1. Description.

Scope of Work. This specification shall govern for the rehabilitation of existing sewer mains by the cured-in-place-pipe (CIPP) method. This method consists of inverting a resin-impregnated flexible sewn felt tube into the original conduit by use of hydrostatic head. The resin is cured by circulating hot water within the tube. The Cured-In-Place Pipe (CIPP) will be continuous and tight fitting. The work shall be completed within TxDOT schedule. Contractors may, when appropriate, elect to use any material that is considered to be equal (i.e. A product that has structural physical properties that are equal or greater than those of the specified products), however, submittal to the design Engineer is required no later than 10 days prior to bid opening.

2. Quality Control.

a. Reference Standards. This specification references Insituform Technologies, Inc., (ITI) Standard Test Methods, which are made a part hereof by such reference, and shall be the latest editions and revisions thereof. References are also made to ASTM F1216 (Rehabilitation of pipelines by inversion and curing a resin impregnated tube), ASTM D5813 (Cured-in-Place, Thermosetting Resin Sewer Pipe), ASTM D790 (Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials) and test report "Long-Term Structural Behavior of Pipeline Rehabilitation Systems" by, and test report "Long Term Structural Behavior of Pipeline Rehabilitation Systems" by the Trenchless Technology Center (TTC) at Louisiana Technical University which are made a part hereof by such reference and shall be the latest edition and revision thereof. In case of conflicting requirements between this specification and these referenced documents, this specification shall govern.

b. General Corrosion Requirements. The CIPP shall be fabricated from materials which, when cured, will be chemically resistant to internal exposure to domestic sewage.

c. Product and Manufacturer/Installer Qualifications. The supplied CIPP product shall have a 50 year design life, and in order to minimize the Owner's risk, only proven products with substantial successful long term track records will be approved. All trenchless rehabilitation products and installers must be pre-approved prior to the formal opening of proposals.

For a Product to be considered Commercially Proven, a minimum of 250,000 linear feet or 1,000 line sections of successful wastewater collection system installations in the U.S. Must be documented to the satisfaction of the Engineer to assure
commercial viability. In addition, at least 50,000 linear feet of the product shall have been in successful service within State for a minimum of three years.

Sewer rehabilitation products submitted for approval must provide third party test results supporting the long-term performance and structural strength of the product and such data shall be satisfactory to the Owner. Test samples shall be prepared so as to simulate installation methods and trauma of the product. No product will be approved without independent third party testing verification.

For an Installer to be considered as Commercially Proven, the Installer must satisfy all insurance, financial, and bonding requirements of the Engineer, and must have had at least 3 (three) years, or 50,000 feet of active experience in the installation of the CIPP liner in diameters 36 inches and larger in wastewater collection systems. Acceptable documentation of these minimum installation must be submitted to the Engineer with the bid.

The Installer/Bidder shall submit to the Engineer all design calculations and proposed material thickness and compositions.

The Installer/Bidder shall submit to the Engineer a bypass-pumping outline for the proposed work. A detailed bypass plan will be required after award of the bid.

Both the rehabilitation product and the installer shall have ISO 9000 Certifications or equal for its quality control and assurance programs. Proof of certification shall be required for approval.

The Bidder may propose a proven alternate method of CIPP, meeting all criteria of this specification. This alternate approval must come from the Owner's Engineering Department. The following documentation shall accompany each alternate proposal and shall be submitted at least 20 days prior to letting date:

1. Physical properties, including pipe creep data (long term deflection under load).
2. Material specifications and description of the materials used in the process.
3. List of testing methods.
4. Third party test data.
5. Product design criteria including calculated wall thickness.
6. Process limitations including finished inside diameters.
7. Evidence of installation in large diameter (greater than 36" pipe).
8. Background information including:
   c. Any penalties imposed by clients or others.
   d. Year Company formed.
   e. Year product was installed.
   f. Total footage installed.
   g. Number of crews.
   h. Crew qualification - foreman resume.
d. Submittals. The Contractor shall a copy of the recommended pipe installations procedures, including: Installation information including method of installing liner, maximum tensile pull, maximum installation rate, installation temperatures, installation pressures, and time required before lateral opening. This information shall be certified by the pipe manufacturer. Any other information as required in this specification. (See section IV. Materials/Resin for Resin submittals.)

3. Special Construction Conditions (Sanitary Sewers).

a. For work activities impacted by the size and shape of the existing pipe, the Contractor is herein informed that the pipe is not exactly circular and a nominal diameter has been approximated.

b. On lines designated for a combination of repair and other specified rehabilitation work, the repair shall be accomplished before the other rehabilitation work.

c. Due to age of the sanitary sewer lines to be rehabilitated, the location of sewer lines and manholes in public right-of-way, and soil conditions which may exist in the different areas of this job, construction conditions may arise which have not been anticipated by the plans and specifications. In such a case, the Contractor shall submit a proposed construction method to solve specific situations/problems not covered by the plans and specifications, to the Engineer, for approval prior to proceeding with the proposed work, if, in the opinion of the Engineer, the specified method available to obtain the desired result, the rehabilitation. Once work has begun at a specific location, the Contractor shall diligently pursue the work to be done until the rehabilitation is complete. The limit for completion of this work will be strictly enforced.

d. Equipment. The Contractor shall provide the Engineer with satisfactory evidence, upon request, that the equipment to be effectively on previous similar work, and any damage to sanitary sewer lines, appurtenances and surrounding property caused by the Contractor's expense and to the satisfaction of the Engineer.

e. Sewer Flow Control. Flow through the sewer, as measured at the manhole, shall not exceed 30% of pipe diameter during any construction operations. Flow depths above the maximum allowable requirements shall be reduced to within allowable limits by plugging and/or bypass pumping as required.

Wastewater flow shall be blocked with a pneumatic sewer plug inserted into the line upstream of the section being worked. The plug shall be so designed that all or any portion of flow can be released as required. The Contractor shall station an observer at the manhole immediately upstream of the plug during the entire period that the line is plugged to constantly watch for flooding and sewage backup of upstream lines. Full flow shall be restored by plug removal as soon as possible after work has been completed.
When flow in a sewer line is plugged or bypassed, sufficient precautions must be taken to protect the sewer lines from damage that might result from sewer surcharging. Precautions must be taken to insure that sewer flow control operations do not cause flooding or damage to public or private property served by the sewers involved. Contractor shall release flow and/or install a bypass pump should surcharging result in sewage bypassing into a storm sewer through indirect or direct cross connections between adjacent sanitary and storm sewers.

No sewer main shall be plugged during Contractor non-working hours. A temporary tie-in shall be made between the end of the new and existing main. Plugs at manholes shall be removed to allow the flow of sewage until work in resumed.

f. Pre-Installation.

a. Prior to commencement of field operations, the Contractor shall furnish to the Engineer, for approval, a detailed schedule of all planned operation sequences, and any other procedures that may be necessary to complete the job. Additionally, the Contractor prior to ordering and manufacturing rehabilitation material(s) shall verify all inner diameter dimensions and distances between existing manholes.

b. Pumps and Force Mains. The Contractor shall have, on the project site, adequate pumps and force main(s) with backup system(s), as specified in the Special Specification, "Sanitary Sewer (By-Pass Pumping)", in order to maintain reliable sanitary sewer service in case of any emergency that may arise during the rehabilitation operation.

c. Safety. The Contractor shall conduct all operations in strict accordance with all applicable federal, state and local safety codes and statutes and shall be fully safety of all work, personnel, and equipment involved in the work. Particular attention is drawn to those safety requirements involving work on an elevated platform and/or entry into a confined space.

The Contractor is advised that sewage encountered may contain harmful viruses and bacteria and may be detrimental to the health of workers. Utmost care is urged to prevent contraction of potentially dangerous diseases. The existing lines known to contain quantities of hazardous gases and caution is advised.

The areas occupied by workmen shall be protected by the best available devices for the detection of oxygen depletion and lethal and combustible gases. Such devices shall be frequently tested to assure functional capability.

All safety measures, including but not limited to safety personnel, first-aid equipment, ventilating equipment and safety equipment are considered the responsibility of the Contractor.

No direct payment will be made for these measures.
No sewer main trenches, manhole excavation, or any other opening will be left open during non-working hours without proper protection.

g. Traffic Control.

1. All streets and traffic ways shall be kept open for the passage of traffic and pedestrians during the construction period unless otherwise approved by the Engineer.

2. When required to cross, obstruct or temporarily close a street or traffic way, the Contractor shall provide and maintain suitable bridges, detours or other approved temporary expedient(s) for the accommodation of traffic. Closings shall be for the shortest time practical, and passage shall be restored immediately after completion of the work.

3. The Contractor shall give the required advance notice of proposed operations to the fire and police departments.

4. The Contractor shall give reasonable notice to owners or tenants of private property who may be affected by proposed operations.

5. The Contractor shall provide signs, signals, barricades, lights, and all other equipment, service and personnel required to regulate and protect all traffic and warn of hazards as approved/directed by the Engineer. The Contractor shall remove temporary equipment and facilities when no longer required and restore the area to its original or specified condition.

6. Provide and operate traffic control required to direct and maintain an orderly flow of traffic in all areas under the Contractor's control or affected by the Contractor's operations.

7. Provide traffic control at the following locations:
   a. At each change of direction of a roadway and at each crossroad.
   b. At detours and hazardous areas.
   c. At parking areas.

8. It is Contractor's responsibility to insure that all traffic control devices are properly installed and maintained. All locations and distances will be determined in the field, by the Contractor, using the Texas Manual on Uniform Traffic Control Devices. If, in the opinion of Engineer, the traffic control devices do not conform to established standards, or are incorrectly placed or insufficient in quantity to protect the general public, the Engineer shall have the authority to stop construction operations until such time as the conditions are corrected.

9. The Contractor shall notify the Engineer then contact the City of San Antonio Traffic and Signalization Departments one (1) week in advance of any street closure.

10. As work progresses, location of traffic control devices will be adjusted and modified by the Contractor, as necessary or directed by the Engineer.

11. Additional traffic control devices, special directional devices, and/or business' name signs (as requested by businesses) may be required at the Contractor's expense. The Contractor shall be responsible for suitable access accommodations for:
a. Pedestrians, including school children.
b. Delivery of mail by the U.S. Postal Service.
c. Residents and all businesses during all phases of work.

12. At no time shall the Contractor have more than 50 feet of trench without backfill or concrete, nor more than two open excavation areas at any one time, unless previously approved by the Engineer.

13. The Contractor shall provide for lane closings and traffic routing such that a minimum of two-way streets is maintained open to traffic at all times.


a. Tube. The sewn Tube shall consist of one or more layers of absorbent non-woven felt fabric and meet the requirements of ASTM F1216, Section 5.1. The tube shall be constructed to withstand inversion pressures, have sufficient strength to bridge missing pipe, stretch to fit irregular pipe sections, and shall invert smoothly around bends.

The wetout tube shall have a uniform thickness that when compressed at installation pressures will meet or exceed the design thickness.

The tube shall be sewn to a size that when installed will tightly fit the internal circumference and length of the original pipe. Allowance should be made for circumferential stretching during inversion. Overlapped layers of felt that cause lumps in the final product shall not be utilized.

The outside layer of the tube (before wetout) shall be polyethylene coated a translucent flexible membrane that clearly allows inspection of the resin impregnation (wetout) procedure. The plastic coating shall separate the resin inside the tube from the inversion water without leakage, accommodate inversion, stretch to size and shall not delaminate before, during, or after curing.

The tube shall be homogeneous across the entire wall thickness containing no intermediate or encapsulated elastomeric layers. No material shall be included in the tube that may cause delamination in the cured CIPP.

The wall color of the interior pipe surface of CIPP after installation shall be a light reflective color so that a clear detail examination with closed circuit television inspection equipment may be made.

Seams in the tube shall be stronger than the unseamed felt. Where the length requires joining, the sewn joint shall not be perpendicular to the long axis but spirally formed.

The outside of the tube shall be marked for distance at regular intervals along its entire length, not to exceed five (5) feet. The Manufacturers name or identifying symbol shall also appear at intervals not exceeding 10 feet. The tube must be manufactured in the USA.

The cured-in-place liner thickness shall be calculated based on the following physical condition of the existing pipe:
a. All pipe shall be considered fully deteriorated.
b. All pipe shall be subject to full soil load of 120 lb/cf, with applicable live load, and water table five (5) feet below the top of the ground.
c. All pipe should be considered to have a minimum of 2 percent ovality in the circumference.

b. Resin. The resin system shall be a corrosion resistant polyester, vinyl ester, or epoxy and catalyst system that when properly cured within the tube composite meets the requirements of ASTM F1216, the physical properties herein, and those, which are to be utilized in the design of the CIPP for this project.

The following information shall be submitted: Resin specifications, characteristics and properties, as well as methods of application. A written certification that the resin material complies with the required application, along with curing temperature and duration of the temperature (step cooking temperatures/hours at each and final stages) depending upon the sewer size and liner thickness and lengths, etc.

5. Structural Requirements. The CIPP shall be designed as per ASTM F1216, Appendix XI. The CIPP design shall assume no bonding to the original pipe wall.

The Contractor must have performed third-party external buckling testing of cured-in-place pipe installed by his company. Such testing results are to be used to determine the long-term, time dependent flexural modulus to be utilized in design. This is a process test of the materials (tube and resin) and general workmanship of the installation and curing. A percentage of the short-term E-modulus value (as measured by ASTM D-790 testing) will be used in design for external buckling. The percentage, or the long-term value utilized, will be verified by this testing. The materials utilized for the contracted project shall be of a quality equal to or better than the materials used in the long term buckling test with respect to initial and long-term design modulus.

The Enhancement Factor "K" to be used in "Partially Deteriorated" design, shall be verified by independent test (such as the Trenchless Technology Center at Louisiana Tech University). If the Product was not tested by the TTC or similar Independent Qualification Testing, then the Owner will be the sole judge of the Enhancement Factor "K", used for design.

The layers of the cured CIPP shall be uniformly bonded. It shall not be possible to separate any two layers with a probe or point of a knife blade so that the layers separate cleanly or the probe or knife blade moves freely between the layers. If separation of the layers occur during testing of field samples, new samples will be cut from the work. Any reoccurrence may cause rejection of the work.

The cured pipe material (CIPP) shall conform to the structural properties, as listed below.
Minimum Physical Properties

<table>
<thead>
<tr>
<th>Test Method</th>
<th>Minimum Materials Per 400,000 psi ASTM F1216 Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modulus of Elasticity ASTM D-790</td>
<td>250,000 psi 400,000 psi</td>
</tr>
<tr>
<td>Flexural Stress ASTM D-790</td>
<td>4,500 psi 4,500 psi</td>
</tr>
</tbody>
</table>

The required structural CIPP wall thickness shall be based as a minimum, on the physical properties in Section 5.5 and in accordance with the design equations in the appendix of ASTM F 1216, and the following design parameters:

Design Safety Factor = 2.0
Retention Factor for Long-Term Flexural Modulus to be used in Design = (to be multiplied by short-term modulus to obtain long-term design modulus)
Ovality* = 2%
Enhancement Factor, K = See Section 5.3
Groundwater Depth (above invert) = 1/2 Soil Depth ft
Soil Depth (above crown)* = 5 ft
Soil Modulus** = NA psi
Soil Density** = 120 pcf
Live Load** = AASHTO H-20 where the CIPP is in roadway
Design Condition (partially or fully deteriorated)***

* Denotes information which can be provided here or in inspection video tape or project construction plans. Multiple line segments may require a table of values.

** Denotes information required only for fully deteriorated design condition.

*** Based on review of video logs, conditions of pipeline can be fully or partially deteriorated. (See ASTM F1216 Appendix.) The Owner will be sole judge as to pipe conditions and parameters utilized in Design.

Refer to Table 1 for Dimensional Ratios (DR's) required for pipe sections, based on the pipe condition, depth, ovality, etc. As computed for the conditions shown, using ASTM F 1216 Design Equations.
### Table 1

**CIPP Thickness Design in terms of Dimensional Ratio "DR"

**"DR" Dimensional Ratio for CIPP (DR = Diameter/Thickness)**

<table>
<thead>
<tr>
<th>Pipe Size (inches)</th>
<th>Pipe Ovality Condition (%)</th>
<th>Pipe Depth Range (ft)</th>
<th>E = 250,000 psi</th>
<th>E = 300,000 psi</th>
<th>E = 400,000 psi</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 - 48 FD</td>
<td>0-2.0</td>
<td>4 - 8</td>
<td>57</td>
<td>60</td>
<td>68</td>
</tr>
<tr>
<td>6 - 48 FD</td>
<td>2.1-5.0</td>
<td>4 - 8</td>
<td>48</td>
<td>50</td>
<td>56</td>
</tr>
<tr>
<td>6 - 48 FD</td>
<td>5.1-10</td>
<td>4 - 8</td>
<td>35</td>
<td>37</td>
<td>41</td>
</tr>
<tr>
<td>6 - 48 FD</td>
<td>0-2.0</td>
<td>9 - 16</td>
<td>44</td>
<td>47</td>
<td>52</td>
</tr>
<tr>
<td>6 - 48 FD</td>
<td>2.1-5.0</td>
<td>9 - 16</td>
<td>37</td>
<td>39</td>
<td>43</td>
</tr>
<tr>
<td>6 - 48 FD</td>
<td>5.1-10</td>
<td>9 - 16</td>
<td>28</td>
<td>29</td>
<td>32</td>
</tr>
<tr>
<td>6 - 48 FD</td>
<td>0-2.0</td>
<td>17 - 24</td>
<td>36</td>
<td>38</td>
<td>42</td>
</tr>
<tr>
<td>6 - 48 FD</td>
<td>2.1-5.0</td>
<td>17 - 24</td>
<td>30</td>
<td>32</td>
<td>34</td>
</tr>
<tr>
<td>6 - 48 FD</td>
<td>5.1-10</td>
<td>17 - 24</td>
<td>22</td>
<td>24</td>
<td>26</td>
</tr>
</tbody>
</table>

**Special Notes:**

FD = Design for Fully Deteriorated pipe, CIPP capable of withstanding all loads; supply a fully structural pipe.

CIPP = Cured In Place Pipe

All of the above Dimensional Ratios are computed for Long Term Design "E" - Flexural Modulus, which equals to 50% of the shown Short Term "E" - Flexural Modulus.

The FD pipe condition design is based on the following parameters:

- Soil Modulus = 700 psi
- Soil Density = 120 lbs/CF
- Safety Factor = 2
- Soil Depth = to inert of pipe
- Ground Water Depth = 1/2 of Soil Depth
- Live Load = HWY H-20 = 16,000 lbs

**Formula:**

For CIPP wall thickness "t" divide diameter (d) by DR: \( t = \frac{d}{DR} \)

**Example:** A 12" FD pipe with 2% ovality at 8' deep and E = 400,000 psi, read DR = 68 from table, CIPP wall thickness \( t = \frac{12}{68} = 0.177" \)

Any layers of the tube are not saturated with resin prior to insertion into the existing pipe shall not be included in the structural CIPP wall thickness computation.

### 6. Testing Requirements.

a. Water-tightness. The water-tightness of the CIPP shall be gauged by monitoring the water level in the inversion tube after curing is complete. The Contractor will provide to the Engineer a videotape showing the completed work including the condition of the restored taps. The water level testing must be done directly on the finished product and not on an intermediary hose which is not part of the final product.

b. Chemical Resistance. The CIPP shall meet the chemical resistance requirements of ASTM F1216, Appendix X2. CIPP samples for testing shall be of tube and resin system similar to...
that proposed for actual construction. It is required that CIPP samples with and without plastic coating meet these chemical testing requirements.

c. Hydraulic Capacity. Overall, the hydraulic profile shall be maintained as large as possible. The CIPP shall have a minimum of the full flow capacity of the original pipe before rehabilitation. Calculated capacities may be derived using a commonly accepted roughness coefficient for the existing pipe material taking into consideration its age and condition. The roughness coefficient for the existing pipe material taking into consideration its age and condition. The roughness coefficient of the CIPP shall be verified by third party test data.

d. CIPP Field Samples. When requested by the Owner, the Contractor shall submit test results from previous field installations in the USA of the same resin system and tube materials as proposed for the actual installation. These test results must verify that the CIPP physical properties specified in Section 5.5 have been achieved in previous field applications. Testing samples for this project shall be made and tested as described in Section 10.1

7. Installation Responsibilities for Incidental Items.

a. It shall be the responsibility of the Owner to locate and designate all manhole access points open and accessible for the work, and provide rights of access to these points. If a street must be closed to traffic because of the orientation of the sewer, the Owner shall institute the actions necessary to do this for the mutually agreed time period. The Owner shall also provide free access to water hydrants for cleaning, inversion and other work items requiring water.

b. Cleaning of Sewer Lines. The Contractor, when required, shall remove all internal debris out of the sewer line that will interfere with the installation of CIPP. The Owner shall also provide a dumpsite for all debris removed from the sewers during the cleaning operation. Unless stated otherwise, it is assumed this site will be at or near the sewage treatment facility to which the debris would have arrived in absence of the cleaning operation. Any hazardous waste material encountered during this project will be considered as a changed condition.

c. Bypassing Sewage. The Contractor, when required, shall provide for the flow of sewage around the section or sections of pipe designated for repair. The bypass shall be made by plugging the line at an existing upstream manhole and pumping the flow into a downstream manhole or adjacent system. The pump and bypass lines shall be of adequate capacity and size to handle the flow. The Owner may require a detail of the bypass plan to be submitted.

d. Inspection of Pipelines. Inspection of pipelines shall be performed by experienced personnel trained in locating breaks, obstacles, and service connections by close circuit television. The interior of the pipeline shall be carefully inspected to determine the location of any conditions, which may prevent proper installation of CIPP into the pipelines, and it shall be noted so that these conditions can be corrected. A videotape and suitable log shall be kept for later reference by the Owner.
e. Line Obstruction. It shall be the responsibility of the Contractor to clear the line of obstructions such as solids and roots that will prevent the insertion of CIPP. If pre-installation inspection reveals an obstruction such as protruding service connection, dropped joint, or a collapse that will prevent the inversion process and it cannot be removed by conventional sewer cleaning equipment, then the Contractor shall make a point repair excavation to uncover and remove or repair the obstruction. Such excavation shall be approved in writing by the Owner's representative prior to the commencement of the work and shall be considered as a separate pay item.

f. Public Notification. The Contractor shall make every effort to maintain service usage throughout the duration of the project. In the event that a service will be out of service, the maximum amount of time of no service shall be 12 hours for any property served by the sewer. A public notification program shall be implemented, and shall as a minimum, require the Contractor to be responsible for contacting each home or business connected to sanitary sewer and informing them of the work to be conducted, and when the sewer will be off-line. The Contractor shall also provide the following:

1. Written notice to be delivered to each home or business describing the work, schedule, how it affects them, and a local telephone number of the Contractor they can call to discuss the project or any problems, which could arise.
2. Personal contact and attempted written notice the day prior to the beginning of work being conducted on the section relative to the residents affected.
3. Personal contact with any home or business, which cannot be reconnected within the time, stated in the written notice.

g. Service Line Reconnections. The Installer shall be responsible for confirming the locations of all branch service connections prior to inversion and curing the CIPP. It is the intent of these specifications that branch connections to buildings be reopened without excavation, utilizing a remotely controlled cutting device, monitored by a video TV camera. The Installer shall certify he has a minimum of two (2) complete working cutters plus spare key components on the site before each inversion. No additional payment will be made for excavations for the purpose of reopening connections and the Contractor will be responsible for all costs and liability associated with such excavation and restoration work.

8. Installation.

CIPP installation shall be in accordance with ASTM F1216, Section 7, with the following additional requirements:

a. Resin Impregnation. The quantity of resin used for tube impregnation shall be sufficient to fill the volume of air voids in the tube with additional allowances for polymerization shrinkage and the loss of resin through cracks and irregularities in the original pipe wall. A vacuum impregnation process shall be used. To insure thorough resin saturation throughout the length of the felt tube, the point of vacuum shall be no further than 75 feet from the leading edge of the resin. The leading edge of the resin slug shall be as near to
perpendicular as possible. A roller system shall be used to uniformly distribute the resin throughout the tube. If the Installer uses an alternate method of resin impregnation, the method must produce the same results. Any alternate resin impregnation method must be proven.

b. Given the non-circular Section of the 38 inch pipe along St. Mary's Street, no pull-in method shall be utilized, but rather tube inversion. The inversion will minimize folds and uneven stretching which would result in thinning of the upper portion is necessary to minimize gouging and for stretching and accommodating bends encountered.

c. Temperature gauges shall be placed to determine the temperature of the incoming and outgoing water from the heat source. Another such gauge shall be placed inside the tube at the invert level at the remote end to determine the temperature at that location during the cure cycle.

d. Curing shall be accomplished by utilizing hot water under hydrostatic pressure.

e. Correction of failed liner, deemed unacceptable as a result of post-TV inspection and/or test reports for structural values thickness, etc., shall be repaired by the Contractor at the Contractor's expense. The method of repair shall be as approved by the Engineer, which may require field or workshop demonstrations.

9. Sewer Service Line Reconnections. It is the intent of these specifications that branch connections to buildings be reopened without excavation, utilizing a remotely controlled cutting device, monitored by a video TV camera. The Contractor shall certify he has a minimum of two (2) complete working cutters plus spare key components on the site before each inversion. No additional payment will be made for excavations for the purpose of reopening connections and the Contractor will be responsible for all costs and liability associated with such excavation and restoration work.

10. Inspection.

a. The Engineer shall be informed, in advance, for verification and inspection of the resin material at the "wet-out" of the felt tube. The inspection shall be at the discretion of the Engineer, which shall not relieve the Contractor of responsibility. The inversion and heating schedule/plan shall be submitted at least 24 hours in advance. Heating shall continue uninterrupted until the desired temperature is achieved. Temperatures shall be measured at both ends by sensitive and accurate measuring devices.

b. CIPP samples shall be prepared and physical properties tested in accordance with ASTM F1216, Section 8.1 using either method proposed. The flexural modulus must meet or exceed with value used in design in Section 5 (structural requirements for the pipe size and thickness furnished in design).
c. Leakage testing of the CIPP shall be accomplished during cure while under a positive head. CIPP products in which the pipe wall is cured while not in direct contact with the pressuring fluid (e.g., a removable bladder) must be tested by an alternative method approved by the Owner.

d. Visual inspection of the CIPP shall be in accordance with ASTM F1216, Section 8.6

11. Clean-Up. Upon acceptance of the installation work and testing, the Contractor shall restore the project area affected by the operations to a condition at least equal to that existing prior to the work.

12. Plan of Record. The Contractor shall mark two sets of construction plans to show any changes to sewer lateral location, alignment, manhole location, and any other revisions to the original plans. At the end of construction, the Contractor shall submit these marked drawings to the Owner for review and preparation of plan of record by the Owner.

13. Measurement. This Item shall be measured by the linear foot, complete in place, based on the measured distance of existing sanitary sewer line to be rehabilitated from centerline of manhole to centerline of manhole.

14. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement", will be paid for at the unit price bid for "Sanitary Sewer (Rehabilitation of Lines)". This price shall be full compensation for all labor, equipment, materials, tools, pre-rehabilitation line cleaning, water, clean-up, dump site(s) and hauling of debris, labor, materials and equipment used in replacing bases and pavements, access to right-of-ways and easements as necessary, removal of equipment due to bad ground or poor pipe conditions, and other incidentals necessary to complete the work.