
Standard Practice for Quality Assurance of Standard Manufactured Materials

AASHTO Designation: R 38-10 (2022)¹

Technically Revised: 2010

Reviewed but Not Updated: 2022

Tech Subcommittee: 5c, Quality Assurance and Environmental



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1. SCOPE

- 1.1. This standard practice contains minimum criteria and guidelines for establishing and implementing quality assurance (QA) procedures for *standard manufactured materials* used in highway construction. The purpose of this document is to establish minimum quality control (QC) requirements for manufacturers and to provide guidelines for acceptance of standard manufactured materials by transportation agencies.
- 1.2. *Standard Manufactured Materials*—Materials used in transportation construction are broadly categorized according to their source and corresponding methods of production. The three principal materials categories are as follows:
 - Project-produced materials,
 - Fabricated structural materials, and
 - Standard manufactured materials.
- 1.3. In order to explain the difference between these materials categories and provide a basic understanding of how QA is applied to them, each of the three primary material categories is defined below (see Section 3). Although QA procedures should be addressed for each of these material categories, the scope of this standard practice is the application of QA to standard manufactured materials.
- 1.4. Standard manufactured materials are standard items that are produced routinely (i.e., not for a specific project) by a manufacturer. They are generally characterized by one or more of the following conditions:
 - 1.4.1. The materials are normally mass-produced under highly controlled and largely automated manufacturing conditions.
 - 1.4.2. The material properties are stable and have no potential for alteration under proper transportation from the manufacturer to the project site.
 - 1.4.3. The materials arrive at the project site in a solid, finished state and require only installation.
- 1.5. *Relevant Items*—This standard practice addresses those items used in transportation construction that meet the above description of standard manufactured materials. Some examples of standard manufactured materials used in transportation construction are presented in Table 1 below. The list of items in Table 1 is not all-inclusive but is intended to provide examples of typical items within each of the three principal materials categories.

Table 1—Typical Items by Materials Category

Materials Category	Example Items
Project-Produced Materials	Earthwork Subbase and Base Courses Geotechnical Items* Hot Mix Asphalt (HMA)* Portland Cement Concrete (PCC)* Field Applied Structural Coatings* Pavement Markings*
Fabricated Structural Materials	Fabricated Structural Steel and Coatings* Precast/Prestressed Concrete Structural Elements* (e.g., Precast Box Culverts, Prestressed Bridge Beams)
Standard Manufactured Materials	Binders and Cements (e.g., PG Binder, Portland Cement) Drainage or Water Systems (e.g., Ductile Iron Pipe, Corrugated Metal Pipe, PVC Pipe, Hydrants, Gates and Valves, etc.) Geotextile Fabrics Landscaping Items (e.g., Lime, Fertilizer, Seed, Mulch, Chain Link Fence, etc.) Paints and Coatings (e.g., Traffic Paints, Glass Beads, Preformed Markings, Epoxy, Zinc Galvanizing, etc.) Roadside Safety Devices (e.g., Impact Attenuators, Steel Beam Guardrail, Wood Posts, etc.) Standard Precast Concrete Items (e.g., Concrete Pipe, Concrete Manholes and Junction Boxes, Concrete Barrier, Concrete MSE Wall Panels, etc.) Standard Steel Shapes or Products (e.g., Anchor Bolts, Frames and Grates, Rebar, Stay-in-Place Forms, Sheeting and Piles, etc.) Traffic Control Devices (e.g., Electrical Conduit, Signal Heads, Signal Poles, Controllers, Signs, etc.)

* Some constituent materials incorporated are evaluated as standard manufactured materials.

2. REFERENCED DOCUMENTS

- 2.1. *AASHTO Standard:*
- [R 18](#), Establishing and Implementing a Quality Management System for Construction Materials Testing Laboratories
- 2.2. *ASTM Standards:*
- [D3665](#), Standard Practice for Random Sampling of Construction Materials
 - [E4](#), Standard Practices for Force Verification of Testing Machines
 - [E105](#), Standard Practice for Probability Sampling of Materials
- 2.3. *Other Document:*
- ISO 10013:2001, Guidelines for Quality Management System Documentation

3. TERMINOLOGY

- 3.1. *Relevant Terms and Definitions*—The terms and definitions included below are provided to ensure standard application of terminology relevant to the QA of transportation construction materials, including standard manufactured materials. Where terms or definitions in this standard practice differ from the above-referenced documents, the terms included herein shall replace those contained in the above-referenced documents.
- 3.1.1. *acceptance*—all factors used by the agency (i.e., sampling, testing, and inspection) to evaluate the degree of compliance with contract requirements and to determine the corresponding value for a given product.

- 3.1.2. *accredited laboratories*—laboratories that are recognized by a formal accrediting body as meeting quality system requirements, including demonstrated competence to perform standard test procedures.
- 3.1.3. *agency*—any organization, constituted under federal, state, or municipal laws, that is responsible for administering contracts for highway or transportation construction.
- 3.1.4. *calibration*—a systematic process used to standardize measurement instruments or test equipment by determining any deviation from an established reference or standard. A correction or adjustment of the instrument or equipment may be required based on the amount of deviation from the standard.
- 3.1.5. *certified personnel*—personnel who are recognized by a formal certifying body as qualified to perform sampling, testing, inspection, or related procedures.
- 3.1.6. *control chart*—also called “statistical control chart.” A graphical plot of QC measurements or test values used to identify variation in a production or placement process due to either chance causes or assignable causes.
- 3.1.7. *control chart limits*—also called “action limits.” Statistically derived boundaries applied to a control chart for controlling material production or placement. [Control chart limits are expressed as the upper control limit (UCL) and the lower control limit (LCL). When values of the material characteristics fall within these limits, the process is “under control.” When values fall outside the limits, there is an indication that some assignable cause is present causing the process to be “out of control.”]
- 3.1.8. *dispute resolution*—the procedure used to resolve conflicts resulting from discrepancies between the agency’s and contractor’s results of sufficient magnitude to impact payment.
- 3.1.9. *engineering limits*—the absolute limiting value(s) placed on a quality characteristic beyond which the test result for an individual sample is considered to be unacceptable. [Engineering limits are established to identify material that does not provide the minimum required engineering properties. They usually have an upper engineering limit (UEL), a lower engineering limit (LEL), or both. The engineering limits may be the same as the specification limits.]
- 3.1.10. *fabricated structural materials*—major structural items produced specifically for an individual construction project by a material fabricator. [They are generally characterized by one or more of the following conditions: (a) The production process for the material occurs under controlled conditions at an established fabricator plant typically located within state or in another state; (b) The material properties are stable and have no potential for alteration under proper transportation from the fabricator to the project site; (c) The materials arrive at the project site in a solid state and require little or no additional work after installation.]
- 3.1.11. *fabricator*—a company that produces fabricated structural materials (e.g., precast/prestressed concrete structural elements, fabricated structural steel) for either the prime contractor or a subcontractor.
- 3.1.12. *lot*—a specific quantity of material from a single source that is assumed to be produced or placed by the same controlled process.
- 3.1.13. *manufacturer*—a company that manufactures and supplies standard manufactured materials for either the prime contractor, a subcontractor, or a fabricator.
- 3.1.14. *population*—a collection of all possible individuals, objects, or items that possess some common specified characteristic(s) that can be measured.

- 3.1.15. *prime (general) contractor*—the company that has the primary construction contract for an agency project and that assumes overall responsibility for completing the work.
- 3.1.16. *producer*—a company that produces and supplies project-produced materials (e.g., aggregates, HMA, PCC) for either the prime contractor or a subcontractor.
- 3.1.17. *project-produced materials*—major items produced directly for an individual construction project either by a contractor or by a material producer. [They are generally characterized by one or more of the following conditions: (a) The production process for the material occurs either at the project site or at a production plant located in close proximity to the project site; (b) The material properties are subject to potential contamination or segregation during transportation from the plant to the project site; (c) The materials arrive and are placed at the project site in a nonsolid or loose mixture state requiring subsequent mixing, compaction, finishing, or curing.]
- 3.1.18. *qualified laboratories*—laboratories that are capable as defined by appropriate programs established or recognized by each agency. [Accredited laboratories are considered “qualified.” However, a “qualified laboratory” need not be accredited.]
- 3.1.19. *qualified personnel*—personnel who are capable as defined by appropriate programs established or recognized by each agency.
- 3.1.20. *quality*—(1) the degree of excellence of a product or service; (2) the degree to which a product or service satisfies the needs of a specific customer; (3) the degree to which a product or service conforms with a given requirement; or (4) conformance to requirements.
- 3.1.21. *quality assurance (QA)*—(1) all those planned and systematic actions necessary to provide confidence that a product or facility will perform satisfactorily in service; or (2) ensuring the quality of a product is what it should be. [The two primary elements of a QA program for standard manufactured materials include QC by the manufacturer and acceptance by the agency. Additional elements of a QA program for standard manufactured materials include qualified personnel, qualified laboratories, and dispute resolution procedures.]
- 3.1.22. *quality characteristics*—a product characteristic that is measured through testing, either for QC purposes or for conformance with acceptance requirements. [Quality characteristics are specific material properties or product requirements that are evaluated by QC and acceptance testing. Quality characteristics are normally selected because they: (a) relate to initial and long-term performance; (b) are quantifiable or measurable; and (c) can be measured with good repeatability.]
- 3.1.23. *quality control (QC)*—the system used by a contractor party to monitor, assess, and adjust its production or placement processes to ensure that the final product will meet the specified level of quality. [QC includes sampling, testing, inspection, evaluation, and corrective action (when required) to maintain continuous control of a production or placement process.]
- 3.1.24. *quality measure*—any one of several mathematical tools used to quantify the level of quality of an individual quality characteristic. [Application of a quality measure to a set of test data provides an overall numeric representation of quality for a specific quality characteristic. Typical quality measures used in QA are selected because they quantify the average quality, the variability, or both. Examples of quality measures that may be used include: mean, standard deviation, percent defective (PD), percent within limits (PWL), average absolute deviation (AAD), moving average, and conformance index (CI). PWL and PD are the quality measures recommended for use in QA specifications.]
- 3.1.25. *quality system manual (QSM)*—a written document that describes the overall QC operating procedures of a contractor party (e.g., prime contractor, subcontractor, producer, fabricator, manufacturer). [A manufacturer’s QSM documents the internal policies for achieving quality and

the assignment of responsibility and accountability for QC within the manufacturer's organization. It may also describe the minimum QC requirements expected of upper- or lower-tier contractor parties who supply constituent materials or who are involved in handling or processing of the manufacturer's products.]

- 3.1.26. *random sampling*—a sampling procedure whereby each sample obtained from the lot has an equal probability of being selected.
- 3.1.27. *run chart*—also called “music bar chart.” A control chart that presents individual measurements or test values for a specific quality characteristic on a vertical axis and the individual sample numbers (in consecutive order) on a horizontal axis. [Run charts plot individual sample values ($n = 1$) and usually check the measurements or test results against the specification limits or engineering limits.]
- 3.1.28. *sample*—(1) also called “material sample.” A small quantity of material or measurement obtained from a subplot or lot. [A sample can refer to either a point of inspection (i.e., visual examination or physical measurement) or an individual material sample obtained for testing. A sample may be composed of one or more increments of equal size that have been obtained from the sampling location and combined]; or (2) also called “statistical sample.” All of the samples obtained from a lot that provide information that may be used to quantify the quality of the entire lot. [The context in which the word “sample” is used determines its meaning. For example, “obtain a sample here” would mean obtain a physical quantity of material from a specific location; while “the sample size equaled nine” means that a total of nine individual material samples were obtained in a random manner and thus comprised the statistical sample of size $n = 9$. Each sample is included in the overall statistical sample for a given lot.]
- 3.1.29. *specification limits*—the statistically based limiting value(s) placed on a quality characteristic that are applied with a particular quality measure (such as PWL) to evaluate the quality of a lot. [Specification limits are usually composed of an upper specification limit (USL), a lower specification limit (LSL), or both. It is important to recognize that because specification limits are statistical limits, individual sample test results may fall beyond the USL or LSL and still be included in the acceptance determination. The specification limits will ultimately be used for computation of quality levels (e.g., PWL), which will be used in calculating pay factors for a lot.]
- 3.1.30. *standard manufactured materials*—standard items that are produced routinely (i.e., not for a specific project) by a manufacturer. [They are generally characterized by one or more of the following conditions: (a) the materials are normally mass-produced under highly controlled and largely automated manufacturing conditions; (b) the material properties are stable and have no potential for alteration under proper transportation from the manufacturer to the project site; (c) the materials arrive at the project site in a solid, finished state and require only installation.]
Note 1—Exceptions to this condition include materials such as PG binders, cements, and paints/coatings that are incorporated into either project-produced materials or fabricated structural materials.
- 3.1.31. *statistical control chart*—see *control chart*.
- 3.1.32. *statistical sample*—see *sample*.
- 3.1.33. *stratified random sampling*—a sampling procedure whereby samples are randomly obtained from each subplot.
- 3.1.34. *subcontractor*—a company that is responsible for field placement or installation of an individual item of work under contract to the prime contractor.

- 3.1.35. *subgroup*—a set ($n > 1$) of QC sample values from within a lot, the mean or range of which are plotted on a control chart.
- 3.1.36. *sublot*—a subdivision of a lot.
- 3.1.37. *target value*—the value that is placed on a quality characteristic that represents the mean of the expected distribution of the specified population.
- 3.1.38. *validation*—the mathematical comparison of two independently obtained sets of data (e.g., agency acceptance data versus manufacturer QC data) to determine whether it can be assumed they came from the same population.

4. SIGNIFICANCE AND USE

- 4.1. *Manufacturer Quality Control*—This document outlines minimum requirements that should be followed by manufacturers in implementing an effective QC system. It is not intended to prescribe the methods by which a manufacturer achieves the desired level of quality but instead establishes minimum guidelines and criteria for documenting and implementing QC procedures for standard manufactured materials.
- 4.2. *Agency Acceptance*—This document outlines recommended approaches for acceptance of standard manufactured materials by transportation agencies. It is not intended to prescribe a singular acceptance procedure for all agencies, but rather provides a uniform framework for acceptance of standard manufactured materials that takes into consideration the quality control requirements established herein.

5. QUALITY CONTROL REQUIREMENTS

- 5.1. Each manufacturer shall have a QC system in place to ensure the quality of its products. Quality control procedures must provide adequate assurance to agencies that the products purchased will meet relevant AASHTO, ASTM, and industry standards. The following minimum requirements for manufacturer QC shall be satisfied.
- 5.1.1. *Quality System Manual*—Each manufacturer shall establish and maintain a QSM. The QSM is a general document intended to outline the overall internal QC operating procedures of the manufacturer. A QSM documents the manufacturer's policies for achieving quality and the assignment of responsibility and accountability for QC within the manufacturer organization. It also describes the minimum QC requirements expected of other manufacturers or material suppliers from whom the manufacturer obtains constituent materials incorporated in each manufactured product.
- 5.1.1.1. Guidelines for the preparation of QSM may be available from industry organizations that administer manufacturing facility certification programs. In addition, ISO 10013 contains guidelines on the development and preparation of QSM. However, each manufacturer QSM shall meet the format and content requirements outlined below.
- 5.2. *QSM Format*—The manufacturer's QSM may be maintained in an electronic format. However, one or more copies of the QSM must be maintained by the manufacturer's QC manager in a printed and bound format (three-ring or other). The QSM shall be available to all of the manufacturer's employees. Each document in the QSM shall indicate its preparation date, and all pages of the QSM shall be numbered. If a document is revised, the date of the revision shall be indicated on the document and recorded in a table of revisions.