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Standard Practice for Proper Use of Mechanical Trenchless Point Repair Sleeve with Locking Gear Mechanism for Pipes of Varying Inner Diameter and Offset Joints[1]

This standard is issued under the fixed designation F3110; 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 establishes minimum requirements for good practices for the materials and installation of mechanical trenchless repair sleeve with a locking gear mechanism for pipes of varying inner diameter and offset joints in the range of 6 to 72 in. (150 to 1800 mm).

1.2 This practice applies to storm, potable water, wastewater and industrial pipes, conduits and drainage culverts.

1.3 When the specified materials are used in manufacturing the sleeve and installed in accordance with this practice, the sleeve shall extend over a predetermined length of the host pipe as a continuous, tight fitting, corrosion resistant and verifiable non-leaking pipe repaired using one or more pieces of the repair sleeve mechanism. The maximum internal pressure this sleeve can carry depends on the diameter and the wall thickness, ranging from 10 to 15 bars; the external pressure shall not exceed 1.5 bars.

1.4 All materials in contact with potable water shall be certified to meet NSF/ANSI 61/372.

1.5 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.6 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use. Particular attention is drawn to those safety regulations and requirements involving entering into and working in confined spaces.*

1.7 *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:*[2]

A240/A240M Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

A666 Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar

2.2 *NASSCO Guidelines:*[3]

Specifications for Sewer Collection System Rehabilitation

2.3 *European Standard:*[4]

EN 681-1 Elastomeric seals—Materials requirement for pipe joint seals used in water and drainage applications—Part 1: Vulcanized rubber

2.4 *NSF/ANSI Standards:*[5]

NSF/ANSI 61 Drinking water system components

NSF/ANSI 372 Drinking water system components

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *access point, n*—upstream or downstream locations that serve as the point of entry or exit for the point repair of the existing pipe.

3.1.2 *bladder, n*—an apparatus, when pressurized, inflates a tube that presses against the inner pipe walls.

3.1.3 *EPDM rubber, n*—ethylene propylene diene monomer rubber formed to yield wide ranging engineering properties using a synthetic process.

[1] This practice is under the jurisdiction of ASTM Committee F36 on Technology and Underground Utilities and is the direct responsibility of Subcommittee F36.20 on Inspection and Renewal of Water and Wastewater Infrastructure.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from National Association of Sewer Service Companies (NASSCO), 2470 Longstone Lane, Suite M, Marriottsville, MD 21104, http://www.nassco.org.

[4] Available from European Committee for Standardization (CEN), Avenue Marnix 17, B-1000, Brussels, Belgium, http://www.cen.eu.

[5] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

3.1.4 *finished thickness, n*—the finished sleeve thickness after installation.

3.1.5 *hydrophilic, n*—a material that is moisture activated with expansion characteristics of 5–8 times its original thickness.

3.1.6 *locking gear, n*—gears that alter the diameter of the sleeve that can be locked to retain a desired diameter for the sleeve when put into service.

3.1.7 *NBR, n*—nitrile butadiene rubber.

3.1.8 *offset joints, n*—joints with defects from the inner bore area not aligning perfectly.

3.1.9 *packer, n*—an inflatable bladder device on wheels that transports a sleeve through the pipe and further inflates/expands for final sleeve installation.

3.1.10 *point repair, n*—repair of a local defect without relining damaged pipe, conduit or culvert from one manhole to the next.

3.1.11 *resin, n*—synthetic fluid that hardens to become a solid when cured by steam, heat, ultraviolet light or under ambient conditions.

3.1.12 *serial installation, n*—using more than one sleeve to perform point repair.

3.1.13 *single installation, n*—using a single sleeve to perform point repair.

3.1.14 *sleeve, n*—tubular shaped component of various length, diameter and wall thickness.

4. Significance and Use

4.1 This practice is for use by design engineers, specifiers, regulatory agencies, owners, installers, and inspection organizations who are involved in the rehabilitation of pipes through the use of a Mechanical Trenchless Point Repair Sleeve with a Locking Gear Mechanism for Pipes of Varying Inner Diameter and Offset Joints within a damaged existing pipe.

4.2 This practice applies to the following types of defects in pipe that can be repaired: longitudinal, radial and circumferential cracks, fragmentation, leaking joints, displacement or joint misalignment, closing or sealing unused laterals, corrosion, spalling, wear, leaks in the barrel of the pipe, deformation in the pipe and root penetration. There are no limitations on the diameters of the laterals that can be sealed. The degree of deformation that can be repaired is dependent on the minimum and maximum diameters for which the sleeve is applicable as listed in the tables of dimensions shown in Appendix X1 but shall never exceed 5 %.

4.3 This practice applies to pipes made of vitrified clay, concrete, reinforced concrete, plastics, glass reinforced plastics, cast iron, ductile iron and steel for both pressure and non-pressure applications.

4.4 In this practice, no issues of snagging waste or build-up of sludge or sediment have been recorded to date; the performance of this sleeve, however, depends on many factors; therefore, past operational records may not include all possible future conditions under which the user may install these sleeves.

4.5 The suitability of the technology covered in this practice for a particular application shall be jointly decided by the authority, the engineer and the installer.

5. Essential Components Forming the Sleeve and Their Functions

5.1 *Stainless Steel Sleeve:*

5.1.1 *Flared End*—The flared end faces the direction of flow and improves the hydrodynamics, prevents solids from depositing, and increases jetting resistance, (1) in Fig. 1 and Fig. 3. Flared ends are not used, however, for potable water applications.

5.1.2 *Metal Overlap*—The steel sleeve is rolled up smaller than its nominal diameter. The overlap is what is left over for expanding to the pipe wall, (2) in Fig. 1.

5.1.3 *Toothed Strip*—The locks that keep the sleeve expanded run along the toothed strip, (3) in Fig. 1.

5.1.4 *Lock*—The lock is a small set of gears that only moves in one direction, thus keeping the sleeve expanded, (4) in Fig. 1 and Fig. 3. The locking gears are also shown in Fig. 4. There are three gears per lock. Six gears per sleeve (two locks per sleeve). Two of the gears in the lock ride in the corresponding "teeth" in the sleeve. The third gear is the lock. It allows the other two gears to only move in a forward direction. All three gears are shielded by a cover. The gears and the shield are all of the same material as the rest of the sleeve. Therefore, all components of the sleeve offer the same design life. Furthermore, the gears are protected by a cover to prevent snagging of waste, or build up of sludge or sediment.

5.1.5 *Adhesive Tape*—The tapes are put on at the factory to protect the sleeve during transport and prevent it from unrolling, (5) in Fig. 1.

5.2 *Rubber Seal:*

5.2.1 *Circumferential Seals*—The actual seal is formed by the circumferential seals compressed against the host pipe. The damaged section must always be between the sealing knobs, (6) in Fig. 2 and Fig. 3.

5.2.2 *Trimming Line*—There is a trimming line marked in the rubber jacket. It shows the installer where to cut off the projecting rubber end (when a single sleeve is installed), (7) in Fig. 2.

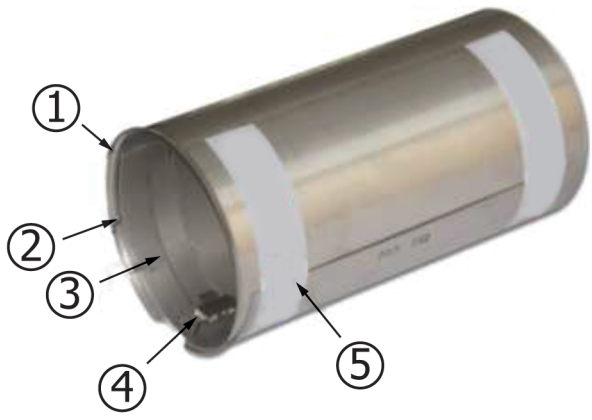

FIG. 1 Stainless Steel Sleeve

FIG. 2 Locking Gear Mechanism and EPDM Rubber Seals

5.2.3 *Projecting Rubber End*—The projecting rubber end acts as a seal between sleeves installed in series, (8) in Fig. 2 and Fig. 3.

6. Pre-installation Inspection and Preparation of Damaged Pipe

6.1 *Inspecting the Pipe:*

6.1.1 Before using the sleeve, the pipe must be inspected to ascertain whether it can be repaired with the system. Cleaning and inspection shall be as per NASSCO guidelines for sewage pipes. For other pipes, cleaning and inspection methods that are acceptable to the authority shall be chosen by the installer. There must be at least one access via a manhole or an inspection chamber. The manhole must have a diameter of at least 24 in. (600 mm) so that the camera/packer system can be inserted. The manhole flume must also be larger than those diameters listed in the column titled "V4A pipe rolled dia" shown in Appendixes X1.1, X1.2, X1.4 and X1.5 in order to ensure insertion of the packer with the sleeve into the pipe. For sleeve diameters 32 to 72 in. (800 to 1800 mm) as shown in Appendixes X1.3 and X1.6, and because these sleeves are provided in 2 or 3 segments, a manhole flume dia of 24 in. (600 mm) is sufficient. The interior of the pipeline shall be carefully inspected to determine the location of any condition that shall prevent proper installation, such as roots, and collapsed or crushed pipe. These conditions shall be noted. Experienced personnel trained in locating breaks, obstacles, and service connections by closed circuit television shall perform inspection of pipelines.

6.2 *Preparing the Pipe:*

6.2.1 The pipe to be repaired must always be cleaned with a high-pressure jet, a drag scraper or an equal approved by the owner, the owner's representative or the manufacturer, before using the sleeve. Hardened deposits, roots, and protruding sockets must be removed with suitable milling or cutting tools. No obstacles may restrict movement through the pipe. There may not be any solids such as sand, gravel, hardened deposits, or wastewater solids around the damaged area. Joint misalignments of more than 0.4 in. (10 mm) must be milled off before an individual sleeve is installed, or repaired using two sleeves. Prudent precautionary measures shall be taken before milling methods are commenced in situations where the structural integrity of the existing pipe may be compromised. The engineer shall conduct a structural condition evaluation and shall set appropriate limits on the depth of milling allowed. Depending on the quantity of flow present, bypassing in accordance with the authority's requirements may be necessary.

6.3 *Measuring the Internal Diameter of Existing Pipe:*

6.3.1 Prior to installation, the internal diameter of the existing pipe to be repaired shall be measured to ascertain correct sizing of the sleeve in accordance with the manufacturer's recommendations. Such measurements shall be taken at both ends of the pipe segment being repaired along both diameters: 6 o'clock to 12 o'clock and 3 o'clock to 9 o'clock orientations.

6.3.2 The above apply to wastewater pipes; when the repair sleeve is used in potable water pressure pipes, a protector sheet, made of high grade stainless steel in accordance with Section 2, around the rubber sleeve is needed.

7. Equipment and Materials

7.1 *Equipment:*

7.1.1 The following equipment is needed for installing the sleeve efficiently: inspection camera or robot with zoom and pan & tilt functions, adjusted to the diameter of the pipe; appropriate sleeve packer for the pipe diameter; hollow sleeve link bar for connecting the camera tractor to the packer; vent valve; a compressor with an output of at least 5.0 bar; an air hose on a drum with a length of at least 330 ft (100 m); a robot cutter for preparatory tasks.

7.2 *Materials Forming the Sleeve:*

7.2.1 *Stainless Steel:*

7.2.1.1 The sleeve shall be made of high grade stainless steel, in accordance with 316 or 316 L type as specified in Specification A240/A240M, Specification A666 or German V4A stainless steel of grade 1.4401 or 1.4404. This grade of stainless steel is characterized by its high corrosion resistance. The sleeve is designed for use in municipal water and wastewater systems. For use with industrial wastewater or where the wastewater contains high levels of chloride salts, the required corrosion resistance must be ascertained. Stainless steel of grade 316 or 316 L or German V4A stainless steel of grade 1.4401 or 1.4404 may be used up to a chloride concentration of 600 mg/l. Higher molybdenum content requirements shall be determined by the engineer for chloride concentrations higher than 600 mg/l. Further dimensional details are given in Appendixes X1.1, X1.2, and X1.3 for pipe sizes 6 to 72 in. (150 to 1800 mm) based on the schematic diagram shown in Appendix X3. Corresponding metric versions are given in Appendixes X1.4, X1.5, and X1.6.

7.2.1.2 Before using in industrial, non-municipal wastewater systems, the corrosion resistance of stainless steel of grade 316 or 316 L or German V4A stainless steel of grade 1.4401 or 1.4404 and the EPDM sleeve must be verified by the engineer.

7.2.1.3 There are three types of sleeves available: non-flared, one end-flared and both ends flared. Non-flared sleeves are mainly used for potable water applications or serial

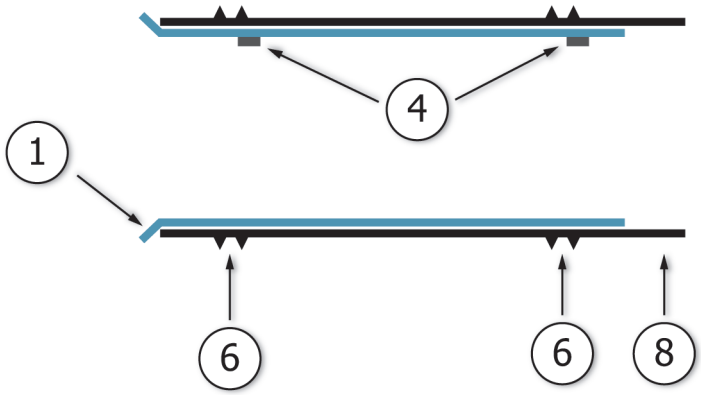

FIG. 3 Cross Sectional View of the Sleeve and the EPDM Rubber Seals

FIG. 4 Locking Gear Mechanism

installations, followed by one end-flared sleeves. The both ends flared type is used for single installations only.

7.2.2 *EPDM Rubber:*

7.2.2.1 EPDM seal shall meet the physical property requirements for elastomeric materials used in cold water supply, drainage, sewerage and rainwater systems for Type WC in Table 2 of EN 681-1 Hardness Category of 40. Like the steel sleeve, the thermoset polymer EPDM seal is chemically resistant to common sewage and potable water. EPDM usually offers desirable physical properties and resistance to aging, ozone, weathering and environmental effects, alkalis, and various chemicals. EPDM is, however, unsuitable, or only suitable with restrictions for: Solvents, Ethers, esters, ketones, methylene chloride, animal and vegetable fats, oils, fuels, concentrated fruit juice, and oxidizing acids. An NBR rubber seal is available on request for possible use with oils, greases, and hydrocarbons. NBR and similar elastomers may be appropriate for other effluents or where contaminated soils are surrounding the exterior of the pipe. The sleeve may also be suitable, with certain restrictions, for industrial use, depending on the properties of the fluids.

7.3 *Material Needed During Installation:*

7.3.1 The following materials are required in order to prepare the sleeve: sharp knife; talcum/baby powder; superglue; bio-degradable penetrating oil or food-grade lubricant; hydrophilic water stop, when groundwater infiltration and exfiltration are present; mineral-based flexible mortar when root penetration, corrosion on reinforced concrete pipes pose problems.

8. Installation Recommendations

8.1 *Access Safety*—Prior to entering access areas such as manholes or excavation pits, to perform inspection or cleaning operations, an evaluation of the atmosphere shall be conducted to determine the presence of toxic or flammable vapors or lack of oxygen in accordance with local, state, and federal safety regulations.

8.2 *Line Obstructions*—The existing host pipe shall be clear of obstructions that prevent the proper insertion, deployment and expansion of the sleeve. Changes in pipe size shall be accommodated according to the pipe diameter and condition. Severely dropped or offset joints may prevent the installation packer from reaching the repair location. In all cases, the user shall consult the tables of dimensions listed for compressed sizes of the sleeves in Appendix X1.

8.3 *Use of a Packer*—The sleeves are installed using a special device named packer. Each packer can be used for at least two different pipe diameters and special sizes in between as shown in the technical data sheet (Appendix X1). For each standard pipe diameter, there is a suitable set of wheels (or a set of wheels with a wider track). Special diameters usually

require special sets of wheels, which are available on request. The maximum installation pressures are listed in Appendix X2. The packer is usually connected to the camera or robot via a bracket and a hollow link bar with ball joints at each end. For repairs more than 20 ft (6 m) into the line the sleeve is installed most efficiently and accurately when the packer is positioned by using a crawler camera equipped with an accurate distance counter. For repairs closer to the manhole, telescopic poles or other insertion apparatus can also be used. Either way, a camera is recommended to observe the installation.

8.4 *Positioning the Sleeve on the Packer*—Select the correct set of wheels for the pipe diameter (see Appendix X1). The sleeve is usually positioned on the packer while in the manhole. When installing flared sleeves, the flared end should face against the direction of flow. Position the sleeve on the packer so that it is flush with the front of the packer. If the installer is using a packer equipped with a laser, position the sleeve so that the laser beam is reflected both on the edge of the sleeve and the host pipe. In both cases, the camera gives a good view of the edge of the sleeve. Depending on which direction the installer is looking, the lock is in the 11:00 or the 1:00 position. After installation, the lock is always near the top, in other words near the 12:00 position.

8.5 *Single Installation Procedure:*

8.5.1 Sleeves can be installed individually to repair areas of damage smaller than the distance between the circumferential seals. If two manholes are available, in consideration of space it is advisable to insert the camera with the packer in one manhole and collect it in the other. For single installation, always use flared sleeves. Grip the sleeve by inflating the packer bladder to a holding pressure of approximately 0.5 bar. This stops the sleeve from slipping off. The holding pressure of 0.5 bar can vary slightly depending on the compressed air unit, the pipe diameter, and the packer. The holding pressure is correct when the sleeve is firmly held on the packer but does not start to open. In the manhole, connect packer to the hollow link bar and then to the camera tractor bracket. Commence the travel through the pipe and position the packer with the sleeve over the center of the damaged pipe area.

8.5.2 The sleeve opens more easily if the metal overlap and gear are lubricated. Particularly in 18 to 32 in. (450 to 800 mm) pipes, the sleeve needs more time to open the full expansion. Increase the pressure to the sleeve in stages and let it expand to the fullest extent for each stage. If the installer notices that the sleeve is obstructed or not opening smoothly, reduce the application pressure and reposition the packer so that the middle of the bladder is in line with the middle of the sleeve. If the sleeve is expanded eccentrically it can produce torsion which may damage the lock or the toothed strips. Let the sleeve expand to the wall of the pipe with a positioning pressure of approximately 2.0–2.5 bar. Deflate the packer bladder slightly so that the installer can position it in the middle of the sleeve. Now apply the appropriate application pressure of 3.0–5.0 bar (Appendix X2), depending on the type of damage and pipe diameter. For longitudinal cracks and fragmentation, particularly in vitrified clay pipes, do not expand the packer outside the sleeve, because this can damage (burst) the host pipe.

8.5.3 With a camera, check that the sleeve is correctly installed. Pan around the edges of the sleeve. The sleeve should now be fully pressed against the wall of the pipe. If there is any misalignment or displacement, one side of the sleeve may have to be expanded again. In vitrified clay pipes, the glare of the camera light may cause a reflection around the edge of the sleeve on the pipe wall, which could be deceiving. The installer might think that the sleeve is not properly fitted. This optical illusion can be eliminated by changing the camera position.

8.6 *Serial Installation:*

8.6.1 Sleeves are installed in series when the damage length comes close to, or extends longer than the distance between the circumferential seals (sealing length) of a single sleeve. For preparation, the projecting part of the rubber jacket is only trimmed off on the last sleeve to be installed. The installation procedure and installation pressures are the same as when installing single sleeves. The first sleeve facing against the direction of flow (see Fig. 5) must always have a flared end (all the others are non-flared).

8.6.2 Ideally, the installer should work against the direction of flow when installing the sleeves. This way, the small step

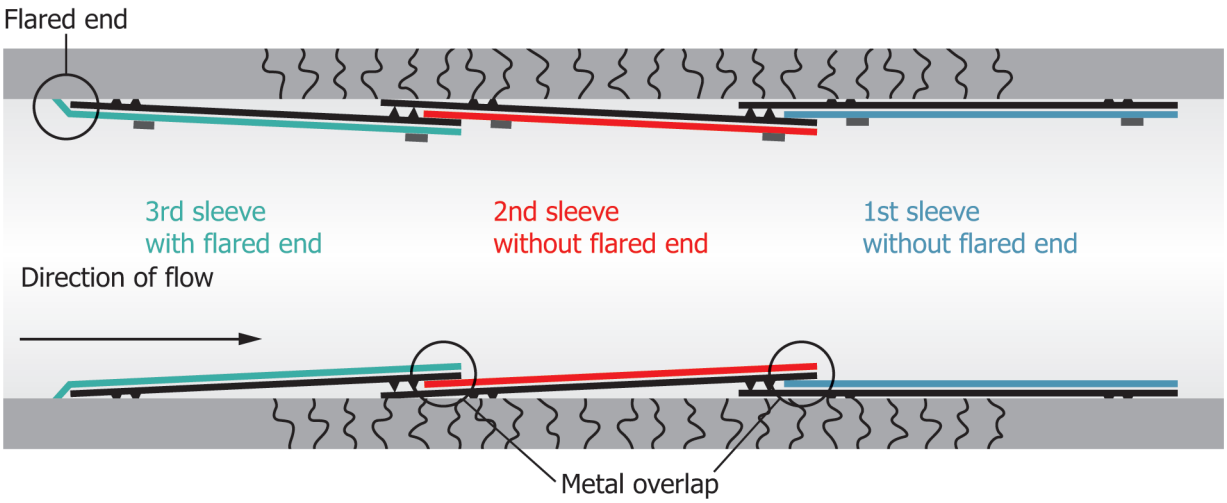

FIG. 5 Serial Installation

where the sleeves overlap does not obstruct the flow, because the water flows downwards. In the case of extreme fragmentation or longitudinal cracks, reduce the application pressure by 0.5–1.0 bar. First, place all the sleeves using reduced application pressure. Once all sleeves are in position, apply the full application pressure to all the sleeves, in the same order as above. This is to prevent fragments from coming loose or the pipe to collapse, particularly if the pipe bedding is damaged. For incipient longitudinal cracks, the entire length of the host pipe must be repaired, because the crack will continue to the end of the pipe regardless of the repair. Sleeves of 6 in. (150 mm) diameter cannot currently be installed in series. If the utility owner wants to install two sleeves, it can be done with two flared sleeves.

NOTE 1—The installer should work against the direction of flow when installing the sleeves.

8.7 *Installation in Pipe Sizes Larger than 32 in. (800 mm):*

8.7.1 This is a manual installation, which requires a person to move through the pipe and use mechanical tools for expanding the sleeve. Depending on the quantity of flow present, bypassing in accordance with the authority's requirements may be necessary.

8.7.2 The length of these sleeves is only 8 in. (200 mm) and the sealed area is only about 5 in. (125 mm). All protruding obstacles shall be removed manually as well as evening out any joint misalignments of more than 2 in. (50 mm) using mineral mortar. There are situations where reprofiling can be better accomplished with epoxy resin on wet concrete show better results. Stop infiltration by using plugging mortar and even out any corroded, porous inner pipe surfaces in the sealing area with mineral mortar. Bring in the sleeve segments through the manhole entrance as components and assemble so that the tracks are on the outside. Place the sliding blocks in the tracks and secure the sliding blocks with the locking screws. Adjust the sleeve to the smallest diameter and tighten the locking screws. Apply talcum powder to the inside of the rubber seal. Pull the seal over the sleeve until the tapered rubber edge is positioned on the steel sleeve. On one side of the damage, at a distance of 4 in. (100 mm) from the center, mark the position of the sleeve all the way around the circumference of the pipe to serve as the positioning reference.

8.7.3 Position the sleeve so that the tapered edge of the rubber seal faces against the direction of flow. Align the sleeve to the reference marking on the pipe. Turn the sleeve so that the locking screws are roughly level on the left and right sides of the pipe (3 and 9 o'clock positions). Loosen the locking screws. Tighten the spindle to about half way until the sleeve is pressed against the pipe. Just before the sleeve is pressed to the pipe, align it once again to the marking or the axis of the pipe. Tighten the locking screws. Loosen the spindles. Reposition the two parts of each clamping tool as close together as possible. Fasten them with the clamping screws. Keep expanding until the thickness of the seal combo (rubber seal + metal sleeve) is less than 0.5 in. (12 mm) for 32 to 52 in. (800 to 1300 mm) or 0.55 in. (13 mm) for more than 52 in. (1300 mm). For minor joint misalignments and bends, or persisting leaks, the sleeve can be expanded eccentrically using the second clamping screw. Make sure that the sleeve has reached its final state. Tighten the locking screws using the ratchet. Loosen the clamping screws of the tools. Remove the tools.

9. Post Installation Inspection

9.1 After the work is completed, the installer shall provide the utility owner or the authority with video footage documenting the completed work, as per NASSCO Guidelines.

9.2 Leakage testing shall be done in accordance with the utility owner's requirements.

9.3 Repairs that do not meet the requirements shall be removed and replaced at no additional cost to the authority at the request of the authority.

10. Keywords

10.1 conduits; cracks; culverts; damage; exfiltration; gear; gravity; infiltration; joints; leakage; locking; mechanical; no-dig; offset; pipes; point repair; pressure; storm drains; trenchless; zero leakage

APPENDIXES

(Nonmandatory Information)

X1. TECHNICAL DATA

X1.1 *Technical Data on Sleeves for Pipes of 6 to 13 in.*—See Table X1.1.

X1.2 *Technical Data on Sleeves for Pipes of 14 to 32 in.*—See Table X1.2.

X1.3 *Technical Data on Sleeves for Pipes of 32 to 72 in.*—See Table X1.3.

X1.4 *Technical Data on Sleeves for Pipes of 150 to 330 mm*—See Table X1.4.

X1.5 *Technical Data on Sleeves for Pipes of 350 to 800 mm*—See Table X1.5.

X1.6 *Technical Data on Sleeves for Pipes of 800 to 1800 mm*—See Table X1.6.