product or to apply a pay adjustment commensurate with the degree of compliance with the specifications. Because end-result specifications offer the contractor flexibility in exercising options for new materials, techniques, and procedures to improve the quality or economy, or both, of the end product, they are often incorporated into design-build contracts as performance specifications.
- Quality assurance specifications require contractor quality control and agency acceptance activities throughout the production and placement of a product. Final acceptance of the product is usually based on a statistical sampling of the measured quality level for key quality characteristics.
- The critical aspect of quality assurance specifications is identifying the material attributes that are essential to good performance and the associated limits within which the material or work can be produced to suggest good performance over the design life of the product. For example, quality characteristics of concrete pavement could include concrete strength, air content, and smoothness.
- Performance-related specifications (PRS) are essentially improved quality assurance specifications that describe the desired levels of key materials and construction quality characteristics that have been found to correlate with fundamental engineering properties that predict performance. PRS identify and quantify those particular technical factors that influence product performance. They may use empirical data, engineering judgment, mechanistic modeling, and life-cycle costing as the basis for determining the potential for performance.
- Like quality assurance specifications, PRS only specify product quality characteristics, for example flexural strength of concrete, that lend themselves to acceptance testing at the time of construction. They do not specify the desired long-term product performance. The "ideal" PRS use mathematical models to predict performance based on the measured quality characteristics and design variables, for example traffic loading and climate. The models provide the rationale for acceptance and pay adjustments based on life-cycle costs.
- Performance-based specifications (PBS) are quality assurance specifications that describe the desired levels of fundamental engineering properties, for example elastic modulus, creep properties, and fatigue properties, that are predictors of performance and appear in primary prediction relationships, such as models that can be used to predict pavement stress, distress, or performance from combinations of predictors that represent traffic, environmental, roadbed, and structural conditions. PBS differ from PRS in that they specify

the desired levels of fundamental engineering properties, rather than key quality characteristics.

3.3.1 Concrete Pavements

The current Caltrans specifications for concrete pavements are in a combination of the subsets of performance specifications, mostly quality assurance specifications and some forms of performance-related specifications. Efforts have been made in the past years and continue to be made for the development and implementation of more improved performance specifications.

For concrete pavements, Caltrans is currently exploring the opportunity of moving towards more performance-based specifications with the considerations of environmental performance as part of the performance characteristics in addition to the engineering properties. Implementation of the refined engineering and environmental performance requirements would help achieve more sustainable concrete pavements through enhanced long-term durability as well as reduced carbon footprint.

For concrete pavements, however, Caltrans does not have a plan at this point to use performance prediction models or life-cycle cost analysis for pay adjustment when implementing performance specifications.

3.3.2 Asphalt Pavements

Performance specifications reflect the values for materials characteristics or engineering properties used in the design process to predict the design performance life of a pavement. The as-built values of those properties are used to predict the as-built performance life. Comparing the as-built performance life to design life is used to calculate the change in life-cycle cost (LCC). The LCC analysis is used to adjust the payment to the contractor. When the as-built life exceeds the design life, the payment would be increased by the decrease in LCC. Conversely, the payment would be decreased by the increase in LCC, when the expected life is less than the design. The advantage to using performance specifications is that the compensation paid to the contractor is adjusted based upon any additional calculated cost or savings to the owner. These types of specifications provide the opportunity for maximum fairness by sharing either savings or cost from respective good or poor performance.

The current Caltrans performance specifications are either performance-related (calculations of performance life are based on engineering properties) or non-performance-related specifications (calculations of performance life are related to materials quality characteristics).

Implementing performance specifications would be most feasible in coordination with development of a new construction quality database system in which to collect and analyze data (such as PaveM data) to correlate performance with selected materials characteristics or engineering properties.

Examples of needed data include:

- As-constructed values for the designated material characteristics or engineering properties
- Type, magnitude, and time of observed distresses
- Correlation between as-built and design life
- Costs associated with correcting the distresses

3.3.2.a Non-Performance-Related Specifications

Non performance-related specifications (non-PRS) are “specifications that use quantified quality characteristics and life-cycle cost analysis (LCCA) relationships that are correlated to product performance.”

Non-PRS identify and quantify the technical factors that influence product performance. Empirical data, engineering judgment, mechanistic modeling, and life-cycle costing are used as the basis for determining the potential for performance. As with quality assurance specifications, non-PRS only specify quality characteristics that lend themselves to acceptance testing at the time of construction. They do not specify the desired long-term product performance.

Mathematical models help predict performance, maintenance requirements, and life-cycle costs. Construction quality characteristics, such as initial smoothness, slab thickness, air voids in asphaltic pavements, and strength of concrete cores, have been found to correlate with fundamental engineering properties that can predict performance. Conceptually, designs are developed based on these models to achieve predetermined service lives for specific conditions of load and environment. Because they are based on data, non-PRS models present a clear and realistic picture of what influences a constructed product’s performance. These models are also the means through which enhanced or diminished life is estimated from results of acceptance tests and, when combined with appropriate economic principles, how rational payment factors are determined. Implementation of non-PRS depends on the development and validation of such models. Correctly applied, non-PRS could enable identifying the level of quality that provides the best balance between cost and performance and assure attaining that level in the constructed work.

3.3.2.a (1) Advantages and Requirements of Non-Performance-Related Specifications

The advantages of using non-PRS include:

- Design relates performance to quality characteristics.
- Testing and inspections measure characteristics that directly influence performance.
- Payment to the contractor is based upon performance determined from the measured as-built quality characteristics.

Non-PRS includes specifications for key materials and construction quality characteristics that have been demonstrated to correlate significantly with long-term performance of the finished work. These specifications are based on quantified relationships between such characteristics measured at the time of construction and subsequent performance. They include sampling and testing procedures, quality levels and tolerances, and acceptance criteria. Typically, non-PRS includes payment schedules with positive or negative adjustments that are directly related through the performance models to changes anticipated in worth of the finished work as a result of departure from the quality level defined as acceptable.

Non-performance-related specifications require:

- A design method that can predict performance based upon material characteristics.
- An information system to register the values of the material characteristics of the constructed facility.
- An information system to register performance data of the constructed facility.
- A system for correlating the as-designed to the as-built of the constructed facility.

Non-performance-related specifications for pavement, as an example, require four major elements:

1. Pavement management system (PaveM)
2. Mechanistic-empirical design and CalME software
3. Life-cycle cost analysis (LCCA)
4. Material management system (DIME, Materials Library)

Non-performance-related specifications for pavement rely upon inter-relationships among these major elements:

- A pavement management system that tracks pavement performance.
- The mechanistic empirical formulation for pavement design relates material quality characteristics to pavement performance.
- The pavement management system data is used to calibrate the mechanistic empirical formulation for the local materials.
- Field measurement data entered in DIME, for material quality characteristics for each project, is compared to those used in the mechanistic empirical design formulation.
- The differences between the material quality characteristics used in the mechanistic empirical design formulation and those measured in the field are used in the life-cycle cost data to determine pay factors.
- Pay factors increase or decrease the payment to the contractor based upon predicted performance. For example, mechanistic empirical method is used to develop the parameters for a 40-year or 20-year pavement life, and the actual field production results show that the pavement would only have a life of 35 or 15 years. The LCCA would be used to calculate the cost for 5 years, and this would be the amount deducted from payment to the contractor.

3.3.2.a (2) Status of Non-Performance-Related Specifications

Caltrans is already working to implement three of the four elements in the numbered list. In 2013, Caltrans' PaveM became functional and was used with the automated pavement condition survey (APCS) database. Specially equipped vehicles are used to collect APCS data annually. Use of the CalME software for flexible pavement was fully implemented by May 2022, and the *Highway Design Manual* was updated. CalME software is calibrated periodically to include APCS data added over time. Caltrans is conducting experimental work for rigid pavement using mechanistic empirical design. LCCA has been performed since 2007. In 2022, Life Cycle Assessment was implemented. Caltrans is evaluating more asphalt mixtures to include in the Materials Library.

3.3.2.b Performance-Related Specifications

Performance-related specifications (PRS) are quality assurance specifications that describe the desired levels of the actual fundamental engineering properties, not the key quality characteristics, that are predictors of performance. The fundamental engineering properties in PRS, for example, resilient modulus, creep properties, and fatigue properties, are used in performance prediction relationships (mathematical models). In turn, these models can be used to predict stress, distress, or performance from combinations of predictors that represent

traffic, environmental, and structural conditions. In the true sense, PRS is concerned with the performance of the final in-place product, not how it was built.

3.3.2.b (1) Distinguishing Features of Performance-Related Specifications

- Acceptance based on measurement of the finished product's fundamental engineering properties that predict performance.
- Acceptance limits that are developed on a statistical basis.
- Mathematical models used to quantify the relationship between the fundamental engineering properties measured and product performance. Price adjustments that are based on the expected LCC of the constructed transportation facility.

3.3.2.b (2) Status of Performance-Related Specifications

Caltrans successfully completed five performance-related specifications projects, called Long Life Projects in Caltrans Districts 2, 3 and 7. Caltrans is gradually implementing performance-related specifications on selected large projects. Specifications in Superpave Performance Graded Asphalt Binder Specifications and Testing, which were developed through the Strategic Highway Research Program, are an example of performance-based specification for asphalt binder. All of a product's constituent materials and their related fundamental engineering properties must be included to have complete models to predict performance of that product. Performance-related test methods have yet to be developed to a user-friendly level that would permit timely acceptance testing. Furthermore, development and validation of performance-related tests are currently underway through research programs.

In addition, PRS requires more good quality PaveM data to generate and validate the models required to determine pavement performance and price adjustments based on expected LCCA. Caltrans management systems do not presently collect and evaluate all the data necessary to develop the required pavement performance and cost models. Accordingly, PRS has gradually been emerged as a viable tool in highway design and construction.

3.3.2.c Quality Assurance Program Changes

As performance specifications are gradually implemented, it will be necessary to make changes to the CQAP accordingly, primarily in the sampling and testing requirements, in the pavement specifications, and the *Construction Manual*. For example, if fatigue and stiffness are chosen as the performance measure for hot mix asphalt, testing requirements will need to be included in those documents.

3.4 Long-Range Objective—Risk-Based Acceptance Criteria

Caltrans should analyze the uniformity and quality of materials produced and, based on the results of those analyses, adjust the quality verification program accordingly.

Risk-based acceptance is a statistical method for establishing the level of risk to each party by calculating the likelihood of accepting materials that do not meet specification and, conversely, rejecting acceptable material. The benefit of using risk-based acceptance is that variances of materials and of testing and sampling are recognized and accounted for, which helps minimize the use of erroneous test results.

Risk-based acceptance criteria assume these governing specifications:

- Incorporate material quality characteristics that are consistent with design requirements.
- Include acceptance limits that consider the normal variability associated with products, sampling and testing processes, contractors, and producers.
- Acknowledge the inherent risk that measurements made to determine compliance with statistically based requirements may result in the acceptance of "bad" material or rejection of "good" material. Include specification limits based on historical data. This data would be stored in DIME.

3.4.1 Analysis Acceptance Limits

Overall product variability can be classified into two main categories:

- Material and construction variability that are mainly the sole responsibility of the contractor.
- Sampling, testing, and performance prediction error, plus any other error sources over which the contractor has no control.

If the specification limits of acceptance do not include reasonable allowances for material and construction variances, sampling variances, and testing variances that are all inherent in the construction process, specification conformity levels will always be low.

An example of this situation can occur in the measurement of slump to determine the consistency of plastic concrete. Research has found that for a reasonably well-controlled process, the overall standard deviation can be expected to be about 1/2 inch. With specification tolerance limits of 1/2 inch imposed, research has found that approximately 32 percent of the test results would be out of specification for concrete with normal variability and the average slump is equal to the specified target value.

To allow for normal variability, the tolerance limits in this example should be set at 1 inch, or equal to two standard deviations, when judging conformity on the basis of one test. With these tolerance limits, approximately 95 percent conformity can be expected. This will avoid having unnecessary process changes. Only when the precision of sampling and testing methods and normal production processes are improved would it be practical to tighten these tolerances.

The following are required to confirm statistically based limits of acceptance:

- The materials and construction quality levels from appropriate contractors and producers to determine representative inherent local variability for each quality characteristic.
- Data collected using multiple random field samples under controlled conditions that reflects the known variability of the materials produced for each quality characteristic.

If conformity with the specification limits of acceptance is consistently high and the specifications are deemed adequate to produce the performance desired, sampling frequencies specified in the quality verification program should be reduced on a project basis. Conversely, if the specification conformance is low, increased sampling frequencies should be considered to reduce the risk of accepting non-specification material.

3.4.2 Analysis to Confirm Acceptance Plan Risks

Establishing the limits to be used for acceptance is an important part of a quality assurance program. Making the limits too restrictive deprives the contractor of a reasonable opportunity to meet the specification. Making them not sufficiently restrictive makes them ineffective in controlling quality. Selecting the limits relates to the determination of risks. The two types of risk encountered are the seller's (or contractor's) risk, alpha, and the buyer's (or Caltrans') risk, beta.

The seller's risk is the probability that an acceptance plan will erroneously reject acceptable quality level material or construction with respect to a single acceptance quality characteristic. The contractor or producer takes the risk of having acceptable quality level material or construction rejected.

The buyer's risk is the probability that an acceptance plan will erroneously fully accept rejectable quality level material or construction with respect to a single acceptance quality characteristic. Caltrans takes the risk of having rejectable quality level material or construction fully accepted.

To evaluate how the acceptance plan will perform over a wide range of possible quality levels, it is necessary to construct an operating characteristic curve that is a graphic representation of an acceptance plan. This would show the relationship between the quality of a lot and either (1) the probability of its acceptance—for accept or reject acceptance plans, or (2) the probability of its acceptance at various pay levels—for acceptance plans that include pay adjustment provisions.

Acceptance plans must consider these risks in a manner that is fair to both the contractor and Caltrans. Too large a risk for either party undermines credibility; therefore, the risks should be both reasonably balanced and reasonably small.

The seller and buyer risk levels that may be appropriate vary, depending on the material or construction process involved. While setting the acceptance risk levels is a Caltrans decision, Section 9, "Risks and Risk Analysis," of AASHTO's Standard Practice for Acceptance Sampling Plans for Highway Construction (AASHTO R 9-05 [2009], page R9-19) presents the following guidance:

> The appropriate risk level is a subjective decision that can vary from agency to agency. However, as an economic decision, typical practice limits risks to no more than 5 percent. The more critical the application, the lower should be the buyer's risk. But only under rare circumstances should the buyer's risk be lower than the seller's risk.

If the acceptance plan risks are considered acceptable in terms of being low and the specifications are deemed adequate to produce the performance desired, consideration should be given to reducing sampling frequencies set forth in the quality verification program on a project basis. However, if the risks are considered unacceptable in terms of being too high, a reassessment of the quality verification plan and possible increased sampling frequencies should be considered to reduce the risk of accepting non-specification material.

In summary, the opportunity exists for Caltrans to use existing quality verification program resources more effectively by including risk-based acceptance criteria provisions in the governing specifications.

Appendixes

Appendix A: Caltrans Quality Assurance Documents

1. 2022 Standard Plans, *Standard Specifications*

   https://design.onramp.dot.ca.gov/2022-construction-contract-standards#overlay-context=construction-contract-standards
2. Bridge Construction Records and Procedures, Vol. 1 and Vol. 2

   https://dot.ca.gov/programs/engineering-services/manuals
3. *Bridge Deck Construction Manual*

   https://dot.ca.gov/programs/engineering-services/manuals
4. California Test Methods

   https://dot.ca.gov/programs/engineering-services/california-test-methods
5. *Concrete Technology Manual*

   https://dot.ca.gov/programs/engineering-services/manuals
6. *Construction Manual*

   https://dot.ca.gov/programs/construction/construction-manual
7. Design-Build Demonstration Program, Quality Manual Outline

   To request a copy of the Quality Manual Outline, email: Innovative.Delivery@dot.ca.gov
8. *Falsework Manual*

   https://des.onramp.dot.ca.gov/structure-construction/falsework-manual
9. *Foundation Manual*

   https://des.onramp.dot.ca.gov/structure-construction/foundation-manual
10. *Independent Assurance Manual*, *Procedures for Accreditation of Laboratories and Qualification of Testers*, July 2005.

    To request a copy of the *Independent Assurance Manual*, *Independent Assurance Manual* Amendments, and Annual Reports, email: IA.Service.Request@dot.ca.gov.
11. *Material Plant Quality Program Manual*

    https://dot.ca.gov/programs/construction/material-plant-quality-program
12. METS Authorized Materials Lists

    https://dot.ca.gov/programs/engineering-services/authorized-materials-lists
13. *Quality Control Manual for Hot Mix Asphalt Using Statistical Pay Factors*

    https://dot.ca.gov/programs/construction/hot-mix-asphalt-construction
14. *METS Quality Manual*

    https://rock.dot.ca.gov/qualitysystem/documents/mets/oqasi/qasi/QASI_MANUAL.pdf

Appendix B: Caltrans Quality Assurance Program Bulletin

Construction Quality Assurance Program Bulletin

CQAPB YY-X **Construction Quality Assurance Program Bulletin Style Sheet 1-line title**

References:	Reference titles here (in order of appearance, when possible)	Cite the number and section title of the reference. If the information raps to the next line, indent ¼ inch.
	Additional reference titles here	Stack information about additional references here. If the information wraps to the next line, indent ¼ inch.
(Example):	*Standard Specifications*	Section 84-9.03B, "Remove Traffic Stripes and Pavement Markings" Section 4-1.06, "Differing Site Conditions" Section 4-1.05, "Changes and Extra Work"
	Construction Manual	Section 4-1503B, "Removing Traffic Stripes, Pavement Markings, and Pavement Markers"
Effective Date:	Day after the approval date	Approved: _____ RACHEL FALSETTI, Chief Division of Construction

Approval Date: Date signed

New Procedure

Begin the "New Procedure" section by briefly introducing and summarizing the new procedure. If there is a change to policy, make a strong policy statement (that is, what MUST staff do now that they didn't have to do before).

- Provide the information the reader will need to perform the new procedure but not more information than necessary. Remember the reader is in the field and may have limited access to reference materials.
- Provide details about each function that must be performed in the new procedure, giving the titles of the persons responsible for performing the functions. Provide timeline information if appropriate.
- If your CQAPB includes revised *Construction Manual* sections, treat them as attachments. Revising sections now will reduce the time spent in the future to update the manual.

"Provide a safe and reliable transportation network that serves all people and respects the environment."

CQAPB YY-X Title
Month XX, YYYY
Page 2 of 2

Background

The "Background" section rarely contains as much information as the "New Procedure" section.

Provide summary information including:

- Information about circumstances, such as changes in the *Standard Specifications* or law that led to the creation of the CQAPB.
- Problems or common errors that required the CQAPB.
- A brief explanation of how the new procedure improves the old procedure or what impact the new procedure will have.
- References relating to existing procedures. Avoid detail. Readers can check the references you provide if they want detail. For example:

  Section X-XXX, "Section Name," of the *Construction Manual* provides processing durations for priority and normal acceptance testing on certain materials.

  Or, if no policies or procedures exist:

  No procedures exist for the installation of safety edge for hot mix asphalt or concrete pavement.

Use the following closing statement with your own contact information:

If you have any questions or comments regarding this bulletin, please contact Joe Policy, Division of Construction, at Joe.Policy@dot.ca.gov or (916) 123-4567.

Appendix C: Caltrans Deputy Directives

California Department of Transportation

Serious drought.
Help save water!

DEPUTY DIRECTIVE

Number:	DD-75-R1
Refer to Director's Policy:	DP-11 Caltrans' Workforce
Effective Date:	05/27/2015
Supersedes:	DD-75 (July 2003)
Responsible Program:	Administration

TITLE Training

POLICY

The California Department of Transportation (Caltrans) strives to continuously enhance the job performance of all employees by providing timely, cost effective, and innovative classroom and eLearning training. The Learning and Development Office (LDO) provides leadership in identifying and supplying training solutions and services to ensure Caltrans meets it mission, vision, goals, and values.

DEFINITION/BACKGROUND

Training is a formalized process during which employees participate in a program of instruction that includes a lesson plan and instructor or instructional device to acquire knowledge, skills, and abilities for their current and/or future job performance. Training benefits both the individual and Caltrans.

The authority and direction for training is cited in the following:

- Government Code sections 19995–19995.4.
- California Code of Regulations (CCR) Title 2, Chapter 3, Article 17, sections 599.815–599.824.
- Memorandums of Understanding (MOUs) for bargaining units.

RESPONSIBILITIES

Learning and Development Office:

- Establishes training policies and guidelines for Caltrans.
- Ensures that Caltrans training activities are aligned with Caltrans strategic goals and are consistent with provisions in the MOUs.
- Develops, delivers, evaluates and continuously improves training programs that have impact throughout Caltrans.
- Establishes and maintains communication with the districts and divisions to ensure consistency in training approaches and applications throughout Caltrans.

"Provide a safe, sustainable, integrated and efficient transportation system to enhance California's economy and livability"

- Consults with Caltrans customers on instructional content, development, and delivery using various training methods and techniques for learning.
- Provides up-to-date training information, innovative tools, and resources throughout Caltrans on the LDO's intranet site.
- Maintains and operates Caltrans state-of-the-art training center in Sacramento.
- Partners with internal programs/divisions to maintain Caltrans Learning Management System (LMS).
- Provides training course registration services throughout Caltrans for LDO's course offerings.

District and Division Trainers/Training Coordinators:

- Establish and maintain communication with the LDO to ensure consistency in training approaches and applications throughout Caltrans.
- Consult with managers and supervisors to identify training needs and recommend solutions.
- Maintain information and resources to assist managers, supervisors, and employees in locating courses.
- Take primary responsibility or assist in designing, implementing, conducting, and coordinating training courses to be administered locally.

Managers:

- Maintain an organizational climate that promotes training and development activities.
- Provide and communicate opportunities for employees to participate in approved training appropriate to their individual needs.
- Ensure training and development activities are aligned with Caltrans strategic goals and objectives and are consistent with provisions in the MOUs.
- Manage resources within budgetary limits to ensure that critical training needs are met.

First-Line Supervisors:

- Communicate with employees to identify their job assignment strengths and development needs.
- Determine employee training and development needs.
- Provide employees with appropriate training for satisfactory job performance and future development within available resources.
- Provide on-the-job opportunities to enhance job performance and future development.
- Maintain a work environment that encourages employee growth and development.

- Provide work assignments that give employees the opportunities to apply newly acquired skills and knowledge, and coach them as needed.
- Ensure that training activities are aligned with Caltrans strategic goals and are consistent with the provisions in the MOUs.
- Provide opportunities for employees to attend approved training and to participate in training and development assignments appropriate to employees' individual needs within available resources.

Employees:

- Assess their individual training and development needs.
- Research training opportunities to improve their job performance.
- Inform supervisor of perceived training needs.
- Obtain supervisor approval to attend scheduled training.
- Participate in approved, planned training activities.
- Apply the skills, knowledge, and techniques acquired from training to improve their job performance.
- Initiate a career development plan in collaboration with their supervisor.

APPLICABILITY

All Caltrans employees.

Original signed by: *05/27/2015*

KOME AJISE
Chief Deputy Director

Date Signed

California Department of Transportation

Deputy Directive

Number: DD-90-R1

Refer to Director's Policy: DP-03, Safety and Health
DP-06, Caltrans' Partnerships
DP-07, Project Delivery
DP-08, Transportation System Management and Operation (TSMO)
DP-10, Departmental Commitments
DP-14, Quality in Caltrans

Effective Date: 12/21/2018

Supersedes: DD-90 (12/01-2006)

Responsible Program: Project Delivery, Division of Project Management

TITLE Funding of Quality Management Assessment on State Highway System

POLICY

The California Department of Transportation (Caltrans), as owner/operator of the State Highway System (SHS) is obligated to perform Quality Management Assessment (QMA) for all projects on its system.

For capital projects implemented by others, Caltrans will perform QMA at State expense unless any of the following conditions apply, in which case, Caltrans shall be reimbursed for QMA:

1) The implementing agency is a non-governmental entity,
2) The proposed project will generate revenue (e.g. managed lanes, toll roads and toll bridges). Reimbursement for QMA will not be sought during the Project Approval and Environmental Document (PA&ED) component of the proposed revenue generating project,
3) Is otherwise required by law,
4) Both parties agree reimbursement is appropriate and documented in a cooperative agreement.

DEFINITION/BACKGROUND

Quality Management Assessment as defined in Deputy Directive 23-R2, Roles and Responsibilities for Development of Projects on the State Highway System, is the systematic activities by the owner/operator that verifies the implementing agency's quality assurance program effectiveness and precede the owner/operator approval.

Non-governmental entity refers to all private and nonprofit establishments that do not meet the standards of a qualified organization per Government Code section 65967(b)(2) in conjunction with 65965(h) - Chapter 6.4 Mitigation Lands: Nonprofit Organizations.

RESPONSIBILITIES

Deputy Director, Project Delivery:
Ensures Project Delivery Programs work with appropriate division and district offices to develop policies, guidelines and procedures to implement this directive.

District Directors:

- Identify, request and assign the resources needed to perform QMA as part of the annual budget process.
- Execute cooperative agreements that include Caltrans' reimbursement in accordance with this directive.
- Implement this directive.

Chief, Division of Accounting:
Develop financial accounting and invoicing methodologies to accommodate QMA expenditures.

Chief, Division of Project Management:

- Monitor compliance of this directive.
- Develop allocation and expenditure methodologies from which to track and report activities and budget expenditures specifically related to QMA.

District Deputies, Branch Chiefs, Project Managers, and Task Managers:

- Ensure cooperative agreements are developed in accordance with this policy.
- Provide quality and timely products, services and information that reflect QMA expenditures.
- Document and communicate any change or problem that could impact the efficient delivery of a project or project component budget to appropriate personnel or agency.
- Accurately document time and resources expended performing QMA to ensure proper reimbursement.

APPLICABILITY

All Caltrans employees involved with project direct work.

Original signed by
RYAN CHAMBERLAIN
Chief Deputy Director

12/21/2018
Date Signed

Appendix D: Charter: Contract Administration Process Evaluation (CAPE)

Caltrans Division of Construction
CHARTER: Contract Administration Process Evaluation (CAPE)

BACKGROUND:
In 2000, the Caltrans Division of Construction (Construction) initiated its first process evaluation of contract administration guidance and practices. Construction's executive management meets each year to compile a list of potential contract administration topics for evaluation. Typically, these topics are areas of concern where there may be a lack of contract enforcement, a lack of understanding by resident engineers, or contractor disputes. Each year, Construction chooses approximately three to four topics for evaluation.

Once topics are selected, a CAPE evaluation plan is developed. The plan consists of the problem statements, objectives, estimates of resources needed, and identifies the managers and team leaders. The team leaders are typically Construction's subject matter experts. The plan is used as a scoping document to help guide the investigating team members in performing the CAPE. Each district and region provides team members for each CAPE topic. The teams investigate and evaluate the effectiveness of current contract administration processes by interviewing resident engineers in each district and region. The information and findings are collected and compiled into the CAPE report, which identifies strengths, weaknesses and suggested improvements provided for each district and region. Construction also uses the findings as an opportunity to improve policies, guidance and develop needed training. The CAPE report and the associated findings for each topic are shared with the Deputy District Directors and Region Division Chiefs of Construction. Each district and region then prepares an action plan that contains planned managerial or training actions and proposed corrections for the suggested improvements. After two years, a self-evaluation or look back is prepared by each district and region to evaluate the effectiveness of the implemented training or corrective actions taken to improve the contract administration processes.

OBJECTIVE:
Evaluate the current state of contract administration methods, guidance material and processes to identify strengths, weaknesses and suggested improvements. This periodic review of current business practices improves the construction and project delivery process. The proposed changes and process improvements help streamline construction processes and achieve success in the delivery of construction projects.

DESIRED DELIVERABLES:

1. Evaluate each CAPE topic for each district and region. Identify strengths, weaknesses and suggested improvements for each CAPE topic. Compile the results in the annual CAPE report.
2. Develop district and region action plans to address suggested improvements identified in the CAPE. Monitor and implement the action plans.
3. Where appropriate, improve contract administration policy, processes, guidance material, specifications and administration by field staff.

RESOURCES:
Individual CAPE teams are made up of Caltrans staff from headquarters and supporting team members from the districts and regions. Consultants may participate in each topic team to aid in collecting data and then preparing the final CAPE report. Travel is authorized as needed to conduct the interviews.

SPONSORS:

12-7-12	12/7/12
SCOTT JARVIS DATE	MARK LEJA DATE
Assistant Chief, Division of Construction	Chief, Division of Construction

December 6, 2012