

PLASTIC LINING FOR CONCRETE STRUCTURES AND REINFORCED CONCRETE PIPE FOR MUNICIPAL WASTEWATER SYSTEMS**PVC SHEET LINER TYPICAL SPECIFICATIONS****PART 1 GENERAL****1.01 SUMMARY**

- A. This specification covers the supply and installation of a flexible PVC sheet liner with continuous locking extensions in reinforced concrete pipe and auxiliary structures to effectively protect the exposed concrete surfaces from corrosion. To accomplish this, the liner must be continuous and free of pinholes both across the joints and in the liner itself. All work for and in connection with the installation of the lining in concrete pipe, and the field sealing and welding of joints, shall be done in strict conformity with all applicable specifications, instructions and recommendations of the lining manufacturer. The manufacturer of the lining shall furnish an affidavit attesting to the successful use of its material as a lining for sewer pipes for a minimum period of 50 years in sewage conditions recognized as corrosive or otherwise detrimental to concrete.

1.02 INSTALLER QUALIFICATIONS AND INSPECTOR QUALIFICATIONS

- A. The application of plastic liner to forms and other surfaces, welding of plastic liner and final testing is considered to be highly specialized work. Personnel performing such work shall be adequately trained in the methods of liner installation, have extensive experience installing PVC concrete embedded lining products and shall demonstrate their ability to the Engineer and lining manufacturer prior to commencing work. In addition to required experience, each applicator who will be applying the protective lining system shall also be in possession of a liner manufacturer issued picture identification card with a valid date indicating the individual applicator is approved to install the product. This identification card shall be presented at any time upon request to the project Owner, Engineer, Liner Manufacturer or designated Inspector. Contact the lining manufacturer for a list of experienced installers.
- B. The Owners Inspector shall be adequately trained in the proper installation and testing methods of the specified PVC Lining System before installation. The contractor installing the PVC Lining System shall provide to the Lining Manufacturer the Inspector contact information a minimum of 15 days prior to Liner installation. Costs for training the Owners Inspector as per this paragraph will be for contractors account.

1.03 SUBMITTALS

- A. Prior to plastic liner installation, the Contractor shall submit shop drawings of construction details. The shop drawings shall include the following information:

1. Contractor shall submit shop drawings showing proposed panel layout to cover area to be lined. Show on shop drawings proposed details for installation of liner at seams, terminations, corners, openings, pipe penetrations, etc.
2. Complete description of plastic liner installation including material lists, certifications and required test results.
3. Welder certifications for each welder including proof of minimum experience requirement in section 1.02 A.

PART 2 MATERIAL

2.01 MANUFACTURERS

- A. Liner shall be T-Lock as manufactured by Northwest Pipe Company, Brea, California.

2.02 COMPOSITION

- A. The material used in the liner, welding strips and other accessory items, shall be a combination of poly vinyl chloride resin, pigments and plasticizers, specially compounded to remain flexible. Poly vinyl chloride resin shall constitute not less than 99 percent by weight, of the resin used in the formulation. Copolymer resins will not be permitted.

2.03 PHYSICAL PROPERTIES

- A. All plastic liner plate sheets, welding strips and other accessory items, shall have the following physical properties when tested at 77°F±5° (25°C±3°).

| Property | Initial | (Para. 2.04) |
|---|------------------------------|-------------------------------|
| Tensile Strength | 2200 psi min. (15 Mpa min.) | 2100 psi min. (14.5 Mpa min.) |
| Elongation at break | 200% min. | 200% min. |
| Shore Durometer, Type D (with respect to initial test results) | 1-sec 50-60 10-sec. 35-50 | ±5 ±5 |
| Weight Change | | ± 1.5% |

- B. Tensile specimens shall be prepared and tested in accordance with ASTM D412 using Die B. Weight change specimens shall be 1-inch (25-mm) by 3-inch (75-mm) samples. Specimens for testing of initial physical properties may be taken from liner sheet and welding strip at any time prior to final acceptance of the work.

- C. Continuous locking extensions embedded in concrete shall withstand a test pull of at least 100 pounds per linear inch (1800 kg/m), applied perpendicularly to the concrete surface for a period of one minute, without rupture of the locking extensions or withdrawal from embedment. This test shall be made at a temperature of 70°- 80°F (21° - 27°C) inclusive.
- D. All plastic liner plate sheets, including locking extensions, all joint, corner and welding strips shall be free of cracks, cleavages or other defects adversely affecting the protective characteristics of the material. The engineer may authorize the repair of such defects by approved methods.
- E. The lining shall have good impact resistance, shall be flexible and shall have an elongation sufficient to bridge up to 1/4-inch (6 mm) settling cracks, which may occur in the pipe or in the joint after installation, without damage to the lining.
- F. The lining shall be repairable at any time during the life of the pipe or the structure.

2.04 CHEMICAL RESISTANCE PREQUALIFICATION TEST

- A. After conditioning to constant weight at 110°F (43°C), tensile specimens and weight change specimens shall be exposed to the following solutions for a period of 112 days at 77°F±5° (25°C±3°). At 28-day intervals, tensile specimens and weight change specimens shall be removed from each of the chemical solutions and tested in accordance with Paragraph 2.03 B. If any specimen fails to meet the 112-day requirement before completion of the 112-day exposure, the material will be subject to rejection.

| Chemical Solution | Concentration |
|---|----------------------------|
| Sulfuric acid | 20%** |
| Sodium hydroxide | 5% |
| Ammonium hydroxide | 5%** |
| Nitric acid | 1%** |
| Ferric chloride | 1% |
| Sodium hypochlorite | 1% |
| Soap | 0.1% |
| Detergent (linear alkyl benzyl sulfonate or LAS) | 0.1% |
| Bacteriological | BOD not less than 700 ppm. |
| | |

This is to be used as a pre-qualification test and when material formulations are changed.

*** Volumetric percentages of concentrated C.P. grade reagents.*

2.05 DETAILS AND DIMENSIONS OF BASIC SIZE SHEETS (4-foot widths)

- A. Liner sheets shall be a minimum of 0.065 inch (1.65 mm) in thickness. Locking extensions (T-shaped) of the same material as that of the liner shall be integrally extruded with the sheet. Locking extensions shall be approximately 2 1/2 inches (64 mm) apart and shall be at least 0.375-inch (9.5 mm) high.
- B. Sheets shall have a nominal width of 48 inches (1200 mm) and a length of not more than 24 feet (7.3 m), except that longer lengths may be supplied on special order. Lengths specified shall include a tolerance at a ratio of $\pm 1/4$ inch (6 mm) for each 100 inches (2500 mm).
- C. Sheets not used for shop fabrication into larger sheets shall be shop tested for pinholes using an electrical spark tester set between 18,000 and 22,000 volts. Any holes shall be repaired and retested.
- D. Special sized, factory pre-welded sheets are available on special order.

2.06 PIPE SIZE SHEETS AND ACCESSORIES

- A. Pipe linings shall be supplied as pipe-size sheets, fabricated by shop-welding the basic-size sheets together. Shop welds shall be made by lapping sheets a minimum of 1/2 inch and applying heat and pressure to the lap to produce a continuous welded joint. Tensile strength measured across shop-welded joints in accordance with ASTM D412 shall be at least 2000 psi (14 MPa).
- B. If required, strap channels shall be 1-inch (25-mm) wide maximum and formed by removing the locking extensions so that a maximum of 3/16 inch (5 mm) remains.
- C. Sheets also can be supplied in prefabricated, pipe-size tubular-shaped sheets, ready to lower onto the inner pipe forms. These normally do not require the use of strap channels.
- D. Transverse flaps may be provided at the ends of sheets for pipe. Locking extensions shall be removed from flaps so that a maximum of 1/32 inch (1mm) of the base of the locking extension is left on the sheet.
- E. Welding strips shall be approximately 1-inch (25 mm) wide with a minimum width of 7/8 inch (22 mm). The edges of weld strips shall be beveled in the manufacturing process. Thickness of weld strip shall be a nominal 1/8 inch (3 mm).

- F. Joint strips for pipe shall be 4-inches (100 mm) wide with a minimum width of 3/4 inches (94 mm). Thickness of joint strips shall be a nominal of 3/32 inch (2.3 mm).
- G. Prior to preparing sheets for shipment, they shall be tested for pinholes using an electrical spark tester set between 18,000 and 22,000 volts. Any holes shall be repaired and retested.

PART 3 INSTALLATION OF LINING

3.01 GENERAL

- A. Installation of the lining, including preheating of sheets in cold weather and the welding of all joints, shall be done in accordance with the recommendations of the liner manufacturer.
- B. Coverage of the lining shall not be less than the minimum shown on the plans.
- C. The lining shall be installed with the locking extensions running parallel with the longitudinal axis of the pipe.
- D. The lining shall be held snugly in place against inner forms.
- E. Locking extensions shall terminate not more than 1 1/2 inches (38 mm) from the end of the inside surface of the pipe section. Joint flaps when used shall extend approximately 4 inches (100 mm) beyond the end of the inside surface.
- F. Concrete poured against lining shall be vibrated, spaded or compacted in a careful manner so as to protect the lining and produce a dense, homogenous concrete, securely anchoring the locking extensions into the concrete.
- G. In removing forms, care should be taken to protect the lining from damage. Sharp instruments shall not be used to pry forms from lined surfaces. When forms are removed, any nails that remain in the lining shall be pulled, without tearing the lining, and the resulting holes clearly marked.
- H. All nail and tie holes and all cut, torn and seriously abraded areas in the lining shall be patched. Patches made entirely with welding strip shall be fused to the liner over patch area. Larger patches may consist of smooth liner sheet applied over the damaged area with adhesive. All edges must be covered with welding strip fused to the patch and the sound lining adjoining the damaged area.
- I. Hot joint compounds, such as coal tar, shall not be poured or applied to the lining.

- J. The contractor shall take all necessary measures to prevent damage to installed lining from equipment and materials used in or taken through the work.

3.02 APPLICATION TO CONCRETE PIPE

- A. The lining shall be set flush with the inner edge of the bell or spigot end of a pipe section and shall extend to the opposite end or to approximately 4 inches (100 mm) beyond the opposite end depending upon the type of lining joint to be made with the adjoining concrete pipe.
- B. Wherever concrete pipe or cast-in-place structures protected with lining joint structures not so lined (such as brick structures, concrete pipe or cast-in-place structures with clay lining or clay pipe), the lining shall be extended over and around the end of the pipe and back into the structure for not less than 4 inches (100 mm). This protecting cap may be molded or fabricated from the lining material but need not be locked into the pipe.
- C. Where a pipe lateral (not of plastic lined concrete) is installed through lined concrete pipe, the seal between the lined portion and the lateral shall be made by the method prescribed for cast-in-place structures under Paragraph 3.04 B.
- D. Lined concrete pipe may be cured by standard curing methods.
- E. Care shall be exercised in handling, transporting and placing lined pipe to prevent damage to the lining. No interior hooks or slings shall be used in lifting pipe. All handling operations shall be done with an exterior sling or with a suitable fork lift.
- F. No pipe with damaged lining will be accepted until the damage has been repaired to the satisfaction of the engineer.

3.03 FIELD JOINTS IN LINING FOR CONCRETE PIPE

- A. The joint between sections of lined pipe shall be prepared in the following manner: If required, the inside joint shall be filled and carefully pointed with cement mortar in such a manner that the mortar shall not, at any point, extend into the pipe beyond the straight line connecting the surfaces of the adjacent pipe sections. Pipe joints must be dry before lining joints are made.
- B. All mortar and other foreign material shall be removed from lining surfaces adjacent to the pipe joint, leaving them clean and dry.
- C. Field joints in the lining at pipe joints may be either of the following described types:

1. Type P-1: The joint shall be made with a separate 4-inch (100 mm) joint strip and two welding strips. The 4-inch (100 mm) joint strip shall be centered over the joint, heat sealed to the lining, then welded along each edge to adjacent liner sheets with a 1-inch (25 mm) weld strip. The 4-inch (100 mm) joint strip shall lap over each sheet a minimum of 1/2 inch (13 mm).
 2. Type P-2: The joint shall be made with a joint flap with locking extensions removed per Paragraph 2.6.4 and extending approximately 4 inches (100 mm) beyond the pipe end. The joint flap shall overlap the lining in the adjacent pipe section a minimum of 1/2 inch (13 mm) and be heat-sealed in place prior to welding. The field joint shall be completed by welding the flap to the lining of the adjacent pipe using 1-inch (25 mm) weld strip. Care shall be taken to protect the flap from damage. Excessive tension and distortion in bending back the flap to expose the pipe joint during laying and joint mortaring shall be avoided. At temperatures below 50°F (10°C), heating of the liner may be required to avoid damage. Consult manufacturer when working with PVC Liner at temperatures below 50 degrees F.
- D. The joint flap or strip on beveled pipe shall be trimmed to a width (measured from the end of the spigot) of approximately 4 inches (100 mm) for the entire circumferential length of the lining.
- E. All welding of joints is to be in strict conformance with the specifications and instructions of the lining manufacturer. Welding shall fuse both sheets and weld strip together to provide a continuous joint equal in corrosion resistance and impermeability to the basic liner sheet. Hot-air welding tools shall provide effluent air to the sheets to be joined at a temperature between 500° and 600°F (260° and 316°C). Welding tools shall be held approximately 1/2 inch (13 mm) from and moved back and forth over the junction of the two materials to be joined. The welding tool shall be moved slowly enough as the weld progresses to cause a small bead of molten material to be visible along both edges and in front of the weld strip.
- F. Joint welding for liners that have 360 degrees of coverage:
- G. When groundwater is encountered the lining joint shall not be made until pumping of groundwater has been discontinued for at least three days and no visible leakage is evident at the joint. The T-Lock Type P-1 or Type P-2 joint can be completely welded 360 degrees for a complete water tight joint, or if required by the project specifications, or if instructed by the project owner or project engineer, a 6" to 8" (150 mm to 200 mm) opening can be left in the downstream side of the joint strip or flap at the pipe invert to provide relief of potential ground water buildup.

3.04 APPLICATION TO CAST-IN-PLACE CONCRETE STRUCTURES

- A. Liner sheets shall be closely fitted and properly secured to the inner forms. Sheets shall be cut to fit curved and warped surfaces using a minimum number of separate pieces.
- B. Unless otherwise shown on the plans, the lining shall be returned at least 3 inches (75 mm) at the surfaces of contact between the concrete structure and items not of concrete (including manhole frames, gate guides, clay pipe or brick manholes and clay or cast iron pipes). The same procedure shall be followed at joints where the type of protective lining is changed or the new work is built to join existing unlined concrete. At each return, the returned liner shall be sealed to the item in contact with the plastic-lined concrete using Amer-Plate T-Lock 19Y adhesive system. If the liner cannot be sealed with this adhesive because of the joint at the return being too wide or rough or because of safety regulations, the joint space shall be densely caulked with lead wool or other approved caulking material to a depth of 2 inches (50 mm) and finished with a minimum of 1 inch (25 mm) of an approved corrosion resistant material.
- C. Liner sheeting, except where indicated otherwise, shall have integral locking extensions. The liner shall be mechanically and permanently embedded in the concrete. Where liner with T-Lock ribbing cannot be installed, flat sheets with 19Y adhesive and batten strips with mechanical anchors spaced minimum 12 inches on center may be used if the Engineer approves.

3.05 JOINTS IN LINING FOR CAST-IN-PLACE CONCRETE STRUCTURES

- A. Lining at joints shall be free of all mortar and other foreign material and shall be clean and dry before joints are made.
- B. Field joints in the lining shall be of the following described types, used as prescribed:
 - 1. Type C-1: The joint shall be made with a separate 4-inch (100 mm) joint strip and two welding strips. The 4-inch (100 mm) joint strip shall be centered over the joint, heat-sealed to the liner then welded along each edge to adjacent sheets with a 1-inch (25 mm) wide welding strip. The width of the space between adjacent sheets shall not exceed 2 inches (50 mm). The 4-inch (100 mm) joint strip shall lap over each sheet a minimum of 1/2 inch (13 mm). It may be used at any transverse or longitudinal joint.
 - 2. Type C-2: The joint shall be made by lapping sheets not less than 1/2 inch (13 mm). One 1-inch (25 mm) welding strip is required. The upstream sheet shall overlap the one downstream. The lap shall be heat-sealed into place prior to welding on the 1-inch (25 mm) welding strip.
 - 3. Type C-3: The joint shall be made by applying 2-inch (50 mm) wide waterproof tape or 1-inch (25 mm) wide welding strip on the back of the

maximum 1/4-inch (6 mm) gap butt joint or by some other method approved by the engineer to prevent wet concrete from getting under the sheet. After the forms have been stripped, a 1-inch (25 mm) welding strip shall be applied over the face of the sheet.

- C. All welding is to be strict conformance with the specifications of the lining manufacturer and Paragraph 3.03 E.

3.06 TESTING AND REPAIRING DAMAGED SURFACES

- A. After the pipe is installed in the trench, or after cast-in-place structures forms have been stripped, all surfaces covered with lining, including welds, shall be tested with an approved electrical holiday detector (Tinker & Rasor Model No. AP-W with power pack) with the instrument set between 18,000 and 22,000 volts. All welds shall be physically tested by a nondestructive probing method. All patches over holes, or repairs to the liner wherever damage has occurred, shall be accomplished in accordance with Paragraph 3.01 H.
- B. Each transverse welding strip which extends to a lower edge of the liner will be tested by the purchasing agency. The welding strips shall extend 2-inches (50 mm) below the liner to provide a tab. A 10-pound (5 kg) pull will be applied to each tab. The force will be applied normal to the face of the structure by means of a spring balance. Liner adjoining the welding strip will be held against the concrete during application of the force. The 10-pound (5 kg) pull will be maintained if a weld failure develops, until no further separation occurs. Defective welds will be retested after repairs have been made. Tabs shall be trimmed away neatly by the installer of the liner after the welding strip has passed inspection. Inspection shall be made within 2 days after the joint has been completed in order to prevent tearing the protecting weld strip and consequent damage to the liner from equipment and materials used in or taken through the work.

Warranty Information

Northwest Pipe Company “NW” warrants that this product conforms to the specific description in their trade literature as to the character and quality of raw materials, workmanship and adaptability for recommended use. Within one year from date of purchase, NW shall supply replacement material for this project or any portion thereof, or at its option equivalent material, F.O.B. their manufacturing facility, if it fails to meet the foregoing warranty, provided that installation and application of the product have been properly accomplished and that NW has been promptly notified of the defect.

The preceding constitutes the sole remedy of the Buyer and the sole liability of NW for the product defect. No other express or implied warranties, whether of merchantability or of fitness for any particular purpose or use, shall apply. NW shall not be responsible for consequential damages. NW’s Standard Terms and Conditions of Sale apply to purchase of this product.

This product data sheet and the recommendations for usage it contains were based on test data believed to be reliable, and are intended for use by personal having skill and know-how, at their own discretion and risk, in accordance with current industry practice and normal operating conditions. Variation in environment, changes in operation procedures or extrapolation of data may cause unsatisfactory results. Since we have no control over the conditions or service, we expressly disclaim responsibility for the results obtained or for any consequential or incidental effects of any kind. Also refer to “Safety Precautions”, and NW’s Terms and Conditions of Sale.