
Certification Standard for Corrugated Metal Pipe Fabrication, Manufacture and Coating

January 11, 2019



NATIONAL CORRUGATED STEEL PIPE ASSOCIATION
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by

National Corrugated Steel Pipe Association

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January 11, 2019

NATIONAL CORRUGATED STEEL PIPE ASSOCIATION

PREFACE

This Preface is not a part of NCSPA 101-19, *Certification Standard for Corrugated Metal Pipe Fabrication, Manufacture and Coating*. It is intended for informational purposes only.

This Standard is the result of the deliberations of a balanced committee, the membership of which included engineers, fabricators, mill suppliers, and quality control consultants. This Standard is proprietary and has been created for the sole use of the NCSPA Certification Program as part of its policies and procedures for auditing and certification.

This Standard brings together provisions of the specifications and methods relating to three of the corrugated metal pipe industry segments: corrugated metal pipe and pipe arch fabrication (Chapter 2) – including hardware and accessories, and steel coil manufacturers and coaters (Chapter 3) comprising the scope of the initial NCSPA Certification Program. Chapter 1 provides general requirements that apply to the three industry segments while Chapters 2 and 3 contain supplementary requirements in addition to those in Chapter 1.

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GLOSSARY

The terms listed below are commonly used terms that are provided for clarification during the use of this standard:

AASHTO. The American Association of State Highway and Transportation Officials.

AREMA. The American Railway Engineering and Maintenance of Way Association.

ASNT. The American Society for Nondestructive Testing.

Assembly. Two or more *components* joined to make a part or product that can be the final item or that join to other *components*. Joining methods include welding, bolting, pressure fit, molding and adhesion.

ASTM.† American Society for Testing and Materials.

AWS.† American Welding Society.

Calibration - The documented operation performed on equipment that, under specified conditions, in a first step, establishes a relation between the quantity values with measurement uncertainties provided by measurement standards and corresponding indications with associated measurement uncertainties (of the calibrated instrument or secondary standard) and, in a second step, uses this information to establish a relation for obtaining a measurement result from an indication. [*as defined by the International Bureau of Weights and Measures*].

Coating. Coatings may include asphalt, paint, powder coatings, aluminizing, galvanizing or other metalizing, laminating and electro-deposited metals.

Coil – A quantity of flat rolled steel used to make corrugated steel pipe and pipe-arch.

Competency - The documented demonstration of the ability of testing technicians to perform a test after proper training is completed. This shall be assessed annually (at a minimum).

Contract documents - The documents that define the responsibilities of the parties that are involved in bidding, manufacturing and *fabricating corrugated steel drainage products*. These documents normally include the design documents, the *specifications* and the contract.

Corrective action. The action or actions undertaken to identify and eliminate the root cause of a service or process *nonconformance* to prevent its recurrence. *Corrective action* is not the *repair* or *rework* of identified nonconforming product or process to meet specified requirements.

Corrective measure. The measure taken to bring a nonconforming product or process into conformance with specified requirements.

Documentation (documented). Material that provides information or evidence. *Documentation* may include written instructions, drawings, diagrams, charts, photographs, electronic media, *specifications*, and references to or excerpts from appropriate technical standards and codes.

Documented procedure. A procedure that is established, documented, implemented and maintained. The documentation provides information about how to perform an activity or process consistently. Documentation shall contain:

- (a) The purpose of the procedure
- (b) Process definition that includes steps required for completion
- (c) Assignment of responsibility for performance
- (d) Assignment of responsibility for review, revision, and/or approval of the *procedure*
- (e) Identification of records that are generated
- (f) For inspection activities, frequency of observations or inspections and how those observations or inspections are *documented*

Documented training. Training in which there is a record of the course outline, a record of who attended, the date it was given, and the instructor who provides the *training*.

Fabrication. The process of preparation and *assembly* of individual parts into a shipping piece in accordance with all customer orders. Fabrication includes all production operations performed in the manufacturing and shipping of the product (e.g., *corrugations, seams, end finish, arching, perforating, drilling, punching, welding, etc.*).

Fabricator. The entity that is responsible for fabricating the *corrugated steel pipe*.

Key position. Top management and positions in the *fabricator's* or *manufacturer's* *quality management system* that manage purchasing, quality assurance, quality control, *fabrication* processes, project management, and the safety functions.

Manufacture (manufacturing, manufactured). The process of producing, testing inspection and delivery of steel coils for fabrication in corrugated steel pipe facilities.

Manufacturer. The entity that *manufactures* the steel sheet coil.

MTR. Mill test report as defined in Section 14 of ASTM A6.

NCSPA. National Corrugated Steel Pipe Association.

Nonconformance. Attributes of materials, consumables, fabricated or *manufactured* product (in-process or final), or processes that do not meet contract, regulatory, or internally-defined requirements.

NDT. Nondestructive testing (nondestructive examination).

Objective evidence. Data supporting the existence or verification of something. Records, statements of fact, or other information which are relevant to the audit criteria and verifiable. In this context, it is evidence of whether the *quality management system* is functioning properly. *Objective evidence* may be obtained through:

- (a) Observation of the performance of a task or physical products
- (b) Measurements
- (c) Tests
- (d) Review of a record, document or procedure
- (e) The result of an interview with one or more employees about their duties or performance of a task.

Owner.† The entity that is identified as such in the *contract documents*.

Procedure. See *documented procedure*.

PQR. Procedure Qualification Record as defined by AWS A3.0M/A3.0.

Quality assurance (QA). Part of quality management focused on providing confidence that quality requirements will be fulfilled.

Quality control (QC). Controls and inspections implemented by the *fabricator* or *manufacturer*, as applicable, to ensure that the material provided and work performed meet the requirements of the approved *customer documents* and referenced standards.

Quality control records. Documents that report the results of inspections mandated by the *documented procedures* and the *contract documents*.

Quality manual. A document stating the quality policy and describing the *quality management system*.

Quality management system. A system to establish policy, objectives, plans and resources to direct and control an organization regarding quality.

Quality record. A document that provides *objective evidence* of activities performed or results achieved.

Repair. Action taken on a nonconforming product to make it acceptable for the intended use.

Rework. Action taken on a nonconforming product to make it conform to the requirements.

Specifications.† The portion of the *contract documents* that consists of the written requirements for materials, standards and workmanship.

Subcontractor. A firm that performs a portion of the contract work such as *fabrication*, *coating* application, testing, calibration, inspection or consulting services.

Supplier. A firm that supplies materials (including but not limited to: mill materials, process supplies, welding consumables, *coatings* and process machinery) and completed purchased product (including but not limited to: fasteners, bands, gaskets, o-rings, angles, end sections, geotextiles and proprietary buy-out items) needed to fulfill the contract requirements.

Top management. Person or group of people who directs and controls the organization at the highest level at the facility. *Top management* has the power to delegate authority and provide resources for the quality management system.

Training. See *documented training*.

Note: Additional terminology can be found in the applicable AASHTO and ASTM Standard(s).

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CHAPTER 1

GENERAL REQUIREMENTS

1.1. PURPOSE

The purpose of this Standard is to confirm to *owners*, the design community, the construction industry, and public officials that **those** who adhere to the requirements in this Standard have the personnel, organization, experience, *documented procedures*, knowledge, equipment and commitment to:

- (a) produce fabricated corrugated metal pipe and pipe-arch to the quality required for highway, railroad, or other infrastructure construction or
- (b) produce coil steel to the quality required for highway, railroad, or other infrastructure construction.

1.2. SCOPE

The requirements in this Standard shall apply as follows:

- (a) Chapters 1 and 2 shall apply to Pipe and Pipe-Arch Fabricators, who fabricate and supply the corrugated metal pipe and pipe-arch for highways, railroads, and buried bridges.
- (b) Chapters 1 and 3 shall apply to Steel Coil Suppliers, who manufacture and supply coil steel for highway, railroad, or buried bridges.

The Glossary is an integral part of this Standard. Non-mandatory Commentaries are provided for background, and the user is encouraged to consult them.

1.3. REFERENCES

The reference documents and standards necessary to make personnel aware of work requirements shall be consistent with the requirements of existing *contract documents* and shall be readily available to those who need them.

The ability to work to and meet the requirements of the latest editions of AASHTO and/or ASTM standards as applicable in Chapters 2 and 3 of the fabricator or manufacturers finished product and/or contract documents shall be demonstrated.

1.4. DEFINITIONS

Definitions for terms in the body of this Standard printed in italics are defined in the Glossary. Acronyms for professional organizations are not italicized in the text but are included in the Glossary.

As used in this Standard, the words **shall** or **will** denote a mandatory requirement. The word **should** denote a guideline or recommendation. The words **may** or **can** denote an opportunity to make a choice.

1.5. MANAGEMENT RESPONSIBILITY

1.5.1. Policy for Quality

Top management shall ensure that the policy for quality is understood, implemented and maintained. The policy for quality shall include:

- (a) A commitment to quality that includes a commitment to meet the requirements in *contract documents*.
- (b) A *quality management system* that provides a framework for establishing, communicating and reviewing quality goals.

Top management shall establish goals to improve quality. Goals shall be measurable and *documented* through *objective evidence*. As quality goals are achieved, new goals shall be set that demonstrate commitment to continuous improvement.

Commentary:

New quality goals can be a new level of achievement of a previous goal, or a new goal that has not been previously identified.

1.5.2. Periodic Management Review

Top management shall conduct periodic review of the *quality management system* at planned intervals, but annually at a minimum. Management review shall encompass, assess and report the following, at a minimum:

- (a) A summary of previous management reviews.
- (b) Results of any internal and external audits conducted since the previous management review.
- (c) An assessment of customer feedback and feedback mechanisms, identifying opportunities for improving quality.
- (d) An assessment of product or work *nonconformances*. Both the number and severity of *nonconformances* shall be assessed.
- (e) An assessment of process *nonconformances*, including compliance with the *documented procedures* comprising the *quality management system*.
- (f) An assessment of the effectiveness of the *corrective actions* taken.
- (g) An assessment of the results of equipment inspections, including the adequacy of equipment resources.
- (h) An assessment of the adequacy of the *training* program with respect to the levels of qualification required as appropriate.
- (i) An assessment of any proposed or required modifications to the *quality management system*.

The management review record shall include the decisions and actions required for implementation of:

- (a) Improvement of the effectiveness of the *quality management system* and its processes
- (b) Improvement of product quality
- (c) Resource needs

Records from management reviews shall be maintained according to the record retention policy.

1.5.3. Responsible Quality Personnel

Top management shall designate management representatives for quality who shall report directly to (or be a part of) *top management*. The designated management representatives for quality may perform other functions within the company, provided that those functions do not conflict with the quality responsibilities. The designated management representative(s) shall have the ability, responsibility and authority to:

- (a) Ensure that *documented procedures* needed for the *quality management systems* are established, implemented and maintained in accordance with this Standard.
- (b) Report to *top management* on the performance of the *quality management system* and any need for improvement.
- (c) Communicate with external parties on matters relating to the *quality management system*.

1.5.4. Resource Management

Resources necessary to comply with the *contract documents* shall be available. Resources shall include, but are not limited to, the resources described in the following. Personnel performing defined functions shall have the required qualifications and the ability to successfully perform the function.

A *fabrication and manufacturing* facility shall consist of areas and buildings that provide space for the routine functions considered to be part of steel coil manufacture or corrugated steel pipe or pipe arch *fabrication*. The work areas and buildings (including housekeeping, ventilation and clean air supply, and electrical supply) shall be conducive to achieving consistent quality work. The *manufacturer* or *fabricator* shall have under their control the equipment and software necessary to perform the *manufacturing* or *fabrication* and inspection consistent with the *contract documents*.

Commentary:

Objective evidence of qualification may be demonstrated through biographies, resumes, *documented training*, and individual licenses or certifications. Personnel may be assigned to more than one function, provided they are qualified and able to perform fully the duties of each position.

See Sections 2.2, 3.2, 4.4, and 5.5 for non-personnel industry-specific resource requirements.

1.5.5. Quality Management System

The *quality management system* shall satisfy all the requirements of this Standard and the requirements of the *contract documents* and referenced standards. The *quality management system* shall include a *quality manual*, *documented procedures* and records as required by this Standard.

The Quality Management System will indicate the line of authority from the testing technicians to the QC manager, ensure that testing technicians have the authority to require corrective action, and ensure that the QC manager is independent of production management and of equal status.

Commentary:

The extent of the *quality management system documentation* can differ from one organization to another due to the size of organization, the type of activities, and the complexity and interaction of processes. Requirements may be satisfied in a single document called the *quality manual* which may incorporate separate documents by reference.

1.5.6. Internal Communication

Top management shall ensure that appropriate communication processes are established, and that communication takes place on a regular basis regarding the effectiveness of management systems.

1.5.7. Quality Manual

The *quality manual* shall include a page showing the current revision date and the name and location of the facility or organization.

The *quality manual* shall include or incorporate by reference the following documents at a minimum:

- (a) *Documented* statements of a quality policy and quality objectives as required by this Standard.
- (b) *Documented procedures* established for the *quality management system* (or references to them), along with their associated *quality records*.
- (c) Documents needed by the organization to ensure the effective planning, operation and control of its processes.
- (d) Organizational chart describing the interrelationship of functional positions that manage, perform and verify work affecting quality.
- (e) Job descriptions outlining responsibilities, authority and required qualifications for *key positions*.
- (f) Qualification evidence for individuals in *key positions/functions*.
- (g) Equipment list.
- (h) Facility plan.

Top management shall define additional *documented procedures*, drawings or other documents that are required beyond the minimum requirements set by this Standard to meet the needs of the organization and its customers.

The highest-ranking member of *top management* shall sign and date the *quality manual*.

Commentary:

Top management determines the level of detail in the *quality manual* and procedures. At a minimum, these documents should be detailed enough to adequately describe the *quality management system* used to assure the end work meets the required quality.

1.6. CONTRACT REVIEW

A *documented procedure* shall be developed for contract review. The procedure shall define how the organization will determine:

- a) requirements specified by the customer, including delivery activities,
- b) requirements not stated by the customer but needed to meet intended purpose,
- c) federal, state or local requirements applicable to the product,
- d) any additional requirements considered necessary by the organization.

The organization shall review the requirements related to the customer order. This review shall be conducted before the organization commits to supply the product to the customer and shall ensure that:

- a) product requirements are defined,
- b) contract or order requirements differing from those previously expressed are resolved, and
- c) the organization has the ability to meet the defined requirements.

Records of this review shall be maintained as described in Section 1.9.

Commentary:

Record of contract review may take the form of technical summaries, sign-offs, schedules, purchase orders, and allocation of adequate resources. Such evidence should indicate consideration of pertinent Sections of this Standard and other critical project requirements that, if missed, will have a major impact on project quality.

1.7. PRODUCTION PLANNING

The organization shall implement production and service provision under controlled conditions. A *documented procedure* shall be developed to define the method for communication of information regarding:

- a) characteristics of the product to be produced to meet customer requirements,
- b) applicable federal, state or local code requirements,
- c) applicable testing requirements and
- d) special shipping, handling or packaging requirements.

1.8. CONTROL OF MANAGEMENT SYSTEM AND PROJECT DOCUMENTS

1.8.1. Management System Documents

A *documented procedure* shall be developed to control *quality management system* documents.

1.8.1.1. Quality Management System Documents

Documents covered by this Section shall include, but not be limited to, the *quality manual*, the *safety manual* as applicable, and any *documented procedures*.

1.8.1.2. Review and Approval

Documents shall be reviewed and approved by the same function and authority level that authorized the original document.

The function and authority levels that have responsibility for review and approval of internal standards and *documented procedures* shall be designated. Revisions to the *quality manual* and other *quality management system* documents shall be reviewed for adequacy and approved by the same function and authority level that authorized the original document.

The *documented procedure* for document and data control shall describe the frequency and requirements for review and update and establish a method to identify changes.

1.8.1.3. Revision Control

Revisions shall be clearly identifiable and there shall be a method for monitoring and identifying the latest revision.

Revisions shall be reviewed for adequacy and approved by the same function and authority level that authorized the original document.

Documents shall remain legible and easily identifiable.

1.8.1.4. Access

Documents shall be available and readily accessible to all personnel responsible for performing functions affecting the quality of the completed work.

1.8.1.5. Communication

Changes and revisions shall be clearly communicated to all personnel responsible for performing functions affecting the quality of the completed work.

1.8.2. Project Documents

A *documented procedure* shall be developed to control production documents. Documents covered by this Section shall include, but not be limited to, order documents, revised order documents, production/shop drawings, assembly drawings, and any testing reports received.

1.8.2.1. Revision Control

For production documents that the fabricator or manufacturer produces, revisions shall be clearly identifiable and there shall be a method for monitoring and identifying the latest revision.

The *documented procedure* shall include provisions to prevent inadvertent use of obsolete documents.

Documents shall remain legible and easily identifiable.

1.8.2.2. Access

Documents shall be available and readily accessible to all personnel responsible for performing functions affecting the quality of the completed work.

1.8.2.3. Communication

Changes and revisions shall be clearly communicated to all personnel responsible for performing functions affecting the quality of the completed work.

1.9. MAINTENANCE OF QUALITY RECORDS

A *documented procedure* shall be developed for the maintenance of *quality records* that provide for record identification, collection, storage and retrieval, retention, and disposition.

Commentary:

Quality records commonly include items such as:

- (a) Contract Review
- (b) Certificates of conformance
- (c) *Corrective action* requests
- (d) Equipment maintenance records
- (e) Inspection records
- (f) Internal and external *quality management system* audits
- (g) Mill and consumable purchase orders
- (h) *MTRs*
- (i) *NDT* reports
- (j) Personnel certifications
- (k) Records or summaries of *nonconformance* reports
- (l) Revisions to the *contract documents*
- (m) *Subcontractor* and *supplier* evaluations
- (n) *Training* and competency records

1.9.1. Retention

Quality records shall be subject to an established retention policy. The *documented procedure* for the control of *quality records* shall contain provisions for the disposition of the records at the end of the retention period.

1.9.2. Storage

Quality records shall be stored in a manner that minimizes damage, deterioration or loss.

1.9.3. Retrieval

Quality records shall be accessible in a reasonable time frame.

1.10. PURCHASING

A *documented procedure* shall be developed to ensure that *subcontractors* and *suppliers* provide contracted services and materials conforming to project requirements.

1.10.1. Purchasing Data

Purchasing documents shall clearly describe subcontracted work, purchased materials and services ordered in written purchasing documents. This information shall include, but shall not be limited to:

- (a) The type of service, material, class, grade, and other unique identification
- (b) The applicable *specifications*, drawings, process requirements, and inspection instructions and any witness points

- (c) Delivery instructions and date
- (d) Required quality reports, certified test reports, and certificates of compliance/conformance of purchased materials

Purchasing documents for materials furnished to ASTM specifications shall include the information required in the “Order Information” section of the ASTM Standard.

1.10.2. Selection of Subcontractors and Suppliers

Subcontractors and *suppliers* shall be evaluated and selected on the basis of their ability to meet subcontract requirements, the *management system* requirements, the requirements of this Standard, and the requirements of the approved *construction documents* and referenced standards.

A *documented procedure* shall be developed that describes how the certified company conducts initial and ongoing evaluation of all *subcontractors* and *suppliers*.

Management shall determine:

- (a) Evaluation criteria
- (b) Reevaluation interval
- (c) Personnel involved in the evaluation process

Subcontractors and *suppliers* shall be evaluated via an audit or *documented* acceptable past experience. As a minimum, quality of the final products and timely, proper delivery of services or products shall be part of the evaluation.

1.10.3. Verification of Purchased Product, Materials and Services

The *documented procedure* for verification shall identify the activities necessary for ensuring that purchased products, materials and services meet project requirements. Purchasing documents, *subcontractor* and *supplier* qualification records, and records of the periodic evaluation of *subcontractors* and *suppliers* shall be maintained as required by Section 1.9.

1.11. MATERIAL IDENTIFICATION

A *documented procedure* shall be developed for the identification of material. Records that provide a basis for material identification shall be maintained as defined for *quality control records*.

Corrugated steel pipe material shall be identified as stated in the applicable AASHTO and ASTM standards, unless otherwise noted in the contract documents.

Coating materials (excluding metallic *coating*) shall be identified on the container by, at a minimum, color (pigment description and federal standard number, or *manufacturer’s* number), lot/batch number, ID/stock number, quantity of *coating* in container, date of *manufacture*, date of expiration, and *manufacturer’s* name and address.

Metallic *coatings* shall be identified by composition and the appropriate AASHTO or ASTM *specification*, including hot dip or mechanical galvanizing and metallizing.

Bolt, nuts and other fasteners shall be stored in containers clearly identified by type, grade, size and lot number(s).

Material traceability to corresponding *MTRs* is necessary only when specifically required by contract. The *fabricator* or *manufacturer* shall develop a *documented procedure* to maintain traceability, when required, of materials from the point of receipt and throughout the course of production. This traceability shall include the method for tracking, controlling and processing of records to tie tests, test results and certified test data to each shipment.

The quality management system shall include a documented procedure describing how finished product is labeled, packaged, and stored. It will also include an explanation of the product markings used by the Manufacturer and the Fabricator.

Commentary:

MTRs, *manufacturer's* test reports, certificates of conformance for base materials, fasteners, welding consumables, and *coatings* provide material identification. In the absence of specific contract requirements, these records usually constitute sufficient evidence that the product satisfies material order requirements.

For traceability, the marking method may identify material type and grade or use a method that provides traceability through piece, *assembly* or group numbering.

Buy America requirements will vary from state to state and it is the responsibility of the manufacturer to comply with the requirements for each state transportation agency to which the manufacturer provides product. (Ref.: 23 CFR 635.410 Buy America requirements).

1.12. PROCESS CONTROLS

Documented procedures shall be developed for the processes necessary to produce a consistent acceptable level of quality of the completed work in accordance with applicable codes and project requirements. The *procedure* shall include method for measuring pipe dimensions and tolerances, or coil/plate dimensions and tolerances for manufacturers.

Regardless if these processes are routinely performed, effective implementation of the *documented procedures* described in Chapters 2 and 3 of this Standard is required as a minimum.

1.12.1. Equipment Maintenance

The *documented procedure* for equipment maintenance shall, at a minimum, define the evaluation of and preventive maintenance for equipment necessary to meet product or work quality and delivery requirements.

1.13. INSPECTION & TESTING

A *documented procedure* shall be developed to ensure that the completed work meets the requirements of the *contract documents*. The *procedure* shall describe sampling plans for inspection that are performed at less than 100%. It shall also include how inspection frequencies are changed when nonconformances are observed during the normal inspection frequency.

1.13.1. Assignment of QC Inspections and Monitoring

Qualification requirements for QC inspectors shall be defined and *documented* as required in Section 1.5.3.

Commentary:

QC inspectors should be assigned on the basis of qualification, evidenced by experience, *training* and education. Qualification standards and certifications granted by recognized industry organizations can be used as a basis for qualification.

Production personnel may be assigned to QC inspection duties under the following conditions:

- (a) They are knowledgeable in proper inspection methods and acceptance criteria specified for the material or products they are inspecting and hold the required certification as applicable.
- (b) They are aware of their responsibilities and are given time to perform them.
- (c) They do not inspect their own work.
- (d) Their inspections are monitored by qualified *quality control* personnel.

1.13.2. Receiving and In-Process Inspection

A *documented procedure* for receiving inspection shall be developed. Materials shall be inspected before the work begins. The inspection of materials shall include a review of material test reports against specifications to determine whether requirements for mechanical and chemical properties have been met prior to acceptance for fabrication. When no material test data exists, acceptance tests will be performed. The *procedure* shall include the methods for verifying material thickness, dimensions, and coating thickness against order requirements and specifications.

A *documented procedure* for in-process inspection shall be developed. The *procedure* shall illustrate how the *fabricator or manufacturer* employs in-process inspection plans and practices for specified process requirements and inspection acceptance criteria that are not verifiable at final inspection or for which final inspection can hinder *subsequent work*. In-process inspection is appropriate for processes including, but not limited to, corrugating, seaming, arching, cutting, welding, bolting, *coating, perforating*, as applicable.

Compliance with *documented* process control *procedures* shall be monitored.

1.13.3. Final Inspection

Final inspection shall be conducted. QC inspectors qualified and responsible for final inspection shall perform the final inspection of corrugated metal pipe coil and products prior to placing in inventory or shipping.

1.13.4. Inspection Records

The inspection *procedure* shall indicate what records and marks are used to *document* inspections. In-process inspections shall be verifiable until the final inspection of the piece.

Final inspections shall be *documented*. The *quality records* produced shall be filed and retained as defined in the procedure required by Section 1.9. Inspection records shall clearly show what was inspected, the result of the inspection, and who performed the inspection.

1.14. CALIBRATION OF INSPECTION, MEASURING AND TEST EQUIPMENT

A *documented procedure* shall be developed to calibrate and maintain inspection, measuring and testing equipment. The *procedure* shall define equipment calibration frequency. The *documented procedure* shall include provisions for:

- (a) A unique identifier for each piece of equipment.
- (b) An equipment list.
- (c) Service use for each piece of equipment including the required precision for the types of inspections, measurements or tests made.
- (d) Calibration or adjustment instructions in accordance with the manufacturer's recommendations.
- (e) Frequency of calibration or adjustment.
- (f) Tracking calibrations, adjustments and repairs.
- (g) Storage and handling of inspection, measuring, and test equipment to maintain accuracy and fitness for use.
- (h) Identification of standards or certified equipment having a known valid relationship to internationally or nationally recognized standards used to calibrate each listed piece of equipment. Where such standards do not exist, the basis used for calibration shall be *documented*.
- (i) The action to be taken when equipment does not meet the calibration requirements. This action includes disposition of the measuring device and an evaluation of the impact to product that was measured using the device.
- (j) Method of preventing inadvertent use of uncalibrated equipment where calibration is required.

Calibration or adjustment history shall be available.

Rented or borrowed equipment must be accompanied by a valid calibration certificate and is subject to the requirements of this Section.

For equipment that is damaged, dropped, knocked over or functioning improperly, the *documented procedure* shall include provisions for prominently marking or tagging such equipment to preclude usage and removing the equipment from service until it can be re-calibrated, adjusted or repaired.

Whenever the accuracy of inspection, measuring and test equipment is in question, proactive calibration shall occur, regardless of manufacturer's recommendations.

The precision required of any piece of equipment shall be sufficient to satisfy the acceptance standards of the project *specifications* or industry standards.

1.15. CONTROL OF NONCONFORMANCES

A *documented procedure* shall be developed to identify and control *nonconformances*.

1.15.1. Nonconformance with Management Systems

A *nonconformance* related to the performance of the *management system* shall be *documented* to the detail level described by the *documented procedure*. These *nonconformances* may be identified by the *management systems*, during external audits, or by *internal audits* inspections.

1.15.2. Nonconforming Product and Work

The *documented procedure* for nonconforming product and work shall provide for identification, *documentation*, evaluation, treatment of nonconforming product and work, and notification of the relevant functions concerned. Nonconforming product and work may also be identified in a *quality assurance* inspection report. These reports, when received, become *quality* inspection records. The *procedure* shall provide for the disposition of *quality* inspection records.

The *procedure* shall provide the method for determining the extent of the nonconformance, quarantine/recall of suspect product and the release of quarantined product following testing and investigation.

Nonconforming product and work shall be clearly marked as soon as practical after it is discovered. Records shall be kept of the pieces affected, the nature of the *nonconformance*, the treatment selection, authorization, and re-inspection results if applicable.

The treatment of nonconforming work may include:

- (a) Redesign and *rework*, as approved by the responsible party, and as required in the *contract documents*
- (b) *Repair*, as approved by the responsible party, and as required in the *contract documents*
- (c) Use as-is, as approved by the responsible party, and as required in the *contract documents*
- (d) Scrap

If the treatment is *rework* or *repair*, the result will be inspected per project requirements, as well as per the *quality control* process.

1.16. CORRECTIVE ACTION

A *documented procedure* shall be developed for *corrective action* to improve quality. Any *corrective action* taken shall be to the degree appropriate to the magnitude of problems and commensurate with the risks to quality. The *documented procedure* shall include periodic review of records or summaries of *nonconformances* and of internal and external quality audit reports for determination and initiation of *corrective actions*. The *corrective action procedure* shall address these steps:

- (a) Document a *corrective action* request (CAR) that includes the *nonconformance* to be addressed by the *corrective action* and the requirement that has not been met. The *corrective action procedure* shall define the functional positions authorized to issue a CAR and initiate the *corrective action* process.
- (b) Assign responsibility and establish a time frame for the response to a CAR.
- (c) Investigate and document the scope of the *nonconformance*, root causes, *corrective measures* taken, and list the actions to be taken to prevent recurrence.
- (d) Communicate the *corrective action* request and resolution to *top management* and appropriate members of the organization.
- (e) Follow up the *corrective action* taken with periodic monitoring to assure the *corrective action* is implemented and is effective.

Corrective action shall be applied when:

- (a) There is a *nonconformance* that is repetitive in nature as identified by periodically reviewing *nonconformance* reports or summaries for negative trends.
- (b) Process *nonconformances* are found during the internal and external quality audits indicating that the *quality management systems* may not be implemented and functioning as stated in the *quality manual*.
- (c) *Nonconformance* with the *quality management system* is found during the day-to-day execution of the system.
- (d) *Nonconformance* is unacceptable as determined by management.
- (e) A customer complaint has been investigated and *corrective action* has been determined necessary.

1.17. MARKING, LABELING, HANDLING, STORAGE AND DELIVERY OF PRODUCTS AND MATERIALS

A *documented procedure* shall be developed to identify how product and materials are marked or labeled. Methods may include bar coding, stenciling, color coding, etc. The identification requirements shall include method for identifying heat numbers, size, thickness and other dimensional information, as needed.

The *procedure* shall also describe how products and materials are stored, loaded and shipped to avoid damage and deterioration. Products and materials shall be protected to prevent use in other than its intended purpose. Any such material that is lost, damaged, or is otherwise unsuitable for use shall be identified, recorded and reported as appropriate.

A *documented procedure* shall define the extent of documentation that is required to accompany each shipment. This documentation may include test reports, inspection reports, certificates of conformance and other documents required by contract or customer requirements.

1.18. TRAINING AND COMPETENCY

Personnel responsible for functions that affect quality, including but not limited to, shop supervisors, inspectors, testing personnel, and production personnel shall receive appropriate initial and periodic *documented training*. *Training* records shall be controlled in the same manner as *quality records*. Personnel providing *training* shall have appropriate *training* or experience in the subject they are teaching. *Training* course outlines include the subject and the key points.

1.18.1 COMPETENCY

Production personnel shall demonstrate and be capable of inspecting their own work as an in-process inspection. A written program shall implement to:

- Assess the skills and general training needs of newly hired craft workers and qualify them for their assigned tasks
- Verify the qualifications of existing craft workers
- Train inexperienced craft workers (trainees) as necessary
- Evaluate the performance of craft workers at least once per calendar year and provide additional training as necessary
- Ensure compliance with contract specific worker training/qualification requirements.

1.19. INTERNAL AUDIT

In accordance with a documented procedure, an internal audit of each section of the *quality management system* shall be performed at least once a year to evaluate the compliance and the effectiveness of implementation. Different parts of the *management systems* may be audited at different times and different frequencies, as long as all sections of the *management systems* are audited annually.

The management representative or a qualified individual, independent of the function being audited, shall perform the audit and produce a written record of the audit result from each section.

Internal audit records shall be controlled in the same manner as *quality records*.

CHAPTER 2

SUPPLEMENTAL REQUIREMENTS FOR CORRUGATED METAL PIPE FABRICATORS

2.3. REFERENCES

The ability to work to and meet the requirements of the latest edition of the following documents shall be demonstrated:

- a) AASHTO M 36 *Standard Specification for Corrugated Steel Pipe, Metallic Coated, for Sewers and Storm Drains*
- b) AASHTO T 249 *Standard Method of Test for Helical Lock Seam Corrugated Pipe*
- c) ASTM A760 *Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains*

Commentary:

The Fabricator should also have the following references available as applicable:

- a) AASHTO M 190 *Standard Specification for Bituminous-Coated Corrugated Metal Culvert Pipe and Pipe Arches*
- b) AASHTO M 196 *Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains*
- c) AASHTO M 245 *Standard Specification for Corrugated Steel Pipe, Polymer-Precoated, for Sewers and Storm Drains*
- d) AASHTO T 241 *Standard Method of Test for Helical Continuously Welded Seam Corrugated Steel Pipe*
- e) ASTM A6
- f) ASTM A90 *Standard Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings*
- g) ASTM A370 *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*
- h) ASTM A463
- i) ASTM A780 *Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings*
- j) ASTM A796 *Standard Practice for Structural Design of Corrugated Steel Pipe, Pipe-Arches, and Arches for Storm and Sanitary Sewers and Other Buried Applications*
- k) ASTM A849 *Standard Specification for Post-Applied Coatings, Pavings, and Linings for Corrugated Steel Sewer and Drainage Pipe*
- l) ASTM A978 *Standard Specification for Composite Ribbed Steel Pipe, Precoated and Polyethylene Lined for Gravity Flow Sanitary Sewers, Storm Sewers, and Other Special Applications*
- m) ASTM A1073 *Standard Practice for Using Hand Micrometers to Measure the Thickness of Uncoated Steel Sheet and Nonmetallic and Metallic-Coated Steel Sheet*
- n) ASTM E376 *Standard Practice for Measuring Coating Thickness by Magnetic-Field or Eddy-Current (Electromagnetic) Testing Methods*

2.12. PROCESS CONTROLS

Documented procedures shall be developed for the processes necessary to produce a consistent, acceptable level of quality of the completed work in accordance with applicable codes and project requirements. Regardless if these processes are routinely performed, effective implementation of the following documented procedures is required as a minimum:

- a) Corrugations including each type of pipe classification produced at the facility.
- b) Seams of each type produced at the facility. These may include riveted, helical lock seam, welded seams, and resistance spot welded seams.
- c) End finish for individual pipe ends and for field joints.
- d) Pipe dimensions including corrugation depth, diameter, shape and length.
- e) Steel sheet thickness measurement and verification
- f) Coating and coating thickness measurement
- g) Pipe arching with dimensional requirements and longitudinal seam location.
- h) Perforations for all classes of perforations supplied by the fabricator.
- i) Asphalt coating including paying type and thickness, if applicable
- j) Workmanship practices
- k) Coating repair for each type of coating used or applied at the facility.
- l) Labeling and storage of finished pipe product
- m) Instructions for loading, handling and shipping

CHAPTER 3

SUPPLEMENTAL REQUIREMENTS FOR MANUFACTURERS

3.3. REFERENCES

The ability to work to and meet the requirements of the latest edition of the following documents shall be demonstrated:

- a) ASTM A370 *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*
- b) ASTM A924 *Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process*
- c) ASTM A929 *Standard Specification for Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe*
- d) ASTM A1073 *Standard Practice for Using Hand Micrometers to Measure the Thickness of Uncoated Steel Sheet and Nonmetallic and Metallic-Coated Steel Sheet*

Commentary:

The Fabricator should also have the following references available as applicable:

- (a) AASHTO M 218 *Standard Specification for Steel Sheet, Zinc-Coated (Galvanized), for Corrugated Steel Pipe*
- (b) AASHTO M 246 *Standard Specification for Steel Sheet, Metallic-Coated and Polymer-Precoated, for Corrugated Steel Pipe*
- (c) AASHTO M 274 *Standard Specification for Steel Sheet, Aluminum-Coated (Type 2), for Corrugated Steel Pipe*
- (d) AASHTO M 289 *Standard Specification for Aluminum-Zinc Alloy Coated Sheet Steel for Corrugated Steel Pipe*
- (e) ASTM A742/A742M-13 *Standard Specification for Steel Sheet, Metallic Coated and Polymer Precoated for Corrugated Steel Pipe*
- (f) ASTM A792 *Standard Specification for Steel Sheet, 55 % Aluminum-Zinc Alloy-Coated by the Hot-Dip Process*

3.12. PROCESS CONTROLS

Documented procedures shall be developed for the processes necessary to produce a consistent, acceptable level of quality of the completed work in accordance with applicable codes and project requirements. Regardless if these processes are routinely performed, effective implementation of the following documented procedures is required as a minimum:

- a) Chemical composition
 - 1) Listing of each chemical element
 - 2) Minimum/maximum content of each element
 - 3) Sampling frequency and location within coil/plate
 - 4) Any special processing requirements including formulas for calculation of elements. For example, if Nitrogen is > 0.0100 , then sulfur must be < 0.010
- b) Mechanical properties
 - 1) Listing of each mechanical property required by the customer
 - 2) Minimum/maximum value of each property
 - 3) Sampling frequency and location within coil/plate
 - 4) Any special instructions with regard to mechanical properties, including any formulas to be used in properties determinations. For example, calculation of N-value at 4-6% strain rate, use of Upper YPE or Lower YPE value, etc.
- c) Coating requirements
 - 1) The type of coating i.e. Aluminized Type 1, hot dig Galvanize zinc
 - 2) Total amount of coating weight
 - 3) Minimum and/or maximum amount of coating weight specified by the customer
 - 4) Any requirements with regard to coating weight per each side
 - 5) Any special requirements with regard to coating weight such as bend tests for adherence, tape testing for adherence, hardness testing, etc.
 - 6) Where and how often the coating specimen sample shall be taken. For example, front of every coil, tail of every 5th coil, etc.
- d) Dimensions and Tolerances
 - 1) All dimensions required by customer such as width, thickness, shape, etc.
 - 2) The minimum and/or maximum values for each dimension.
 - 3) Where and how the dimensions are to be taken. For example, by micrometer at tail of each coil, using X-ray gauge thru out body of coil, etc.
 - 4) Any other special requirements as noted by the customer
- e) Marking –
 - 1) How coils are to be marked and identified, such as bar code tag, stenciled information.
 - 2) What information is to be included in the marking/identification such as coil number, footage of coil, heat number of the coil, etc.
 - 3) How often coils are to be identified, such as each coil, every heat of steel, etc.



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