UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021
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05/16, CHG 1: 08/16

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USACE / NAVFAC / AFCEC / NASA	**UFGS-33 01 30.72 (May 2016)** **Change 1 - 08/16**
Preparing Activity: NAVFAC	**Superseding** **UFGS-33 01 99 (May 2009)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 33 01 30.72

RELINING SEWERS
05/16, CHG 1: 08/16

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NOTE: This guide specification covers the requirements for storm sewer and sanitary sewer main rehabilitation utilizing pipe within a pipe methods, Fold-and-Form Pipeliner (FFP) and Cured-In-Place Pipe (CIPP).

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

Pipe rehabilitation by FFP and CIPP are effective means to rehabilitate existing storm water and sanitary sewer mains that are appropriately sized for their intended use. When this section is utilized, also include Section 33 01 30.16 TV INSPECTION OF SEWER PIPELINES.

****

PART 1 GENERAL

1.1 BASIS OF PAYMENT

Include all costs to perform the work in this section in the Lump Sum bid.

Provide unit price costs of permits, materials, labor, equipment, and services necessary for traffic control, bypass pumping and diversion of sewage flows, cleaning and Pre-television (Pre-TV) inspection of sewers to

be lined, liner installation, reconnection of service connections, quality controls, Post-TV inspection. Provide samples for performance of required material tests, testing of the lined pipe system, and warranty work, as specified herein.

Include the cost of removal of obstructions that appeared on pre-bid video documentation and made available prior to the bid opening in the bid price.

Final payment for the project will be withheld pending receipt and approval of test results, Post-TV inspection videos, Warranty-TV inspection, and repairs found in the Post-TV and Warranty-TV video inspection. If properties tested do not meet the minimum physical and thickness requirements as required in the Contract, repair the Fold-and-Form Pipeliner (FFP)Cured-In-Place Pipe (CIPP) according to manufacturer's recommendations or remove and replace the lining material.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE MOP 120	(2009) Trenchless Renewal of Culverts and Storm Sewers

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA M45	(2013; 3rd Ed) Fiberglass Pipe Design

ASTM INTERNATIONAL (ASTM)

ASTM D790	(2017) Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

ASTM D2412	(2011) Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
ASTM D2990	(2017) Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics
ASTM D5813	(2004; R 2008) Standard Specification for Cured-In-Place Thermosetting Resin Sewer Piping Systems
ASTM F1216	(2016) Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube
ASTM F1504	(2014) Standard Specification for Folded Poly(Vinyl Chloride) (PVC) Pipe for Existing Sewer and Conduit Rehabilitation
ASTM F1533	(2001; R 2009) Standard Specification for Deformed Polyethylene (PE) Liner
ASTM F1743	(2016) Standard Practice for Rehabilitation of Existing Pipeline and Conduits by Pulled-In-Place Installation of Cured-In-Place Thermosetting Resin Pipe (CIPP)
ASTM F1867	(2006; R 2012) Standard Practice for Installation of Folded/Formed Poly (Vinyl Chloride) (PVC) Pipe Type A for Existing Sewer and Conduit Rehabilitation
ASTM F1871	(2011) Standard Specification for Folded/Formed Poly (Vinyl Chloride) Pipe Type A for Existing Sewer and Conduit Rehabilitation
ASTM F2019	(2011) Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Pulled in Place Installation of Glass Reinforced Plastic (GRP) Cured-in-Place Thermosetting Resin Pipe (CIPP)

1.3 DEFINITIONS

1.3.1 Storm Sewers

Unless otherwise specified or indicated, see ASCE MOP 120 for definitions.

1.4 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal

items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Choose the first bracketed item for Navy, Air Force, and NASA projects, or choose the second bracketed item for Army projects.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

****
NOTE: It is recommended that Contractor Quality Control (CQC) Plan, and SD-03, SD-04, SD-05, SD-06, and SD-11 items be submitted for Government approval.
****

SD-01 Preconstruction Submittals

Contractor Quality Control (CQC) Plan; G[, [_____]]

Equipment; G[, [_____]]

Sequence Of Liner Installation; G[, [_____]]

Traffic Control Plan; G[, [_____]]

Bypass Plan; G[, [_____]]

Odor Control Plan; G[, [_____]]

Disposal of Superheated Water; G[, [_____]]

FFP Repair Method; G[, [_____]]

SD-03 Product Data

Hydrophilic Seal; G[, [_____]]

Fabric Tube; G[, [_____]]

Manufacturer's Technology Data; G[, [_____]]

Catalyst; G[, [_____]]

Raw Resin Data; G[, [_____]]

Flexible Membrane; G[, [_____]]

Lubricant; G[, [_____]]

SD-04 Samples

FFP Samples; G[, [_____]]

CIPP Liner Samples;G[, [_____]]

SD-05 Design Data

Engineering Design Calculations; G[, [_____]]

Flow Capacity Waiver; G[, [_____]]

SD-06 Test Reports

IR Analyses; G[, [_____]]

Pre-TV Videos on CD or DVD; G[, [_____]]

Curing Logs; G[, [_____]]

Temperature Logs; G[, [_____]]

FFP Liner Sample Test Results; G[, [_____]]

CIPP Liner Sample Test Results; G[, [_____]]

Post-TV Video Inspection; G[, [_____]]

Pre-TV and Post-TV CDs/DVDs; G[, [_____]]

SD-07 Certificates

Liner Manufacturer's Qualifications; G[, [_____]]

Contractor's Qualifications; G[, [_____]]

CIPP Installer's Qualifications; G[, [_____]]

Superintendent's Qualifications; G[, [_____]]

Certificate of QC Laboratory Accreditation; G[, [_____]]

Shipping Documents; G[, [_____]]

Manufacturing Certifications; G[, [_____]]

Resin Dye; G[, [_____]]

SD-11 Closeout Submittals

Warranty-TV Inspection; G[, [_____]]

As-Built Drawings; G[, [_____]]

1.5 QUALITY CONTROL

1.5.1 Quality Control Plan (QCP)

Submit a detailed Contractor Quality Control (CQC) Plan that fully represents and conforms to the requirements of these specifications. At a minimum the CQC is to include the following:

a. Defined responsibilities, of the personnel, for assuring that quality requirements, for this Contract are met. Assign these responsibilities to specific personnel.

b. Submit clearly defined proposed procedures for quality control, product sampling and testing as part of the plan.

c. Proposed methods for product performance controls, including method of and frequency of product sampling and testing both in raw material form and cured product form.

d. A scheduled performance and product test result review with the Contracting Officer at a regularly scheduled progress meeting.

e. Prepare Inspection Forms and guidelines for quality control inspections in accordance with the standards specified in this Contract and submitted with the QCP.

f. Outline specific repair or replacement procedures for potential defects that occur in the installed liner system, following repair or replacement procedures that are compatible with the system being used. Submit Repair or Replacement Procedures must adhere to the product manufacturer's written specifications for repair or replacement.

****

NOTE: Product and installation improvements are rapidly changing the pipe lining industry. Up to date training is recommended for all sizes of projects. Select training options based upon the anticipated duration of the lining portion of the project.

If other than two people are to receive training insert the number of personnel in the brackets.

****

g. [Provide two days of training for [two][_____] people, conducted by the FFPCIPP system manufacturer, for Government personnel. Provide this training prior to liner installation, include both technical and field training and include key aspects of visual inspection and sampling procedures for testing requirements.] [On smaller projects, having an estimated duration of less than 10 working days of lining work, furnish a checklist containing key elements of the FFPCIPP installation criteria that is important for the Government personnel to ensure that quality control and testing requirements are performed in accordance with the Contract documents.]

1.5.2 Liner Manufacturer's Inspection

a. During the process of manufacture and impregnation, provide the Contracting Officer with a reasonable opportunity to examine operations where the manufacture and impregnation (if applicable) of the liner is being carried out. Provide a minimum of fourteen days written notice to the Contracting Officer to observe the various processes. If the CIPP is manufactured without providing the required notice to the Contracting Officer the CIPP will be marked as rejected prior to installation and will not be approved for installation.

b. Provide full access to witness the CIPP wet-out process and provide information related to the manufacturing as requested by the Contracting Officer, without delay and without claims of confidentiality or product privacy.

1.5.3 Liner Manufacturer's Qualifications

Use felt material manufactured by companies specializing in felt production for CIPP. The manufacturer is to have manufactured felt material for CIPP for at least two years as documented by references. Submit felt manufacturer, references and location of the manufacturing facility. The felt material manufacturer and facility cannot change during construction unless specifically approved by the Contracting Officer in writing and in advance of its use.

1.5.4 Contractor's Qualifications

The Contractor is to have a minimum of three years of continuous experience installing CIPP liners in pipe of a similar size, length and configuration as contained in this Contract. A minimum of 45,720 meters 150,000 linear feet of shop wet-out liner installation is required and a minimum of six onsite wet-out installations are required as specifically applicable to this Contract.

A minimum of three years experience using the proposed FFP rehabilitation of sewers' product is required as well as the installation of at least 15,240 meters 50,000 linear feet of the proposed FFP product(s). Employees and subcontractors performing work on the FFP rehabilitation are to be certified by the FFP rehabilitation system supplier as qualified to perform work with the proposed product. The firm performing the work is to be licensed by the liner process manufacturer.

1.5.5 CIPP Installer's Qualifications

The lead personnel including the superintendent, the foreman and the lead

crew personnel for the resin wet-out, the CIPP liner installation, liner curing and the robotic service reconnections each are to have a minimum of three years of total experience with the CIPP technology utilized.

1.5.6 Superintendent's Qualifications

The superintendent for the Contract is to have supervised projects in which at least 7620 meters 25,000 linear feet of pipe has been rehabilitated using the product. The superintendent must be on-site during all phases of the work involving the insertion and processing of the liner pipe.

1.5.7 QC Specialist

The Quality Control (QC) Specialist is responsible for monitoring and documenting activities related to QC of the liner system from manufacturing through installation. The QC Specialist is to have a minimum of three years of continuous experience installing FFPCIPP liners of similar size, length and configuration as contained in this contract. The QC Specialist is to be certified by the liner system supplier as qualified to perform work with the proposed liner system.

1.5.8 QC Laboratory

Select a QC Laboratory that has provided QC testing for at least three completed projects with the proposed liner system; and is independent from, and not associated with, the Contractor. QC Laboratory certification in accordance with the following standards is required: ASTM D790, ASTM D2412, ASTM D2990, ASTM D5813, and ASTM F1216. Submit the Certificate of QC Laboratory Accreditation.

1.6 DELIVERY, STORAGE, AND HANDLING

Include test reports certifying that the materials conform to the applicable ASTM standards listed herein with materials shipped to the project site. Ship, store, and handle materials in a manner consistent with the written specifications of the liner system manufacturer to avoid damage. Damage may include, but is not limited to, gouging, abrasion, flattening, cutting, puncturing, or ultra-violet (UV) degradation. Select on site storage locations for approval by the Contracting Officer. Promptly remove and dispose of damaged materials.

As a minimum the FFP delivered to the job site is to contain the manufacturers name or trademark, the nominal outside diameter, the cell classification, the DR designation, and the ASTM designation of the pipe.

1.7 PROJECT/SITE CONDITIONS

The use of the product is not to result in the formation or production of any detrimental compounds or by-products including cuttings and pipe coupons, at the wastewater treatment plant or environment. Cool superheated water to below 38 degrees C 100 degrees F before discharge. Notify the Contracting Officer and identify any by-products produced as a result of the installation operations. Comply with local waste discharge requirements.

1.8 WARRANTY

1.8.1 Warranty-TV Inspection

****

NOTE: This inspection is generally performed at 10 months after completion of a lining section and reveals flaws in material and workmanship not otherwise seen, such as settlement, leaks and delamination.

NOTE: Consider adding Warranty-TV inspection to the commissioning requirements of the project. The benefits include a final internal examination of selected portions of the newly installed culverts and storm drain piping system.

****

a. After a pipe section has been lined and for a period of time up to one year following completion of the project, complete a Warranty-TV Inspection as specified in Section 33 01 30.16 TV INSPECTION OF SEWER PIPELINES and at a time directed by the Contracting Officer. The specific locations will be selected by the Contracting Officer.

b. Repair any defects or abnormalities in lining, laterals or manhole connections which may materially affect the integrity, strength, function or operation of the pipe in accordance with Repair or Replacement Procedures.

PART 2 PRODUCT

2.1 SYSTEM DESCRIPTION

Rehabilitate sewer pipelines by the installation of Fold-and-Form Pipeliners (FFP)a Cured-in-Place Pipe (CIPP)liner. Provide a continuous and tight-fitting liner throughout the entire length of the original pipe. Extend the FFPCIPPthe full length of the original pipe, from entry point to exit point, and provide a structurally sound and water-tight new pipe within a pipe. Cleanup, restore existing surface conditions and structures, and repair portions of the FFPCIPP system determined to be defective. Conduct installation operations and schedule cleanup in a manner to minimize obstruction and inconvenience to traffic, pedestrians, and tenants.

2.1.1 Structural Requirements

a. The physical properties, wall thickness and characteristics of the finished FFP will vary according to the material installed. Provide a FFP system which meets or exceeds the minimum properties specified herein:

(1) Design the FFP in accordance with the applicable ASTM Standard, depending on the material being installed. The FFP design is not to assume bonding to the original pipe wall.

(2) The FFP design engineer is to set the long term (50 year extrapolated) Modulus Retention Factor as a percentage of the flexural modulus as determined by ASTM D790 test method. Base the Modulus Retention Factor on long term test data (ASTM D2990 or

equal) submitted by the manufacturer of the product selected to substantiate the long term creep retention factor.

(3) The installed FFP material is to meet or exceed the structural properties, as listed below.

(a) As a minimum, base the required structural FFP wall thickness on the physical properties of the manufactured FFP and according to the design of the Professional Engineer and in accordance with ASTM F1504 and ASTM F1533.

Design Safety Factor	2.0
Modulus Retention Factor	As submitted and specific to type of pipe material
Ovality	2% or as measured by field inspection
Constrained Soil Modulus	Per AASHTO LRFD Section 12 and AWWA M45
Groundwater Depth	As specified or indicated on the Plans
Soil Depth (above the crown)	As specified or indicated on the Plans
Live Load	Highway, railroad or airport as applicable
Soil Load (assumed)	1922 kg/cu. m120 lb/cu. ft. (or data from specific project soil borings)
Minimum service life	50 years

MINIMUM PHYSICAL PROPERTIES

Property	Test Method	Per Applicable ASTM
Flexural Modulus of Elasticity	ASTM D790	HDPE - 814 MPa118,000 psi PVC - 1931 MPa280,000 psi PVC Type A - 1000 MPa145,000 psi
Flexural Strength	ASTM D790	HDPE - N/A PVC - 34.5 MPa5,000 psi PVC Type A - 28.3 MPa4,100 psi

2.1.2 Structural Requirements

a. Provide calculations supporting the liner thickness. The data is to include both the calculated thicknesses and the thicknesses proposed to be installed. Design the CIPP in accordance with the applicable provisions of ASTM F1216 and ASTM D2412 for fully deteriorated gravity pipe

conditions.

b. The installed, cured liner thickness is the largest thickness as determined by calculations for deflection, bending, buckling and minimum stiffness. The minimum installed, cured liner thickness is as follows, regardless of what the calculations indicate as the required minimum thickness:

****

NOTE: Thickness values are stated in SI or metric units since they are regarded as the standard; therefore, English units are not provided for thickness values below. Refer to ASTM D790, paragraph 1.3.

****

150 mm6 inch sewer: 4.5 mm
200 mm8 inch sewer: 6 mm up to 5.2 meters 17 feet deep
200 mm8 inch sewer: 7.5 mm up to 7.6 meters 25 feet deep
250 mm10 inch sewer: 6 mm up to 3.4 meters 11 feet deep
250 mm10 inch sewer: 7.5 mm up to 5.5 meters 18 feet deep
250 mm10 inch sewer: 9 mm up to 7.6 meters 25 feet deep
300 mm12 inch sewer: 7.5 mm up to 3.7 meters 12 feet deep
300 mm12 inch sewer: 9 mm up to 5.5 meters 18 feet deep
300 mm12 inch sewer: 10.5 mm up to 7.6 meters 25 feet deep
375 mm15 inch sewer: 7.5 mm up to 3.0 meters 10 feet deep
375 mm15 inch sewer: 9 mm up to 4.3 meters 14 feet deep
375 mm15 inch sewer: 10.5 mm up to 6.1 meters 20 feet deep

c. The physical properties and characteristics of the finished liner will vary considerably, depending on the types and mixing proportions of the materials used, and the degree of cure executed. Control these variables and provide a CIPP system which meets or exceeds the minimum properties specified herein:

(1) Design the CIPP to meet or exceed ASTM F1216 Appendixes. The CIPP design is to assume no bonding to the original pipe wall.

(2) The CIPP design engineer is to set the long term (50 year extrapolated) Creep Retention Factor at 50 percent of the initial design flexural modulus as determined by ASTM D790 test method. Use this value unless long term test data (ASTM D2990) substantiates a higher retention factor is required.

(3) At a minimum, the CIPP is to meet or exceed the structural properties, as listed below:

	MINIMUM PHYSICAL PROPERTIES	
Property	Test Method	Cured Composite (ASTM F1216)
Flexural Modulus of Elasticity (Short Term) (Felt Tubes) Felt/Fiberglass, Fiberglass meeting manufacturer's specifications	ASTM D790	1724 MPa250,000 psi
Flexural Strength (Short Term) (Felt Tubes) Felt/Fiberglass, Fiberglass meeting Manufacturer's specifications	ASTM D790	31.0 MPa4,500 psi

(4) As a minimum, base the required structural CIPP wall thickness on the physical properties of the cured composite and the design of the Contractor's Professional Engineer and in accordance with the Design Equations contained in the Appendix of the ASTM standards, and the following design parameters:

Design Safety Factor	2.0 (1.5 for pipes 900 mm36 inch or larger)
Creep Retention Factor	50 percent
Ovality	2 percent or as measured by field inspection
Constrained Soil Modulus	AASHTO LRFD Section 12 and AWWA M45
Groundwater Depth	As specified or indicated on the plans, in the specifications or geotechnical report
Soil Depth (above the crown)	As specified or indicated on the plans
Live Load	Highway, railroad or airport as applicable
Soil Load (assumed)	1922 kg/cu. m120 lb/cu.ft.
Minimum service life	50 years

(5) Prior to installation of the lining materials, submit certification of compliance with these specifications or the requirements of the pre-approved CIPP system. Include certified material test results that confirm materials conform to these specifications. Materials not complying with these requirements will be rejected.

2.1.3 Engineering Design Calculations

****
NOTE: Use ASCE MOP 120 as applicable.
****

Provide engineering design calculations, performed and sealed by a qualified registered Professional Engineer in accordance with the Appendix of ASTM F1216, for each length of liner to be installed including the thickness of each proposed FFPCIPP. It is acceptable to submit a design for the most severe line condition and apply that design to all of the line sections. Calculations are to include data that conforms to the requirements of these specifications.

2.1.4 Performance Requirements

a. Provide continuous and jointless FFP from manhole to manhole, free of defects that will affect the long term life and operation of the pipe.

   (1) The FFP is to fit sufficiently tight within the existing pipe so as to not leak at the manholes, at the service connections, or through the wall of the installed pipe.

   (2) Seal these areas to stop leakage using a material compatible with the FFP. Repair or replace the liner if leakage occurs through the wall of the pipe. Final approval of the liner installation will be based on a leak tight pipe.

b. The installed FFP is to have a 50 year corrosion resistance to the typical chemicals found in domestic sewage.

c. Provide a continuous and jointless CIPP from manhole to manhole or access point to access point, free of defects that will affect the long term life and operation of the pipe.

d. Fit the CIPP sufficiently tight within the existing pipe so as to not leak at the manholes, at the service connections or through the wall of the installed pipe. Seal leaks at the manholes or the service connections using a material compatible with the CIPP. If leakage occurs through the wall of the pipe, repair or replace the liner.

e. Design the CIPP for a life expectancy of 50 years or greater and to have a 50 year corrosion resistance to the typical chemicals found in domestic sewage.

f. Robotically re-open existing and confirmed active service connections and any other service laterals to be reinstated as directed by the Contracting Officer to their original shape and to a minimum of 90 percent of their original capacity. Repair over-cut service connections to meet the requirements of these specifications. Re-establish the service openings utilizing a remotely controlled brushing device to smoothly cut and remove jagged edges, material and shavings resulting in the cutting operation.

2.1.5 Hydrophilic Seals

Submit Hydrophilic Seal information that specifically indicates that the seal material is compatible with the liner material being utilized and the

hydrophilic seal will produce a tight fitting, waterproof seal between the liner and the host pipe at the manhole location.

2.2 ASSEMBLY

2.2.1 Tolerances

a. Maintain the hydraulic capacity as large as possible. At a minimum, the rehabilitated pipe is to equal the full flow capacity of the original pipe before rehabilitation. In those cases where full capacity cannot be achieved after liner installation, submit a request to waive this requirement, together with the reasons for the waiver request. Derive calculated capacities using a commonly accepted roughness coefficient for the existing pipe material taking into consideration its age and condition.

b. Measure the installed CIPP thickness for each line section installed. The installed CIPP liner thickness tolerance is minus 5 percent to plus 10 percent as compared to the approved liner design. Submit a minimum of one CIPP liner sample for every line section of installed CIPP liner to be used to check the liner thickness. Replace sections where the liner thickness does not fall within the approved design thickness.

2.2.2 Equipment

Provide sufficient equipment to stop or by-pass sewer flow, clean and CCTV mains, install and cure liners, and re-instate service connections as indicated in the Contract documents.

2.2.3 Manhole Connections

Form a tight seal between the rehabilitation (lining) material and the host pipe at the pipe penetration of the manhole wall. Apply the seal consisting of a resin mixture or hydrophilic seal compatible with the installed liner at the manhole-wall interface in accordance with the liner system manufacturer's specifications. Seal annular spaces greater than 13 mm 1/2 inch with manhole wall repair material. Finish off the seal with non-shrink grout or cementitious liner material placed around the pipe opening from the inside of the manhole in a band at least 100 mm 4 inches wide. Provide an epoxy coating over the repair on the manhole walls.

Provide a continuous and smooth invert through manholes. If a liner is installed through a manhole, the bottom portion of the liner is to remain. Grout and shape the bench of the manhole as necessary to support the liner. If the liner terminates on either side of the manhole, build up the invert to remove flow restrictions and to form a continuous invert through the manhole.

2.2.4 Assembly of Fabric Tube

a. Provide a fabric tube manufactured of one or more layers of absorbent non-woven felt fabric, felt fiberglass composite or fiberglass and meet the requirements of ASTM F1216, ASTM F1743, ASTM D5813, and ASTM F2019 that is capable of absorbing and carrying resins, constructed to withstand installation pressures and curing temperatures and have sufficient strength to bridge missing pipe segments, and stretch to fit irregular pipe sections. Submit certified information from the felt manufacturer of the nominal void

volume in the fabric tube that will be filled with resin.

b. The wet-out fabric tube is to have a uniform thickness and excess resin distribution that, when compressed at installation pressures, will meet or exceed the design thickness after cure.

c. Manufacture the fabric tube to a size and length that when installed will tightly fit the internal circumference of the host pipe. Allowance for circumferential stretching during installation. Size the tube to the diameter of the existing pipe and the length to be rehabilitated, and be able to stretch to fit irregular pipe sections and negotiate bends. Prior to ordering, measure in the field the minimum tube length necessary to effectively span the designated run between manholes to ensure that the tube will have sufficient length to extend the entire length of the run. Measure the inside diameter of the existing pipelines in the field prior to ordering liner so that the liner can be installed in a tight-fitted condition.

d. Coat the outside or inside layer of the fabric tube (before inversion or pull-in, as applicable) with an impermeable, flexible membrane that contains the resin and facilitates, if applicable, vacuum impregnation and monitoring of the resin saturation during the resin impregnation (wet out) procedure.

e. Do not include material in the fabric tube that may cause delamination in the cured CIPP. Dry or unsaturated layers are not acceptable upon visual inspection as evident by color contrast between the tube fabric and the active resin containing a colorant.

f. Use a light reflective interior pipe surface color so that a clear detailed examination of the CIPP can be made with closed circuit television inspection equipment. Provide a hue of the color dark enough to distinguish a contrast between the fully resin saturated felt fabric and dry or resin lean areas.

g. When seams in the fabric are required, sew them so that the seams are stronger than unseamed felt.

h. Spirally form and sew where the length requires joining.

i. Mark the outside of the fabric tube every 1.5 meters 5 feet with the name of the manufacturer or CIPP system, manufacturing lot and production footage.

j. The installer will determine the minimum length of the fabric tube to effectively span the distance from the starting manhole to the terminating manhole or access point, plus that amount required to run-in and run-out for the installation process.

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NOTE: Thickness values are stated in SI or metric units since they are regarded as the standard; therefore, English units are not provided for thickness values below. Refer to ASTM D790, paragraph 1.3.

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k. As a minimum, provide the fabric tube wall thickness manufactured to the nearest 0.5 mm 0.02 in increment, rounded up from the design

thickness for that section of installed CIPP. Wall thickness transitions, in 0.5 mm 0.02 in increments or greater as appropriate, may be fabricated into the fabric tube between installation entrance and exit access points. Provide a sufficient quantity of resin used in the impregnation to entirely fill the felt voids for the nominal felt thickness.

2.2.5 Resin

a. Provide a corrosion resistant polyester or vinyl ester resin and catalyst system or epoxy and hardener system that, when cured within the tube composite, meets the requirements of ASTM F1216, ASTM F1743, or ASTM F2019, the physical properties herein, and those, indicated in the design of the CIPP for this project. The resin is to produce CIPP which will comply with or exceed the structural and chemical resistance requirements of this specification.

b. Submit the resin to tube ratio, by volume, as determined by the Design Calculations.

c. Provide the polyester or vinyl ester resin that is PREMIUM, NON-RECYCLED resin only. Do not use Polyethylene Terephthalate (PET) resins, or those containing fillers, additives or enhancement agents. Old resin or reworked resin is not permitted.

d. Do not use Quick-cure or accelerated resin systems that cure in half the specified time or substantially quicker than the minimum three hours.

e. Do not change resins, catalysts, resin/catalysts, or mixing ratios during this Contract unless specifically approved by the Contracting Officer in writing in advance.

f. Ship the resin directly from the resin manufacturer's facility to the CIPP wet-out facility. Submit copies of the shipping documents from the resin manufacturer to the Contracting Officer showing dates of shipment, the originating location and the receiving location.

g. Use the resin to manufacture the CIPP as shipped. Do not add fillers or additives at the wet-out facility except for the required catalyst.

h. Apply the resin to the felt tubing (wet-out) under factory conditions. Protect the materials against ultraviolet (UV) light, excessive heat and contamination at all times.

2.2.6 Materials

2.2.6.1 Manufacturer's Technology Data

a. Submit manufacturer's technology data for FFPCIPP products and associated technologies.

(1) Include infrared spectrum (IR) analysis for proposed resin and confirmation that the resins meet ASTM D5813. The IR analyses will be used to verify that the resin and the resin catalyst composition and mixture being used is the approved resin and resin catalyst system.

(2) Submit results of IR analyses of the proposed resin and resin

catalyst mixture, performed and certified by the resin manufacturer, prior to manufacturing CIPP.

(3) The results of these analyses (the resin's chemical fingerprint) will be used as the standard for verifying the resin and resin catalyst mixture being used throughout construction.

2.2.7 Manufacturing Certifications

a. Submit manufacturing certifications that the CIPP was manufactured in accordance with these specifications and ASTM D5813 with each shipment. The certifications are to include:

(1) A signed statement by the wet-out manager/supervisor that no fillers were added to the resin system during manufacture of the CIPP.

(2) Wet-out forms documenting the wet-out for each section of CIPP manufactured without delay or claim to any confidentiality.

(a) The wet-out forms are to document the date and time of wet-out, the wet-out supervisor, the wet-out facility address, the location where the CIPP will be installed (by work order and manhole numbers), the CIPP diameter, the length of wet-tube and dry-tube, the thickness of the CIPP, the roller gap setting for establishing the liner thickness, the felt manufacturer, the resin used (by product name and batch or shipment number) and quantity, the catalyst(s) used (by product name) and quantity, quality control samples taken, and other information pertinent to the wet-out process.

2.2.8 Catalyst

Catalyst product data and quantity. Include a Certificate of Authenticity from the resin manufacturer for each shipment to the wet-out facility as part of the Catalyst product data submittal. Include the date of manufacture and the Heat Distortion Temperature.

2.2.9 Raw Resin Data

Submit Raw Resin Data, including the manufacturer and description of product components.

2.2.10 Flexible Membrane

Submit product data for the Flexible Membrane (coating) material including the manufacturer's recommended repair (patching) procedure.

2.2.11 Lubricant

Submit detailed description of the lubricant proposed for the insertion or inversion process. Ensure that the lubricant is compatible with the wastewater treatment plant operations and pre-treatment program.

2.2.12 Resin Dye

Submit certification that the Resin Dye quantity and type is compatible with the components of the lining system.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Set-Up and Sequence

Submit a Sequence of Liner Installation plan. Include proposed set-up locations in the plan that are coordinated with the Traffic Control Plan.

3.1.2 Traffic Control

a. Utilize manholes in the project area as installation access points, at the direction of the Contracting Officer.

b. When a street must be closed to traffic because of the location of the sewer access point, submit a detailed Traffic Control Plan to the Contracting Officer at least 10 days in advance. Meet the requirements of the local agency having jurisdiction over traffic control.

c. Provide labor, signs, barricades, cones, arrow boards, flaggers and any additional equipment necessary to complete the work.

3.2 CLEANING OF PIPE LINES

Clean mains and services as indicated in SECTION 33 01 30.16 TV INSPECTION OF SEWER PIPELINES..

Remove internal debris from the existing pipe line that will interfere with the installation of the liner as required in these specifications.

Legally dispose of solid debris and deposits removed from the system. Moving solid material from manhole section to manhole section is not permitted.

As applicable, either plug the pipe to be cleaned, or install a flow bypass pumping system to facilitate the proper cleaning the pipe lines. Immediately clean up raw sewage spills caused by the Contractor's operations and disinfect the spill area using methods and materials approved by the Contracting Officer. In the event of a spill, notify the Contracting Officer immediately and take appropriate actions to stop and contain the spill.

Exercise care and caution in the use of cleaning equipment in order to avoid damage to the existing pipe.

Provide backflow prevention on fire hydrants used to obtain water as required in Division 01 sections for temporary utilities.

3.3 BYPASSING EXISTING SEWAGE FLOWS

Provide for the flow of existing mainline and service connection effluent around the section or sections of pipe designated for liner installation.

Plug service connections only after proper notification to the Contracting Officer. Service connections are not to remain plugged overnight.

Begin work after plugs or a sewage bypass system and pumping facilities have been installed and tested under full operating conditions, including

the bypass of mainline and side sewer flows.

Once the lining process has begun, maintain existing sewage flows until the resin/felt tube composite is fully cured, cooled down, fully televised and the CIPP ends finished.

Coordinate sewer bypass and flow interruptions with the Contracting Officer at least 14 days in advance.

Provide pump(s) and bypass line(s) of adequate capacity and size to handle peak flows.

Submit a detail of the sewer Bypass plan and design to the Contracting Officer before proceeding with liner installation.

3.4 ODOR CONTROL PLAN

Submit an odor control plan that will ensure that project specific odors will be minimized at the project site and surrounding area.

3.5 PRE-TV INSPECTION

Perform post-cleaning Pre-TV video inspections of the pipelines.

PACP certified personnel are to perform the TV inspection.

Submit the Pre-TV videos on CD or DVD and corresponding written logs prior to installation of the liner and for later reference by the Contracting Officer.

3.6 LINE OBSTRUCTIONS

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NOTE: The vast majority of point repairs are made by the open cut method. No dig sectional point repairs are typically suited for high volume traffic areas and deeper mains.

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Remove obstructions, correct misalignments, repair broken or collapsed sections and sags that will prohibit the installation or will interfere with the long-term performance of the lining materials by performing a point repair. Point repairs may be by [open cut repair methods] [or] [by sectional point repair methods in accordance with ASTM F1216].

3.7 LATERAL LOCATIONS

Confirm the locations of branch service connections prior to installing and curing the liner material. In the event the status of a service connection cannot be adequately defined, the Contracting Officer will make the final decision, prior to installation and curing of the liner, as to the status.

Unless directed otherwise, only re-open service connections deemed active.

3.8 INSTALLATION OF CIPP LINER

Prior to the installation of the liner, place temperature sensors in the host pipe in order to monitor the temperature of the liner wall and to

verify correct curing. Place temperature sensors between the host pipe and the liner in the bottom of the host pipe (invert) throughout its length and monitor the temperature on the outside of the liner during the curing process.

Place the temperature sensors at intervals as indicated in the sensor manufacturer's written specifications. Place additional sensors where significant heat sinks are likely or anticipated.

Monitor the sensors by a computer using a tamper proof data base that is capable of recording temperatures at the interface of the liner and the host pipe.

Install the liner in accordance with ASTM F1216 and ASTM F1743 with the following modification: Position the wet-out tube in the pipeline using the method indicated in the manufacturer's instructions. Do not damage the tube as a result of installation. Pull-in or invert through an existing manhole or access point and fully extend to the next manhole or termination point.

Install and cure the CIPP Liner in the host pipe as indicated in the manufacturer's specifications and as described in the approved submittals.

Accomplish curing by utilizing the medium in accordance with the cure schedule. Continuously monitor the curing source, or input and output temperatures and log the temperatures during the cure cycles. Use the manufacturer's recommended cure method and schedule for each line segment installed. Take the liner wall thickness and the existing ground conditions with regard to temperature, moisture level, and thermal conductivity of soil into account during the curing process.

For heat cured liners, if one or more temperature sensor(s) do not reach the temperature as specified by the manufacturer to achieve proper curing or cooling, the installer is to make necessary adjustments to comply with the manufacturer's specifications.

Compile and submit Curing Logs from the system computer that specifically identifies each installed sensor station in the length of pipe, indicates the maximum temperature achieved and the sustained temperature time. Each sensor is to record both the maximum temperature and the minimum cool down temperature and comply with the manufacturer's written product data.

For UV Cured Liners, record all light train sensor readings along the entire length of the installed liner into a tamper proof computer. Follow the cure procedure in accordance with the manufacturer's written product data.

3.9 INSTALLATION OF FFP LINER

Install and process the FFP in the host pipe according to these specifications, ASTM F1867 and the manufacturer's specifications.

Prior to installation of the FFP liner, place temperature sensors in the host pipe to monitor the temperatures during the processing of the FFP. Monitor and log temperatures during processing and cool down. Submit temperature logs.

Position the FFP in the pipeline using the method specified by the manufacturer. Pull-in the FFP through an existing manhole or access point

and fully extend the FFP liner to the next designated manhole or termination point.

Complete the processing of the FFP by utilizing the appropriate medium in accordance with the manufacturer's instructions. Use ASTM F1867 and the manufacturer's recommended processing procedure for each line segment installed. Consider the FFP wall thickness and the existing ground conditions with regard to temperature, moisture level, and thermal conductivity of the host pipe and soil, during the installation of the FFP. Adjust pressures according to site conditions to ensure a tight expansion out against the host pipe.

3.10 DISPOSAL OF SUPERHEATED WATER

Submit a procedure for the disposal of superheated water for approval by the Contracting Officer.

3.11 COOL DOWN

Cool the FFPCIPP in accordance with the approved FFPCIPP product specifications.

Monitor and record temperatures and curing data throughout the installation process to ensure that each phase of the process is achieved in accordance with the FFPCIPP system product specifications.

3.12 CURING LOGS

Submit completed curing logs for each pipe segment.

3.13 FINISH (CIPP)

Provide CIPP that is continuous over the entire length of a sewer line section, is free from visual defects such as foreign inclusions, dry spots, pinholes, major wrinkles and de-lamination, and is impervious and free of leakage from the pipe to the surrounding ground or from the ground to inside the lined pipe.

Repair defects in accordance with the Repair or Replacement Procedures which may affect the structural integrity or strength of the linings.

Seal the beginning and end of the CIPP to the existing host pipe utilizing a hydrophilic end sealing material compatible with the existing (HOST) pipe and the liner.

Provide water tight service connections.

3.14 FINISH (FFP)

Provide FFP that is fully expanded and continuous over the entire length of a sewer line section, is free from visual defects such as foreign inclusions, dry spots, pinholes, major wrinkles, is impervious and free of any leakage from the pipe to the surrounding ground or from the ground to inside the lined pipe.

Repair any defect, in accordance with the Repair or Replacement Procedureswhich may affect the structural integrity or strength of the linings.

Seal the beginning and end of the FFP to the existing host pipe using a hydrophilic end sealing material compatible with the existing (host) pipe and the FFP.

Provide watertight service connections.

If the wall of the FFP leaks, remove and replace the section of FFP with a watertight pipe.

3.15 FIELD QUALITY CONTROL

All costs for the collection, transportation and testing of samples are the responsibility of the Contractor.

3.15.1 Testing of Installed FFP

a. Verify the physical properties of the installed FFP through field sampling and laboratory testing. Submit FFP Samples for testing to the Contracting Officer for testing, by a qualified, independent laboratory that specializes in material testing; testing will be at the Contractor's expense. Test in accordance with ASTM F1871 and ASTM F1504test methods to confirm compliance with the requirements specified in these Contract documents.

b. Provide samples for testing to the Contracting Officer from the actual installed FFP. At a minimum, provide samples from one location per 762 meters 2500 linear feet of installed pipe. Cut the sample from a section of processed FFP that has been installed through a like diameter pipe which has been held in place by a suitable heat sink, such as sandbags. Process, cut, and label test samples in the presence of the Contracting Officer. Immediately package the samples in a pre-addressed, postage paid, pre-labeled, unsealed packing, addressed for delivery to the testing laboratory. Seal packages in the presence of the Contracting Officer; and ship or transport to the testing lab.

c. On pipelines greater in diameter than is practical to produce restrained samples, the Contracting Officer may, at his or her discretion, designate a location in the newly installed FFP where the Contractor is to take a sample. Repair the opening produced from the sample, in accordance with manufacturer's specifications.

d. Identify on the sample and as built drawings the test sample location as referenced to the nearest manhole and station. One re-testing of failed samples will be permitted for proper protocol compliance verification. If properties tested do not meet minimum requirements, repair or replace the FFP pipe section. Sample and test sections of the replaced FFP section.

e. Submit FFP liner sample test results.

f. Chemical resistance - The FFP system installed is to meet the chemical resistance requirements for a typical domestic sewage environment. Use materials proposed for actual construction for FFP testing.

g. Maintain the hydraulic capacity as large as possible. At a minimum the installed FFP is to equal the full flow capacity of the original pipe before rehabilitation. In those cases where full capacity cannot be achieved after FFP installation, submit a Flow Capacity Waiver

request together with the reasons for the waiver request. Calculated capacities may be derived using a commonly accepted roughness coefficient for the existing pipe material taking into consideration its age and condition.

(1) Measure the installed FFP thickness for each line section installed.

(2) Use non-destructive methods for confirming the thickness of the installed FFP.

(3) Remove the FFP if the FFP thickness does not meet the specified Contract requirements. The FFP thickness has a tolerance of minus 5 percent and plus 10 percent.

h. Where leakage is observed through the wall of the pipe, institute localized testing (weirs or similar) that will verify that the leakage rate of the installed liner does not exceed acceptable tolerances for new sanitary sewer installations for the local jurisdictions.

3.15.2 Testing of Installed CIPP

a. Verify the physical properties of the installed CIPP through field sampling and laboratory testing. Submit CIPP Liner Samples for testing by an independent third party laboratory. Test in accordance with ASTM F1216, ASTM F1743, and ASTM D5813 for chemical resistance. Test methods to confirm compliance with the requirements specified in these Contract documents.

b. Collect samples from the actual installed CIPP liner. At a minimum, one sample for each 305 meters 1000 linear feet of CIPP Liner installed; one sample for each size of CIPP Liner installed; and one plate sample cured with CIPP on pipelines greater than 450 mm 18 inches in diameter. Cut the samples from a section of cured CIPP that has been inverted or pulled through a like diameter pipe which has been held in place by a heat sink, such as sandbags.

c. Process, cut, and label test samples in the presence of the Contracting Officer. Immediately package the samples in a pre-addressed, postage paid, pre-labeled, unsealed packing, addressed for delivery to the testing laboratory. Seal packages in the presence of the Contracting Officer; and ship or transport to the testing lab.

d. Submit CIPP liner sample test results.

3.16 RECONNECTIONS OF EXISTING SERVICES

Make reconnections of existing services after the liner has been installed, fully cured, and cooled down.

Make external reconnections with a tee fitting in accordance with the lining system manufacturer's written specifications. Seat and seal saddle connections to the new CIPP using grout or resin compatible with the CIPP. FFP following manufacturer's specifications.

Utilize a CCTV camera and remote cutting tool for internal reconnections. The machined opening must be at least 90 percent of the service connection opening and the bottom of both openings are required to match. The opening cannot be more than 100 percent of the service connection

opening. Smooth the edges of the opening and remove pipe or liner fragments, which may obstruct flow or snag debris. Cut the invert of the sewer connection flush with the invert entering the mainline.

In the event that service reinstatements result in openings that are greater than 100 percent of the service connection opening, install a repair, sufficient in size to completely cover the over-cut service connection according to the manufacturer's specifications.

Collect coupons of pipe material resulting from service tap cutting at the next manhole downstream of the pipe rehabilitation operation prior to leaving the site. Account for all pipe coupons and do not allow them to pass through the system.

3.17 POST-TV INSPECTION

Perform a detailed closed-circuit Post-TV inspection in the presence of the Contracting Officer after installation of the liner and reconnection of the side sewers in accordance with Section 33 01 30.16 TV INSPECTION OF SEWER PIPELINES. Utilize a radial view (pan and tilt) TV camera. A post-TV video inspection is to confirm that the finished liner is continuous over the entire length of the installation, free of significant visual defects, damage, deflection, holes, leaks and other defects. Submit unedited digital video documentation of the inspection (Post-TV video inspection) to the Contracting Officer within 10 working days of the liner installation.

Include the following data on the Post-TV video: Inspection date, manhole identification numbers, size of pipe, direction of flow, location of reconnected side sewers, debris, as well as defects in the liner, such as gouges, cracks, bumps, or bulges.

Clean the newly installed liner removing accumulated debris and build-up immediately prior to conducting the Post-TV inspection.

3.18 REPAIR OF CIPP DEFECTS

Locate and succinctly define defects in the installed CIPP that will not affect the operation and long term life of the product. The warranty CCTV inspection will include pipe segments with noted defects that were not repaired.

Locate and succinctly define repairable defects that occur in the installed CIPP based on approved product specifications, including a detailed step-by-step repair procedure.

Clearly locate and define un-repairable defects in the CIPP based on the approved product specifications, including a recommended procedure for the removal and replacement of the CIPP.

3.19 REPAIR OF FFP DEFECTS

Repair or replace any defects which, in the judgment of the Contracting Officer, will affect the integrity or strength of the lining. Prior to the repair of defective work, submit a Shop Drawing indicating the FFP Repair Method. Provide field or workshop demonstration of the method of repair if requested by the Contracting Officer. Make the repairs in full compliance with the FFP manufacturer's specifications. Re-TV repairs to FFP in accordance in accordance with Section 33 01 30.16 TV INSPECTION OF

SEWER PIPELINES.

3.20 SITE CLEANUP

Cleanup and restore existing surface conditions and structures. Repair any of the FFP system determined to be defective.

Schedule cleanup in a manner to cause the least possible obstruction and inconvenience to traffic, pedestrians, and property occupants.

3.21 CLOSEOUT ACTIVITIES

3.21.1 Demonstration

Complete Post-TV inspections and repairs to the installed liner before acceptance. Complete Pre-TV, Post-TV, Re-TV and Warranty-TV inspections in accordance with Section 33 01 30.16 TV INSPECTION OF SEWER PIPELINES.

Submit post installation inspection documentation within 10 working days of the liner installation. The Contracting Officer may, at his or her discretion, suspend any further installation of lining materials if post-installation documentation is not submitted within 10 working days. As a result of this suspension, no additional working days will be added to the Contract, nor will any adjustment be made for increase in cost.

Submit as-built drawings for the portions of the sanitary sewer system that were rehabilitated showing complete detail with dimensions, both above and below grade, including invert elevations at the manholes.

Include the identification of the work completed on one set of Contract Drawings. Keep legible as-built drawings on the project site at times and maintain them as the work progresses. Continuously update the as-built drawings with accurate dimensions and notations concerning locations, sizes, pipe lengths and specific material types. Include dimensional location, size and type of point repairs on the as-built drawings.

Within 10 working days of final acceptance of said work, submit As-built drawings; Pre-TV and Post-TV CDs/DVDs; and Inspection forms.

-- End of Section --