

PIPE CULVERT INSPECTION FOR NEW CONSTRUCTION

Introduction

The following Post-Installation Inspection Guide is a compilation of best practices from AASHTO, DOT's, and other agencies across the United States. This document was prepared to be used as guidance document for the preparation of Post Installation Inspection and Evaluation specifications.

Pipe Installation Inspection

The post-installation inspection shall be performed on 100% of all pipelines no sooner than 30 calendar days after completion of the pipe installation and final cover, which includes the embankment and all non-asphalt bases and/or subgrades. Post installation inspection may be completed by either the Remote Inspection Method or the Manual Inspection Method as outlined in *Post Installation Methods, Tools, and Report*. Conditions including joint gaps, tears, misalignment, cracks, and deformation shall be noted and reviewed by the Engineer. Engineer evaluation for the various conditions noted in PII report shall be evaluated as outlined in *Guide for Drainage Pipe Evaluation* section of this document.

In cases where paving operations will be conducted in less than 30 calendar days after pipe installation, a preliminary inspection of the pipe prior to paving shall be performed to ensure the pipe in areas to be paved meets all evaluation criteria prior to paving operations. Performing a preliminary inspection does not relieve the Contractor from the requirement of completing the post installation inspection for all pipe, including pipe that is inspected during preliminary inspection, after the prescribed 30 calendar day period.

A Post-Installation Inspection Report as described in *Post Installation Methods, Tools, and Report* of this document shall be delivered to the Engineer and kept as a permanent record in the project documents. Payment for pipe installation and post installation inspection shall be measured and paid for at the contract unit price as provided by the contract specification and in conformance with this specification.

All necessary remediation or replacement of pipe as required in *Drainage Pipe Evaluation* section of this document or determined to be necessary by the Engineer in conformance with this specification shall be the responsibility of the contractor at no additional expense to the owner. All supplemental work items that are affected by the remediation or replacement of pipe shall be the responsibility of the contractor at no additional expense to the owner. The Engineer shall approve all corrective actions before the work is performed and work shall be completed to the Engineers satisfaction. If any pipe requires remediation or replacement it shall be re-inspected after remediation or replacement has been completed. The Final Post Installation Inspection Report shall include all notes and data from the initial Post Installation Inspection and all subsequent Post Installation Inspections necessary to fulfill the requirements of this specification.

The Contractor is responsible for ensuring that all post installation requirements are performed in accordance with this document. It is the contractor's responsibility before post installation inspection to dewater and remove all debris and sediment from the installed pipe. The Engineer shall be provided an inspection schedule at least seven days in advance of beginning inspection.

Post Installation Methods, Tools, and Report

The inspection equipment utilized for all post installation inspection of all pipe types shall be capable of delivering accurate, repeatable measurements of all items of interest as described in the *Guide for Drainage Pipe Evaluation*. All individuals performing the in-field inspections and those responsible for preparing the Post Installation Report shall be certified Technicians in a program approved or developed by the DOT. The inspection company and or its employees shall be an independent third party to the contractor and the DOT. The DOT reserves the right to confirm any and all inspection data and defect measurement accuracy to insure the PII report and information included there in meets the requirements outlined in this specification. If the PII report and or data is found to be in non-conformance the owner shall require the inspections and the report to be corrected as needed. Any re-inspection required by owner or required due to remediation or replacement shall be the responsibility and at the expense of the contractor.

Manual Inspection Method

Manual inspections are permitted for all pipe and pipe types with a vertical rise of 36" and greater. Perform a manual inspection by entering the pipe to document pipe condition and to record any required measurements. The person performing the manual inspection shall use a high quality hand held video camera or a digital camera capable of clearly documenting any observed deficiencies. If the pipe is considered a confined space, provide entry for all project inspection personnel according to OSHA requirements.

Furnish pictures, still images, and/or video recording of areas of the pipe with noted deficiencies. Any deficiency noted shall include information necessary to locate the pipe and the noted deficiencies in the field at a future date. Such factors shall at a minimum include the project number, the station number, the structure number, size of pipe, the date and time of inspection, direction of travel from a given landmark, distance from given landmark for all noted deficiencies, and any other identifying data. The Contractor shall provide a source of light that allows all deficiencies to be readily observed on the camera or video recording. Furnish the still images or video recording in a digital, reproducible format approved by the Engineer.

The crack width or the width of any separation of the pipe wall, in all pipe types, shall be measured using a device or technology capable of measuring cracks from 0.01 inch to 0.10 inch on an accurate and repeatable basis. Cracks or tears greater than 0.10 inch, and joint gaps may be measured with either a metal or a fabric tape capable of measuring to the nearest 1/16 inch. Other measuring devices may be used if approved by the Engineer.

In addition to the items above measure the deflection of all flexible pipe types using either a metal or a fabric tape and record to the nearest 1/16 inch. Deflection shall be determined by measuring the diameter of the pipe every 10 feet along the length of the pipe. Deflection shall also be measured at any location where deflection, bulging, buckling, or racking is evident. To determine the minimum deflected diameter, eight measurements shall be taken at each location at roughly 45-degree angles. All diameter measurements on corrugated pipe shall be from the top of corrugation to the top of corrugation. All measurements and the percent deflection for each location shall be recorded. Percent deflection shall be arrived at by the following formulae.

$$[(MMD - CMD)/CMD]100 = \% \text{ deflection}$$

MMD = The minimum of the eight diameter measurements at each location every 10 feet along the length of the pipe or any location where deflection, bulging, buckling, or racking is evident.

CMD = Original certified mean diameter as provided by the pipe supplier

Remote Inspection:

Perform remote inspection for all pipe types with a vertical rise of less than 36 inches. Remote inspection shall be performed by using a crawler mounted camera and measurement technology. The camera shall incorporate a lens with low barrel distortion and capable of recording video. The measurement technology shall have the capability to make measurements of any defect on all pipe types. Remote inspections may also be accomplished with digital side scan technology equipment.

A check for deflection shall be performed on all flexible pipe types by either laser profiling or by use of a mandrel. Deflection testing is not required for rigid pipe.

Laser profiling and crack/joint measurement technology must be certified by the company performing the work to be in compliance with ASTM E 691 and ASTM E 177 which includes the following calibration criteria. The equipment and software used must be tested and approved by a recognized independent testing group and include a tested certified accuracy of 0.5% or better and a repeatability of 0.12% or better. . Laser profiling technology may utilize actual pipe diameter as measured with this device to calculate percent deflection and ovality.

The camera technology utilized shall be able to deliver a high quality MPEG2 format video with a standard resolution of 720 X 480 or other format acceptable to the Engineer. A camera with lighting suitable to allow a clear picture of the entire periphery of the pipe shall be used. The camera shall be centered in the pipe both vertically and horizontally and be able to pan and tilt to a 90 degree angle with the axis of the pipe and rotating 360 degrees. Digital 360 Degree side scanning data collection equipment that will allow an image of the entire pipe surface and joint circumferences to be clearly visualized and evaluated is also an approved inspection tool. Equipment to move the camera through the pipe that will not obstruct the camera's view or interfere with proper documentation of the pipe's condition shall be used. The video image shall be clear, focused, and relatively free from roll, static, or other image distortion qualities that would prevent the reviewer from evaluating the condition of the pipe.

Furnish a video recording of 100% of all pipe with information at the beginning of the video which clearly identifies the pipe being inspected. The identification shall include the project number, the structure number corresponding to the structure number from project documents, size of pipe, the date and time of inspection, direction of travel from a given landmark, distance from given landmark for all noted deficiencies, and any other identifying factors needed to locate the pipe in the field at a future date. Provide a source of light that allows all areas of concern to be readily observed on the video recording. Furnish the video recording in a digital, reproducible format approved by the Engineer.

Move the camera through the pipe at a speed not greater than 30 feet per minute (If Digital 360 side scan technology is used the speed may be increased but should never exceed inspection equipment manufactures recommendations). Mark the video with the distance down the pipe. The distance shall have an accuracy of one foot per 100 feet.

Camera operator (or evaluation technician reviewing side-scan report) shall pan and tilt all joints exhibiting damage or questionable joint gap.

If mandrels are used to check for deflection they shall be nine (or greater odd number) arm, non-adjustable, fixed arm mandrels, and shall be sized and inspected by the owner Engineer utilizing the appropriately sized proving rings prior to testing. The diameter of the mandrels and matching proving rings shall be based upon the actual certified mean diameter as provided by the pipe manufacturer (0.95 x certified mean diameter for 5% deflection or 0.925 x certified mean diameter for 7.5% deflection). The diameter of the mandrel at any point shall not be less than the allowable percent deflection of the actual certified mean diameter of the pipe being tested. The Fixed arm mandrels shall be fabricated of metal, fitted with pulling rings at each end, stamped or engraved on some segment other than a runner with the nominal pipe size and mandrel outside diameter. The mandrel shall be pulled through the pipe or culvert by hand with a rope or cable.

[Note to user; The use of crawler mounted camera combined with appropriate measurement technology as outlined above has proven to provide inspection data that will allow the evaluation team or engineer to accurately and objectively evaluate the severity or damage that may be found in the inspection of storm piping systems. However, there are still owners who do not have access or wish to utilize some of the advanced measurement technologies available. The outline document above could be modified as needed to only include Crawler mounted cameras and mandrels for remote inspections if the owner desires to do so.

At a very minimum, Post Installation Inspection requirements should require crawler mounted cameras be utilized for remote inspection for any pipe that is too small for man-entry. Inspection of all flexible pipe should always include a check for deflection. Pipe deflection confirmation can be accomplished through the use of fixed arm mandrels as outlined above for required remote inspections when man entry is not possible and use of laser profilers are not required]

Post Installation Inspection (PII) Report Criteria

A written PII Report shall be provided to the Engineer along with corresponding video, pictures, and laser profiler data on a digital media storage device. The PII Report shall include a written description of any noted deficiency as outlined in *the Drainage Pipe Evaluation* section of this document for each pipe. The report shall include a still image of these areas along with all field inspection information that indicates why this area is noted. Each still image and description of condition shall also have information that will allow the Engineer to locate and view this issue in the video recording if the inspection was a remote inspection.

If a condition continuously occurs along the pipe wall, the report should note the entire area where this condition was found, include at least one still image that best documents the condition and the information necessary to locate the entire condition in the video recording. If the Manual Inspection Method is utilized, the PII Report shall include the actual field measurements taken for all deficiencies noted. Payment will be made for a line of pipe and the Post Installation Inspection at the appropriate contract unit prices when the Post Installation Report indicates that all deficiencies have been corrected to the Engineers satisfaction in conformance with this specification.

The Report shall include type of equipment utilized for the inspection and clearly provide data to prove the equipment used meets this specification. The inspection contractor shall provide a statement of field accuracy achieved for all measurements including plus/minus tolerances. The report shall also include a narrative about required field/measurement calibration and provide proof that all calibration procedures were followed when collecting data within the report. The Post Installation Report shall include documentation that all individuals performing the in-field inspections and preparing the Post Installation Report are certified technicians in a program approved or developed by the DOT.

The PII Report and corresponding electronic media and data as discussed in this specification shall be made part of the permanent project public records.

Guide for Drainage Pipe Evaluation

[Note to user; the information provided in [...] are provided as suggested evaluation criteria for remote inspections where advanced measurement tools are not utilized for inspection data collection. As noted earlier the use of advanced measurement tools allows the engineer or evaluation team to make a more accurate and objective decision with respect to the severity of any given defect or area of damage.]

Concrete Pipe Culverts and Storm Sewers

Misalignment: Check for vertical and horizontal mis-alignment, faulting (differential alignment between joints of the pipe, creating a non-uniform profile of the pipe), sagging (ponding of water in invert due to vertical mis-alignment), and invert heaving, that would prevent proper function of the system. . During Manual Inspections alignment shall be checked by sighting along the crown, invert and sides of the pipe and the inspector shall note any deviation in horizontal alignment or sagging as they progress through the pipe. When lines are inspected using the Remote Inspection Method, the inspection shall note any horizontal deviation in line as well as any faulting, sagging faulting or invert heaving. The technician performing the inspection should take into account pipe or culvert laid with a designed camber or grade change in accordance with project or site requirements. Horizontal alignment shall be checked for straightness and smooth curvature.

Misalignment Evaluation Criteria: Any issues with vertical and/or horizontal misalignment shall be noted in the inspection report. If any issues are noted, a further evaluation shall be conducted by the Engineer to determine the impact of the misalignment on the joints and wall of the pipe to ascertain if corrective actions are needed.

[Camera Only Evalutaion Criteria for Misalignment; Same as noted above.]

Joints: Joint performance shall be evaluated to determine if they meet the criteria as outlined below for silt tight or leak resistant applications. (Note it is important to evaluate joints based upon the design joint performance criteria of silt tight or leak resistant, most storm culverts and storm drains are designed or required to meet silt tight performance criteria) Items to be noted and evaluated include excessive differential movement, cracks greater than 0.10" in the joint sealing surface portion of the pipe wall , spalling of areas that expose reinforcement or expose the joint sealing material, improper gasket placement, and any soil migration shall be noted in the Post Installation Report.

Silt Tight Joints Evaluation Criteria: Per AASHTO PP-63, Silt tight *joints* are intended to be resistant to infiltration of particles that are smaller than particles passing the No. 200 sieve. Silt-tight joints provide protection against infiltration of backfill material containing a high percentage of fines. Joint separation greater than the pipe manufactures recommended allowable joint gap shall be remediated. If joint separation is less than the pipe manufactures allowable joint gap and there is no evidence of soil migration through the joint, no corrective action necessary. If soil migration is apparent, the joint shall be sealed. Vertical or horizontal variations at the joint of a concrete pipe do not require remediation unless they exceed allowable manufacturing tolerances for the pipe and significantly reduce the flow characteristics of pipe system. Chipped or spalls at the face of the joint shall not require remediation unless reinforcement is exposed or the chipped area is large enough to allow backfill material to migrate through the joint.

[Camera Only Remote Inspection Evaluation Criteria Silt Tight Joints: Remediate any joint with the following defects or damage: joints allowing soil infiltration, joints with vertical offset where pipe wall at joint area also exhibits large open cracks with vertical offset, joints with damage that exposes primary steel of the pipe, a joint with joint gap that exposes backfill material]

Leak Resistant Joints Evaluation Criteria: Per AASHTO PP-63, Leak resistant joints are intended to limit water leakage at a maximum rate of 200 gallons/inch-diameter/mile/day for the pipeline system for the project specified head or pressure. Joint separation greater than pipe manufactures recommended allowable joint gap shall require remediation. Pipe lines shall be tested to determine leakage rate or a plant test certifying each producers joint for each specific pipe size may be established. Pipe lines with Infiltration/Exfiltration exceeding 200 Gal/inch of pipe diameter/Mile/Day shall require evaluation as to which joints or areas of leakage shall require remediation. Any joint with continuous flow observed, or with evidence of soil migration through the joint, shall require remediation. Retesting and subsequent remediation shall be required as necessary to satisfy the leakage rate requirement. Vertical or horizontal variations at the joint of a concrete pipe do not require remediation unless they exceed allowable manufacturing tolerances and significantly decreases flow characteristics of the pipe system. Chips or spalls at the face of the joint shall not require remediation unless reinforcement is exposed or the chipped area is large enough to allow a continuous flow of water to migrate through the joint.

[Camera Only Remote Inspection Evaluation Criteria for Leak Resistant Joints: Remediate any joint with the following defects or damage; joints allowing soil infiltration, joint allowing a continuous flow of water into the pipe, joint with vertical offset where pipe wall at joint area also exhibits open cracks, joints with damage at the joint that exposes primary steel of the pipe, joint gap that exposes backfill material, joint with chip area that exposes a portion of the gasket.]

Cracks

Longitudinal cracks < 0.05"

Longitudinal cracks with a width less than five hundredths of an inch (0.05") are considered minor and are not a cause for remediation. Cracks of 0.05" or less do not penetrate through the pipe wall and are the smallest crack that can be measured with reasonable accuracy. Longitudinal cracks having a width equal to or greater than five hundredths of an inch (0.05") but equal to or less than one tenth of an inch (0.1) shall be evaluated by the Engineer to determine if any remediation is required.

Longitudinal cracks < 0.05" Evaluation Criteria: Pipe with cracks less than 0.05" shall be noted in the inspection report; however, no remedial action is required. Pipe with cracks greater than 0.05" and less than or equal to 0.1" and in areas where soil and or runoff Ph is 5.5 or greater shall not require remediation. Pipe with cracks greater than 0.05" and less than or equal to 0.1" and in areas where soil and or runoff Ph is less than 5.5 shall require remediation. Remediate or replace pipe having longitudinal crack widths larger than 0.10". Prior to remediation or replacement of pipe with cracks exceeding 0.10", an engineering review shall be conducted to verify the class of pipe installed was adequate for the actual parameters of the project, such as, burial depth, additional loading requirements, and installation type.

[Camera Only Remote Inspection Evaluation Criteria for Longitudinal Cracks: two longitudinal cracks the length of the pipe section is acceptable when the cracks are within 15 degrees of any quarter point of pipe, i.e 11 O-Clock to 1 O-clock, 2 – 4 O-Clock, 5 – 7 O-clock, and 8-10 O-Clock. Cracks at these points are signs of acceptable stress load cracks and are typically small cracks and do not allow soil infiltration and are not cause for concern unless the pipe is in an acidic condition (Ph of soil/runoff less than 5). Pipes with more than two longitudinal cracks the length of the pipe at the quarter points or pipe with cracks at 30 degrees +/- from invert i.e. 4-5 O'clock and or 7-8 O-Clock should be further evaluated by an Engineer with experience in RCP pipe design and evaluation. Any crack exhibiting significant vertical offset should be remediated,]

Transverse cracks (circumferential) Evaluation Criteria: Transverse cracks with no sign of backfill infiltration do not need remediation. If migration of backfill material is evident the transverse crack shall require remediation.

[Camera Only Remote Inspection Evaluation Criteria for Transverse Cracks; Crack allowing migration of backfill into the pipe shall be remediated.]

Reduced Payment Option: In lieu of the options noted above for remediation of longitudinal cracks in concrete pipe installations, the Contractor may elect to follow the payment schedule below if agreed to by the Engineer.

Remediation efforts and payment shall apply to the entire section(s) of the pipe experiencing the crack, joint to joint. Payment shall mean to include the complete installed unit bid price including the cost of the pipe, bedding material, backfill material, overfill, and other incidental costs included in the contractors original bid amount.

Longitudinal Crack Width	Percent of Payment	[Camera Only]
≤ 0.05"	100% of Unit Bid Price	≤ two longitudinal cracks
* < 0.10" > 0.05" + no remediation	75% of Unit Bid	three longitudinal cracks
> 0.10"	Remediate or Replace	Four Longitudinal cracks

* In areas where the pH is less than 5.5

Spalls: Spalling is defined as a localized delamination of concrete along the wall of the pipe or at the edges of longitudinal or circumferential cracks. Spalling may be detected by visual examination of the concrete along the edges of the crack. This section does not address spalled or chipped areas near the pipe joint: see section 1.1.2.

Spalling Evaluation Criteria: The person conducting the inspection shall visually check for delamination in areas where spalling is noted. If delamination is evident the pipe shall be remediated.

[Camera Only Remote Inspection Evaluation Criteria for Spalling; Same as noted above.]

Slabbing: Slabbing is the result of radial or diagonal tension forces in the pipe. Slabbing is characterized by large slabs of concrete delaminating from the wall of the pipe and a straightening of the steel.

Slabbing Evaluation Criteria: Any pipe experiencing slabbing shall be evaluated by an engineer. If it is determined that the pipe can be stabilized, the pipe may be remediated. Where slabbing is of such magnitude that, the system cannot be stabilized or the service life of the pipe is severely compromised, the pipe exhibiting such deficiency shall be replaced. Prior to remediation or replacement of pipe exhibiting slabbing, an engineering review shall be conducted to verify the class of pipe installed was adequate for the actual parameters of the project, such as, burial depth, additional loading requirements, and installation type.

[Camera Only Remote Inspection Evaluation Criteria for Slabbing; SAME as noted above.]

Flexible Pipe

Thermoplastic, and CMP Pipe Culverts and Storm Sewer

Misalignment: Vertical and horizontal alignment of the pipe shall be checked for horizontal misalignment, sagging (ponding of water in invert due to vertical mis-alignment), faulting (differential alignment between joints of the pipe, creating a non-uniform profile of the pipe and invert heaving. During Manual Inspections alignment shall be checked by sighting along the crown, invert and sides of the pipe and the inspector shall note any deviation in horizontal alignment or sagging as they progress through the pipe. When lines are inspected using the Remote Inspection Method, the inspection shall note any horizontal deviation in line as well as any faulting, sagging and invert heaving. The technician performing the inspection should take into account pipes laid with a designed camber or grade change. Horizontal alignment shall be checked for straightness and smooth curvature.

Misalignment Evaluation Criteria: Any issues with horizontal and/or vertical alignment shall be noted in the Post Installation Inspection Report. If any vertical and/or horizontal misalignment problems are noted, a further evaluation shall be performed by the Engineer to determine the impact of the misalignment on the joints and wall of the pipe to ascertain what corrective actions are needed.

[Camera Only Evaluation Criteria for Misalignment; Same as noted above.]

Cracks: Cracks or splits in the interior wall of the pipe are not acceptable.

Crack Evaluation Criteria: All cracks, tears or splits shall be remediated.

[Camera Only Evaluation Criteria for Cracks; Same as noted above.]

Coating (CMP): Areas of the pipe where the original coating has been scratched, scoured, peeled, or in some way damaged during the production or installation process shall be noted in the inspection report.

Coating Evaluation Criteria: All damage to coating shall require remediation. Remediation shall satisfy the requirements for coating repair as detailed in the appropriate manufacturing specification for corrugated metal pipe and be acceptable to the Engineer.

[Camera Only Evaluation Criteria for Coating Damage; Same as noted above.]

Joints: Differential movement, improper joint sealing, movement or settlement of pipe sections, crushing/buckling, and leakage shall be noted in the inspection report.

Silt Tight Joints Evaluation Criteria: Per AASHTO PP-63, Silt tight *joints* are intended to be resistant to infiltration of particles that are smaller than particles passing the No. 200 sieve. Silt-tight joints provide protection against infiltration of backfill material containing a high percentage of fines. Joint separation greater than the pipe manufactures recommended allowable joint gap shall be remediated. If joint separation is less than the pipe manufactures allowable joint gap and there is no evidence of soil migration through the joint, no corrective action necessary. If soil migration is apparent, the joint shall be sealed.

[Camera Only Remote Inspection Evaluation Criteria: Remediate any joint with the following defects or damage: joints allowing soil infiltration, joints with vertical offset where pipe wall at joint area also exhibits large open cracks or tears. Joint with vertical offset exposing backfill, a joint with joint gap that exposes backfill material]

Leak Resistant Joints Evaluation Criteria: Per AASHTO PP-63, Leak resistant joints are intended to limit water leakage at a maximum rate of 200 gallons/inch-diameter/mile/day for the pipeline system for the project specified head or pressure. Joint separation greater than pipe manufactures recommended allowable joint gap shall require remediation. Pipe lines shall be tested to determine leakage rate or a plant test certifying each producers joint for each specific pipe size may be established. Pipe lines with Infiltration/Exfiltration exceeding 200 Gal/inch of pipe diameter/Mile/Day shall require evaluation as to which joints or areas of leakage shall require remediation. Any joint with continuous flow observed, or with evidence of soil migration through the joint, shall require remediation. Retesting and subsequent remediation shall be required as necessary to satisfy the leakage rate requirement.

[Camera Only Remote Inspection Evaluation Criteria for Leak Resistant Joint: Remediate any joint with the following defects or damage; joints allowing soil infiltration, joint allowing a continuous flow of water into the pipe, joint with vertical offset that exposes backfill, joint gap that exposes backfill material, joint damage that exposes a portion of the sealing gasket, joint where pipe deformation has caused obvious separation of adjoining pipe walls at the joint.]

Buckling, Bulging, and Racking: Flat spots or dents at the crown, sides or flow line of the pipe due to racking, wall buckling, and or inverse curvature shall be noted in the inspection report.

Buckling, Bulging, and Racking Evaluation Criteria: Flat spots, dents or racking that will reduce flow in any way shall be remediated. Flat spots, dents or racking that are determined to be detrimental to the long-term performance of the pipe by the Engineers review shall be replaced. Any pipe exhibiting wall buckling or inverse curvature shall be replaced.

[Camera Only Remote Inspection Evaluation Criteria for Buckling, Bulging, or Racking; Mandrel testing must be completed for all flexible pipe. Any buckling, bulging, or racked areas shall meet deflection limitations noted in Deflection ovality section below. In addition any Bulging areas or buckling areas that exceed 15% of the pipe wall surface should be further evaluated by Engineer experienced in the design and remediation techniques of pipe material being inspected.]

Deflection (x and y plane)/Ovality (out of plane deflection): Laser profiler or mandrel for remote inspections or direct measurement for manual inspections may be used to measure deflection and ovality of flexible pipe . Pipe deflection and ovality shall be calculated and based upon actual field measured diameter if laser profiler or direct manual measurements are utilized. If a mandrel is used the mandrel shall be sized to the required percent deflection based upon the actual certified mean diameter as supplied by the pipe producer. The actual certified mean diameter shall be supplied in writing by the pipe manufacturer to the contractor and the engineer when the product is shipped to job site and recorded in the Post Installation Report. All measurements and subsequent deflections shall be noted in the inspection report..

Deflection Evaluation Criteria: Deflections or Ovality of less than 5% of the actual pipe diameter, either measured or certified, shall not require remediation. If the pipe experiences additional deficiencies combined with deflection or ovality greater than 5% but less than 7.5% of the certified mean diameter, the pipe shall be evaluated by an engineer to determine whether it should be remediated or replaced . The evaluating Engineer shall include an analysis of the measured deflection/buckling compared to anticipated deformation/buckling and wall stress per the Engineer of record's design.

Pipe that is deflected or exhibits ovality exceeding 7.5% of the original diameter shall be replaced. Any area of pipe that cannot be physically checked by a 7.5% mandrel due to overdeflection in other areas of the pipe that inhibits progression of the mandrel, or be physically measured shall be assumed to have deflection greater than 7.5% and shall be removed or deflection tested by laser profiling.

Use of mechanical re-rounding technology on installed pipe is not an acceptable remediation technique.

[Camera Only Remote Inspection Evaluation Criteria for Deflection/Ovality; Mandrel testing must be completed for all flexible pipe. Deflections or Ovality of less than 5% of the actual pipe diameter, either measured or certified, shall not require remediation. If the pipe experiences additional deficiencies combined with deflection or ovality greater than 5% but less than 7.5% of the certified mean diameter, the pipe shall be evaluated by an engineer to determine whether it should be remediated or replaced . The evaluating Engineer shall include an analysis of the measured deflection/buckling compared to anticipated deformation/buckling and wall stress per the Engineer of record's design.

Pipe that is deflected or exhibits ovality exceeding 7.5% of the original diameter shall be replaced. Any area of pipe that cannot be physically checked by a 7.5% mandrel due to over deflection in other areas of the pipe that inhibits progression of the mandrel, or be physically measured shall be assumed to have deflection greater than 7.5% and shall be removed or deflection tested by laser profiling.

Use of mechanical re-rounding technology on installed pipe is not an acceptable remediation technique.

Reduced Payment Option: In lieu of the options noted above for remediation of deflection in flexible pipe installations, the Contractor may elect to follow the payment schedule below if agreed to by the Engineer.

Remediation efforts and percentage of payment shall apply to the entire section of the deflected pipe, joint to joint. Payment shall mean to include the complete installed unit bid price including the cost of the pipe, bedding material, backfill material, overfill, and other incidental costs included in the contractor's original bid amount.

Amount of Deflection/Ovality

0.0 % TO 5.0%

Greater than 5.0% but < 7.5%

Greater than 7.5%

Percent of Payment

100% of Unit Bid Price

50% of Unit Bid Price

Remove and Replace at

Contractor's Expense

