Designation: C1840/C1840M – 17

Standard Practice for Inspection and Acceptance of Installed Reinforced Concrete Culvert, Storm Drain, and Storm Sewer Pipe[1]

This standard is issued under the fixed designation C1840/C1840M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers the requirements for inspection and acceptance of installed reinforced concrete pipe by either person-entry, or remote inspection as shown in Figs. 1 and 2, respectively.

1.2 The scope of this specification is intended for installation related observations and assumes that pre-installation inspection has been completed.

1.3 The reinforced concrete culvert, storm drain and storm sewer pipe shall be manufactured in accordance with Specification C76, C506, C507, C655, or C1417 and accepted in accordance with AASHTO R073. This specification shall only be used for gravity, non-pressure storm drainage applications.

1.4 Person Entry shall be used unless extenuating circumstances preclude this type inspection. Remote inspection is acceptable for use for pipe diameters of 30 in. [750 mm] and smaller unless otherwise specified by owner or engineer.

1.5 Access of installed pipe for manual inspection shall follow OSHA 29 CFR PART 1926 SUBPART AA regulations for confined space entry. However, this standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

1.6 This practice does not cover deformation or deflection assessment. Concrete pipe is classified as a rigid structure because they do not bend or deflect appreciably under load before cracking. Due to these facts shape evaluation are of little or no value when evaluating concrete pipe.

1.7 The values stated in either Imperial/US or [SI units] are to be regarded separately as standard. The SI units are shown in brackets. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other.

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*

C76 Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe

C506 Specification for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe

C507 Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe

C655 Specification for Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe

C822 Terminology Relating to Concrete Pipe and Related Products

C1417 Specification for Manufacture of Reinforced Concrete Sewer, Storm Drain, and Culvert Pipe for Direct Design

D932 Practice for Filamentous Iron Bacteria in Water and Water-Formed Deposits

2.2 *AASHTO Standards:*

AASHTO LRFD Bridge Design Specification

AASHTO LRFD Bridge Construction Specification, Section 27

AASHTO PP63 Standard Practice for Pipe Joint Selection for Highway Culvert and Storm Drains

AASHTO R073 Standard Practice for Evaluation of Precast Concrete Drainage Products

2.3 *Occupational Safety and Health Standards:*

OSHA 29 CFR Part 1926 Subpart AA for the Construction Industry

2.4 *ISO/IEC Standards:*

ISO/IEC 17025 General Requirements for the Competence of Testing and Calibration Laboratories

3. Terminology

3.1 For definitions of other terms relating to concrete pipe not defined in this specification, see Terminology C822.

[1] This test method is under the jurisdiction of ASTM Committee C13 on Concrete Pipe and is the direct responsibility of Subcommittee C13.05 on Special Projects.

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FIG. 1 Person Entry Inspection

FIG. 2 Remote Inspection Camera

3.2 *Definitions:*

3.2.1 *calcium carbonate crystals*—as shown in Fig. 3, crystals are formed when the carbon dioxide in the surrounding soil, air and water carbonates the free (un-hydrated) calcium oxide in the cement and the calcium hydroxide liberated by the hydration of the tricalcium silicate of the cement. This chemical process results in white crystals along the pipe wall at a crack location and if it fills the crack is commonly referred to as autogenous healing.

3.2.2 *clock positions*—the relative circumferential position, direction or location of an observation on the pipe interior is described using the analogy of a 12-hour clock as shown in Fig. 4. For example, 12 o'clock is the pipe crown; 3 o'clock the spring line right; 6 o'clock the invert; and 9 o'clock the spring line left. The viewing orientation (upstream or downstream) of the clock position observations must be identified to establish the spring line positions. When two clock positions are utilized

FIG. 3 Calcium Carbonate Filled Crack

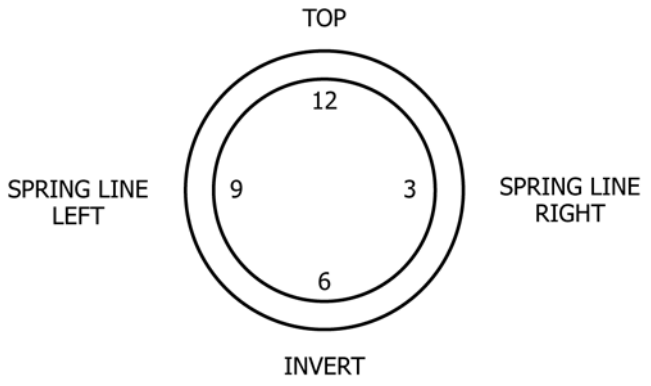

FIG. 4 Clock Positions

to characterize the location or relative size of an anomaly within the pipe, the clock positions should be entered clockwise (for example, circumferential crack begins at 10 o'clock and ends at 2 o'clock).

3.2.3 *quadrant*—descriptor for one fourth of the circumference of the pipe, or a circumferential 90-degree arc. An example quadrant shown in Fig. 5.

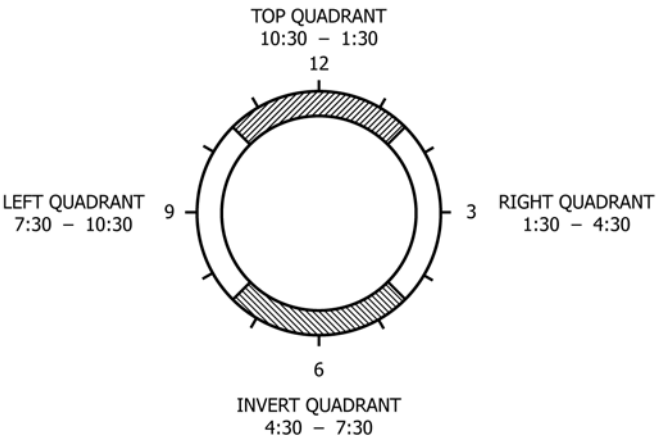

FIG. 5 Pipe Wall Quadrants

3.2.4 *crack*—a measurable surface separation found in concrete indicating stress is being transferred from the concrete to the reinforcement.

3.2.4.1 *circumferential crack*—a crack aligned with the circumference of the pipe and perpendicular to the longitudinal axis of the pipe as shown in Fig. 6.

3.2.4.2 *hinge cracks*—when more than one longitudinal crack (at 12, 3, 6, or 9 o'clock) occurs at the same cross section location in the pipe as shown in Fig. 7.

3.2.4.3 *longitudinal crack*—a crack aligned with the axis of the pipe as shown in Fig. 8.

3.2.4.4 *multi-directional crack*—a combination of longitudinal and circumferential cracks that intersect at one point as shown in Fig. 9.

3.2.4.5 *diagonal tension crack*—longitudinal cracks ±30 to 60 degrees from the invert or obvert of the pipe (1-2 o'clock, 4-5 o'clock, 7-8 o'clock, or 10-11 o'clock) with a visible vertical offset across the crack.

3.2.4.6 *Discussion*—Normal load induced longitudinal cracks can be present in the same locations but will not have a vertical offset across the crack.

3.2.5 *engineer*—The qualifications for an engineer involved in the evaluation of installed RCP shall be established by the owner. Engineer designation as noted in this standard can be the design engineer of record for the subject project, an engineer working for or on behalf of the owner, or an engineer specializing in the evaluation of installed RCP.

3.2.6 *infiltration*—ground water entering the pipe.

3.2.6.1 *Level 1 Infiltration*—moisture visible on the surface of the pipe wall without any observable active water movement such as drips or water traveling along the surface as shown in Fig. 10.

3.2.6.2 *Level 2 Infiltration*—the slow entry of water identified by visible drips or a constant flow of water traveling along the surface. See Fig. 11.

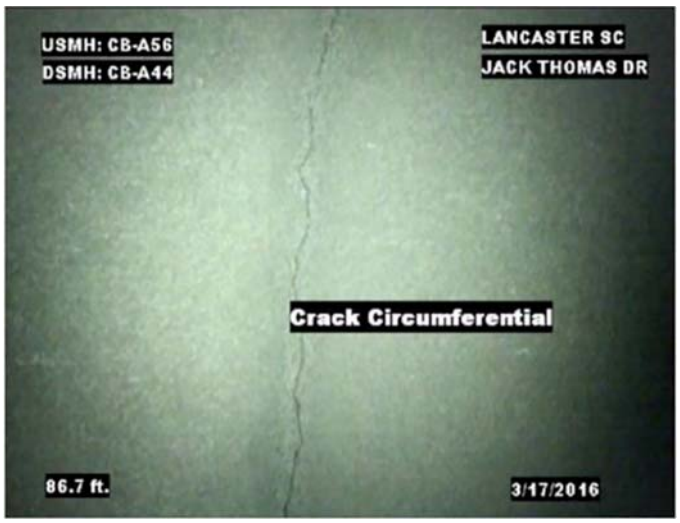

FIG. 6 Circumferential Crack

3.2.6.3 *Level 3 Infiltration*—a continuous stream of water running into the pipe or spraying through the pipe "under pressure." See Fig. 12.

3.2.7 *joint offset*—when the inside surface of the spigot (tongue) is not in alignment or centered with the interior pipe surface on the Bell (groove) end of the installed joint. See Fig. 13.

3.2.8 *joint separation*—the space from the end of the spigot (tongue) to the face (shoulder) of the bell (groove) of the installed joint. See Fig. 14.

3.2.9 *leak resistant joint*—according to AASHTO PP-63 and for the purpose of this specification, a joint that limits water leakage at a maximum rate of 200 gallons/(inch of internal diameter) (mile of pipeline) (24h) [18.5 L/(mm of internal diameter) (km of pipeline) (24h)] for the pipeline sysytem.

3.2.10 *non-corrosive environments*—according to AASHTO Section 27 and for the purpose of this specification, "a pH level of the soil surrounding the pipe or effluent water running through the pipe greater than 5.5" or less than a pH of 10 or environments established by the engineer or owner.

3.2.11 *owner*—the person or entity that owns or has maintenance and operation responsibility of the pipeline or storm system being inspected.

3.2.12 *scaling*—surface damage that appears as local flaking of poor concrete. Scaling is often associated with exposure to freezing and thawing cycles.

3.2.13 *silt-tight joint*—according to AASHTO PP-63 and for the purpose of this specification, a joint that is resistant to infiltration of particles smaller than those retained on the No. 200 sieve.

3.2.14 *slabbing*—a radial tension failure of the concrete wall which occurs from straightening of the reinforcement cage due to tension in the reinforcing as shown in Fig. 15.

3.2.15 *spalling*—a fracture of the concrete inclined to the surface resulting in pieces of concrete detaching from the pipe wall, as shown in Fig. 16, or along a crack.

3.2.16 *soil tight joint*—a joint that is resistant to infiltration of particles larger than those retained on a No. 200 sieve.

3.2.17 *stain/efflorescence*—deposits left by the partial evaporation of infiltrating groundwater containing dissolved salts or minerals. These deposits will often be concentrated at or alongside infiltration locations.

3.2.18 *soil/watermark*—discoloration(s) on the pipe interior left by the evaporation of water containing minerals or soil fines contained in the pipe effluent or surrounding groundwater. This type of discoloration is often observed longitudinally along the pipe wall coincident with the effluent water line level.

3.2.19 *rust colored staining*—a rust colored stain may occur due to iron ochre bacteria as determined by Practice D932, iron-oxide, or other mineral accumulation on the pipe surface. In the absence of cracks and infiltration in excess of those permitted in 8.5, or spalling that exposes the primary steel reinforcement, rust colored staining is not indicative of structural distress and does not require remediation. See Fig. 17.

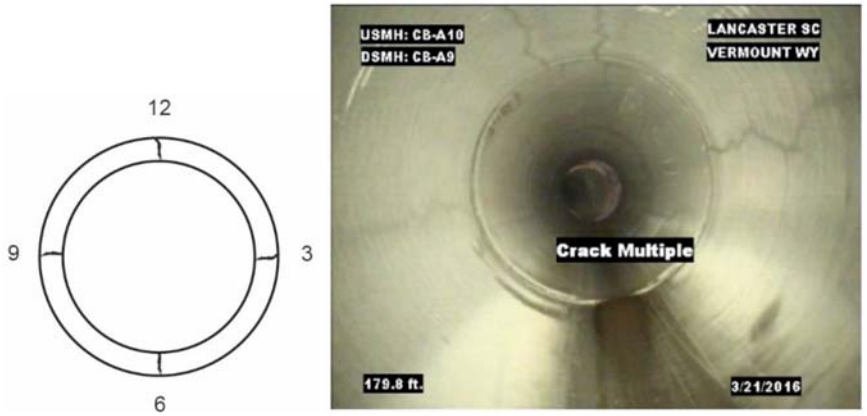

FIG. 7 Hinged Cracks (Multiple Longitudinal Cracks)

FIG. 8 Longitudinal Crack

FIG. 9 Multi-Directional Crack

4. Significance and Use

4.1 The inspection of installed reinforced concrete pipe verifies proper installation of the product and establishes thresholds for comparison further evaluation.

4.2 This practice is useful as a reference by an owner in preparing project specifications and to identify, evaluate and interpret observations during post installation inspections of pipe.

5. Pipe Inspection Equipment and Procedures

5.1 Pipe inspections may be made using person-entry, remote equipment, or a combination thereof. In general, pipe diameters 30 in. [750 mm] and smaller are not considered to be person-entry and typically require the use of remote equipment.

5.2 *Remote Inspection Equipment:*

5.2.1 The remote inspection system shall be equipped with adjustable or variable lighting suitable to allow a clear color image of the entire interior perimeter of the pipe.

5.2.2 The system shall produce a video image with a resolution to properly classify any observed features on the pipe wall. The image shall be clear, focused, and free from roll, static, or other image distortion qualities that would prevent the reviewer from evaluating the condition of the pipe.

5.2.3 The pipe shall be free from debris and other obstructions to allow for a reasonable view of the pipe during inspection. Standing water in the bottom of the pipe is common. Acceptable water depth or water volume limits for inspection shall be established in the project specifications, or for existing lines in the inspection protocol. Pipe with water volume or depth that exceeds acceptable limits must be dewatered.

5.2.4 The remote inspection video equipment shall be able to accurately measure and verify in accordance with Section 6, crack width and or other observable items as small as 0.05 in. [1.5 mm] ± 0.01 in [0.3 mm], or be so equipped that the image can be analyzed by computer software to accurately determine observation measurement and distances as small as 0.05 in. [1.5 mm] ± 0.01 in [0.3 mm]. For purposes of evaluation, visible cracks less than 0.05 in. [1.5 mm] shall be reported as less than 0.05 in. [1.5 mm].

NOTE 1—Equipment limitations may preclude measurements less than 0.05 in. [1.5 mm]. Therefore, measurements less than 0.05 in. are only

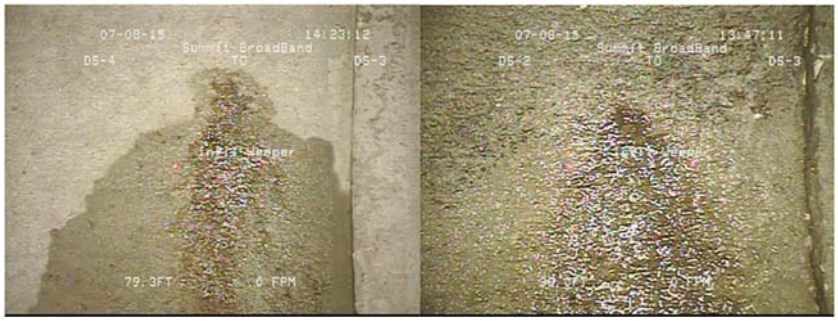

FIG. 10 Level 1 Infiltration

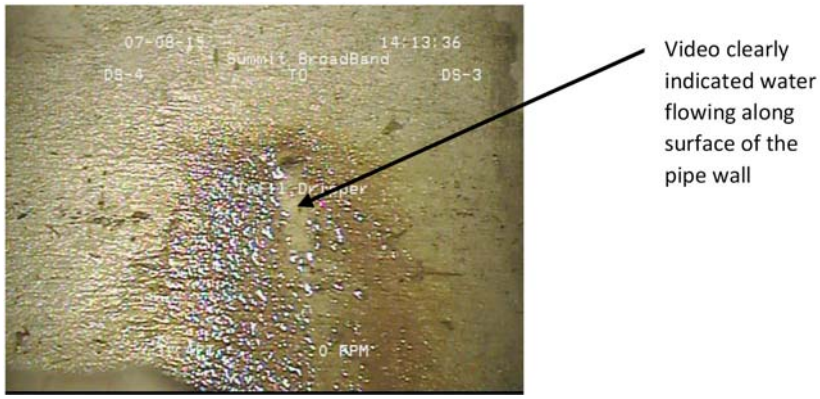

FIG. 11 Level 2 Infiltration

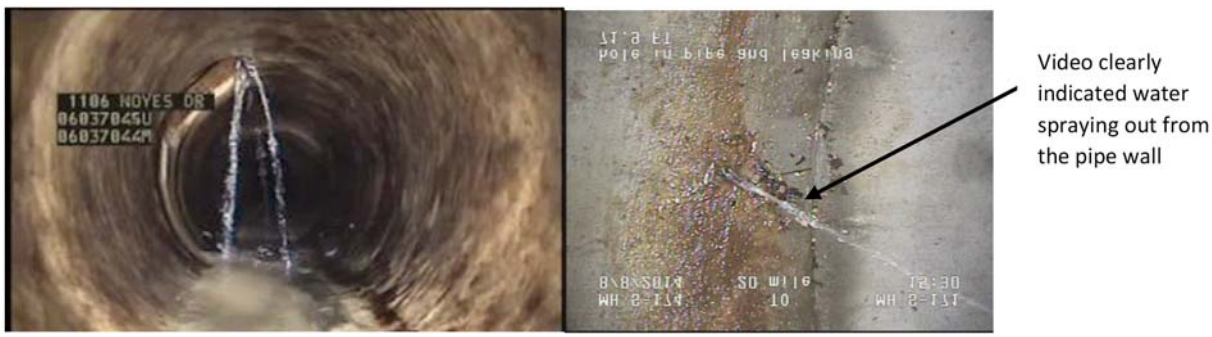

FIG. 12 Level 3 Infiltration

expected to be made during person-entry inspections.

5.2.5 The inspection equipment shall have a distance counter so as to accurately locate the observations made along the pipe run.

5.2.6 The video equipment shall be calibrated in accordance with the manufacturer's recommendation within one year prior to the inspection date.

5.3 *Remote Inspection Procedures:*

5.3.1 The instrument shall be moved through the pipe at a steady pace not to exceed 30 ft/min [9 m/min].

5.3.2 The camera should be stopped while the operator views and records observations. Side scan cameras are not required to stop, pan, and tilt while recording video as these operations may be accomplished during the post inspection evaluation process.

5.3.3 The operator's objective in positioning the camera to view an observation or feature will be to provide a perspective view of the observation and the entire circumference of the surrounding pipe.

5.4 *Person-Entry Inspection Equipment:*

5.4.1 The installed pipe is a confined space. Follow proper OSHA 29 CFR PART 1926 SUBPART AA regulations and safety protocols in assuring safe entry for project inspection personnel.

5.4.2 The person-entry inspection shall utilize a high resolution hand held digital video or still camera capable of clearly documenting inspection observations. Video may be necessary in order to document some observations.

5.4.3 Measurements of observations may be made with any combination of measurement tools including: measuring tapes,

FIG. 13 Joint Offset

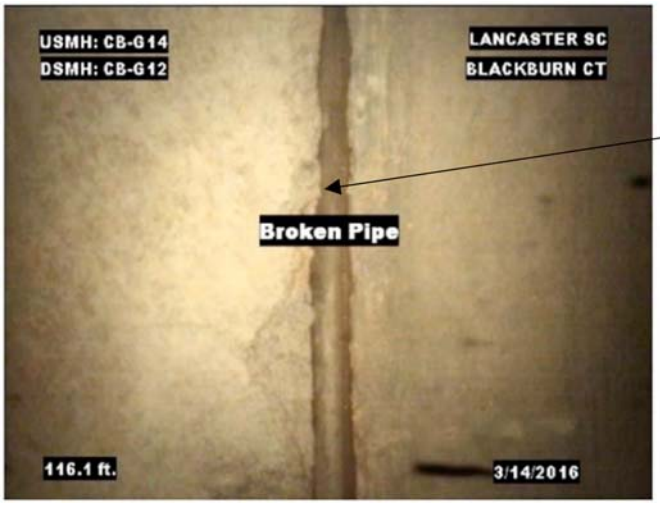

FIG. 14 Joint Separation

FIG. 15 Extreme Slabbing Due to Radial Tension

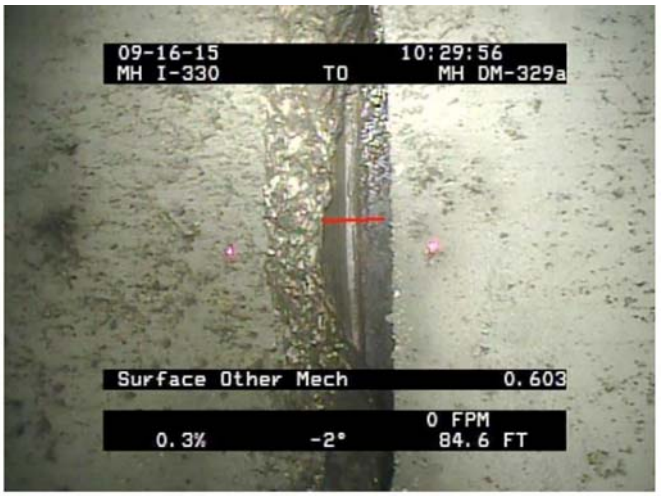

FIG. 16 Minor Spalling at a Joint

FIG. 17 Rust Colored Staining

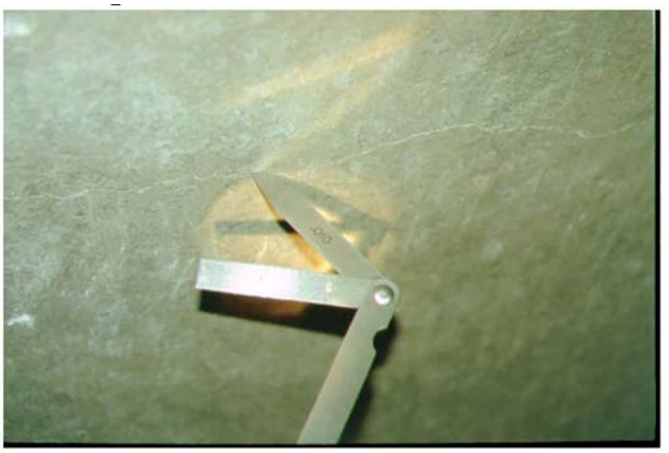

FIG. 18 Feeler Gauge Measuring a Minor 0.01 in. Crack

rulers, feeler gauges (Fig. 18), calipers, micrometers, optical comparators, etc. Cracks shall be measured from 0.01 in. [0.3 mm] to 0.10 in. [3 mm] on an accurate and repeatable basis.

5.4.4 Cracks greater than 0.10 in. [3 mm], and joint separations and/or vertical or horizontal offsets may be measured with either a metal or fabric tape capable of measuring to the nearest 1⁄16 in. [2 mm].

5.4.5 Adequate lighting shall be provided during the person entry inspection. Headlamps and handheld flashlights are considered adequate, provided measurements and observations can be properly recorded.

6. Equipment and Operator Accuracy Verification

6.1 Documentation shall be provided to the owner or the Engineer in conformance with 5.2.1 through 5.2.6.

6.2 A verification process is to be completed and documented prior to the inspection to ensure the equipment is performing within specifications and all operators are proficient in the setup, calibration process, and usage of equipment and are capable of making accurate and repeatable measurements.

6.2.1 The equipment and operator(s) utilized for the inspection must be tested and verified. Equipment must be identified on certification documentation by make, model, and serial number. Operator must be identified on certificate by driver's license number or photo identification.

6.2.1.1 Each operator and equipment combination shall be tested for verification of accuracy and proficient use of the video micrometer or digital side-scan data collection.

6.2.1.2 This test shall consist of the operator providing three measurements. One measurement of 0.05 in. [1.5 mm], a second dimension between 0.05 in. and 0.1 in. [1.5 mm-3 mm], and a third dimension between 0.5 in. and 1.0 in. [15 mm-30 mm] with an allowable tolerance of ±0.01 in. [0.3 mm], verified by a minimum of five readings for each of the three test points.

6.2.1.3 Verification testing must be successfully completed within one year prior to time of the inspection being performed.

6.2.1.4 Verification shall be administered by an independent third-party lab. The independent lab shall be ISO/ISE 17025 accredited.

6.2.1.5 More than one operator may be certified on a specific piece of equipment. Every operator certified for a particular piece of equipment must be tested individually and prove proficiency in setup, usage and be able to make accurate and repeatable measurements as required above. The test data for any or all certified operators for a piece of equipment shall be included in the proof of certification.

7. Inspection Report Requirements

7.1 *Person-entry and Remote Inspection Report Requirements:*

7.1.1 A report shall be provided to the owner or engineer along with all recorded video/still digital images, in electronic media on a digital media storage device.

7.1.1.1 The report shall include the location, length, and width measurements of all cracks. Cracks shall be recorded to the nearest 0.5 in. [15 mm] for length and 0.01 in. [0.3 mm] for width. Cracks smaller than 0.05 in. [1.5 mm] shall be noted as less than 0.05 in. [1.5 mm] in width when remote inspection procedure is utilized.

7.1.1.2 The report shall include recorded separation measurement of all pipe joints in excess of 1.0 in. [25 mm] to the nearest 0.1 in. [3 mm] or as required in the project specifications.

7.1.1.3 The report shall include other notable observations found in the pipe.

7.1.1.4 The report shall include a still image of each area that exceeds acceptance criteria as outlined in Section 8.

7.1.1.5 Each still image and description of condition shall include reference to allow the owner or engineer to correlate the still image with the inspection video footage.

7.1.1.6 The report shall include documentation of camera/operator verification for remote inspections or the credentials of the inspection personnel for all person entry inspections.

7.1.1.7 Report for remote inspection shall include the delivery of a high quality video from low barrel distortion video equipment and when specified, with non-contact video micrometer measurements and associated video playback software.

(1) The remote inspection report shall also include documentation that the equipment utilized meets criteria as outlined in 5.2 and equipment and personnel verification as outlined in Section 6.

(2) The recorded remote inspection video shall include identification before each line of pipe televised with the following information: the project name and number, the structure identification at the start of the video footage, size of pipe, date/time, direction of travel (upstream or downstream) and which pipe is being filmed (if multiple pipes are connected to the structure).

8. Installed Pipeline Evaluation and Acceptance Criteria

8.1 Inspection of newly installed reinforced concrete pipe shall occur after final fills are placed over the pipe, but before pavements or other structures are installed.

NOTE 2—For deep fills, the soil should be allowed time to settle prior to inspection, AASHTO Section 27 states that post installation inspections should not be completed until 30 days after all backfill has been placed.

8.2 *Crack Evaluation*—Cracks shall be evaluated based upon crack pattern (location and orientation in the wall), length, crack width, and environmental conditions.

8.2.1 *Longitudinal Crack Observations Not Requiring Remediation:*

8.2.1.1 Longitudinal cracks less than or equal to 0.01 in. [0.3 mm] in width and length up to the entire pipe segment require no further investigation.

8.2.1.2 Longitudinal cracks having a width less than or equal to 0.05 in. [1.5 mm] and length up to the entire pipe segment and in a non-corrosive environment are considered minor and are not a cause for further investigation unless the observed crack pattern meets or exceeds conditions listed in 8.2.2.

8.2.2 *Longitudinal Crack Observations Requiring Further Engineer Evaluation:*

8.2.2.1 Longitudinal cracks having a width greater than 0.01 in. [0.3 mm] and less than 0.05 in. [1.5 mm] and length up to the entire pipe wall that exhibit the following patterns or conditions require further evaluation by an engineer.

(1) Longitudinal hinge cracks running the length of the pipe in more than two quadrants.

(2) Longitudinal cracks that exhibit more than 0.1 in. [3 mm] vertical offset across the crack face.

(3) Longitudinal cracks allowing entry of backfill material into pipe.

8.2.2.2 Longitudinal cracks with a width greater than 0.05 in. [1.5 mm] but equal to or less than 0.10 in. [3 mm] that exhibit the following patterns or conditions.

(1) Longitudinal crack greater than 0.05 in. [1.5 mm] and running the length of a pipe segment in a corrosive environment.

(2) Longitudinal hinged cracks running the length of the pipe in more than one quadrant.

(3) Longitudinal cracks that exhibit any vertical offset across the crack face.

8.2.2.3 Longitudinal crack with width greater than 0.10 in. [3 mm] and less than 3 ft in length.

8.2.3 *Longitudinal Crack Observations Requiring Remediation:*

8.2.3.1 Longitudinal cracks having widths greater than 0.10 in. [3 mm] and longer than 3 ft in length.

NOTE 3—Prior to remediation of pipe with cracks exceeding 0.10 in. [3 mm], an engineering review shall be conducted to verify that pipe is stabilized and the installed condition pipe is adequate for the actual parameters of the project, such as burial depth, loads, and installation type.

8.2.4 *Circumferential Cracks Not Requiring Remediation:*

8.2.4.1 Circumferential crack less than or equal to 0.10 in. [3 mm] in width including a crack for the full circumference of the pipe.

8.2.5 *Circumferential Cracks that require Further Engineer Evaluation:*

8.2.5.1 Circumferential crack greater than 0.10 in. [3 mm], more than 50 % of the circumference in length, and in a corrosive environment.

8.2.5.2 Circumferential crack with vertical or horizontal offset that impedes flow of fluid through pipe.

8.2.6 *Circumferential Cracks Requiring Remediation:*

8.2.6.1 Circumferential crack allowing entry of backfill into pipe.

8.2.7 *Multi-Directional Crack Patterns*—Remediate multi-directional cracks where the damage zone extends over one quadrant (more than 25 % of inside circumference) at a single location and crack widths exceed 0.05 in. [1.5 mm].

8.2.8 Cracks filled with calcium carbonate and not measured larger than or equal to 0.10 in. [3 mm] do not require remediation. Cracks larger than 0.10 in. [3 mm] require further evaluation by the engineer.

8.2.9 Spalling of concrete does not need to be remediated unless the spall exposes structural reinforcement or reduces the concrete cover over the steel reinforcing below acceptable limits of the project specification.

8.2.10 Scaling is indicative of the durability of the concrete under service conditions and the need for remediation shall be evaluated by the engineer.

8.2.11 Slabbing is a serious condition that should be evaluated by the engineer prior to any remediation.

8.3 *Joint Evaluation:*

NOTE 4—Most storm drainage systems are designed and specified to be soil or silt tight. Soil and silt tight applications do not require the installed pipe system to be water tight or leak resistant. Water infiltration should be expected in these soil/silt tight systems. Leak resistant designed systems typically include an allowable leakage rate for the pipelines in the project specifications. Therefore, even in leak resistant systems it is not uncommon to have some infiltration observed during inspection of installed pipe.

Evaluation criteria discussed below is for infiltration and joint performance for both soil/silt tight and leak resistant designs/applications. Unless the owner or Engineer have specific knowledge that the system was designed and required by specification to provide leak resistant performance the system shall be evaluated based upon the silt/soil tight criteria. If the project specification or standards require the use of leak resistant joints but does not contain an allowable leakage rate, the evaluation of the installed pipe shall be based upon soil/silt tight criteria established below.

8.3.1 *Joint Observations Not Requiring Remediation:*

8.3.1.1 *Silt and Soil Tight Joints:*

(1) Joints with separation less than the manufacturer's recommendation for silt/soil tight joints provided for the project and meeting the criteria listed below.

(2) Cracks in joint sealing surface with width less than or equal to 0.10 in. [3 mm].

(3) Joints exhibiting vertical or horizontal offset less than 0.75 in. [20 mm].

(4) Joint that allows entry of backfill of particles smaller than those retained on a No. 200 sieve through the joint.

(5) Joints with chips or spalls at the face of the joint that do not expose any circumferential steel reinforcement.

(6) Joints that exhibit a stain, Level 1 Infiltration, or Level 2 Infiltration.

(7) Joints with exposed gasket or sealing material is not cause for remediation as long all other items noted above are met.

8.3.1.2 *Leak Resistant Joints:*

(1) Joints with separation less than the manufacturer's recommendation for leak resistant joints provided for the project and meeting the criteria listed below.

(2) Joint with crack in joint sealing surface of width less than or equal to 0.05in. [1.5 mm].

(3) Joints exhibiting vertical or horizontal offset less than 0.75 in. [20 mm].

(4) Joints with chips or spalls that do not expose gasket, sealing material, or circumferential steel reinforcement.

(5) Leak resistant design joints that exhibit a stain, or Level 1.

8.3.2 *Joint Observations Requiring Further Engineer Evaluation:*

8.3.2.1 *Soil or Silt Tight Joints:*

(1) Joints with separation greater than the manufacturer's recommendation.

(2) Cracks in joint sealing surface of width greater than 0.10 in. [3 mm].

(3) Joints exhibiting vertical or horizontal variations greater than 0.75 in. [20 mm].

(4) Any joint allowing infiltration classified as Level 3 Infiltration.

8.3.2.2 *Leak Resistant Joints:*

(1) Joints with separation greater than the manufacturer's recommendation.

(2) Cracks in joint sealing surface exceeding 0.05 in. [1.5 mm].

(3) Joints exhibiting vertical or horizontal variations greater than 0.75 in. [20 mm].

(4) Joints with exposed gasket or sealing material.

(5) Any joint exhibiting Level 2 Infiltration.

8.3.3 *Joint Observations Requiring Remediation:*

8.3.3.1 *Soil or Silt Tight Joints:*

(1) Joints with chips or spalls in the sealing surface that expose the structural reinforcement.

(2) Any joint that allows entry of backfill of particles larger than those retained on a No. 200 sieve through the joint.

8.3.3.2 *Leak Resistant Joints:*

(1) Joints with chips or spalls in the sealing surface that expose the structural reinforcement.

(2) Any joint that allows entry of backfill.

(3) Any Joint exhibiting Level 3 infiltration.

8.4 *Infiltration Evaluation in Pipe Wall:*

8.4.1 *Infiltration Observations in Pipe Wall Not Requiring Remediation:*

8.4.1.1 Infiltration in the barrel of the pipe classified as Level 1 Infiltration.

8.4.1.2 Infiltration in the barrel of the pipe classified as Level 2 Infiltration is not cause for remediation when pipe is located in a non-corrosive environment.

8.4.1.3 Infiltration in the barrel of the pipe classified as Level 2 Infiltration is not cause for remediation when associated with a crack width less than or equal to 0.05 in. [1.5 mm].

8.4.2 *Infiltration Observations in Pipe Wall Requiring Further Engineer Evaluation:*

8.4.2.1 Infiltration in the barrel of the pipe classified as Level 2 Infiltration and the pipe is located in a corrosive environment.

8.4.2.2 Infiltration in the barrel of the pipe classified as Level 2 Infiltration and is associated with a crack wider than 0.05 in. [1.5 mm].

8.4.3 *Infiltration Observations in the pipe Wall Requiring Remediation:*

8.4.3.1 Infiltration in the barrel of the pipe classified as Level 3 shall be remediated.

8.5 *Stains and Efflorescence Evaluation in Concrete Pipe:*

NOTE 5—In the absence of cracks and infiltration in excess of those permitted below, stains or efflorescence are not indicative of structural distress and do not require remediation.

8.5.1 *Stains and Efflorescence Not Requiring Remediation:*

8.5.1.1 Stains or efflorescence associated with a crack having a width of less than 0.05 in. [1.5 mm].

8.5.1.2 Stains or efflorescence accompanied by infiltration classified as Level 1 or Level 2 in a non-corrosive environment.

8.5.2 *Stains and or Efflorescence Requiring Further Engineer Evaluation:*

8.5.2.1 Stains or efflorescence associated with a crack having a width greater than 0.05 in. [1.5 mm] and less than 0.10 in. [3 mm].

8.5.2.2 Stains or efflorescence accompanied by infiltration classified as Level 2 in a corrosive environment.

8.5.3 *Stains or Efflorescence Requiring Remediation:*

8.5.3.1 Stains or efflorescence accompanied by Level 3 infiltration.

8.5.3.2 Stains or efflorescence associated with a crack having a width greater than 0.10 in. [3 mm].

9. Keywords

9.1 acceptance; arch pipe; circular pipe; culvert; elliptical pipe; evaluation; inspection; reinforced concrete pipe; remediation; sewer pipe; storm drain