Infrastructure Repair Systems, Inc.

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Infrastructure Point Repair System
Technical Specifications

1. Scope:
This specification defines the approved methodology and materials for the rehabilitation of a sectionalized portion of a structurally damaged or leaking gravity flow system, service line, joint, crown failure, and the bridging of offset pipe joints, by the installation of Infrastructure Repair Systems Inc.'s ambient cured-in-place, thermosetting epoxy, impregnated structural liner system.

2. Description:
A cured-in-place liner containing a polyester-fiberglass liner, impregnated with a thermosetting epoxy resin that is placed on a sleeve carrier and inserted into the pipeline. With the assistance of a pan and tilt 360 degree optical lens camera, capable of viewing the complete circumference of the pipe, the carrier is positioned in the area to be repaired and bladder is pressurized to a pressure that will maintain the liner pipe interface during the entire cure period. The impregnated composite liner cocures forming a mechanically bonded, monolithic, seamless repair with the internal circumference of the host pipe, with no annular space. The length of the liner must be reviewed by a qualified engineer, and shall effectively span the designated defective section, plus one foot at each end.

3. Significance and Use:
This specification is for use by Regulatory Agencies, Engineers, Commissioner of Public Works, Superintendent of Public Works, and others who are authorized and are involved in the rehabilitation of a sectionalized portion of a structurally damaged or leaking gravity flow system.

4. Manufacturer's Specifications:

4.1 Patented Reinforcement Liner:
Polyester-fiberglass felt composite liner, consisting of a non-woven polyester felt and bonded to 32 oz. per square yard woven 0/90 fiberglass and fitted with a hook and loop fastening system. The reinforced liner must be capable of accepting sufficient volume to compensate for any migration of the resin into defects in the pipe, which will effectively prevent intrusion of water and soil, while retaining it's integrity.

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4.2 Resin:
A two component 100% thermosetting epoxy containing zero grams per liter VOC's and having a cure time of approximately two (2) hours without the need of external sources of heat. The resin formulation contains wetting agents, defoamers, and surfactants to insure complete wet out of the reinforcement liner, also assuring that the liner will achieve superior mechanical bond strength to the substrate under both dry and wet conditions in both warm and cold climates.

4.3 Alternative Materials:
No alternative materials shall be employed without prequalification and written approval from Infrastructure Repair Systems, Inc.

5. Chemical and Corrosion Resistance:
The system (epoxy and liner) must meet the standards for domestic sewage resistance in accordance with testing as outline by the American Society of Testing and Materials ASTM D 543 (Table 1).

5.1 Mechanical & Physical Properties:
The cured impregnated epoxy liner must meet the minimum mechanical & physical properties in accordance with testing as outlined by the American Society of Testing and Materials, ASTM D 638 Tensile Properties of Plastics, ASTM D 695 Compressive Properties of Rigid Plastics, ASTM D 790 Flexural Properties of Unreinforced and Reinforced Plastics, ASTM D 1876 Peel Resistance of Adhesives (T-Peel Test), ASTM D2583 Indentation Hardness of Rigid Plastics by Means of a Brachial Impressor, ASTM D 648 Deflection Temperature of Plastics Under Flexural Load, (Table 2), ASTM D 2412 (Modified) Parallel-Plate Loading.

5.2 Independent Testing:
An approved chemical, structural and composite testing laboratory must corroborate all mechanical and physical ASTM testing with the results being made part of this specification.

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5.3 Liner Thickness:
The Contractor shall submit to the Engineer for approval, complete design calculations for the liners, signed and sealed by a Professional Engineer and certified by the manufacturer as to the compliance of his materials to the values used in the calculations. The liners shall be designed to withstand a live load equivalent to two H-20 passing trucks plus all pertinent dead loads, hydrostatic pressure and grout pressure (if any). For design purposes water table shall be considered at grade elevation. The liner shall be designed in accordance with Appendix XI of ASTM F1216 (Table 3). The existing pipe shall not be considered as providing any structural support. Modulus of soil reaction shall not be greater than 1,000 psi; the soil density shall be taken as 120 pounds per cubic foot; the minimum ovality of the host pipe shall be 5 percent; the enhancement factor, K, shall not be greater than 7.0; the flexural modulus of elasticity shall be reduced by fifty percent account for long term effects and used in the design equation as E sub L; the minimum safety factor shall be 2.0.

6. Contractor:
All contractors biding rehabilitation projects using the Infrastructure Repair System must show proof of successfully completing Infrastructure Repair System Inc. training program.

7. Material:
The materials required for the rehabilitation project must be delivered to the site in undamaged, unopened containers bearing Infrastructure Repair System Inc. original label and stored in an area that will insure the materials maintain a temperature not to exceed 90° F. The material must be mixed at a temperature per manufacturers specification. Do not alter in any way.

8. Material Safety Data Sheet:
The MSDS will be included with each shipment and shall be kept on the job during the entire time work is in progress.

9. Safety:
Prior to entering access areas an evaluation of the atmosphere to determine the presence of toxic or flammable vapors or lack of oxygen must be undertaken in accordance with local, state, or federal safety regulations. Safety shall be in strict accordance with all applicable OSHA standards. The Infrastructure Repair System kit provides protective clothing, safety glasses, and gloves that the workers should avail themselves to while working with the epoxy.

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10. Cleaning and Inspection:

10.1 Cleaning:
The intent of this procedure is the removal of internal foreign materials and all debris from the host pipe. This procedure is critical for the successful rehabilitation of the pipe. The procedure is accomplished with the use of a hydraulically propelled high velocity jet spray.

10.2 Pre Installation Television Inspection:
Closed circuit television inspection is to be carried out immediately after cleaning to document sewer line conditions. The pipeline documentation shall be carried out using a pan and tilt 360-degree optical lens camera, capable of viewing the complete circumference of the pipe. The camera lens is an auto-iris type with remote controlled manual override. The camera light head includes a high intensity side viewing lighting system to provide illumination of internal portions of the of the pipe, and shall be pulled through the sewer line from either direction at a speed not to exceed 30 feet per minute, and stopping as necessary to document the condition of the pipe. The documentation of the pipe's condition is recorded on color VHS videotape, along with computer-generated reports that accompany the videotape or disc.

10.3 Flow Control:
As a result of the use of a flow-through bladder, bypass pumping is normally not necessary.

10.4 Installation Procedure:
Installation shall follow strict Infrastructure Repair Systems, Inc. certified guidelines. All installers must be trained and certified by Infrastructure Repair Systems, Inc. and proof of that certification shall be supplied upon request.

10.5 Finish:
The cured liner shall overlap the repair by at least one (1) foot at each end while providing a smooth transition from the host pipe to the repair. The remaining portion of the liner shall be free of any defects that would affect the integrity or strength of the repair.

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ADVANTAGES

- Ease of installation
- Cost effective lower overall project cost
- Available in a variety of diameter sizes
- Available in a variety of lengths
- Permanent repair
- Minimal inconvenience to the public and traffic
- Ambient cure
- Environmentally friendly - 0 voc’s
- System integrity - a result of research & development
- High performance corrosion strength
- High performance tensile strength
- High performance durability
- Ability to conform to most pipe configurations
- Stronger than original pipe
- Bonds to dry and wet substrates
- Seals infiltration
- Seals exfiltration
- Field training
- Technical support
- Resists micro cracking
- Works in all type of pipe material
- Mechanically bonds to host pipe w/ no annular space

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Table 1

Minimum Chemical Resistance Requirements for

Domestic Sanitary Sewer Applications

ASTM D 543

Minimum One Month at 73.4 ° F (23° C)

Chemical Solution	Percent of Concentration
Tap Water pH	100%
Nitric Acid-	5%
Phosphoric Acid	10%
Sulfuric Acid	10%
Gasoline	100%
Vegetable Oil	100%
Detergent	0.1%
Soap	0.1%

28 Day Immersion Chemical Resistance

Maximum Percent of Weight Gain

Toluene	100%	1.2%
Ethanol	100%	5.5%
Acetic Acid	10%	12.1%
Sulfuric Acid	70%	0.4%
Sodium Hydroxide	50%	0.0%
Distilled Water	100%	0.0%

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Table 2
Mechanical and Physical Properties

Test Method	*Results*	
ASTM D 256	**Impact Strength**	
	9.95 ft-lb/in	
ASTM D 638:	**Tensile Strength**	**Tensile Modulus**
	16,577 psi	1,119,000 psi
ASTM 648:	**Stress**	**Stress Deflection**
	264 psi	139° F.
ASTM D 695:	**Compressive Strength**	**Compressive Modulus**
	23,595 psi	1,446,000 psi
ASTM D 732	**Shear Strength**	
	12,303 psi	
ASTM D 790	**Flexural Strength**	**Flexural Modulus**
	33,266 psi	822,000 psi
ASTM D 2583	**Average Hardness Reading**	
	81.2	

ASTM D 2412		**(Modified) Parallel-Plate Loading**		
	Strength (lb/in length)	**STD. DEV.** (lb/in length)	**Load** (lbs.)	**STD. DEV.** (lbs.)
Standard Liner:	156	11	303	20
8-3/8" OD PVC:	154	3	305	5

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TABLE 3

(ASTM F 1216)
Summary of Minimum Sectional Liner Thickness (mm)

Depth of Pipe in Feet					
Diameter (inches)	**1-4 ft.**	**>4-8 ft.**	**>8-12 ft.**	**>12-16 ft.**	**>16-20 ft.**
8	4.5	3.1	3.6	4.2	4.6
10	5.5	3.9	4.5	5.2	5.7
12	6.4	4.7	5.4	6.2	6.9
15	7.7	5.8	6.8	7.8	8.6
18	8.8	7.0	8.1	9.3	10.3
21	9.9	8.2	9.5	10.9	12.0
24	11.0	9.3	10.8	12.4	13.7

Product Properties	
Density:	9.07 lbs. Per Gallon
Viscosity:	800 cps
% Vehicle Solids:	100%
% Volatile:	0%
VOC:	0
Working Time:	20 minutes @ 75° F. (25° C.)
Shelf Life:	1 year @ 75° F. in Original Containers

SUMMARY OF RESULTS

1. **Buckling Pressure**

Minimum Liner Thickness	**t =**	**0.147 inch**
Actual Liner Thickness	**t =**	**0.148 inch**

3.8 mm

2. **Computed Deflection** **y = 0.064 inch**
   Allowable Deflection **5% = 0.400 inch**

0.064 < 0.400

Deflection is within acceptable limits.

3. **Computed Ring Bending** **OI = 2963 psi**
   Maximum Ring Bending **OI (max) = 10800 psi**

2963 < 10800

Ring Bending is within acceptable limits.

4. **Computed Minimum Stiffness** **= 0.423 in-lb**
   Allowable Minimum Stiffness **= 0.093 in-lb**

0.423 > 0.093

The liner thickness meets the minimum Long-Term Stiffness requirements.

5. **Percent Increase In Flow Capacity** **= 17.55 %**