QUALITY CONTROL PLAN

PR-4

REQUIRED

GOAL

Have a process in place to monitor and improve construction quality.

REQUIREMENTS

The prime contractor shall establish, implement, and maintain a formal construction Quality Control Plan (QCP). The QCP must address the following quality control elements:

1. Key quality control personnel, their responsibilities and their qualifications (résumés, certifications, etc.).
2. Procedures used to control quality during construction including (as a minimum):

    a. Items to be monitored (including pavement mix designs)
    b. Testing to be done (including testing standards and frequency)
    c. When corrective action is required (action limits)
    d. Procedures to implement corrective action
    e. Procedures to modify QCP if ineffective or when modifications are necessary

Details

Some state and local owner agencies already have requirements for such plans written in to their standard specifications. Such existing requirements should be able to meet the requirements above, however some only address construction quality for hot mix asphalt (HMA) or Portland cement concrete (PCC) paving and not construction of the overall project. Testing frequency and test procedures should not be based on minimum owner requirements for acceptance.

Some state highway agencies use contractor testing in their acceptance process. In these cases the independent assurance tests must be performed on samples that are taken independently of quality control samples. Quality control plans are required in these cases, as defined in CFR 637, Title 23.

The Quality Control Plan should cover all project construction; not just the pavement. Subcontractors need to be included in this plan, which typically means identifying a responsible party and obtaining a quality control procedure from the subcontractor.

A large document that repeats language from the contract specifications should not be generated for this Project Requirement. Rather, the document should clearly identify the major aspects of the prime contractor's plan to control project construction quality and who is responsible for implementing those aspects. A reasonable Quality Control Plan for a typical roadway project (i.e., less than $10 million contract price) can be written in about 6 to 12 pages (FLHD, 1998). A Quality Control Plan should be approved by the owner before construction begins.

DOCUMENTATION

- Copy of the contractor Quality Control Plan.

RELATED CREDITS

- ✓ CA-1 Quality Management System
- ✓ CA-8 Contractor Warranty
- ✓ PT-1 Long-Life Pavement
- ✓ PT-6 Pavement Performance Tracking

SUSTAINABILITY COMPONENTS

- ✓ Economy
- ✓ Extent
- ✓ Expectations

BENEFITS

- ✓ Increases Service Life
- ✓ Improves Human Health & Safety
- ✓ Reduces Lifecycle Costs
- ✓ Improves Accountability

APPROACHES & STRATEGIES

- Write a Quality Control Plan. Often this can be accomplished by having a prime contractor with an established quality control manual and then writing a plan that refers to that manual for procedures and identifies key personnel, materials and processes associated with the particular project in question.

Example: Agencies with Quality Control Plans

Many owners already require QCPs in their standard specifications. Following are examples of both comprehensive QCPs that cover all of construction and some that just refer to paving operations.

QCPs Covering All of Construction

These plans **do** meet the requirements for PR-4.

- **Federal Lands Highway Division.** This document discusses a QCP that covers all construction aspects and provides a fictitious example: http://www.wfl.fhwa.dot.gov/resources/construction/field-notes/documents/d-02-15.pdf.
- **Florida Department of Transportation (FDOT).** FDOT's *Construction Project Administration Manual (2007)* describes FDOT requirements and how to use a contractor's quality control manual to supplement a QCP in Section 3.3. Section 6-8 of the FDOT 2007 *Standard Specifications for Road and Bridge Construction* requires a contractor quality control program: http://www.dot.state.fl.us/construction/manuals/cpam/CPAMManual.shtm
- **Saskatchewan Highways and Transportation:** The *Standard Test Procedure Manual (1994)* Standard Test 400 (last updated in 1994) describes what a quality control plan does and its minimum elements: http://www.highways.gov.sk.ca/standard-test

QCPs Covering Paving Operations Only

These plans **do not** meet the requirements for PR-4.

- **Alabama DOT (ALDOT)** ALDOT-375-91: http://www.dot.state.al.us/NR/rdonlyres/A1E8B299-F518-41BF-B0A9-2326C1177C91/0/ALDOT375ApprovedFHWAOctober202008_.pdf
- **Illinois DOT** HMA QCP template: http://www.dot.state.il.us/aero/PDF/HMA%20QC%20plan%20template.pdf
- **North Carolina DOT** Section 609 of the Standard Specifications: http://www.ncdot.org/doh/preconstruct/ps/specifications/english/s609.html
- **Unified Facilities** Guide Specifications, Section 3.10: http://www.wbdg.org/ccb/DOD/UFGS/UFGS%2032%2012%2016.pdf

Many other organizations also have guides and specifications for contractor Quality Control Plans.

POTENTIAL ISSUES

1. It is not possible to determine from the content of the QCP whether quality construction will result. Therefore, this credit does not guarantee quality construction in any way.
2. A contractor Quality Control Plan that only addresses paving operations is not sufficient to meet the intent of this credit. For some owners, standard specification language may only require a Quality Control Plan for the paving operation. While paving needs to be covered in the Quality Control Plan, all other major components of construction (e.g., structures, earthwork, drainage, traffic control items, etc.) must also be covered.
3. The Quality Control Plan should not be a repeat of the technical specifications. Rather, the plan should address who is responsible for quality control for a particular item or process, when key inspections are made, when corrective actions are to be taken and how they are to be taken.
4. A formal process for monitoring and improving construction quality should not conflict with minimum quality standards that are maintained by the roadway owner.

RESEARCH

Construction quality can significantly influence final project quality and performance. Poor construction can lead to early and excessive maintenance and/or early replacement. This costs more money and uses more resources leading to a less sustainable project. Unfortunately, there is a general lack of empirical evidence to document these items as they are often taken to be intuitively obvious. This section, therefore, presents a discussion of several pavement items since for these items there is substantial evidence that construction quality impacts performance and cost.

Subgrade and Base Compaction

Subgrade or base material that is not adequately compacted may settle over time, which in turn causes the overlying pavement to settle and crack. This can lead to roughness and early pavement failure. Often adequate subgrade density is described in terms of relative density (e.g., 90 or 95 percent of maximum density).

Hot Mix Asphalt (HMA) Density

Compaction is the greatest determining factor in dense-graded hot mix asphalt performance (Scherocman & Martenson, 1984; Scherocman, 1984; Geller, 1984; Brown, 1984; Bell et. al., 1984; Hughes, 1984; Hughes, 1989). Inadequate compaction results in a pavement with decreased stiffness, reduced fatigue life, accelerated aging/decreased durability, rutting, raveling, and moisture damage (Hughes, 1984; Hughes, 1989).

HMA Aggregate Segregation

Based on several articles (Kennedy et al., 1987; Brown & Brownfield, 1988; Williams et al., 1996a and 1996b; Khedaywi & White, 1996; American Association of State Highway and Transportation Officials: AASHTO, 1997) the commonly accepted qualitative definition of **aggregate segregation** is “the non-uniform distribution of coarse and fine aggregate components within the asphalt mixture.” The chief detrimental effects of segregation on HMA performance are: reduced fatigue life, rutting, raveling, and moisture damage. These effects can cause a severe reduction in pavement life. More information on segregation causes and cures can be found in Segregation Causes and Cures for Hot Mix Asphalt (QIP-110) by AASHTO and the National Asphalt Pavement Association (NAPA).

HMA Temperature Differentials

HMA temperature differentials are large mat temperature differences resulting from placement of a significantly cooler portion of HMA mass into the mat. This cooler mass comes from the surface layer (or crust) typically developed during HMA transport from the mixing plant to the job site. These cooler areas will reach cessation temperature more quickly than the surrounding mat. Roller patterns developed based on general mat temperatures may not be adequate to compact these cooler areas before they cool to cessation temperature resulting in isolated spots of inadequate compaction. Thus, temperature differentials can cause isolated areas of inadequate compaction resulting in decreased strength, reduced fatigue life, accelerated aging/decreased durability, rutting, raveling, and moisture damage (Hughes, 1984; Hughes, 1989).

Portland Cement Concrete (PCC) Consolidation

Consolidation is the process of making the freshly placed PCC into a more uniform and compact mass by eliminating undesirable air voids and causing it to move around potential obstructions (such as reinforcing steel). This is usually accomplished using vibrators. Inadequate consolidation can lead to undesirable air voids that can weaken PCC or be unsightly.

Pavement Roughness

Pavement roughness is an expression of irregularities in the pavement surface that adversely affect the ride quality of a vehicle (and thus the user). Roughness affects not only ride quality but also vehicle delay costs, fuel consumption and maintenance costs. The World Bank found road roughness to be a primary factor in the analyses and trade-offs involving road quality vs. user cost (UMTRI, 1998). Other studies (e.g., Papagiannakis & Delwar, 2001; Barnes & Langworthy, 2003) have attempted to quantify the cost of vehicle operation in relation to pavement roughness.

GLOSSARY

AASHTO	American Association of State Highway and Transportation Officials
Aggregate segregation	the non-uniform distribution of coarse and fine aggregate components within the asphalt mixture (Kennedy et. al., 1987; Brown and Brownfield, 1988; Williams et. al., 1996a and 1996b; Khedaywi and White, 1996; American Association of State Highway and Transportation Officials: AASHTO, 1997)
Consolidation	the process of making the freshly placed portland cement concrete into a more uniform and compact mass by eliminating undesirable air voids
HMA	Hot mix asphalt
NAPA	National Asphalt Paving Association
Pavement roughness	an expression of irregularities in the pavement surface that adversely affect the ride quality of a vehicle (and thus the user)
PCC	Portland cement concrete

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