# Plumbing

## Proposed Code Modifications

**This document created by the Florida Department of Community Affairs - 850-487-1824**

# TAC: Plumbing

## Sub Code: Building

Total Mods for Plumbing: 34

## P3936



| | | | | | |
|---|---|---|---|---|---|
| **Date Submitted** | 3/26/2010 | **Section** | 424.2.17.1.9 | **Proponent** | Jennifer Hatfield |
| **Chapter** | 4 | **Affects HVHZ** | No | **Attachments** | No |

**TAC Recommendation** Approved as Modified
**Commission Action** Pending Review

**Related Modifications**

3934

**Summary of Modification**

This proposal makes changes to the pool alarm requirements in order to provide for consistency with the UL 2017 General-Purpose Signaling Devices and Systems standard that an exit alarm must comply with per the code.

**Rationale**

Without this change requirements within the code would be inconsistent with what is required in UL 2017. For example, section 78.4 of the standard requires the alarm to sound within 7 secs of access to the open position, but section 424.2.17.1.9 of the Code says it must sound immediately. An exit alarm manufacturer certifies its product to UL 2017 requirements.

**Fiscal Impact Statement**

**Impact to local entity relative to enforcement of code**

None, it simply removes language inconsistent with a referenced standard.

**Impact to building and property owners relative to cost of compliance with code**

None, it simply removes language inconsistent with a referenced standard.

**Impact to industry relative to the cost of compliance with code**

The modification may decrease cost by eliminating confusion when trying to comply. If this change is not made and enforcement was required of both the UL standard and the inconsistent requirements laid out in the Code, additional costs could occur in order to make the product comply with both.

**Requirements**

**Has a reasonable and substantial connection with the health, safety, and welfare of the general public**

Exit alarms are safety features certified to a national standard. This proposal clarifies that exit alarms in FL will meet these requirements. This proposal does not make any changes that are inconsistent with the Florida Residential Swimming Pool Safety Act, where exit alarms are an option.

**Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction**

The modification improves the code by making it consistent with the UL 2017 standard.

**Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities**

This modification does not discriminate; in fact, it ensures all products are on the same playing field, each having to meet the requirements of the UL 2017 standard.

**Does not degrade the effectiveness of the code**

The modification improves the effectiveness of the code by clarifying what is required of an exit alarm used in association with the swimming pool barrier requirements.

**424.2.17.1.9** Where a wall of a dwelling serves as part of the barrier, one of the following shall apply:

1. All doors and windows providing direct access from the home to the pool shall be equipped with an exit alarm complying with UL 2017 that has a minimum sound pressure rating of 85 dB A at 10 feet (3048 mm). ~~The exit alarm shall produce an continuous audible alarm within 7 seconds warning when the access is door and its screen are opened. The alarm shall sound immediately after the door is opened and be capable of being heard throughout the house during normal household activities. The alarm may shall be equipped with a momentary self restoring switch manual means to temporarily deactivate the alarm for a single opening. Such deactivation shall last no more than 15 seconds.~~ Any ~~Th~~e deactivation switch shall be located at least 54 inches (1372 mm) above the threshold of the access ~~door~~. Separate alarms are not required for each door or window if sensors wired to a central alarm sound when contact is broken at any opening.

**Exceptions:**

a. Screened or protected windows having a bottom sill height of 48 inches (1219 mm) or more measured from the interior finished floor at the pool access level.

b. Windows facing the pool on floor above the first story.

c. Screened or protected pass-through kitchen windows 42 inches (1067 mm) or higher with a counter beneath.

2. All doors providing direct access from the home to the pool must be equipped with a self-closing, self-latching device with positive mechanical latching/locking installed a minimum of 54 inches (1372 mm) above the threshold, which is approved by the authority having jurisdiction.

**424.2.17.1.9** Where a wall of a dwelling serves as part of the barrier, one of the following shall apply:

1. All doors and windows providing direct access from the home to the pool shall be equipped with an exit alarm complying with UL 2017 that has a minimum sound pressure rating of 85 dB A at 10 feet (3048 mm). The exit alarm shall produce an ~~continuous~~ audible alarm within 7 seconds ~~warning~~ when the access is ~~door and its screen are~~ opened. ~~The alarm shall sound immediately after the door is opened and be capable of being heard throughout the house during normal household activities.~~ The alarm may ~~shall~~ be equipped with a momentary self-restoring switch ~~manual means~~ to temporarily deactivate the alarm for a single opening. Such deactivation shall last no more than 15 seconds. The deactivation switch shall be located at least 54 inches (1372 mm) above the threshold of the access ~~door~~. Separate alarms are not required for each door or window if sensors wired to a central alarm sound when contact is broken at any opening.

**Exceptions:**

a. Screened or protected windows having a bottom sill height of 48 inches (1219 mm) or more measured from the interior finished floor at the pool access level.

b. Windows facing the pool on floor above the first story.

c. Screened or protected pass-through kitchen windows 42 inches (1067 mm) or higher with a counter beneath.

2. All doors providing direct access from the home to the pool must be equipped with a self-closing, self-latching device with positive mechanical latching/locking installed a minimum of 54 inches (1372 mm) above the threshold, which is approved by the authority having jurisdiction.

# P4311



| | | | | | |
|---|---|---|---|---|---|
| **Date Submitted** | 4/1/2010 | **Section** | APSP | **Proponent** | Jennifer Hatfield |
| **Chapter** | 35 | **Affects HVHZ** | No | **Attachments** | No |

**TAC Recommendation** Approved as Modified
**Commission Action** Pending Review

**Related Modifications**

4328

**Summary of Modification**

Clarifies that NSPI is the former name of the APSP. Updates the ANSI/NSPI-5 standard for residential inground pools to reflect the 2010 revision. Deletes one of two portable spa standard references (ANSI-6), which is referenced twice, deletes the '92 reference.

**Rationale**

The current 2010 draft references ANSI/APSP-6 twice, this deletes the duplication that references the older standard. This proposal also clarifies that NSPI is the former name of APSP. The third change is to update the ANSI/NSPI-5 Residential Inground Swimming Pools standard to the 2010 revision. This revision is currently in the last phase of being approved and should be available by the time this code proposal goes in front of the TAC.

**Fiscal Impact Statement**

**Impact to local entity relative to enforcement of code**

The only fiscal impact may be associated with purchasing the revised ANSI/APSP-5 standard.

**Impact to building and property owners relative to cost of compliance with code**

There is no fiscal impact to consumers.

**Impact to industry relative to the cost of compliance with code**

The industry will have to comply with any changes in the revised ANSI-5 standard and will need to purchase this updated standard.

**Requirements**

**Has a reasonable and substantial connection with the health, safety, and welfare of the general public**

Updating to the lastest revision of a standard provides consumers who install a new pool with the most recent requirements.

**Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction**

This proposal improves the code by updating the ANSI approved standard that provides construction requirements for inground residential pools.

**Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities**

This proposal does not discriminate.

**Does not degrade the effectiveness of the code**

This proposal does not degrade the effectiveness of the code.

**Note: changes to what is in the online draft are in green.**

**APSP**

**Association of Pool and Spa Professionals**

**[formerly National Spa and Pool Institute (NSPI~~A~~)]**

**~~NSPI~~**

~~National Spa and Pool Institute~~

2111 Eisenhower Avenue

Alexandria, VA 22314

Standard reference number Title Referenced in section number

ANSI/NSF International Standard 50-1996, Circulation System Components and Related Materials for Swimming Pools, Spas/Hot Tubs 424.1.6.5.1, 424.1.6.5.2, 424.1.6.5.16, 424.1.6.5.16.4.2, 424.1.6.5.16.5.2, 424.1.9.2.5.2

ANSI/NSPI 3—99 American National Standard for Permanently Installed Residential Spas 424.2.6.1

ANSI/NSPI 4—99 American National Standard for Aboveground/Onground Residential Swimming Pools 424.2.6.1

ANSI/~~NSPI~~~~APSP~~ NSPI 5—03 ~~03~~10 American National Standard for Residential Inground Swimming Pools 424.2.6.1

ANSI/NSPI 6—99 American National Standard for Portable Spas……………………………………………………………………….424.2.6.1

~~ANSI/NSPI 6—92 American National Standard for Residential Portable Spas 424.2.6.1~~

ANSI/APSP 7—06 American National Standard for Suction Entrapment Avoidance in Swimming Pools, Wading Pools, Spas, Hot Tubs, and Catch Basins…………………………424.2.6.1, 424.2.6.3, 424.2.6.6

***Note: changes to what is in the online draft are in green.***

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~~**NSPI**~~

~~National Spa and Pool Institute~~

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Standard reference number Title Referenced in section number

ANSI/NSF International Standard 50-1996, Circulation System Components and Related Materials for Swimming Pools, Spas/Hot Tubs 424.1.6.5.1, 424.1.6.5.2, 424.1.6.5.16, 424.1.6.5.16.4.2, 424.1.6.5.16.5.2, 424.1.9.2.5.2

ANSI/NSPI 3—99 American National Standard for Permanently Installed Residential Spas 424.2.6.1

ANSI/NSPI 4—99 American National Standard for Aboveground/Onground Residential Swimming Pools 424.2.6.1

ANSI/~~NSPI~~APSP 5—~~03~~10 American National Standard for Residential Inground Swimming Pools 424.2.6.1

ANSI/NSPI 6—99 American National Standard for Portable Spas……………………………………………………………………………424.2.6.1

~~ANSI/NSPI 6—92 American National Standard for Residential Portable Spas 424.2.6.1~~

ANSI/APSP 7—06 American National Standard for Suction Entrapment Avoidance in Swimming Pools, Wading Pools, Spas, Hot Tubs, and Catch Basins……………………………424.2.6.1, 424.2.6.3, 424.2.6.6

# Sub Code: Residential

# P3934

| | | | | | |
|---|---|---|---|---|---|
| **Date Submitted** | 3/26/2010 | **Section** | R4101.17.1.9 | **Proponent** | Jennifer Hatfield |
| **Chapter** | 41 | **Affects HVHZ** | No | **Attachments** | No |

**TAC Recommendation** Approved as Modified
**Commission Action** Pending Review

**Related Modifications**

**Summary of Modification**

This proposal makes changes to the pool alarm requirements in order to provide for consistency with the UL 2017 General-Purpose Signaling Devices and Systems standard that an exit alarm must comply with per the code.

**Rationale**

Without this change requirements within the code would be inconsistent with what is required in UL 2017. For example, section 78.4 of the standard requires the alarm to sound within 7 secs of access to the open position, but section 424.2.17.1.9 of the Code says it must sound immediately. An exit alarm manufacturer certifies its product to UL 2017 requirements.

**Fiscal Impact Statement**

**Impact to local entity relative to enforcement of code**

None, it simply removes language inconsistent with a referenced standard.

**Impact to building and property owners relative to cost of compliance with code**

None, it simply removes language inconsistent with a referenced standard.

**Impact to industry relative to the cost of compliance with code**

The modification may decrease cost by eliminating confusion when trying to comply. If this change is not made and enforcement was required of both the UL standard and the inconsistent requirements laid out in the Code, additional costs could occur in order to make the product comply with both.

**Requirements**

**Has a reasonable and substantial connection with the health, safety, and welfare of the general public**

Exit alarms are safety features certified to a national standard. This proposal clarifies that exit alarms in FL will meet these requirements. This proposal does not make any changes that are inconsistent with the Florida Residential Swimming Pool Safety Act, where exit alarms are an option.

**Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction**

The modification improves the code by making it consistent with the UL 2017 standard.

**Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities**

This modification does not discriminate; in fact, it ensures all products are on the same playing field, each having to meet the requirements of the UL 2017 standard.

**Does not degrade the effectiveness of the code**

The modification improves the effectiveness of the code by clarifying what is required of an exit alarm used in association with the swimming pool barrier requirements.

**R4101.17.1.9** Where a wall of a dwelling serves as part of the barrier, one of the following shall apply:

1. All doors and windows providing direct access from the home to the pool shall be equipped with an exit alarm complying with UL 2017 that has a minimum sound pressure rating of 85 dB A at 10 feet (3048 mm). ~~The exit alarm shall produce a~~n ~~continuous audible~~ alarm within 7 seconds ~~warning when the~~ access is ~~door and its screen are opened. The alarm shall sound immediately after the door is opened and be capable of being heard throughout the house during normal household activities. The alarm~~ may ~~shall be equipped with a~~ momentary self restoring switch ~~manual means to temporarily deactivate the alarm for a single opening. Such deactivation shall last no more than 15 seconds.~~ Any ~~The~~ deactivation switch shall be located at least 54 inches (1372 mm) above the threshold of the access ~~door~~. Separate alarms are not required for each door or window if sensors wired to a central alarm sound when contact is broken at any opening.

**Exceptions:**

a. Screened or protected windows having a bottom sill height of 48 inches (1219 mm) or more measured from the interior finished floor at the pool access level.

b. Windows facing the pool on floor above the first story.

c. Screened or protected pass-through kitchen windows 42 inches (1067 mm) or higher with a counter beneath.

2. All doors providing direct access from the home to the pool must be equipped with a self-closing, self-latching device with positive mechanical latching/locking installed a minimum of 54 inches (1372 mm) above the threshold, which is approved by the authority having jurisdiction

**R4101.17.1.9** Where a wall of a dwelling serves as part of the barrier, one of the following shall apply:

1. All doors and windows providing direct access from the home to the pool shall be equipped with an exit alarm complying with UL 2017 that has a minimum sound pressure rating of 85 dB A at 10 feet (3048 mm). The exit alarm shall produce an ~~continuous~~ audible alarm within 7 seconds ~~warning~~ when the access is ~~door and its screen are~~ opened. ~~The alarm shall sound immediately after the door is opened and be capable of being heard throughout the house during normal household activities.~~ The alarm may ~~shall~~ be equipped with a momentary self-restoring switch ~~manual means~~ to temporarily deactivate the alarm for a single opening. Such deactivation shall last no more than 15 seconds. The deactivation switch shall be located at least 54 inches (1372 mm) above the threshold of the access ~~door~~. Separate alarms are not required for each door or window if sensors wired to a central alarm sound when contact is broken at any opening.

**Exceptions:**

a. Screened or protected windows having a bottom sill height of 48 inches (1219 mm) or more measured from the interior finished floor at the pool access level.

b. Windows facing the pool on floor above the first story.

c. Screened or protected pass-through kitchen windows 42 inches (1067 mm) or higher with a counter beneath.

2. All doors providing direct access from the home to the pool must be equipped with a self-closing, self-latching device with positive mechanical latching/locking installed a minimum of 54 inches (1372 mm) above the threshold, which is approved by the authority having jurisdiction.

**P4328**

| | | | | | |
|---|---|---|---|---|---|
| **Date Submitted** | 4/1/2010 | **Section** | APSP | **Proponent** | Jennifer Hatfield |
| **Chapter** | 43 | **Affects HVHZ** | No | **Attachments** | No |

**TAC Recommendation** Approved as Modified
**Commission Action** Pending Review

**Related Modifications**

**Summary of Modification**

Clarifies that NSPI is the former name of the APSP. Updates the ANSI/NSPI-5 standard for residential inground pools to reflect the 2010 revision.

**Rationale**

This proposal clarifies that NSPI is the former name of APSP. It also updates the ANSI/NSPI-5 Residential Inground Swimming Pools standard to the 2010 revision. This revision is currently in the last phase of being approved and should be available by the time this code proposal goes in front of the TAC.

**Fiscal Impact Statement**

**Impact to local entity relative to enforcement of code**

The only fiscal impact may be associated with purchasing the revised ANSI/APSP-5 standard.

**Impact to building and property owners relative to cost of compliance with code**

There is no fiscal impact to consumers.

**Impact to industry relative to the cost of compliance with code**

The industry will have to comply with any changes in the revised ANSI-5 standard and will need to purchase this updated standard.

**Requirements**

**Has a reasonable and substantial connection with the health, safety, and welfare of the general public**

Updating to the lastest revision of a standard provides consumers who install a new pool with the most recent requirements.

**Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction**

This proposal improves the code by updating the ANSI approved standard that provides construction requirements for inground residential pools.

**Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities**

This proposal does not discriminate.

**Does not degrade the effectiveness of the code**

This proposal does not degrade the effectiveness of the code.

**Note: changes to what is in the online draft are in green.**

**APSP**

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ANSI/APSP 7—06 American National Standard for Suction Entrapment Avoidance in Swimming Pools, Wading Pools, Spas, Hot Tubs, and Catch Basins……………………………………………R4101.6.1, R4101.6.3, R4101.6.6

ANSI/NSPI 3—99 American National Standard for Permanently Installed Residential Spas…………………………………R4101.6.1

ANSI/NSPI 4—99 American National Standard for Aboveground/On ground Residential Swimming Pools……………………………………………..R4101.6.1

ANSI/~~NSPI 5—03~~~~APSP 5—10~~ NSPI 5-03 American National Standard for Residential In ground Swimming Pools…………………………………………………………R4101.6.1

ANSI/NSPI 6—99 American National Standard for Portable Spas…………………………………………………………………...R4101.6.1

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ANSI/APSP 7—06 American National Standard for Suction Entrapment Avoidance in Swimming Pools, Wading Pools, Spas, Hot Tubs, and Catch Basins………………………………………………R4101.6.1, R4101.6.3, R4101.6.6

ANSI/NSPI 3—99 American National Standard for Permanently Installed Residential Spas…………………………………R4101.6.1

ANSI/NSPI 4—99 American National Standard for Aboveground/On ground Residential Swimming Pools……………………………………………R4101.6.1

ANSI/~~NSPI 5—03~~APSP 5—10 American National Standard for Residential In ground Swimming Pools………………………………………………………….R4101.6.1

ANSI/NSPI 6—99 American National Standard for Portable Spas…………………………………………………………………………..R4101.6.1

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|---|---|---|---|---|---|
| **Date Submitted** | 3/26/2010 | **Section** | UL | **Proponent** | Jennifer Hatfield |
| **Chapter** | 35 | **Affects HVHZ** | No | **Attachments** | No |

**TAC Recommendation** Approved as Submitted
**Commission Action** Pending Review

**Related Modifications**

**Summary of Modification**

Updates the UL 2017 Standard for General-Purpose Signaling Devices and Systems to the 2008 second edition.

**Rationale**

Manufacturers of products relative to this standard will be certifying to the updated 2008 second edition; therefore our code should reference the latest version of the ANSI approved UL 2017 standard. The 2007 code also referenced the wrong section of the Building Code; the FBC Supplement to the 2009 IBC corrected the code section number, which should be the pool barrier alarm section, 424.2.17.1.9.

**Fiscal Impact Statement**

**Impact to local entity relative to enforcement of code**

There will not be any cost related to this modification to update references to the national standard.

**Impact to building and property owners relative to cost of compliance with code**

There will not be any cost related to this modification to update references to the national standard.

**Impact to industry relative to the cost of compliance with code**

There will not be any cost related to this modification to update references to the national standard.

**Requirements**

**Has a reasonable and substantial connection with the health, safety, and welfare of the general public**

Yes by referencing the latest edition of the standard it ensures products will have to meet the revised edition. These products include exit alarms that may be part of a pool safety barrier a consumer chooses to install to meet the Florida Residential Swimming Pool Safety Act, chapter 515, F.S.

**Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction**

The modification improves the code by referencing the latest edition of the national standard.

**Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities**

This modification does not discriminate.

**Does not degrade the effectiveness of the code**

The modification improves the effectiveness of the code by referencing the latest edition of the national standard.

UL

Underwriters Laboratories, Inc.
333 Pfingsten Road
Northbrook, IL 60062-2096

~~2017-2002 Standards for General-purpose Signaling Devices and Systems 424.2.17.1.9~~

2017-04 Standard for General-Purpose Signaling Devices and Systems – with Revisions through October 13, 2009 424.2.17.1.9

# Sub Code: Fuel Gas

## P4400



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|---|---|---|---|---|---|
| **Date Submitted** | 4/2/2010 | **Section** | 301.1.1 | **Proponent** | Christopher Jones |
| **Chapter** | 3 | **Affects HVHZ** | No | **Attachments** | No |

**TAC Recommendation** Approved as Submitted
**Commission Action** Pending Review

**Related Modifications**

**Summary of Modification**

Clarify the elevation above which appliances, equipment and installations are required to be elevated is the elevation specified in 1612.4.

**Rationale**

The purpose of this code change is to provide consistency between the elevations of buildings and structures that are specified in Section 1612.4 and the elevations required for materials, elements, and equipment in those buildings and structures. Approved by ICC in Baltimore for 2012 IFGC (S92).

**Fiscal Impact Statement**

**Impact to local entity relative to enforcement of code**

No impact to Florida's communities that participate in the NFIP and administer floodplain management ordinances consistent with the NFIP regulations (44 CFR 60.3).

**Impact to building and property owners relative to cost of compliance with code**

No impact. Owners must comply with local floodplain management ordinances adopted by Florida communities.

**Impact to industry relative to the cost of compliance with code**

No impact. Compliance with local floodplain management ordinances adopted by Florida communities is not affected.

**Requirements**

**Has a reasonable and substantial connection with the health, safety, and welfare of the general public**

Achieves protection of health, safety, and welfare of the general public, the same bases for adoption and enforcement of local floodplain management ordinances.

**Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction**

Clarifies code requirements for materials, products, methods, and systems.

**Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities**

Materials, products, methods, and systems that comply with local floodplain management ordinances are not affected by this proposed modification.

**Does not degrade the effectiveness of the code**

Improves effectiveness of the code by clarifying the specific intent of the provision.

## 1st Comment Period History 04/15/2010 - 06/01/2010

**P4400-G1**

**Proponent** Joy Duperault **Submitted** 5/27/2010 **Attachments** No

**Comment:**

The FL Division of Emergency Management, Floodplain Management Office, recommends support for this proposal. It is appropriate that equipment serving a building be at or above the elevation of the lowest floor, otherwise equipment may be damaged even if the building is not affected. This is the way most buildings are built. In addition, if equipment is lower than the lowest floor, federal flood insurance discounts for elevating the floor above the minimum required elevation don't apply.

**[B] 301.11 Flood hazard.** For structures located in flood hazard areas, the appliance, equipment and system installations regulated by this code shall be located at or above the elevation required by Section 1612.4 of the Florida Building Code for utilities and attendant equipment design flood elevation and shall comply with the flood-resistant construction requirements of the Florida Building Code.

**Exception:** The appliance, equipment and system installations regulated by this code are permitted to be located below the ~~design flood~~ elevation required by Section 1612.4 of the Florida Building Code for utilities and attendant equipment provided that they are designed and installed to prevent water from entering or accumulating within the components and to resist hydrostatic and hydrodynamic loads and stresses, including the effects of buoyancy, during the occurrence of flooding to such elevation ~~the design flood elevation shall comply with the flood-resistant construction requirements of the Florida Building Code~~.

# P3479

7

| | | | | | |
|---|---|---|---|---|---|
| **Date Submitted** | 3/3/2010 | **Section** | 301.3 | **Proponent** | Jose Guanch |
| **Chapter** | 3 | **Affects HVHZ** | No | **Attachments** | No |

**TAC Recommendation** Approved as Submitted
**Commission Action** Pending Review

**Related Modifications**

**Summary of Modification**

This section refers to 105, however 105 exists only in the ICC code. Unless this is corrected there is no way to allow provisions for "alternative" methods in the Fuel Gas Code. I suggest either using the ICC wording in 105 or referring the reader to section 101.1.

**Rationale**

As it stands, section 105 is "reserved" thereby making section 301.3 unenforceable. Referring to the correct code section would allow proper enforcement of the code and make the code more of a "performance" type code by allowing alternative, innovative, equivalent materials and systems.

**Fiscal Impact Statement**

**Impact to local entity relative to enforcement of code**

NONE

**Impact to building and property owners relative to cost of compliance with code**

NONE

**Impact to industry relative to the cost of compliance with code**

NONE

**Requirements**

**Has a reasonable and substantial connection with the health, safety, and welfare of the general public**

As it stands, section 105 is "reserved" thereby making section 301.3 unenforceable. Referring to the correct code section would allow proper enforcement of the code and make the code more of a "performance" type code by allowing alternative, equivalent materials and systems.

**Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction**

Fixes a "glitch" and failure in the code wording. Allows for "alternative" equal or better products, systems, methods.

**Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities**

NO. On the contrary it supports and encourages the same.

**Does not degrade the effectiveness of the code**

NO. It strengthens it's wording.

301.3 Listed and labeled. Appliances regulated by this code shall be listed and labeled for the application in which they are used unless otherwise approved in accordance with Section ~~105~~ 101.1. The approval of unlisted appliances in accordance with Section 101.1 shall be based upon approved engineering evaluation.

## P4079



| | | | | | |
|---|---|---|---|---|---|
| **Date Submitted** | 3/30/2010 | **Section** | 305.4 | **Proponent** | Robert Trumbower |
| **Chapter** | 3 | **Affects HVHZ** | No | **Attachments** | No |

**TAC Recommendation** Approved as Submitted
**Commission Action** Pending Review

**Related Modifications**

**Summary of Modification**

To make Section 305.4 of the Florida Fuel Gas Code the same as the 2009 International Fuel Gas Code.

**Rationale**

I see no reason why section 305.4 of the Florida Building should be different than section 305.4 of the International Fuel gas Code.

**Fiscal Impact Statement**

**Impact to local entity relative to enforcement of code**

None

**Impact to building and property owners relative to cost of compliance with code**

None

**Impact to industry relative to the cost of compliance with code**

None

**Requirements**

**Has a reasonable and substantial connection with the health, safety, and welfare of the general public**

This change clarifies the requirements for installing appliances in Public garage.

**Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction**

Makes it the same as the IFGC

**Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities**

no

**Does not degrade the effectiveness of the code**

no

**305.4 Public garages~~/Parking structures~~.** Appliances ~~shall be installed in accordance with manufacturer's instrutions and NFPA 88B~~ located in public garages, motor fuel-dispensing facilities, repair garages or other areas frequented by motor vehicles shall be installed a minimum of 8 feet (2438mm) above the floor. Where motor vehicles are capable of passing under an appliance, the appliance shall be installed at the clearances required by the appliance manufacturer and not less than 1 foot (305 mm) higher than the tallest vehicle garage door opening.

**Exception:** The requirements of this section shall not apply where the appliances are protected from motor vehicle impact and installed in accordance with Section 305.3 and NFPA 30A.

# P3745

9

| | | |
|---|---|---|
| **Date Submitted** 3/23/2010 | **Section** 404.15.3 | **Proponent** J Glenn-BASF |
| **Chapter** 4 | **Affects HVHZ** No | **Attachments** No |

**TAC Recommendation** Approved as Submitted
**Commission Action** Pending Review

**Related Modifications**

4023

**Summary of Modification**

Retain base code (IFGC) language as it provides better direction

**Rationale**

The base code change provides more specific direction and restores the Florida Code to the nationally accepted practice.

**Fiscal Impact Statement**

**Impact to local entity relative to enforcement of code**

None

**Impact to building and property owners relative to cost of compliance with code**

None

**Impact to industry relative to the cost of compliance with code**

None

**Requirements**

**Has a reasonable and substantial connection with the health, safety, and welfare of the general public**

No change

**Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction**

Brings Florida in-line with national practice

**Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities**

Does not discriminate against anything

**Does not degrade the effectiveness of the code**

Does not degrade the code

~~**404.15.3 Tracer.** An insulated copper tracer wire or other approved conductor shall be installed adjacent to underground nonmetallic gas piping. Access shall be provided to the tracer wire or the tracer wire shall terminate above ground at each end of the nonmetallic gas piping. The tracer wire size shall not be less than 18 AWG and the insulation type shall be suitable for direct burial.~~

**404.15.3 Tracer.** A yellow insulated copper tracer wire or other approved conductor shall be installed adjacent to underground nonmetallic piping. Access shall be provided to the tracer wire or the tracer wire shall terminate above ground at each end of the nonmetallic piping. The tracer wire size shall not be less than 18 AWG and the insulation type shall be suitable for direct burial.

**P3748**

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|---|---|---|---|---|---|
| **Date Submitted** | 3/23/2010 | **Section** | 406.7.4 | **Proponent** | J Glenn-BASF |
| **Chapter** | 4 | **Affects HVHZ** | No | **Attachments** | No |

**TAC Recommendation** Approved as Submitted
**Commission Action** Pending Review

**Related Modifications**

**Summary of Modification**

Retain base code (IFGC) language as it provides better direction

**Rationale**

The base code change provides more specific direction and restores the Florida Code to the nationally accepted practice.

**Fiscal Impact Statement**

**Impact to local entity relative to enforcement of code**

None

**Impact to building and property owners relative to cost of compliance with code**

None

**Impact to industry relative to the cost of compliance with code**

none

**Requirements**

**Has a reasonable and substantial connection with the health, safety, and welfare of the general public**

No change

**Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction**

Brings Florida in-line with national practice

**Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities**

Does not discriminate against anything

**Does not degrade the effectiveness of the code**

Does not degrade the code

~~**406.7.4 Placing equipment in operation.** After the piping has been placed in operation, all equipment shall be placed in operation per its listing and the manufacturer's instructions.~~

**406.7.4 Placing appliances and equipment in operation.** After the piping system has been placed in operation, all appliances and equipment shall be purged and then placed in operation, as necessary.

## P4402



| | | | | | |
|---|---|---|---|---|---|
| **Date Submitted** | 4/2/2010 | **Section** | 309.2 | **Proponent** | Christopher Jones |
| **Chapter** | 3 | **Affects HVHZ** | No | **Attachments** | No |

**TAC Recommendation** Approved as Submitted
**Commission Action** Pending Review

**Related Modifications**

**Summary of Modification**

Clarify the elevation above which plumbing systems, equipment and fixtures are required to be elevated is the elevation specified in 1612.4.

**Rationale**

The purpose of this code change is to provide consistency between the elevations of buildings and structures that are specified in Section 1612.4 and the elevations required for materials, elements, and equipment in those buildings and structures. Approved by ICC in Baltimore for 2012 IPC (S92).

**Fiscal Impact Statement**

**Impact to local entity relative to enforcement of code**

No impact to Florida's communities that participate in the NFIP and administer floodplain management ordinances consistent with the NFIP regulations (44 CFR 60.3).

**Impact to building and property owners relative to cost of compliance with code**

No impact. Owners must comply with local floodplain management ordinances adopted by Florida communities.

**Impact to industry relative to the cost of compliance with code**

No impact. Compliance with local floodplain management ordinances adopted by Florida communities is not affected.

**Requirements**

**Has a reasonable and substantial connection with the health, safety, and welfare of the general public**

Achieves protection of health, safety, and welfare of the general public, the same bases for adoption and enforcement of local floodplain management ordinances.

**Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction**

Clarifies code requirements for materials, products, methods, and systems.

**Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities**

Materials, products, methods, and systems that comply with local floodplain management ordinances are not affected by this proposed modification.

**Does not degrade the effectiveness of the code**

Improves effectiveness of the code by clarifying the specific intent of the provision.

## 1st Comment Period History 04/15/2010 - 06/01/2010

P4402-G2

**Proponent** Joy Duperault **Submitted** 5/27/2010 **Attachments** No

**Comment:**

The FL Division of Emergency Management, Floodplain Management Office, recommends support for this proposal. It is appropriate that equipment serving a building be at or above the elevation of the lowest floor, otherwise equipment may be damaged even if the building is not affected. This is the way most buildings are built. In addition, if equipment is lower than the lowest floor, federal flood insurance discounts for elevating the floor above the minimum required elevation don't apply.

**[B] 309.2 Flood hazard.** For structures located in flood hazard areas, the following systems and equipment shall be located ~~at or above~~ and installed as required by Section 1612.4 of the Florida Building Code~~the design flood elevation~~.

**Exception:** The following systems are permitted to be located below the ~~design flood elevation~~ the elevation required by Section 1612.4 of the Florida Building Code for utilities and attendant equipment provided that the systems are designed and installed to prevent water from entering or accumulating within their components and the systems are constructed to resist hydrostatic and hydrodynamic loads and stresses, including the effects of buoyancy, during the occurrence of flooding up to ~~such~~ the design flood elevation.

1. All water service pipes.

2. Pump seals in individual water supply systems where the pump is located below the design flood elevation.

3. Covers on potable water wells shall be sealed, except where the top of the casing well or pipe sleeve is elevated to at least 1 foot (305 mm) above the design flood elevation.

4. All sanitary drainage piping.

5. All storm drainage piping.

6. Manhole covers shall be sealed, except where elevated to or above the design flood elevation.

7. All other plumbing fixtures, faucets, fixture fittings, piping systems and equipment.

8. Water heaters.

9. Vents and vent systems.

# P3741



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|---|---|---|---|---|---|
| **Date Submitted** | 3/23/2010 | **Section** | 403.7 | **Proponent** | J Glenn-BASF |
| **Chapter** | 4 | **Affects HVHZ** | No | **Attachments** | No |

**TAC Recommendation** Approved as Submitted
**Commission Action** Pending Review

**Related Modifications**

**Summary of Modification**

Sections 403.5 and 403.6 do not exist in the IPC Renumber 403.7 to 403.5 and remove the "reserved"

**Rationale**

This will put the Florida Specific Amendment in the proper location.

**Fiscal Impact Statement**

**Impact to local entity relative to enforcement of code**

None

**Impact to building and property owners relative to cost of compliance with code**

None

**Impact to industry relative to the cost of compliance with code**

None

**Requirements**

**Has a reasonable and substantial connection with the health, safety, and welfare of the general public**

None

**Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction**

No change

**Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities**

Does not discriminate

**Does not degrade the effectiveness of the code**

Does not degrade the code

~~**403.5-5** Reserved.~~

~~**403.5-6** Reserved.~~

**403.5** ~~**403.7**~~ **Unisex toilet and bathing rooms.** In assembly and mercantile occupancies, an accessible unisex toilet room shall be provided where an aggregate of six or more male and female water closets is required. In buildings of mixed occupancy, only those water closets required for the assembly or mercantile occupancy shall be used to determine the unisex toilet room requirement. In recreational facilities where separate-sex bathing rooms are provided, an accessible unisex bathing room shall be provided. Fixtures located within unisex toilet and bathing rooms shall be included in determining the number of fixtures provided in an occupancy.

**Exception:** Where each separate-sex bathing room has only one shower or bathtub fixture, a unisex bathing room is not required.

# Sub Code: Residential

# P4023



| | | | | | |
|---|---|---|---|---|---|
| **Date Submitted** | 3/28/2010 | **Section** | 2415.14.3 | **Proponent** | J Glenn-BASF |
| **Chapter** | 24 | **Affects HVHZ** | No | **Attachments** | No |

**TAC Recommendation** Approved as Submitted
**Commission Action** Pending Review

**Related Modifications**

**Summary of Modification**

Retain base code (IRC) language.

**Rationale**

The base code change provides more specific direction and restores the Florida Code to the nationally accepted practice.

**Fiscal Impact Statement**

**Impact to local entity relative to enforcement of code**

No impact on local enforcement.

**Impact to building and property owners relative to cost of compliance with code**

None

**Impact to industry relative to the cost of compliance with code**

none

**Requirements**

**Has a reasonable and substantial connection with the health, safety, and welfare of the general public**

No change

**Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction**

Brings Florida in-line with nationally accepted practice

**Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities**

Does not discriminate against anything.

**Does not degrade the effectiveness of the code**

Does not degrade the code.

**G2415.14.3 (404.14.3)** ~~An insulated copper tracer wire or other approved conductor shall be installed adjacent to underground nonmetallic gas piping. Access shall be provided to the tracer wire or the tracer wire shall terminate above ground at each end of the nonmetallic gas piping. The tracer wire size shall not be less than 18 AWG and the insulation type shall be suitable for direct burial.~~

**G2415.15.3 (404.15.3)** <u>**Tracer.** A yellow insulated copper tracer wire or other approved conductor shall be installed adjacent to underground nonmetallic piping. Access shall be provided to the tracer wire or the tracer wire shall terminate above ground at each end of the nonmetallic piping. The tracer wire size shall not be less than 18 AWG and the insulation type shall be suitable for direct burial.</u>

# P4024

| | | | | | |
|---|---|---|---|---|---|
| **Date Submitted** | 3/28/2010 | **Section** | 2417.7.4 | **Proponent** | J Glenn-BASF |
| **Chapter** | 24 | **Affects HVHZ** | No | **Attachments** | No |

**TAC Recommendation** Approved as Submitted
**Commission Action** Pending Review

**Related Modifications**

**Summary of Modification**

Retain base code (IRC) language

**Rationale**

The base code change provides more specific direction and restores the Florida Code to the nationally accepted practice.

**Fiscal Impact Statement**

**Impact to local entity relative to enforcement of code**

No impact on local enforcement.

**Impact to building and property owners relative to cost of compliance with code**

None

**Impact to industry relative to the cost of compliance with code**

None

**Requirements**

**Has a reasonable and substantial connection with the health, safety, and welfare of the general public**

No change

**Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction**

Brings Florida in-line with nationally accepted practice.

**Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities**

Does not discriminate agaiinst anything.

**Does not degrade the effectiveness of the code**

Does not degrade the code.

~~**G2417.7.4 (406.7.4)** Placing equipment in operation. After the piping has been placed in operation, all equipment shall be placed in operation per its listing and the manufacturer's instructions.~~

**G2417.7.4 (406.7.4)** Placing appliances and equipment in operation. After the piping system has been placed in operation, all appliances and equipment shall be purged and then placed in operation, as necessary.

**P4081**



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|---|---|---|---|---|---|
| **Date Submitted** | 3/30/2010 | **Section** | G2408.2 (305.3) | **Proponent** | Robert Trumbower |
| **Chapter** | 24 | **Affects HVHZ** | No | **Attachments** | No |

**TAC Recommendation** Approved as Submitted
**Commission Action** Pending Review

**Related Modifications**

**Summary of Modification**

To make Section G2408.2 (305.3) of the Florida Residential Code the same as the Section 305.3 of the Florida Fuel Gas Code.

**Rationale**

I see no reason why section G2408.2 of the Florida Residential Code should be different than section 305.3 of the Florida Fuel Gas Code.

**Fiscal Impact Statement**

**Impact to local entity relative to enforcement of code**

None

**Impact to building and property owners relative to cost of compliance with code**

None

**Impact to industry relative to the cost of compliance with code**

None

**Requirements**

**Has a reasonable and substantial connection with the health, safety, and welfare of the general public**

This change clarifies the Florida Residential Code.

**Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction**

Yes

**Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities**

No

**Does not degrade the effectiveness of the code**

No

**G2408.2 (305.3)** ~~**Water heaters installed in garages.** Water heaters shall be installed in accordance with manufacturer's instructions which shall be available on the job site at the time of inspection.~~ **Elevation of ignition source.** Equipment and appliances having an ignition source shall be elevated such that the source of ignition is not less than 18 inches (457 mm) above the floor in hazardous locations and public garages, private garages, repair garages, motor fuel-dispensing facilities and parking garages. For the purpose of this section, rooms or spaces that are not part of the living space of a dwelling unit and that communicate directly with a private garage through openings shall be considered to be part of the private garage.

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Exception: Elevation of the ignition soure is not required for appliances that are listed as flammable vapor ignition resistant.

## P4022

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|---|---|---|---|---|---|
| **Date Submitted** | 3/28/2010 | **Section** | 2603.6 | **Proponent** | J Glenn-BASF |
| **Chapter** | 26 | **Affects HVHZ** | No | **Attachments** | No |

**TAC Recommendation** Approved as Submitted
**Commission Action** Pending Review

**Related Modifications**

**Summary of Modification**

Retain base code language

**Rationale**

The base code requirement is basically the same.

**Fiscal Impact Statement**

**Impact to local entity relative to enforcement of code**

There is no impact on local enforcement.

**Impact to building and property owners relative to cost of compliance with code**

None

**Impact to industry relative to the cost of compliance with code**

None

**Requirements**

**Has a reasonable and substantial connection with the health, safety, and welfare of the general public**

No change

**Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction**

Provides the same level of protection while maintaining the nationally recognize language

**Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities**

Does not discriminate against anything.

**Does not degrade the effectiveness of the code**

Does not degrade the code.

~~**P2603.6 Freezing.** Where the design temperature is less than 32°F (0°C), a water, soil or waste pipe shall not be installed outside of a building, in attics or crawl spaces, or be concealed in outside walls in any location subjected to freezing temperatures unless an adequate provision is made to protect it from freezing by insulation or heat or both. Water service pipe shall be installed not less than 12 inches (305 mm) deep or less than 6 inches (152 mm) below the frost line.~~

**P2603.6 Freezing.** In localities having a winter design temperature of 32°F (0°C) or lower as shown in Table R301.2(1) of this code, a water, soil or waste pipe shall not be installed outside of a building, in exterior walls, in attics or crawl spaces, or in any other place subjected to freezing temperature unless adequate provision is made to protect it from freezing by insulation or heat or both. Water service pipe shall be installed not less than 12 inches (305 mm) deep and not less than 6 inches (152 mm) below the frost line.

# P3899



**Date Submitted** 3/26/2010
**Chapter** 41
**Section** R4101.4.2
**Affects HVHZ** No
**Proponent** Rebecca Quinn
**Attachments** No
**TAC Recommendation** Approved as Submitted
**Commission Action** Pending Review

**Related Modifications**

**Summary of Modification**

Move provisions for pools in flood hazard areas that are found in Appendix G of the IRC into the body of the code. This modification refers back to R322 to determine whether specific requirements apply.

**Rationale**

Modifications recommended by FBC Flood Resistant Standards Workgroup, with concurrence by Structural TAC, to retain IRC flood provisions IBC and make Florida-specific amendments. IRC flood provisions are consistent with the NFIP. The FBC adopted the recommendation at its October 2009 meeting. Workgroup's final report is attached to the modification for R322 and http://consensus.fsu.edu/FBC/Flood-Resistant-Standards.html

**Fiscal Impact Statement**

**Impact to local entity relative to enforcement of code**

No impact; 454 Florida communities participate in the NFIP and administer ordinance that include NFIP requirements (44 CFR 60.3).

**Impact to building and property owners relative to cost of compliance with code**

No impact; building and property owners already are required to comply with local floodplain management ordinances.

**Impact to industry relative to the cost of compliance with code**

No impact; building and property owners already are required to comply with local floodplain management ordinances.

**Requirements**

**Has a reasonable and substantial connection with the health, safety, and welfare of the general public**

Compliance with flood-resistant provisions reduces flood damage and protects life, property and general welfare.

**Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction**

Improves the code by having all load requirements addressed; provides equivalency with requirements of local floodplain management ordinances. The requested statutory authority will allow locally-adopted higher standards to preserve better protection and insurance discounts.

**Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities**

Includes provisions for flood damage-resistant materials and methods, consistent with the NFIP and current floodplain management ordinances.

**Does not degrade the effectiveness of the code**

Improves effectiveness by requiring buildings to be designed and constructed with consideration of all applicable codes.

## 1st Comment Period History 04/15/2010 - 06/01/2010

P3899-G1

**Proponent** Mo Madani **Submitted** 5/26/2010 **Attachments** No

**Comment:**

if approved. Section 424.2 of the FBC, Building should be revised to make consistent.

**R4101.4.2 Items not covered**. For any items not specifically covered in these requirements, the administrative authority is hereby authorized to require that all equipment, materials, methods of construction and design features shall be proven to function adequately, effectively and without excessive maintenance and operational difficulties.

**R4101.4.2.1. Flood hazard areas.** Pools installed in flood hazard areas established in Section R322 shall comply with Section R322.2.4 (A Zones) or R322.3.3.1 in coastal high-hazard areas (V Zones).

## P3937



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|---|---|---|---|---|---|
| **Date Submitted** | 3/26/2010 | **Section** | UL | **Proponent** | Jennifer Hatfield |
| **Chapter** | 43 | **Affects HVHZ** | No | **Attachments** | No |

**TAC Recommendation** Approved as Submitted
**Commission Action** Pending Review

**Related Modifications**

**Summary of Modification**

Updates the UL 2017 Standard for General-Purpose Signaling Devices and Systems to the 2008 second edition with revisions.

**Rationale**

Manufacturers of products relative to this standard will be certifying to the updated 2008 second edition; therefore our code should reference the latest version of the ANSI approved UL 2017 standard.

**Fiscal Impact Statement**

**Impact to local entity relative to enforcement of code**

There will not be any cost related to this modification to update references to the national standard.

**Impact to building and property owners relative to cost of compliance with code**

There will not be any cost related to this modification to update references to the national standard.

**Impact to industry relative to the cost of compliance with code**

There will not be any cost related to this modification to update references to the national standard.

**Requirements**

**Has a reasonable and substantial connection with the health, safety, and welfare of the general public**

Yes by referencing the latest edition of the standard it ensures products will have to meet the revised edition. These products include exit alarms that may be part of a pool safety barrier a consumer chooses to install to meet the Florida Residential Swimming Pool Safety Act, chapter 515, F.S.

**Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction**

The modification improves the code by referencing the latest edition of the national standard.

**Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities**

This modification does not discriminate.

**Does not degrade the effectiveness of the code**

The modification improves the effectiveness of the code by referencing the latest edition of the national standard.

UL

Underwriters Laboratories, Inc.
333 Pfingsten Road
Northbrook, IL 60062-2096

~~2017-2000 Standards for General-purpose Signaling Devices and Systems~~ 2017-2004 (R2008) Standard for General-Purpose Signaling Devices and Systems – with Revisions through October 13, 2009
R4101.17.1.9

# P4337



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|---|---|---|---|---|---|
| **Date Submitted** | 4/1/2010 | **Section** | New 302.5 | **Proponent** | Duren Gary |
| **Chapter** | 3 | **Affects HVHZ** | No | **Attachments** | No |

**TAC Recommendation** No Affirmative Recommendation with a Second
**Commission Action** Pending Review

**Related Modifications**

See proposed mods to chapter 5 and 6

M0ds 4338, 4339

**Summary of Modification**

Add language to address residential swimming pools

**Rationale**

This code change is intended address residential swimming pools and spas under the existing building code - there are many pools and spas that do not meet the current FBC requirements for barriers, alarms and entrapment prevention.

**Fiscal Impact Statement**

**Impact to local entity relative to enforcement of code**

local authorities having jurisdiction will need to implement measures to permit swimming pool and spa repair and renovations

**Impact to building and property owners relative to cost of compliance with code**

there will be moderate costs associated with bringing existing pools and spas up to current minimum safety standards

**Impact to industry relative to the cost of compliance with code**

Industry will not be adversely impacted by this code change

**Requirements**

**Has a reasonable and substantial connection with the health, safety, and welfare of the general public**

Public safety and wlefare will be improved as many sub-standard pools and spas will be brought into compliance with exsisting rules

**Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction**

The exisiting building code is improved by including swimming pools and spas in its scope

**Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities**

The code change does not discriminate against any product, method, system of construction or material

**Does not degrade the effectiveness of the code**

The inclusion of swimming pool and spa verbiage improves the effectiveness of the existing building code

ADD A NEW SUBSECTION TO CHAPTER 3 PRESCRIPTIVE COMPLIANCE METHOD, OF THE *FLORIDA BUILDING CODE, EXISTING BUILDINGS*

302.5 R3 Pools and Spas. Additions, alterations, renovations or repairs to existing installations shall conform to the *Florida Building Code, Residential* without requiring the existing installation to comply with all the requirements of the code. Additions, alterations or repairs shall not cause the existing installation to become unsafe or hazardous.

Minor alterations, renovations and repairs to existing installations shall meet the provisions for new construction, unless such work is done in the same manner and arrangement as was in the existing system, is not hazardous and is approved.

# P3740

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|---|---|---|---|---|---|
| **Date Submitted** | 3/23/2010 | **Section** | 305.6 | **Proponent** | J Glenn-BASF |
| **Chapter** | 3 | **Affects HVHZ** | No | **Attachments** | No |

**TAC Recommendation** No Affirmative Recommendation with a Second
**Commission Action** Pending Review

**Related Modifications**

4022

**Summary of Modification**

Retain base code language

**Rationale**

The requirements are basically the same

**Fiscal Impact Statement**

**Impact to local entity relative to enforcement of code**

None

**Impact to building and property owners relative to cost of compliance with code**

None

**Impact to industry relative to the cost of compliance with code**

None

**Requirements**

**Has a reasonable and substantial connection with the health, safety, and welfare of the general public**

No change

**Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction**

No chnge

**Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities**

Does not discriminate against anytrhing

**Does not degrade the effectiveness of the code**

Does not degrade the code.

~~**305.6 Freezing.** Where the design temperature is less than 32oF (0°C), a water, soil or waste pipe shall not be installed outside of a building, in attics or crawl spaces, or be concealed in outside walls in any location subjected to freezing temperatures unless an adequate provision is made to protect it from freezing by insulation or heat or both. Water service pipe shall be installed not less than 12 inches (305 mm) deep or less than 6 inches (152 mm) below the frost line.~~

**305.6 Freezing.** Water, soil and waste pipes shall not be installed outside of a building, in attics or crawl spaces, concealed in outside walls, or in any other place subjected to freezing temperatures unless adequate provision is made to protect such pipes from freezing by insulation or heat or both. Exterior water supply system piping shall be installed not less than 6 inches (152 mm) below the frost line and not less than 12 inches (305 mm) below grade.

# P3742



| | | | | | |
|---|---|---|---|---|---|
| **Date Submitted** | 3/23/2010 | **Section** | 604.1 | **Proponent** | J Glenn-BASF |
| **Chapter** | 6 | **Affects HVHZ** | No | **Attachments** | No |

**TAC Recommendation** No Affirmative Recommendation with a Second
**Commission Action** Pending Review

**Related Modifications**

**Summary of Modification**

Retain the based code (IPC) language

**Rationale**

There is no Florida Specific justification for reference back to Table 603.1.

**Fiscal Impact Statement**

**Impact to local entity relative to enforcement of code**

None

**Impact to building and property owners relative to cost of compliance with code**

None

**Impact to industry relative to the cost of compliance with code**

None

**Requirements**

**Has a reasonable and substantial connection with the health, safety, and welfare of the general public**

None

**Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction**

No change

**Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities**

Does not discriminate

**Does not degrade the effectiveness of the code**

Does not degrade the code

**604.1 General.** The design of the water distribution system shall conform to accepted engineering practice. Methods utilized to determine pipe sizes shall be approved. ~~Table 603.1 shall be permitted to be used to size the water distribution system.~~

# P3426

22

| | | | | | |
|---|---|---|---|---|---|
| **Date Submitted** | 2/19/2010 | **Section** | 606.1 (5) | **Proponent** | James Bickford |
| **Chapter** | 6 | **Affects HVHZ** | No | **Attachments** | No |

**TAC Recommendation** No Affirmative Recommendation with a Second
**Commission Action** Pending Review

**Related Modifications**

None

**Summary of Modification**

Adds text "supplying three or more branch intervals". This clarifies the intent of this code section to apply only to multistory buildings.

**Rationale**

Adding the text "supplying three or more branch intervals" clarifies the original intent of this code section.

**Fiscal Impact Statement**

**Impact to local entity relative to enforcement of code**

none

**Impact to building and property owners relative to cost of compliance with code**

Will reduce cost when unnesessary valves are not required to be installed.

**Impact to industry relative to the cost of compliance with code**

none

**Requirements**

**Has a reasonable and substantial connection with the health, safety, and welfare of the general public**

Clarifies unclear text in the code.

**Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction**

Clarifies unclear text in the code.

**Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities**

Does not change current material requirements.

**Does not degrade the effectiveness of the code**

Clarifies unclear text in the code.

606.1 (5). On the top of every water down-feed pipe <u>supplying three or more branch intervals</u> in occupancies other than one- and two-family residential occupancies.

## P3744



| | | | | | |
|---|---|---|---|---|---|
| **Date Submitted** | 3/23/2010 | **Section** | 611.2 | **Proponent** | J Glenn-BASF |
| **Chapter** | 6 | **Affects HVHZ** | No | **Attachments** | No |

**TAC Recommendation** No Affirmative Recommendation with a Second
**Commission Action** Pending Review

**Related Modifications**

**Summary of Modification**

Retain the based code (IPC) language

**Rationale**

The base code language provides the same level of protection.

**Fiscal Impact Statement**

**Impact to local entity relative to enforcement of code**

None

**Impact to building and property owners relative to cost of compliance with code**

None

**Impact to industry relative to the cost of compliance with code**

None

**Requirements**

**Has a reasonable and substantial connection with the health, safety, and welfare of the general public**

None

**Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction**

No change

**Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities**

Does not discriminate against anything

**Does not degrade the effectiveness of the code**

Does not degrade the code

~~**611.2** Reverse osmosis drinking water treatment systems shall meet the requirements of NSF 58, Reverse Osmosis Drinking Water Treatment Units, or Water Quality Association Standard S-300, Point-of-Use Low Pressure Reverse Osmosis Drinking Water Systems.~~

~~**611.3** When reduction of regulated health contaminants is claimed, such as inorganic or organic chemicals, or radiological substances, the reverse osmosis drinking water treatment unit must meet the requirements of NSF 58, Reverse Osmosis Drinking Water Treatment Systems.~~

~~**611.4** Waste or discharge from reverse osmosis or other types of water treatment units must enter the drainage system through an air gap or be equipped with an equivalent backflow prevention device.~~

-

**611.2 Reverse osmosis systems.** The discharge from a reverse osmosis drinking water treatment unit shall enter the drainage system through an air gap or an air gap device that meets the requirements of NSF 58.

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| | | | | | |
|---|---|---|---|---|---|
| **Date Submitted** | 4/1/2010 | **Section** | 702.1 | **Proponent** | Allen Johnson |
| **Chapter** | 7 | **Affects HVHZ** | No | **Attachments** | Yes |

**TAC Recommendation** No Affirmative Recommendation with a Second
**Commission Action** Pending Review

**Related Modifications**

702.1, 702.2, 702.3, 1102.1, 1102.2, 1102.3, 1102.4

Mods 4255, 4315, 4316, 4318, 4319, 4321

**Summary of Modification**

Modify the current building materials list to include Cure-In Place (CIPP) Thermosetting Resin Conduit Liner that meets ASTM F-1743, ASTM F-1216, ASTM D790, ASTM D638 and ASTM D543. in sections 702.1,702.2, 702.3, 1102.1, 1102.2, 1102.3 and 1102.4 for building drains and building sewer pipes.

**Rationale**

CIPP liners are an alternative to traditional pipe replacement that increases the flow charicteristics of the pipe.

**Fiscal Impact Statement**

**Impact to local entity relative to enforcement of code**

There are no additional costs relative to enforcement compared to tradional pipe replacement.

**Impact to building and property owners relative to cost of compliance with code**

There is a significant cost savings to building and property owners as well as reducing potentially hazardous materials left undisturbed as compared to traditional pipe replacement.

**Impact to industry relative to the cost of compliance with code**

There is no impact to the industry relative to the cost of compliance with code.

**Requirements**

**Has a reasonable and substantial connection with the health, safety, and welfare of the general public**

CIPP lining eliminates the destruction of landscapes and property as well as the health dangers associated with removing of sewer pipes in need of repair.

**Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction**

CIPP liners provide a repair solution that allows drain, waste and sewer pipes to be repaired without the digging and destruction required for traditional pipe repairs or replacement. CIPP liners are seamless and jointless, reducing the number of potential failures. More resistant to corrosion.

**Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities**

CIPP lining can be installed in any type of host pipe used for Building drains and Building sewer pipes for residential, commercial and industrial applications.

**Does not degrade the effectiveness of the code**

CIPP lining does not degrade the effectiveness of the code.

## SECTION 702 MATERIALS

**702.1 Above-ground sanitary drainage and vent pipe.** Above-ground soil, waste and vent pipe shall conform to one of the standards listed in Table 702.1.

### TABLE 702.1 ABOVE-GROUND DRAINAGE AND VENT PIPE

| MATERIAL | STANDARD |
|---|---|
| Acrylonitrile butadiene styrene (ABS) plastic pipe in IPS diameters, including Schedule 40, DR 22 (PS 200) and DR 24 (PS 140); with a solid, cellular core or composite wall | ASTM D 2661; ASTM F 628; ASTM F 1488; CSA B181.1 |
| Brass pipe | ASTM B 43 |
| Cast-iron pipe | ASTM A 74; ASTM A 888; CISPI 301 |
| Copper or copper-alloy pipe | ASTM B 42; ASTM B 302 |
| Copper or copper-alloy tubing (Type K, L, M or DWV) | ASTM B 75; ASTM B 88; ASTM B 251; ASTM B 306 |
| Galvanized steel pipe | ASTM A 53 |
| Glass pipe | ASTM C 1053 |
| Polyolefin pipe | ASTM F 1412; CAN/CSA B181.3 |
| Polyvinyl chloride (PVC) plastic pipe in IPS diameters, including schedule 40, DR 22 (PS 200), and DR 24 (PS 140); with a solid, cellular core or composite wall | ASTM D 2665; ASTM F 891; ASTM F 1488; CSA B181.2 |
| Polyvinyl chloride (PVC) plastic pipe with a 3.25-inch O.D. and a solid, cellular core or composite wall | ASTM D 2949, ASTM F 1488 |
| Polyvinylidene fluoride (PVDF) plastic pipe | ASTM F 1673; CAN/CSA B181.3 |
| Stainless steel drainage systems, Types 304 and 316L | ASME A112. |
| Cured-In Place Thermosetting Resin Conduit Liner (CIPP) | ASTM F 1743, ASTM F 1216, ASTM D 790, ASTM D 638, ASTM D 543 |

Designation: F 1743 – 96 (Reapproved 2003)

An American National Standard

# Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe (CIPP)[1]

This standard is issued under the fixed designation F 1743; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This practice describes the procedures for the reconstruction of pipelines and conduits (4 to 96 in. (10 to 244 cm) diameter) by the pulled-in-place installation of a resin-impregnated, flexible fabric tube into an existing conduit and secondarily inflated through the inversion of a calibration hose by the use of a hydrostatic head or air pressure (see Fig. 1). The resin is cured by circulating hot water or by the introduction of controlled steam into the tube. When cured, the finished cured-in-place pipe will be continuous and tight fitting. This reconstruction process may be used in a variety of gravity and pressure applications such as sanitary sewers, storm sewers, process piping, electrical conduits, and ventilation systems.

1.2 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for informational purposes only.

NOTE 1—There are no ISO standards covering the primary subject matter of this practice.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

2.1 *ASTM Standards:*

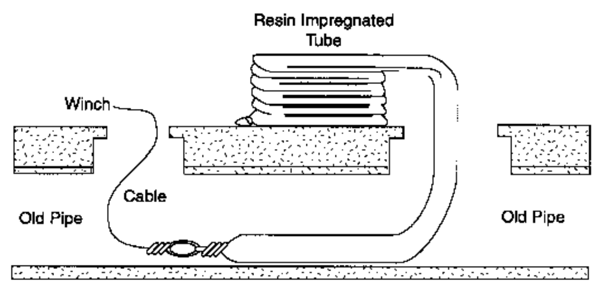
D 543 Test Method of Resistance of Plastics to Chemical Reagents[2]

D 638 Test Method for Tensile Properties of Plastics[2]

D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials[2]

D 903 Test Method for Peel or Stripping Strength of Adhesive Bonds[3]

**Step 1 – Pull resin-impregnated tube into existing pipe.**




**Step 2 – Calibration hose inversion**

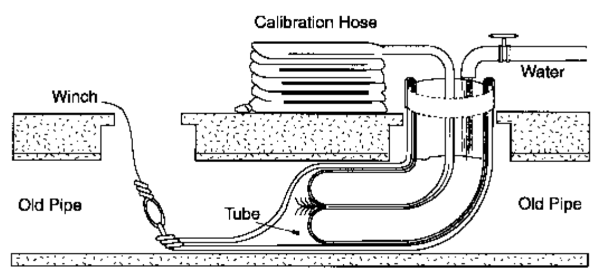



FIG. 1 Cured-in-Place Pipe Installation Methods

D 1600 Terminology for Abbreviated Terms Relating to Plastics[2]

D 1682 Test Method for Breaking Load and Elongation of Textile Fabrics[4]

D 3039/D3039M Test Method for Tensile Properties of Polymer Matrix Composite Materials[5]

[1] This practice is under the jurisdiction of ASTM Committee F-17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.67 on Trenchless Plastic Pipeline Technology.

Current edition approved Feb. 10, 2003. Published April 2003. Last previous edition approved in 1996 as F1743–96.

[2] *Annual Book of ASTM Standards*, Vol 08.01.

[3] *Annual Book of ASTM Standards*, Vol 15.06.

[4] *Discontinued: See 1991 Annual Book of ASTM Standards*, Vol 07.01.

[5] *Annual Book of ASTM Standards*, Vol 15.03.

D 3567 Practice for Determining Dimensions of Reinforced Thermosetting Resin Pipe (RTRP) and Fittings[6]

D 4814 Specification for Automotive Spark—Ignition Engine Fuel[7]

D 5813 Specification for Cured-in-Place Thermosetting Resin Sewer Pipe[6]

F 412 Terminology Relating to Plastic Piping Systems[6]

F 1216 Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube[6]

2.2 *AWWA Standard:*

M28 Manual on Cleaning and Lining Water Mains[8]

2.3 *NASSCO Standard:*

Recommended Specifications for Sewer Collection System Rehabilitation[9]

NOTE 2—An ASTM specification for cured-in-place pipe materials appropriate for use in this practice is under preparation and will be referenced in this practice when published.

## 3. Terminology

3.1 *General*—Definitions are in accordance with Terminology F 412. Abbreviations are in accordance with Terminology D 1600, unless otherwise indicated.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *calibration hose*—an impermeable bladder which is inverted within the resin-impregnated fabric tube by hydrostatic head or air pressure and may optionally be removed or remain in place as a permanent part of the installed cured-in-place pipe as described in 5.2.2.

3.2.2 *cured-in-place pipe (CIPP)*—a hollow cylinder consisting of a fabric tube with cured (cross-linked) thermosetting resin. Interior or exterior plastic coatings, or both, may be included. The CIPP is formed within an existing pipe and takes the shape of and fits tightly to the pipe.

3.2.3 *delamination*—separation of layers of the CIPP.

3.2.4 *dry spot*—an area of fabric of the finished CIPP which is deficient or devoid of resin.

3.2.5 *fabric tube*—flexible needled felt, or equivalent, woven or nonwoven material(s), or both, formed into a tubular shape which during the installation process is saturated with resin and holds the resin in place during the installation and curing process.

3.2.6 *inversion*—the process of turning the calibration hose inside out by the use of water pressure or air pressure.

3.2.7 *lift*—a portion of the CIPP that is a departure from the existing conduit wall forming a section of reverse curvature in the CIPP.

## 4. Significance and Use

4.1 This practice is for use by designers and specifiers, regulatory agencies, owners, and inspection organizations who are involved in the rehabilitation of conduits through the use of a resin-impregnated fabric tube pulled-in-place through an existing conduit and secondarily inflated through the inversion of a calibration hose. Modifications may be required for specific job conditions.

## 5. Recommended Materials and Manufacture

5.1 *General*—The resins, fabric tube, tube coatings, or other materials, such as the permanent calibration hose when combined as a composite structure, shall produce CIPP that meets the requirements of this specification.

5.2 *CIPP Wall Composition*—The wall shall consist of a plastic coated fabric tube filled with a thermosetting (cross-linked) resin, and if used, a filler.

5.2.1 *Fabric Tube*—The fabric tube should consist of one or more layers of flexible needled felt, or equivalent, woven or nonwoven material(s), or both, capable of carrying resin, withstanding installation pressures, and curing temperatures. The material(s) of construction should be able to stretch to fit irregular pipe sections and negotiate bends. Longitudinal and circumferential joints between multiple layers of fabric should be staggered so as not to overlap. The outside layer of the fabric tube should have an impermeable flexible coating(s) whose function is to contain the resin during and after fabric tube impregnation. The outer coating(s) must facilitate monitoring of resin saturation of the material(s) of construction of the fabric tube. The fabric tube should be fabricated to a size that, when installed, will tightly fit the internal circumference and the length of the original conduit. Allowance should be made for circumferential and longitudinal stretching of the fabric tube during installation. As required, the fabric tube should meet minimum tensile strength requirements in the longitudinal and transverse directions as specified in 7.1. All the material(s) of construction for the fabric tube should be compatible with the resin system used.

5.2.2 *Calibration Hose*:

5.2.2.1 *Removable Calibration Hose*—The removable calibration hose should consist of an impermeable plastic, or impermeable plastic coating(s) on flexible woven or nonwoven material(s), or both, that do not absorb resin and are capable of being removed from the CIPP.

5.2.2.2 *Permanent Calibration Hose*—The permanent calibration hose should consist of an impermeable plastic coating on a flexible needled felt or equivalent woven or nonwoven material(s), or both, that are capable of absorbing resin and are of a thickness to become fully saturated with resin. The calibration hose should be translucent to facilitate post-installation inspection. The calibration hose should be fabricated to a size that, when installed, will tightly fit the internal circumference and the length of the resin saturated fabric tube. Once inverted, the calibration hose becomes part of the fabric tube, and once properly cured, should bond permanently with the fabric tube. The properties of the calibration hose should meet minimum tensile strength requirements in the longitudinal and transverse directions as specified in 7.1. All the material(s) of construction for the calibration hose should be compatible with the resin system used.

5.2.3 *Resin*—A chemically resistant isophthalic based polyester, or vinyl ester thermoset resin and catalyst system or an

[6] *Annual Book of ASTM Standards*, Vol 08.04.

[7] *Annual Book of ASTM Standards*, Vol 05.03.

[8] Available from the American Water Works Association, 6666 W. Quincey Ave., Denver, CO 80235.

[9] Available from the National Association of Sewer Service Companies, 101 Wymore Rd., Suite 501, Altamonte, FL 32714.

epoxy resin and hardener that is compatible with the installation process should be used. The resin should be able to cure in the presence of water and the initiation temperature for cure should be less than 180°F (82.2°C). The cured resin/fabric tube system, with or without the calibration hose, shall be expected to have as a minimum the initial structural properties given in Table 1. These physical properties should be determined in accordance with Section 8. The cured resin/fabric tube system, with or without the calibration hose, should meet the minimum chemical resistance requirements as specified in 7.2.

## 6. Installation Recommendations

6.1 *Cleaning and Pre-Inspection*:

6.1.1 Prior to entering access areas, such as manholes, and performing inspection or cleaning operations, 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.

6.1.2 *Cleaning of Pipeline*—All internal debris should be removed from the original pipeline. Gravity pipes should be cleaned with hydraulically powered equipment, high-velocity jet cleaners, or mechanically powered equipment in accordance with NASSCO Recommended Specifications for Sewer Collection System Rehabilitation. Pressure pipelines should be cleaned with cable attached devices or fluid propelled devices in accordance with AWWA M28.

6.1.3 *Inspection of Pipelines*—Inspection of pipelines should be performed by experienced personnel trained in locating breaks, obstacles, and service connections by closed-circuit television or man entry. The interior of the pipeline should be carefully inspected to determine the location of any conditions that may prevent proper installation of the impregnated tube, such as protruding service taps, collapsed or crushed pipe, and reductions in the cross-sectional area of more than 40 %. These conditions should be noted so that they can be corrected.

6.1.4 *Line Obstructions*—The original pipeline should be clear of obstructions such as solids, dropped joints, protruding service connections, crushed or collapsed pipe, and reductions in the cross-sectional area of more than 40 % that may hinder or prevent the installation of the resin-impregnated fabric tube. If inspection reveals an obstruction that cannot be removed by conventional sewer-cleaning equipment, then a point-repair excavation should be made to uncover and remove or repair the obstruction.

6.2 *Resin Impregnation*—The fabric tube should be totally impregnated with resin (wet-out) and run through a set of rollers separated by a space, calibrated under controlled conditions to ensure proper distribution of resin. The volume of resin used should be sufficient to fully saturate all the voids of the fabric tube material, as well as all resin-absorbing material of the calibration hose at nominal thickness and diameter. The volume should be adjusted by adding 3 to 15 % excess resin to allow for the change in resin volume due to polymerization, the change in resin volume due to thermal expansion or contraction, and resin migration through the perforations of the fabric tube and out onto the host pipe.

6.3 *Bypassing*—If bypassing of the flow is required around the sections of pipe designated for reconstruction, the bypass should be made by plugging the line at a point upstream of the pipe to be reconstructed and pumping the flow to a downstream point or adjacent system. The pump and bypass lines should be of adequate capacity and size to handle the flow. Services within this reach will be temporarily out of service.

6.3.1 Public advisory services shall notify all parties whose service laterals will be out of commission and advise against water usage until the main line is back in service.

6.4 *Installation Methods*:

6.4.1 *Perforation of Resin-Impregnated Tube*—Prior to pulling the resin-impregnated fabric tube in place, the outer impermeable plastic coating may optionally be perforated. When the resin-impregnated fabric tube is perforated, this should allow resin to be forced through the perforations and out against the existing conduit by the force of the hydrostatic head or air pressure against the inner wall of the calibration hose. The perforation should be done after fabric tube impregnation with a perforating roller device at the point of manufacture or at the jobsite. Perforations should be made on both sides of the lay-flat fabric tube covering the full circumference with a spacing no less than 1.5 in. (38.1 mm) apart. Perforating slits should be a minimum of 0.25 in. (6.4 mm) long.

6.4.2 *Pulling Resin-Impregnated Tube into Position*—The wet-out fabric tube should be pulled into place using a power winch. The saturated fabric tube should be pulled through an existing manhole or other approved access to fully extend to the next designated manhole or termination point. Care should be exercised not to damage the tube as a result of friction during pull-in, especially where curvilinear alignments, multilinear alignments, multiple offsets, protruding services, and other friction-producing host pipe conditions are present. Once the fabric tube is in place, it should be attached to a vertical standpipe so that the calibration hose can invert into the center of the resin-impregnated fabric tube. The vertical standpipe should be of sufficient height of water head to hold the fabric tube tight to the existing pipe wall, producing dimples at side connections. A device such as a dynamometer or load cell should be provided on the winch or cable to monitor the pulling force. Measure the overall elongation of the fabric tube after pull-in completion. The acceptable longitudinal elongation shall not be more than 5 % of the overall length measured after the calibration hose has been installed, or exceed the recommended pulling force.

6.4.3 *Hydrostatic Head Calibration Hose Inversion*—The calibration hose should be inserted into the vertical inversion standpipe, with the impermeable plastic membrane side out. At the lower end of the inversion standpipe, the calibration hose should be turned inside out and attached to the standpipe so

**TABLE 1 CIPP Initial Structural Properties[A]**

| Property | Test Method | Minimum Value | |
|---|---|---|---|
| | | psi | (MPa) |
| Flexural strength | D 790 | 4 500 | (31) |
| Flexural modulus | D 790 | 250 000 | (1724) |
| Tensile strength (for pressure pipes only) | D 638 | 3 000 | (21) |

[A]The values in Table 1 are for field inspection. The purchaser should consult the manufacturer for the long-term structural properties.

that a leakproof seal is created. The resin-impregnated fabric tube should also be attached to the standpipe so that the calibration hose can invert into the center of the resin-impregnated tube. The inversion head should be adjusted to be of sufficient height of water head to cause the calibration hose to invert from the initial point of inversion to the point of termination and hold the resin-impregnated fabric tube tight to the pipe wall, producing dimples at side connections. Care should be taken during the inversion so as not to overstress the felt fiber. At the request of the purchaser, the fabric tube manufacturer should provide information on the maximum allowable axial and longitudinal tensile stress for the fabric tube.

6.4.3.1 An alternative method of installation is top inversion. In this case, the calibration hose and resin-impregnated fabric tube are attached to a top ring. In this case, the tube itself forms the standpipe for generation of the hydrostatic head. Other methods of installation are also available and should be submitted for acceptance by the purchaser.

6.4.4 *Using Air Pressure*—The resin-impregnated fabric tube should be perforated as described in 6.4.1. Once perforated, the wet-out fabric tube should be pulled into place using a power winch as described in 6.4.2. The calibration hose should be inserted through the guide chute or tube of the pressure containment device in which the calibration hose has been loaded, with the impermeable plastic membrane side out. At the end of the guide chute, the calibration hose should be turned inside out and attached so that a leakproof seal is created. The resin-impregnated tube should also be attached to the guide chute so that the calibration hose can invert into the center of the resin-impregnated tube. The inversion air pressure should be adjusted to be of sufficient pressure to cause the calibration hose to invert from point of inversion to point of termination and hold the resin saturated fabric tube tight to the pipe wall, producing dimples at side connections. Care should be taken during the inversion so as not to overstress the woven and nonwoven materials. Take suitable precautions to eliminate hazards to personnel in the proximity of the construction when pressurized air is being used.

6.5 *Lubricant During Installation*—The use of a lubricant during installation is recommended to reduce friction during inversion. This lubricant should be poured into the fluid in the standpipe in order to coat the calibration hose during inversion. When air is used to invert the calibration hose, the lubricant should be applied directly to the calibration hose. The lubricant used should be a nontoxic, oil-based product that has no detrimental effects on the tube or boiler and pump system, and will not adversely affect the fluid to be transported.

6.6 *Curing*:

6.6.1 *Using Circulating Heated Water*—After installation is completed, suitable heat source and water recirculation equipment are required to circulate heated water throughout the section to uniformly raise the water temperature above the temperature required to effect a cure of the resin. The water temperature in the line during the cure period should be as recommended by the resin manufacturer or seller.

6.6.1.1 The heat source should be fitted with suitable monitors to measure the temperature of the incoming and outgoing water supply. Temperature sensors should also be placed between the resin-impregnated tube and the host pipe invert at both termination points to monitor the temperatures during cure.

6.6.1.2 Initial cure will occur during temperature heat-up and is completed when exposed portions of the CIPP appear to be hard and sound and the remote temperature sensor indicates that the temperature is of a magnitude to realize an exotherm or cure in the resin. After initial cure is reached, the temperature should be raised to the post-cure temperature and held there for a period recommended by the resin manufacturer or seller. During post-cure, the recirculation of the water and cycling of the boiler to maintain the temperature continues. The curing of the CIPP must take into account the existing pipe material, the resin system, and ground conditions (temperature, moisture level, and thermal conductivity of soil).

6.6.2 *Using Steam*—After installation is completed, suitable steam-generating equipment is required to distribute steam throughout the pipe. The equipment should be capable of delivering steam throughout the section to uniformly raise the temperature within the pipe above the temperature required to effect a cure of the resin. The temperature in the line during the cure period should be as recommended by the resin manufacturer or seller.

6.6.2.1 The steam-generating equipment should be fitted with a suitable monitor to measure the temperature of the outgoing steam. Temperature sensors should also be placed between the resin-impregnated tube and the host pipe invert at both termination points to monitor the temperatures during cure.

6.6.2.2 Initial cure will occur during temperature heat-up and is completed when exposed portions of the new pipe appear to be hard and sound and the remote temperature sensor indicates that the temperature is of a magnitude to realize an exotherm or cure in the resin. After initial cure is reached, the temperature should be raised to the post-cure temperature and held there for a period recommended by the resin manufacturer or seller, during which time the distribution and control of steam to maintain the temperature continues. The curing of the CIPP must take into account the existing pipe material, the resin system, and ground conditions (temperature, moisture level, and thermal conductivity of soil).

6.6.3 *Required Pressures*—As required by the purchase agreement, the estimated maximum and minimum pressure required to hold the flexible tube tight against the existing conduit during the curing process should be provided by the seller and shall be increased to include consideration of external ground water, if present. Once the cure has started and dimpling for laterals is completed, the required pressures should be maintained until the cure has been completed. For water or steam, the pressure should be maintained within the estimated maximum and minimum pressure during the curing process. If the steam pressure or hydrostatic head drops below the recommended minimum during the cure, the CIPP should be inspected for lifts or delaminations and evaluated for its ability to fully meet the applicable requirements of 6.8 and Section 8.

6.7 *Cool-Down*:

6.7.1 *Using Cool Water after Heated Water Cure*—The new CIPP should be cooled to a temperature below 100°F (38°C) before relieving the static head in the inversion standpipe. Cool-down may be accomplished by the introduction of cool water into the inversion standpipe to replace water being drained from a small hole made in the downstream end. Take care to cool down the CIPP in a controlled manner, as recommended by the resin manufacturer or the seller. Care should be taken to release the static head so that a vacuum will not be developed that could damage the newly installed CIPP.

6.7.2 *Using Cool Water after Steam Cure*—The new CIPP should be cooled to a temperature below 100°F (38°C) before relieving the internal pressure within the section. Cool-down may be accomplished by the introduction of cool water into the section to replace the mixture of air and steam being drained from a small hole made in the downstream end. Take care to cool the CIPP in a controlled manner as recommended by the resin manufacturer or the seller. Care should be taken to release the air pressure so that a vacuum will not be developed that could damage the newly installed CIPP.

6.8 *Workmanship*—The finished CIPP should be continuous over the entire length of an installation and be free of dry spots, lifts, and delaminations. If these conditions are present, the CIPP will be evaluated for its ability to meet the applicable requirements of Section 8. Where the CIPP does not meet the requirements of Section 8 or specifically stated requirements of the purchase agreement, or both, the affected portions of CIPP will be removed and replaced with an equivalent repair.

6.8.1 If the CIPP does not fit tightly against the original pipe at its termination point(s), the full circumference of the CIPP exiting the existing host pipe or conduit should be sealed by filling with a resin mixture compatible with the CIPP.

6.9 *Service Connections*—After the new CIPP has been installed, the existing active (or inactive) service connections should be reinstated. This should generally be done without excavation, and in the case of non-man entry pipes, from the interior of the pipeline by means of a television camera and a remote-control cutting device. Service connections shall be reinstated to at least 90 % of the original area as it enters the host pipe or conduit.

NOTE 3—In many cases, a seal is provided where the formed CIPP dimples at service connections. However, this practice should not be construed to provide a 100 % watertight seal at all service connections. If total elimination of infiltration and inflow is desired, other means, which are beyond the scope of this practice, may be necessary to seal service connections and to rehabilitate service lines and manholes.

## 7. Material Requirements

7.1 *Fabric Tube Strength*—If required by the purchaser in the purchase agreement, the fabric tube, and seam (if applicable) as a quality control test, when tested in accordance with Test Method D 1682 shall have a minimum tensile strength of 750 psi (5 MPa) in both the longitudinal and transverse directions.

7.2 *Chemical Resistance*:

7.2.1 *Chemical Resistance Requirements*—The cured resin/fabric tube matrix, with or without the calibration hose, shall be evaluated in a laminate form for qualification testing of long-term chemical exposure to a variety of chemical effluents and should be evaluated in a manner consistent with 6.4.1 of Specification D 5813. The specimens shall be capable of exposure to the solutions in Table 2 at a temperature of 73.4 ± 3.6°F (23 ± 2°C), with a percentage retention of flexural modulus of elasticity of at least 80 % after one year exposure. Flexural properties, after exposure to the chemical solution(s), shall be based on dimensions of the specimens after exposure.

7.2.2 *Chemical Resistance Procedures*—The CIPP laminates should be constructed of identical fabric and resin components that will be used for anticipated in-field installations. The cured resin/fabric tube laminates, with or without the calibration hose should be exposed to the chemical agents in a manner consistent with Test Method D 543. The edges of the test coupons should be left exposed and not treated with resin, unless otherwise specified by the purchaser. The specimen thicknesses should be in the range of 0.125 to 0.25 in. (3.2 to 6.4 mm), with the sample dimensions suitable for preparing a minimum of five specimens for flexural testing as described in 8.1.4. Flexural properties after exposure to the chemical solutions should be based on the dimensions of the specimen after exposure.

7.2.2.1 For applications other than standard domestic sewerage, it is recommended that chemical resistance tests be conducted with actual samples of the fluid flowing in the pipe. These tests can also be accomplished by depositing CIPP test samples in the active pipe.

7.2.2.2 As required by the purchaser, additional chemical resistance requirements for the CIPP may be evaluated as described in 6.4 of Specification D 5813.

## 8. Recommended Inspection Practices

8.1 For each installation length designated by the purchaser in the purchase agreement, the preparation of CIPP samples is required from one or both of the following two methods:

8.1.1 The samples should be cut from a section of cured CIPP at an intermediate manhole or at the termination point that has been installed through a like diameter section of pipe or other tubular restraining means which has been held in place by a suitable heat sink, such as sandbags.

8.1.2 The sample should be fabricated from material taken from the fabric tube and the resin/catalyst system used, and cured in a clamped mold, placed in the downtube when heated circulated water is used, and in the silencer when steam is used. When the CIPP is constructed of oriented continuous or discontinuous fibers to enhance the physical properties of the CIPP, this method of sample preparation is recommended in order to allow testing in the axial (that is, along the length) and

TABLE 2 Minimum Chemical Resistance Requirements for Domestic Sanitary Sewer Applications

| Chemical Solution | Concentration, % |
|---|---|
| Nitric acid | 1 |
| Sulfuric acid | 5 |
| ASTM Fuel C[A] | 100 |
| Vegetable oil[B] | 100 |
| Detergent[C] | 0.1 |
| Soap[C] | 0.1 |

[A] In accordance with Specification D 4814.
[B] Cottonseed, corn, or mineral oil.
[C] In accordance with Test Method D 543.

circumferential (that is, hoop) directions of the CIPP. This method is also recommended when large-diameter CIPP is installed that may otherwise not be prepared with a tubular restraint.

8.1.3 The CIPP samples for each of these cases should be large enough to provide a minimum of three specimens and a recommended five specimens for flexural testing and also for tensile testing for internal pressure applications. The flexural and tensile specimens should be prepared in a manner consistent with 8.3.1 of Specification D 5813. For flexural and tensile properties, the full wall thickness of the CIPP samples shall be tested. Any plastic coatings or other CIPP layers not included in the structural design of the CIPP may be carefully ground off of the specimens prior to testing. If the sample is irregular or distorted such that proper testing is inhibited, attempts shall be made to machine any wall thickness from the inside pipe face of the sample. Any machining of the outside pipe face of the sample shall be done carefully so as to minimize the removal of material from the outer structural wall of the sample. Individual specimens should be clearly marked for easy identification and retained until final disposition or CIPP acceptance, or both, has been given.

8.1.4 *Short-Term Flexural (Bending) Properties*—The initial tangent flexural modulus of elasticity and flexural stress should be measured for gravity and pressure pipe applications in accordance with Test Method D 790, Test Method I, Procedure A and should meet the requirements of Table 1 within the 16:1 length to depth constraints. For specimens greater than 0.5 in. (12.7 mm) in depth, the width-to-depth ratio of the specimen should be increased to a minimum of 1:1 and should not exceed 4:1. For samples prepared in accordance with 8.1.1, determine flexural properties in the axial direction where the length of the test specimen is cut along the longitudinal axis of the pipe. Special consideration should be given to the preparation of flexural specimens to ensure opposite sides are parallel and adjacent edges are perpendicular. Flexural specimens should be tested such that the inside pipe face is tested in tension and the outside pipe face is in compression.

8.1.4.1 *Fiber-Reinforced CIPP Flexural Properties*—Where the CIPP is reinforced with oriented continuous or discontinuous fibers to enhance the physical properties of the CIPP, specimens should be sampled in accordance with 8.1.2, and flexural properties should be determined in accordance with 8.1.3 along the longitudinal axis and circumferential axis of the installed CIPP.

8.1.5 *Short-Term Tensile Properties*—The tensile strength should be measured for pressure pipe applications in accordance with Test Method D 638. Specimens should be prepared in accordance with Types I, II, and III of Fig. 1 of Test Method D 638. Specimens greater than 0.55 in. (14 mm) thick should maintain all dimensions for a Type III specimen, except the thickness will be that of the CIPP sample obtained. The rate of specimen testing should be carried out in accordance with Table 1 of Test Method D 638. Specimens should be prepared in accordance with 8.1.1 and tested along the longitudinal axis of the installed CIPP.

8.1.5.1 *Fiber-Reinforced CIPP Tensile Testing*—Where the CIPP is reinforced with oriented continuous or discontinuous fibers to enhance the physical properties of the CIPP, specimens should be sampled in accordance with 8.1.2 and tensile properties should be determined in accordance with Test Method D 3039 and tested along the longitudinal axis and circumferential axis of the installed CIPP.

8.1.6 *CIPP Wall Thickness*—The method of obtaining CIPP wall thickness measurements should be determined in a manner consistent with 8.1.2 of Specification D 5813. Thickness measurements should be made in accordance with Practice D 3567 for samples prepared in accordance with 8.1. Make a minimum of eight measurements at evenly spaced intervals around the circumference of the sample to ensure that minimum and maximum thicknesses have been determined. Deduct from the measured values the thickness of any plastic coatings or CIPP layers not included in the structural design of the CIPP. The average thickness should be calculated using all measured values and shall meet or exceed minimum design thickness as agreed upon between purchaser and seller. The minimum wall thickness at any point shall not be less than 87.5 % of the specified design thickness as agreed upon between purchaser and seller.

8.2 *Gravity Pipe Leakage Testing*—If required by the owner in the contract documents or purchase order, gravity pipes should be tested using an exfiltration test method where the CIPP is plugged at both ends and filled with water. This test should take place after the CIPP has cooled down to ambient temperature. This test is limited to pipe lengths with no service laterals and diameters of 36 in. or less. The allowable water exfiltration for any length of pipe between termination points should not exceed 50 U.S. gallons per inch of internal pipe diameter per mile per day, providing that all air has been bled from the line. During exfiltration testing, the maximum internal pipe pressure at the lowest end should not exceed 10 ft (3.0 m) of water or 4.3 psi (29.7 kPa), and the water level inside of the inversion standpipe should be 2 ft (0.6 m) higher than the top of the pipe or 2 ft (0.6 m) higher than groundwater level, whichever is greater. The leakage quantity should be gaged by the water level in a temporary standpipe placed in the upstream plug. The test should be conducted for a minimum of 1 h.

NOTE 4—It is impractical to test pipes above 36 in. diameter for leakage due to the technology available in the pipe rehabilitation industry. Post inspection of larger pipes will detect major leaks or blockages.

8.3 *Pressure Pipe Testing*—If required by the purchaser in the purchase agreement, pressure pipes should be subjected to a hydrostatic pressure test. A pressure and leakage test at twice the known working pressure or at the working pressure plus 50 psi, whichever is less, is recommended. The pressure should initially be held at the known working pressure for a period not less than 12 h, then increased to the test pressure for an additional period of 2 to 3 h to allow for stabilization of the CIPP. After this period, the pressure test will begin for a minimum of 1 h. The allowable leakage during the pressure test should be 20 U.S. gallons per inch of internal pipe diameter per mile per day, providing that all air has been evacuated from the line prior to testing and the CIPP has cooled down to ambient temperature.

NOTE 5—The allowable leakage for gravity and pressure pipe testing is a function of water loss at the end seals and trapped air in the pipe.

8.4 *Delamination Test*—If required by the purchaser in the purchase agreement, a delamination test should be performed on each installation length specified. CIPP samples should be prepared in accordance with 8.1.2, except that a portion of the fabric tube material in the sample should be dry and isolated from the resin in order to separate tube layers for testing (consult the tube manufacturer for further information). Delamination testing should be in accordance with Test Method D 903 with the following exceptions:

8.4.1 The rate of travel of the power-actuated grip should be 1 in. (25 mm)/min.

8.4.2 Five test specimens should be tested for each installation specified.

8.4.3 The thickness of the test specimen should be minimized, but should be sufficient to adequately test delamination of nonhomogeneous CIPP layers.

8.5 The peel or stripping strength between any nonhomogeneous layers of the CIPP laminate should be a minimum of 10 lb/in. (178.60 g/mm) for typical CIPP applications.

NOTE 6—The purchaser may designate the similar layers between which the delamination test will be conducted.

NOTE 7—For additional details on conducting the delamination test, contact the seller.

8.6 *Inspection and Acceptance*—The installation may be inspected visually if appropriate, or by closed-circuit television if visual inspection cannot be accomplished. Variations from true line and grade may be inherent because of the conditions of the original piping. No infiltration of groundwater should be observed. All service entrances should be accounted for and be unobstructed.

## 9. Keywords

9.1 cured-in-place pipe; installation—underground; plastic pipe—thermoset; rehabilitation; thermosetting resin pipe

## APPENDIX

### (Nonmandatory Information)

### X1. DESIGN CONSIDERATIONS

X1.1 *General Guidelines*—The design thickness of the CIPP is a function of the resin, materials of construction of the fabric tube, and the condition of the existing pipe. In addition, depending on the condition of the pipe, the design thickness of the CIPP may also be a function of groundwater, soil type, and influence of live loading surrounding the host pipe. For guidance relating to terminology of piping conditions and related design equations, see Appendix X1 of Practice F 1216.

**Amendment to ASTM F1743-96**
**Author: Doug Kleweno of DGK Technologies**

Douglas Kleweno
25124 235th Way SE
Maple Valley, WA 93038-5905

May 22, 2001

Whom it may concern:

I am writing this letter at the request of Mr. David Ratliff (Nu Flow Installer, Abilene, Texas) in order to provide clarification for ASTM F1743 "Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-In-Place Thermosetting Resin Pipe (CIPP)" and similar pulled-in-place products. In my previous position I was the Technical Manager for InLiner USA CIPP products and am the author of ASTM F1743. I have also been involved in editing ASTM F1216 and ASTM D5813, which are also CIPP installation and material specifications, respectively.

When writing an ASTM specification it is necessary to provide enough minimum requirements so that the product can meet or exceed engineering and design criteria. However, ASTM specifications also must be generalized enough to accommodate the majority of products and processes that may want to reference it. F1743 was generally written for most CIPP applications where heated cures predominate in the market. There are many resin applications for CIPP and other products (boat building, automotive, heavy truck) where ambient cure resin formulations are common and used successfully. Technically speaking, an ambient cure formulation for CIPP does initiate at a temperature less that 180F, which is recommended in Section 5.2.3 or F1743.

More critical to CIPP and other applications is whether the product (CIPP in this case) meets the minimum initial structural property recommendations. The minimum properties for the CIPP were provided in Section 4.2.3 of ASTM F1743 and this is probably the most important aspect for the product to meet the requirements for external hydrostatic or soil loading that may surround the pipe. These minimum properties are the numbers by which the minimum design thickness is determined for the installed CIPP or part liner.

As a side note it is my experience that the curing strategy is chosen for handling and transportation purposes. Large liners for CIPP require long catalyzed stability so the product can be processed, transported, and installed. For short runs or tubes processed at a job site, it was common to use ambient or semi-ambient cure formulations to reduce the time at the job site and the associated inconvenience to the surrounding community.

I hope this has provided some additional clarification.

Doug Kleweno
(423) 413-8529

NSF International

August 24, 2005

# TEST REPORT

Send To: 1P790
NU FLOW TECHNOLOGIES 2000 INC.
1010 THORNTON ROAD SOUTH
OSHAWA ON L1J 7E2
CANADA
Attn: MR. BOB FOWLE

Customer: 1P790
NU FLOW TECHNOLOGIES 2000 INC.
1010 THORNTON ROAD SOUTH
OSHAWA ON L1J 7E2
CANADA
Attn: MR. BOB FOWLE

Plant: 1P790
NU FLOW TECHNOLOGIES 2000 INC.
1010 THORNTON ROAD SOUTH
OSHAWA ON L1J 7E2
CANADA
Attn: MR. BOB FOWLE

Sample Description: Nu Flow #2000 Pipe Lining - Liner
Test Type: AA - Annual Collection

Thank you for having your product tested by NSF.

The enclosed report details the result of the testing performed on your product. Your program representative will be contacting you in the near future if there are any remaining issues concerning the status of this product.

Please do not hesitate to contact us if you have any immediate questions pertaining to your product.

Reviewer: Ata Ciel.

Atabek Ciechanowski - Manager, Engineering Laboratory

Status: **Pass**

CC: Program: 010 - Plumbing and Related Programs
Program Rep: AMY CHOKSEY
Region: 01 - Domestic
PA Project: 224520

FI200508241202 13 J-00012414 Page 1 of 4



789 N. Dixboro Road, Ann Arbor, Michigan 48105-9723 USA
1-800-NSF-MARK 734-769-8010
www.nsf.org

General Information

Standard: 014 - PLASTICS PIPING SYSTEM COMPONENTS AND RELATED MATERIALS

DCC Number / Tracking ID PL04249
Family Code A
Material Type Epoxy
Monitor Code A
Performance Standard F1216
Performance Standard Year 2003
Product Identifier Part A Batch # 030904, Part B Batch # 040405_3
Sample Description Liner
Trade Designation Nu Flow #2000 Pipe Lining

Sample Id: S-0000161582
Description: Nu Flow #2000 Pipe Lining - Liner
Sampled Date: 05/19/2005
Received Date: 05/23/2005

| Testing Parameter | Result | Units |
|---|---|---|
| | | |
| **Engineering Lab** | | |
| Gravity Pipe Leakage Test | | |
| Initial water column: | 10 | feet |
| Final water column: | 10 | feet |
| Time: | 60 | minutes |
| Leakage rate: | 0 | g/in/day |
| Required maximum leakage rate: | 50 | g/in/day |
| Actual leakage rate: | 0 | g/in/day |
| Gravity Pipe Leakage Test: | Pass | |
| Flex Modulus | | |
| Specimens conditioned for | 40 | hours |
| Specimens conditioned at | 73 | degrees F |
| Relative humidity | 50 | % |
| Test temperature Required | 73 | degrees F |
| Test temperature Actual | 73 | degrees F |
| Required crosshead speed | 0.22 | in/min |
| Actual crosshead speed | 0.22 | in/min |
| Deflection | <5 | % |
| Specimen 1 | 280000 | psi |
| Specimen 2 | 315000 | psi |
| Specimen 3 | 275000 | psi |
| Specimen 4 | 242000 | psi |
| Specimen 5 | 257000 | psi |
| Required Average Modulus (minimum) | 250000 psi | |
| Actual Average Modulus | 274000 | psi |
| Flex Modulus Test | PASS | |
| Flexural Strength Test | | |
| Specimens conditioned for | 40 | hours |
| Specimens conditioned at | 73 | degrees F |
| Relative Humidity | 50 | percent |
| Test Temperature | 73 | degrees F |
| Cross Head Speed | 0.22 | in/min. |
| Specimen 1 Flexural Strength | 6280 | psi |
| Specimen 2 Flexural Strength | 6480 | psi |
| Specimen 3 Flexural Strength | 6010 | psi |
| Specimen 4 Flexural Strength | 5210 | psi |

Sample Id: S-0000161582

| Testing Parameter | Result | Units |
|---|---|---|
| | | |
| **Engineering Lab ( Cont'd )** | | |
| Specimen 5 Flexural Strength | 5820 | psi |
| Average Flexural Strength | 5960 | psi |
| Required Flexural Strength | 4500 | psi |
| Flexural Strength Test | Pass | |
| Strength, Tensile | | |
| Specimens conditioned for | 40 | hours |
| Specimens conditioned at | 73 | degrees F |
| Relative humidity | 50 | % |
| Test Temperature | 73 | degrees F |
| Actual Crosshead Speed | 0.2 | in/min. |
| Required Crosshead Speed | 0.2 | in/min. |
| Specimen 1: Tensile Strength | 3930 | psi |
| Specimen 2: Tensile Strength | 4540 | psi |
| Specimen 3: Tensile Strength | 4010 | psi |
| Specimen 4: Tensile Strength | 3690 | psi |
| Specimen 5: Tensile Strength | 3920 | psi |
| Req'd Average Tensile Strength (minimum) | 3000 | |
| Actual Average Tensile Strength | 4020 | psi |
| Tensile Strength Test | PASS | |
| Specimen Fabrication | | |
| Specimen Fabrication | COMPLETE | |
| Time | 1 | hours |
| Technician | 3356 | |

*Testing Laboratories:*

| | Id | Address |
|---|---|---|
| All work performed at: → | NSF_AA | NSF International<br>789 Dixboro Road<br>Ann Arbor MI 48105-0140<br>USA |

*References to Testing Procedures:*

| NSF Reference | Parameter / Test Description |
|---|---|
| P3084 | Gravity Pipe Leakage Test |
| P3122 | Flex Modulus |
| P3123 | Flexural Strength Test |
| P3127 | Strength, Tensile |
| P3172 | Specimen Fabrication |

03/16/2007 FRI 14:39 FAX 905 673 8394 ACUREN GROUP INC. 002/002

ACUREN

*Client*

NU FLOW TECHNOLOGIES 2000 INC.
1010 Thornton Road South
Oshawa, Ontario
L1J 7E2

# Laboratory Report

| *Attention* | *Client's Order Number* | *Date* | *Report Number* |
|---|---|---|---|
| Sinan Omari | 9282 | 16 March 2007 | **07-845** |

| *Client's Material / Product Description* | *Date Sample Received* | *Material / Product Specification* |
|---|---|---|
| (1) Sample | 06 March 2007 | ASTM D5813-04 |

## Test Performed — Result

1. Tangent Flexural Modulus
   (ASTM D790)
   - Crosshead speed: 0.05"/min
   - 1000 lbf Load cell
   - 2 inch support span
   - L/D = 16
   - Specimen Geometry: 1/8" x 1/2" x 4"
   - 5 specimens tested
   - Units: psi

| Sample # | Result | Specification |
|---|---|---|
| 1 | 384400 | |
| 2 | 420900 | 250,000 psi Minimum |
| 3 | 304600 | |
| 4 | 425400 | |
| 5 | 397100 | |
| Average | 386500 | |

2. Flexural Strength
   (ASTM D790)
   - 5 specimens tested
   - Units: psi

| Sample # | Result | Specification |
|---|---|---|
| 1 | 6 070 | |
| 2 | 6 670 | |
| 3 | 5 400 | 4,500 psi Minimum |
| 4 | 6 200 | |
| 5 | 6 440 | |
| Average | 6 160 | |

3. Wall Thickness
   - Units: mm
   - Four measurements taken on each side

| Side A | Side B |
|---|---|
| 3.56 | 3.26 |
| 3.62 | 3.45 |
| 3.67 | 3.50 |
| 3.79 | 3.74 |

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Corrine Dimnik, B.Sc.
Certified Inspector.

Dr. Erhan Ulvan, Ph. D, P. Eng.,
Laboratory Manager.

NU FLOW RELINE REPAIR RENEW ®

# Flow Comparisons

## Comparison between a new pipe and a rehabilitated pipe

| Diameter (m) | Diameter (in) | Hazen Williams Coefficient (C) | Flow for new pipe ($m^3/s$) | Thickness of Liner (mm) | Resulting internal diameter (m) | Hazen Williams coefficient (C) | Flow for rehabilitated pipe ($m^3/s$) | % Loss |
|---|---|---|---|---|---|---|---|---|
| 0.15 | 6 | 140 | 0.27 | 2 | 0.146 | 140 | 0.25 | -6.86 |
| 0.20 | 8 | 140 | 0.57 | 2 | 0.196 | 140 | 0.54 | -5.17 |
| 0.30 | 10 | 140 | 1.02 | 2 | 0.246 | 140 | 0.98 | -4.15 |
| 0.40 | 12 | 140 | 1.65 | 2.5 | 0.295 | 140 | 1.57 | -4.32 |

## Comparison between old pipe and a rehabilitated pipe

| Old Pipe Diameter (m) | Old Pipe Diameter (in) | Hazen Williams Coefficient (C) | Flow for old pipe ($m^3/s$) | Thickness of Liner (mm) | Old Pipe diameter (m) | Hazen Williams coefficient (C) | Flow for rehabilitated pipe ($m^3/s$) | % Increase |
|---|---|---|---|---|---|---|---|---|
| 0.13 | 6 | 60 | 0.08 | 2 | 0.146 | 140 | 0.25 | 216.63 |
| 0.18 | 8 | 60 | 0.18 | 2 | 0.196 | 140 | 0.54 | 191.91 |
| 0.23 | 10 | 60 | 0.35 | 2 | 0.246 | 140 | 0.98 | 178.48 |
| 0.27 | 12 | 60 | 0.53 | 2.5 | 0.295 | 140 | 1.57 | 194.52 |

# P4255

| | | | | | |
|---|---|---|---|---|---|
| **Date Submitted** | 4/1/2010 | **Section** | 702.2 | **Proponent** | Allen Johnson |
| **Chapter** | 7 | **Affects HVHZ** | No | **Attachments** | Yes |

**TAC Recommendation** No Affirmative Recommendation with a Second
**Commission Action** Pending Review

**Related Modifications**

702.1, 702.3, 1102.1, 1102.2, 1102.3, 1102.4

**Summary of Modification**

Modify the current building materials list to include Cure-In Place (CIPP) Thermosetting Resin Conduit Liner that meets ASTM F-1743, ASTM F-1216, ASTM D790, ASTM D638 and ASTM D543. in sections 702.1,702.2, 702.3, 1102.1, 1102.2, 1102.3 and 1102.4 for building drains and building sewer pipes.

**Rationale**

CIPP liners are an alternative to traditional pipe replacement that increases the flow charicteristics of the pipe.

**Fiscal Impact Statement**

**Impact to local entity relative to enforcement of code**

There are no additional costs relative to enforcement compared to traditional replacement.

**Impact to building and property owners relative to cost of compliance with code**

There is a significant cost savings to building and property owners as well as reducing potentially hazardous materials left undisturbed as compared to traditional pipe replacement CIPP liners are seamless and jointless, reducing the number of potential failures.

**Impact to industry relative to the cost of compliance with code**

There is no impact to the industry relative to the cost of compliance with code.

**Requirements**

**Has a reasonable and substantial connection with the health, safety, and welfare of the general public**

CIPP lining eliminates the destruction of landscapes and property as well as the health dangers associated with removing of sewer pipes in need of repair.

**Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction**

CIPP liners provide a repair solution that allows drain, waste and sewer pipes to be repaired without the digging and destruction required for traditional pipe repairs or replacement.

**Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities**

CIPP lining can be installed in any type of host pipe used for Building drains and Building sewer pipes for residential, commercial and industrial applications.

**Does not degrade the effectiveness of the code**

CIPP lining does not degrade the effectiveness of the code.

TopPrevious SectionNext Section

**SECTION 702 MATERIALS**

**702.1 Above-ground sanitary drainage and vent pipe.** Above-ground soil, waste and vent pipe shall conform to one of the standards listed in Table 702.1.

**TABLE 702.1 ABOVE-GROUND DRAINAGE AND VENT PIPE**

| MATERIAL | STANDARD |
|---|---|
| Acrylonitrile butadiene styrene (ABS) plastic pipe in IPS diameters, including Schedule 40, DR 22 (PS 200) and DR 24 (PS 140); with a solid, cellular core or composite wall | ASTM D 2661; ASTM F 628; ASTM F 1488; CSA B181.1 |
| Brass pipe | ASTM B 43 |
| Cast-iron pipe | ASTM A 74; ASTM A 888; CISPI 301 |
| Copper or copper-alloy pipe | ASTM B 42; ASTM B 302 |
| Copper or copper-alloy tubing (Type K, L, M or DWV) | ASTM B 75; ASTM B 88; ASTM B 251; ASTM B 306 |
| Galvanized steel pipe | ASTM A 53 |
| Glass pipe | ASTM C 1053 |
| Polyolefin pipe | ASTM F 1412; CAN/CSA B181.3 |
| Polyvinyl chloride (PVC) plastic pipe in IPS diameters, including schedule 40, DR 22 (PS 200), and DR 24 (PS 140); with a solid, cellular core or composite wall | ASTM D 2665; ASTM F 891; ASTM F 1488; CSA B181.2 |
| Polyvinyl chloride (PVC) plastic pipe with a 3.25-inch O.D. and a solid, cellular core or composite wall | ASTM D 2949, ASTM F 1488 |
| Polyvinylidene fluoride (PVDF) plastic pipe | ASTM F 1673; CAN/CSA B181.3 |
| Stainless steel drainage systems, Types 304 and 316L | ASME A112. |
| Cured-In Place Thermosetting Resin Conduit Liner (CIPP) | ASTM F1743, ASTM F1216, ASTM D790, ASTM D638, ASTM D543 |

Designation: F 1743 – 96 (Reapproved 2003)

An American National Standard

# Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe (CIPP)[1]

This standard is issued under the fixed designation F 1743; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This practice describes the procedures for the reconstruction of pipelines and conduits (4 to 96 in. (10 to 244 cm) diameter) by the pulled-in-place installation of a resin-impregnated, flexible fabric tube into an existing conduit and secondarily inflated through the inversion of a calibration hose by the use of a hydrostatic head or air pressure (see Fig. 1). The resin is cured by circulating hot water or by the introduction of controlled steam into the tube. When cured, the finished cured-in-place pipe will be continuous and tight fitting. This reconstruction process may be used in a variety of gravity and pressure applications such as sanitary sewers, storm sewers, process piping, electrical conduits, and ventilation systems.

1.2 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for informational purposes only.

NOTE 1—There are no ISO standards covering the primary subject matter of this practice.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

2.1 *ASTM Standards:*

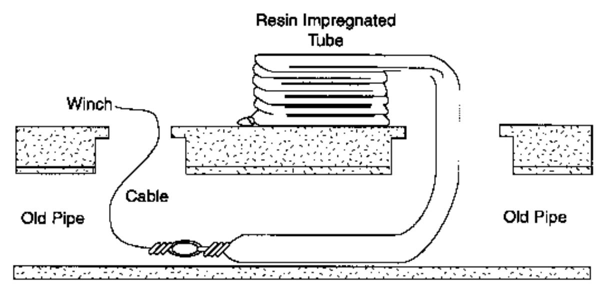
D 543 Test Method of Resistance of Plastics to Chemical Reagents[2]

D 638 Test Method for Tensile Properties of Plastics[2]

D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials[2]

D 903 Test Method for Peel or Stripping Strength of Adhesive Bonds[3]

**Step 1 – Pull resin-impregnated tube into existing pipe.**




**Step 2 – Calibration hose inversion**

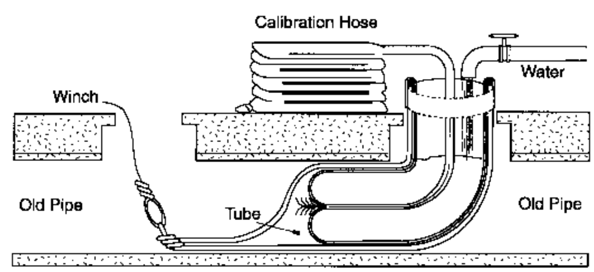



FIG. 1 Cured-in-Place Pipe Installation Methods

D 1600 Terminology for Abbreviated Terms Relating to Plastics[2]

D 1682 Test Method for Breaking Load and Elongation of Textile Fabrics[4]

D 3039/D3039M Test Method for Tensile Properties of Polymer Matrix Composite Materials[5]

[1] This practice is under the jurisdiction of ASTM Committee F-17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.67 on Trenchless Plastic Pipeline Technology.

Current edition approved Feb. 10, 2003. Published April 2003. Last previous edition approved in 1996 as F1743–96.

[2] *Annual Book of ASTM Standards*, Vol 08.01.

[3] *Annual Book of ASTM Standards*, Vol 15.06.

[4] *Discontinued: See 1991 Annual Book of ASTM Standards*, Vol 07.01.

[5] *Annual Book of ASTM Standards*, Vol 15.03.

D 3567 Practice for Determining Dimensions of Reinforced Thermosetting Resin Pipe (RTRP) and Fittings[6]
D 4814 Specification for Automotive Spark—Ignition Engine Fuel[7]
D 5813 Specification for Cured-in-Place Thermosetting Resin Sewer Pipe[6]
F 412 Terminology Relating to Plastic Piping Systems[6]
F 1216 Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube[6]
2.2 *AWWA Standard:*
M28 Manual on Cleaning and Lining Water Mains[8]
2.3 *NASSCO Standard:*
Recommended Specifications for Sewer Collection System Rehabilitation[9]

NOTE 2—An ASTM specification for cured-in-place pipe materials appropriate for use in this practice is under preparation and will be referenced in this practice when published.

## 3. Terminology

3.1 *General*—Definitions are in accordance with Terminology F 412. Abbreviations are in accordance with Terminology D 1600, unless otherwise indicated.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *calibration hose*—an impermeable bladder which is inverted within the resin-impregnated fabric tube by hydrostatic head or air pressure and may optionally be removed or remain in place as a permanent part of the installed cured-in-place pipe as described in 5.2.2.

3.2.2 *cured-in-place pipe (CIPP)*—a hollow cylinder consisting of a fabric tube with cured (cross-linked) thermosetting resin. Interior or exterior plastic coatings, or both, may be included. The CIPP is formed within an existing pipe and takes the shape of and fits tightly to the pipe.

3.2.3 *delamination*—separation of layers of the CIPP.

3.2.4 *dry spot*—an area of fabric of the finished CIPP which is deficient or devoid of resin.

3.2.5 *fabric tube*—flexible needled felt, or equivalent, woven or nonwoven material(s), or both, formed into a tubular shape which during the installation process is saturated with resin and holds the resin in place during the installation and curing process.

3.2.6 *inversion*—the process of turning the calibration hose inside out by the use of water pressure or air pressure.

3.2.7 *lift*—a portion of the CIPP that is a departure from the existing conduit wall forming a section of reverse curvature in the CIPP.

## 4. Significance and Use

4.1 This practice is for use by designers and specifiers, regulatory agencies, owners, and inspection organizations who are involved in the rehabilitation of conduits through the use of a resin-impregnated fabric tube pulled-in-place through an existing conduit and secondarily inflated through the inversion of a calibration hose. Modifications may be required for specific job conditions.

## 5. Recommended Materials and Manufacture

5.1 *General*—The resins, fabric tube, tube coatings, or other materials, such as the permanent calibration hose when combined as a composite structure, shall produce CIPP that meets the requirements of this specification.

5.2 *CIPP Wall Composition*—The wall shall consist of a plastic coated fabric tube filled with a thermosetting (cross-linked) resin, and if used, a filler.

5.2.1 *Fabric Tube*—The fabric tube should consist of one or more layers of flexible needled felt, or equivalent, woven or nonwoven material(s), or both, capable of carrying resin, withstanding installation pressures, and curing temperatures. The material(s) of construction should be able to stretch to fit irregular pipe sections and negotiate bends. Longitudinal and circumferential joints between multiple layers of fabric should be staggered so as not to overlap. The outside layer of the fabric tube should have an impermeable flexible coating(s) whose function is to contain the resin during and after fabric tube impregnation. The outer coating(s) must facilitate monitoring of resin saturation of the material(s) of construction of the fabric tube. The fabric tube should be fabricated to a size that, when installed, will tightly fit the internal circumference and the length of the original conduit. Allowance should be made for circumferential and longitudinal stretching of the fabric tube during installation. As required, the fabric tube should meet minimum tensile strength requirements in the longitudinal and transverse directions as specified in 7.1. All the material(s) of construction for the fabric tube should be compatible with the resin system used.

5.2.2 *Calibration Hose*:

5.2.2.1 *Removable Calibration Hose*—The removable calibration hose should consist of an impermeable plastic, or impermeable plastic coating(s) on flexible woven or nonwoven material(s), or both, that do not absorb resin and are capable of being removed from the CIPP.

5.2.2.2 *Permanent Calibration Hose*—The permanent calibration hose should consist of an impermeable plastic coating on a flexible needled felt or equivalent woven or nonwoven material(s), or both, that are capable of absorbing resin and are of a thickness to become fully saturated with resin. The calibration hose should be translucent to facilitate post-installation inspection. The calibration hose should be fabricated to a size that, when installed, will tightly fit the internal circumference and the length of the resin saturated fabric tube. Once inverted, the calibration hose becomes part of the fabric tube, and once properly cured, should bond permanently with the fabric tube. The properties of the calibration hose should meet minimum tensile strength requirements in the longitudinal and transverse directions as specified in 7.1. All the material(s) of construction for the calibration hose should be compatible with the resin system used.

5.2.3 *Resin*—A chemically resistant isophthalic based polyester, or vinyl ester thermoset resin and catalyst system or an

[6] *Annual Book of ASTM Standards*, Vol 08.04.
[7] *Annual Book of ASTM Standards*, Vol 05.03.
[8] Available from the American Water Works Association, 6666 W. Quincey Ave., Denver, CO 80235.
[9] Available from the National Association of Sewer Service Companies, 101 Wymore Rd., Suite 501, Altamonte, FL 32714.

epoxy resin and hardener that is compatible with the installation process should be used. The resin should be able to cure in the presence of water and the initiation temperature for cure should be less than 180°F (82.2°C). The cured resin/fabric tube system, with or without the calibration hose, shall be expected to have as a minimum the initial structural properties given in Table 1. These physical properties should be determined in accordance with Section 8. The cured resin/fabric tube system, with or without the calibration hose, should meet the minimum chemical resistance requirements as specified in 7.2.

## 6. Installation Recommendations

6.1 *Cleaning and Pre-Inspection*:

6.1.1 Prior to entering access areas, such as manholes, and performing inspection or cleaning operations, 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.

6.1.2 *Cleaning of Pipeline*—All internal debris should be removed from the original pipeline. Gravity pipes should be cleaned with hydraulically powered equipment, high-velocity jet cleaners, or mechanically powered equipment in accordance with NASSCO Recommended Specifications for Sewer Collection System Rehabilitation. Pressure pipelines should be cleaned with cable attached devices or fluid propelled devices in accordance with AWWA M28.

6.1.3 *Inspection of Pipelines*—Inspection of pipelines should be performed by experienced personnel trained in locating breaks, obstacles, and service connections by closed-circuit television or man entry. The interior of the pipeline should be carefully inspected to determine the location of any conditions that may prevent proper installation of the impregnated tube, such as protruding service taps, collapsed or crushed pipe, and reductions in the cross-sectional area of more than 40 %. These conditions should be noted so that they can be corrected.

6.1.4 *Line Obstructions*—The original pipeline should be clear of obstructions such as solids, dropped joints, protruding service connections, crushed or collapsed pipe, and reductions in the cross-sectional area of more than 40 % that may hinder or prevent the installation of the resin-impregnated fabric tube. If inspection reveals an obstruction that cannot be removed by conventional sewer-cleaning equipment, then a point-repair excavation should be made to uncover and remove or repair the obstruction.

6.2 *Resin Impregnation*—The fabric tube should be totally impregnated with resin (wet-out) and run through a set of rollers separated by a space, calibrated under controlled conditions to ensure proper distribution of resin. The volume of resin used should be sufficient to fully saturate all the voids of the fabric tube material, as well as all resin-absorbing material of the calibration hose at nominal thickness and diameter. The volume should be adjusted by adding 3 to 15 % excess resin to allow for the change in resin volume due to polymerization, the change in resin volume due to thermal expansion or contraction, and resin migration through the perforations of the fabric tube and out onto the host pipe.

**TABLE 1 CIPP Initial Structural Properties[A]**

| Property | Test Method | Minimum Value psi | Minimum Value (MPa) |
|---|---|---|---|
| Flexural strength | D 790 | 4 500 | (31) |
| Flexural modulus | D 790 | 250 000 | (1724) |
| Tensile strength (for pressure pipes only) | D 638 | 3 000 | (21) |

[A] The values in Table 1 are for field inspection. The purchaser should consult the manufacturer for the long-term structural properties.

6.3 *Bypassing*—If bypassing of the flow is required around the sections of pipe designated for reconstruction, the bypass should be made by plugging the line at a point upstream of the pipe to be reconstructed and pumping the flow to a downstream point or adjacent system. The pump and bypass lines should be of adequate capacity and size to handle the flow. Services within this reach will be temporarily out of service.

6.3.1 Public advisory services shall notify all parties whose service laterals will be out of commission and advise against water usage until the main line is back in service.

6.4 *Installation Methods*:

6.4.1 *Perforation of Resin-Impregnated Tube*—Prior to pulling the resin-impregnated fabric tube in place, the outer impermeable plastic coating may optionally be perforated. When the resin-impregnated fabric tube is perforated, this should allow resin to be forced through the perforations and out against the existing conduit by the force of the hydrostatic head or air pressure against the inner wall of the calibration hose. The perforation should be done after fabric tube impregnation with a perforating roller device at the point of manufacture or at the jobsite. Perforations should be made on both sides of the lay-flat fabric tube covering the full circumference with a spacing no less than 1.5 in. (38.1 mm) apart. Perforating slits should be a minimum of 0.25 in. (6.4 mm) long.

6.4.2 *Pulling Resin-Impregnated Tube into Position*—The wet-out fabric tube should be pulled into place using a power winch. The saturated fabric tube should be pulled through an existing manhole or other approved access to fully extend to the next designated manhole or termination point. Care should be exercised not to damage the tube as a result of friction during pull-in, especially where curvilinear alignments, multilinear alignments, multiple offsets, protruding services, and other friction-producing host pipe conditions are present. Once the fabric tube is in place, it should be attached to a vertical standpipe so that the calibration hose can invert into the center of the resin-impregnated fabric tube. The vertical standpipe should be of sufficient height of water head to hold the fabric tube tight to the existing pipe wall, producing dimples at side connections. A device such as a dynamometer or load cell should be provided on the winch or cable to monitor the pulling force. Measure the overall elongation of the fabric tube after pull-in completion. The acceptable longitudinal elongation shall not be more than 5 % of the overall length measured after the calibration hose has been installed, or exceed the recommended pulling force.

6.4.3 *Hydrostatic Head Calibration Hose Inversion*—The calibration hose should be inserted into the vertical inversion standpipe, with the impermeable plastic membrane side out. At the lower end of the inversion standpipe, the calibration hose should be turned inside out and attached to the standpipe so

that a leakproof seal is created. The resin-impregnated fabric tube should also be attached to the standpipe so that the calibration hose can invert into the center of the resin-impregnated tube. The inversion head should be adjusted to be of sufficient height of water head to cause the calibration hose to invert from the initial point of inversion to the point of termination and hold the resin-impregnated fabric tube tight to the pipe wall, producing dimples at side connections. Care should be taken during the inversion so as not to overstress the felt fiber. At the request of the purchaser, the fabric tube manufacturer should provide information on the maximum allowable axial and longitudinal tensile stress for the fabric tube.

6.4.3.1 An alternative method of installation is top inversion. In this case, the calibration hose and resin-impregnated fabric tube are attached to a top ring. In this case, the tube itself forms the standpipe for generation of the hydrostatic head. Other methods of installation are also available and should be submitted for acceptance by the purchaser.

6.4.4 *Using Air Pressure*—The resin-impregnated fabric tube should be perforated as described in 6.4.1. Once perforated, the wet-out fabric tube should be pulled into place using a power winch as described in 6.4.2. The calibration hose should be inserted through the guide chute or tube of the pressure containment device in which the calibration hose has been loaded, with the impermeable plastic membrane side out. At the end of the guide chute, the calibration hose should be turned inside out and attached so that a leakproof seal is created. The resin-impregnated tube should also be attached to the guide chute so that the calibration hose can invert into the center of the resin-impregnated tube. The inversion air pressure should be adjusted to be of sufficient pressure to cause the calibration hose to invert from point of inversion to point of termination and hold the resin saturated fabric tube tight to the pipe wall, producing dimples at side connections. Care should be taken during the inversion so as not to overstress the woven and nonwoven materials. Take suitable precautions to eliminate hazards to personnel in the proximity of the construction when pressurized air is being used.

6.5 *Lubricant During Installation*—The use of a lubricant during installation is recommended to reduce friction during inversion. This lubricant should be poured into the fluid in the standpipe in order to coat the calibration hose during inversion. When air is used to invert the calibration hose, the lubricant should be applied directly to the calibration hose. The lubricant used should be a nontoxic, oil-based product that has no detrimental effects on the tube or boiler and pump system, and will not adversely affect the fluid to be transported.

6.6 *Curing*:

6.6.1 *Using Circulating Heated Water*—After installation is completed, suitable heat source and water recirculation equipment are required to circulate heated water throughout the section to uniformly raise the water temperature above the temperature required to effect a cure of the resin. The water temperature in the line during the cure period should be as recommended by the resin manufacturer or seller.

6.6.1.1 The heat source should be fitted with suitable monitors to measure the temperature of the incoming and outgoing water supply. Temperature sensors should also be placed between the resin-impregnated tube and the host pipe invert at both termination points to monitor the temperatures during cure.

6.6.1.2 Initial cure will occur during temperature heat-up and is completed when exposed portions of the CIPP appear to be hard and sound and the remote temperature sensor indicates that the temperature is of a magnitude to realize an exotherm or cure in the resin. After initial cure is reached, the temperature should be raised to the post-cure temperature and held there for a period recommended by the resin manufacturer or seller. During post-cure, the recirculation of the water and cycling of the boiler to maintain the temperature continues. The curing of the CIPP must take into account the existing pipe material, the resin system, and ground conditions (temperature, moisture level, and thermal conductivity of soil).

6.6.2 *Using Steam*—After installation is completed, suitable steam-generating equipment is required to distribute steam throughout the pipe. The equipment should be capable of delivering steam throughout the section to uniformly raise the temperature within the pipe above the temperature required to effect a cure of the resin. The temperature in the line during the cure period should be as recommended by the resin manufacturer or seller.

6.6.2.1 The steam-generating equipment should be fitted with a suitable monitor to measure the temperature of the outgoing steam. Temperature sensors should also be placed between the resin-impregnated tube and the host pipe invert at both termination points to monitor the temperatures during cure.

6.6.2.2 Initial cure will occur during temperature heat-up and is completed when exposed portions of the new pipe appear to be hard and sound and the remote temperature sensor indicates that the temperature is of a magnitude to realize an exotherm or cure in the resin. After initial cure is reached, the temperature should be raised to the post-cure temperature and held there for a period recommended by the resin manufacturer or seller, during which time the distribution and control of steam to maintain the temperature continues. The curing of the CIPP must take into account the existing pipe material, the resin system, and ground conditions (temperature, moisture level, and thermal conductivity of soil).

6.6.3 *Required Pressures*—As required by the purchase agreement, the estimated maximum and minimum pressure required to hold the flexible tube tight against the existing conduit during the curing process should be provided by the seller and shall be increased to include consideration of external ground water, if present. Once the cure has started and dimpling for laterals is completed, the required pressures should be maintained until the cure has been completed. For water or steam, the pressure should be maintained within the estimated maximum and minimum pressure during the curing process. If the steam pressure or hydrostatic head drops below the recommended minimum during the cure, the CIPP should be inspected for lifts or delaminations and evaluated for its ability to fully meet the applicable requirements of 6.8 and Section 8.

6.7 *Cool-Down*:

6.7.1 *Using Cool Water after Heated Water Cure*—The new CIPP should be cooled to a temperature below 100°F (38°C) before relieving the static head in the inversion standpipe. Cool-down may be accomplished by the introduction of cool water into the inversion standpipe to replace water being drained from a small hole made in the downstream end. Take care to cool down the CIPP in a controlled manner, as recommended by the resin manufacturer or the seller. Care should be taken to release the static head so that a vacuum will not be developed that could damage the newly installed CIPP.

6.7.2 *Using Cool Water after Steam Cure*—The new CIPP should be cooled to a temperature below 100°F (38°C) before relieving the internal pressure within the section. Cool-down may be accomplished by the introduction of cool water into the section to replace the mixture of air and steam being drained from a small hole made in the downstream end. Take care to cool the CIPP in a controlled manner as recommended by the resin manufacturer or the seller. Care should be taken to release the air pressure so that a vacuum will not be developed that could damage the newly installed CIPP.

6.8 *Workmanship*—The finished CIPP should be continuous over the entire length of an installation and be free of dry spots, lifts, and delaminations. If these conditions are present, the CIPP will be evaluated for its ability to meet the applicable requirements of Section 8. Where the CIPP does not meet the requirements of Section 8 or specifically stated requirements of the purchase agreement, or both, the affected portions of CIPP will be removed and replaced with an equivalent repair.

6.8.1 If the CIPP does not fit tightly against the original pipe at its termination point(s), the full circumference of the CIPP exiting the existing host pipe or conduit should be sealed by filling with a resin mixture compatible with the CIPP.

6.9 *Service Connections*—After the new CIPP has been installed, the existing active (or inactive) service connections should be reinstated. This should generally be done without excavation, and in the case of non-man entry pipes, from the interior of the pipeline by means of a television camera and a remote-control cutting device. Service connections shall be reinstated to at least 90 % of the original area as it enters the host pipe or conduit.

NOTE 3—In many cases, a seal is provided where the formed CIPP dimples at service connections. However, this practice should not be construed to provide a 100 % watertight seal at all service connections. If total elimination of infiltration and inflow is desired, other means, which are beyond the scope of this practice, may be necessary to seal service connections and to rehabilitate service lines and manholes.

## 7. Material Requirements

7.1 *Fabric Tube Strength*—If required by the purchaser in the purchase agreement, the fabric tube, and seam (if applicable) as a quality control test, when tested in accordance with Test Method D 1682 shall have a minimum tensile strength of 750 psi (5 MPa) in both the longitudinal and transverse directions.

7.2 *Chemical Resistance*:

7.2.1 *Chemical Resistance Requirements*—The cured resin/fabric tube matrix, with or without the calibration hose, shall be evaluated in a laminate form for qualification testing of long-term chemical exposure to a variety of chemical effluents and should be evaluated in a manner consistent with 6.4.1 of Specification D 5813. The specimens shall be capable of exposure to the solutions in Table 2 at a temperature of 73.4 ± 3.6°F (23 ± 2°C), with a percentage retention of flexural modulus of elasticity of at least 80 % after one year exposure. Flexural properties, after exposure to the chemical solution(s), shall be based on dimensions of the specimens after exposure.

7.2.2 *Chemical Resistance Procedures*—The CIPP laminates should be constructed of identical fabric and resin components that will be used for anticipated in-field installations. The cured resin/fabric tube laminates, with or without the calibration hose should be exposed to the chemical agents in a manner consistent with Test Method D 543. The edges of the test coupons should be left exposed and not treated with resin, unless otherwise specified by the purchaser. The specimen thicknesses should be in the range of 0.125 to 0.25 in. (3.2 to 6.4 mm), with the sample dimensions suitable for preparing a minimum of five specimens for flexural testing as described in 8.1.4. Flexural properties after exposure to the chemical solutions should be based on the dimensions of the specimen after exposure.

7.2.2.1 For applications other than standard domestic sewerage, it is recommended that chemical resistance tests be conducted with actual samples of the fluid flowing in the pipe. These tests can also be accomplished by depositing CIPP test samples in the active pipe.

7.2.2.2 As required by the purchaser, additional chemical resistance requirements for the CIPP may be evaluated as described in 6.4 of Specification D 5813.

## 8. Recommended Inspection Practices

8.1 For each installation length designated by the purchaser in the purchase agreement, the preparation of CIPP samples is required from one or both of the following two methods:

8.1.1 The samples should be cut from a section of cured CIPP at an intermediate manhole or at the termination point that has been installed through a like diameter section of pipe or other tubular restraining means which has been held in place by a suitable heat sink, such as sandbags.

8.1.2 The sample should be fabricated from material taken from the fabric tube and the resin/catalyst system used, and cured in a clamped mold, placed in the downtube when heated circulated water is used, and in the silencer when steam is used. When the CIPP is constructed of oriented continuous or discontinuous fibers to enhance the physical properties of the CIPP, this method of sample preparation is recommended in order to allow testing in the axial (that is, along the length) and

TABLE 2 Minimum Chemical Resistance Requirements for Domestic Sanitary Sewer Applications

| Chemical Solution | Concentration, % |
|---|---|
| Nitric acid | 1 |
| Sulfuric acid | 5 |
| ASTM Fuel C[A] | 100 |
| Vegetable oil[B] | 100 |
| Detergent[C] | 0.1 |
| Soap[C] | 0.1 |

[A] In accordance with Specification D 4814.
[B] Cottonseed, corn, or mineral oil.
[C] In accordance with Test Method D 543.

circumferential (that is, hoop) directions of the CIPP. This method is also recommended when large-diameter CIPP is installed that may otherwise not be prepared with a tubular restraint.

8.1.3 The CIPP samples for each of these cases should be large enough to provide a minimum of three specimens and a recommended five specimens for flexural testing and also for tensile testing for internal pressure applications. The flexural and tensile specimens should be prepared in a manner consistent with 8.3.1 of Specification D 5813. For flexural and tensile properties, the full wall thickness of the CIPP samples shall be tested. Any plastic coatings or other CIPP layers not included in the structural design of the CIPP may be carefully ground off of the specimens prior to testing. If the sample is irregular or distorted such that proper testing is inhibited, attempts shall be made to machine any wall thickness from the inside pipe face of the sample. Any machining of the outside pipe face of the sample shall be done carefully so as to minimize the removal of material from the outer structural wall of the sample. Individual specimens should be clearly marked for easy identification and retained until final disposition or CIPP acceptance, or both, has been given.

8.1.4 *Short-Term Flexural (Bending) Properties*—The initial tangent flexural modulus of elasticity and flexural stress should be measured for gravity and pressure pipe applications in accordance with Test Method D 790, Test Method I, Procedure A and should meet the requirements of Table 1 within the 16:1 length to depth constraints. For specimens greater than 0.5 in. (12.7 mm) in depth, the width-to-depth ratio of the specimen should be increased to a minimum of 1:1 and should not exceed 4:1. For samples prepared in accordance with 8.1.1, determine flexural properties in the axial direction where the length of the test specimen is cut along the longitudinal axis of the pipe. Special consideration should be given to the preparation of flexural specimens to ensure opposite sides are parallel and adjacent edges are perpendicular. Flexural specimens should be tested such that the inside pipe face is tested in tension and the outside pipe face is in compression.

8.1.4.1 *Fiber-Reinforced CIPP Flexural Properties*—Where the CIPP is reinforced with oriented continuous or discontinuous fibers to enhance the physical properties of the CIPP, specimens should be sampled in accordance with 8.1.2, and flexural properties should be determined in accordance with 8.1.3 along the longitudinal axis and circumferential axis of the installed CIPP.

8.1.5 *Short-Term Tensile Properties*—The tensile strength should be measured for pressure pipe applications in accordance with Test Method D 638. Specimens should be prepared in accordance with Types I, II, and III of Fig. 1 of Test Method D 638. Specimens greater than 0.55 in. (14 mm) thick should maintain all dimensions for a Type III specimen, except the thickness will be that of the CIPP sample obtained. The rate of specimen testing should be carried out in accordance with Table 1 of Test Method D 638. Specimens should be prepared in accordance with 8.1.1 and tested along the longitudinal axis of the installed CIPP.

8.1.5.1 *Fiber-Reinforced CIPP Tensile Testing*—Where the CIPP is reinforced with oriented continuous or discontinuous fibers to enhance the physical properties of the CIPP, specimens should be sampled in accordance with 8.1.2 and tensile properties should be determined in accordance with Test Method D 3039 and tested along the longitudinal axis and circumferential axis of the installed CIPP.

8.1.6 *CIPP Wall Thickness*—The method of obtaining CIPP wall thickness measurements should be determined in a manner consistent with 8.1.2 of Specification D 5813. Thickness measurements should be made in accordance with Practice D 3567 for samples prepared in accordance with 8.1. Make a minimum of eight measurements at evenly spaced intervals around the circumference of the sample to ensure that minimum and maximum thicknesses have been determined. Deduct from the measured values the thickness of any plastic coatings or CIPP layers not included in the structural design of the CIPP. The average thickness should be calculated using all measured values and shall meet or exceed minimum design thickness as agreed upon between purchaser and seller. The minimum wall thickness at any point shall not be less than 87.5 % of the specified design thickness as agreed upon between purchaser and seller.

8.2 *Gravity Pipe Leakage Testing*—If required by the owner in the contract documents or purchase order, gravity pipes should be tested using an exfiltration test method where the CIPP is plugged at both ends and filled with water. This test should take place after the CIPP has cooled down to ambient temperature. This test is limited to pipe lengths with no service laterals and diameters of 36 in. or less. The allowable water exfiltration for any length of pipe between termination points should not exceed 50 U.S. gallons per inch of internal pipe diameter per mile per day, providing that all air has been bled from the line. During exfiltration testing, the maximum internal pipe pressure at the lowest end should not exceed 10 ft (3.0 m) of water or 4.3 psi (29.7 kPa), and the water level inside of the inversion standpipe should be 2 ft (0.6 m) higher than the top of the pipe or 2 ft (0.6 m) higher than groundwater level, whichever is greater. The leakage quantity should be gaged by the water level in a temporary standpipe placed in the upstream plug. The test should be conducted for a minimum of 1 h.

NOTE 4—It is impractical to test pipes above 36 in. diameter for leakage due to the technology available in the pipe rehabilitation industry. Post inspection of larger pipes will detect major leaks or blockages.

8.3 *Pressure Pipe Testing*—If required by the purchaser in the purchase agreement, pressure pipes should be subjected to a hydrostatic pressure test. A pressure and leakage test at twice the known working pressure or at the working pressure plus 50 psi, whichever is less, is recommended. The pressure should initially be held at the known working pressure for a period not less than 12 h, then increased to the test pressure for an additional period of 2 to 3 h to allow for stabilization of the CIPP. After this period, the pressure test will begin for a minimum of 1 h. The allowable leakage during the pressure test should be 20 U.S. gallons per inch of internal pipe diameter per mile per day, providing that all air has been evacuated from the line prior to testing and the CIPP has cooled down to ambient temperature.

NOTE 5—The allowable leakage for gravity and pressure pipe testing is a function of water loss at the end seals and trapped air in the pipe.

8.4 *Delamination Test*—If required by the purchaser in the purchase agreement, a delamination test should be performed on each installation length specified. CIPP samples should be prepared in accordance with 8.1.2, except that a portion of the fabric tube material in the sample should be dry and isolated from the resin in order to separate tube layers for testing (consult the tube manufacturer for further information). Delamination testing should be in accordance with Test Method D 903 with the following exceptions:

8.4.1 The rate of travel of the power-actuated grip should be 1 in. (25 mm)/min.

8.4.2 Five test specimens should be tested for each installation specified.

8.4.3 The thickness of the test specimen should be minimized, but should be sufficient to adequately test delamination of nonhomogeneous CIPP layers.

8.5 The peel or stripping strength between any nonhomogeneous layers of the CIPP laminate should be a minimum of 10 lb/in. (178.60 g/mm) for typical CIPP applications.

NOTE 6—The purchaser may designate the similar layers between which the delamination test will be conducted.

NOTE 7—For additional details on conducting the delamination test, contact the seller.

8.6 *Inspection and Acceptance*—The installation may be inspected visually if appropriate, or by closed-circuit television if visual inspection cannot be accomplished. Variations from true line and grade may be inherent because of the conditions of the original piping. No infiltration of groundwater should be observed. All service entrances should be accounted for and be unobstructed.

## 9. Keywords

9.1 cured-in-place pipe; installation—underground; plastic pipe—thermoset; rehabilitation; thermosetting resin pipe

# APPENDIX

**(Nonmandatory Information)**

## X1. DESIGN CONSIDERATIONS

X1.1 *General Guidelines*—The design thickness of the CIPP is a function of the resin, materials of construction of the fabric tube, and the condition of the existing pipe. In addition, depending on the condition of the pipe, the design thickness of the CIPP may also be a function of groundwater, soil type, and influence of live loading surrounding the host pipe. For guidance relating to terminology of piping conditions and related design equations, see Appendix X1 of Practice F 1216.

**Amendment to ASTM F1743-96**
**Author: Doug Kleweno of DGK Technologies**

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May 22, 2001

Whom it may concern:

I am writing this letter at the request of Mr. David Ratliff (Nu Flow Installer, Abilene, Texas) in order to provide clarification for ASTM F1743 "Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-In-Place Thermosetting Resin Pipe (CIPP)" and similar pulled-in-place products. In my previous position I was the Technical Manager for InLiner USA CIPP products and am the author of ASTM F1743. I have also been involved in editing ASTM F1216 and ASTM D5813, which are also CIPP installation and material specifications, respectively.

When writing an ASTM specification it is necessary to provide enough minimum requirements so that the product can meet or exceed engineering and design criteria. However, ASTM specifications also must be generalized enough to accommodate the majority of products and processes that may want to reference it. F1743 was generally written for most CIPP applications where heated cures predominate in the market. There are many resin applications for CIPP and other products (boat building, automotive, heavy truck) where ambient cure resin formulations are common and used successfully. Technically speaking, an ambient cure formulation for CIPP does initiate at a temperature less that 180F, which is recommended in Section 5.2.3 or F1743.

More critical to CIPP and other applications is whether the product (CIPP in this case) meets the minimum initial structural property recommendations. The minimum properties for the CIPP were provided in Section 4.2.3 of ASTM F1743 and this is probably the most important aspect for the product to meet the requirements for external hydrostatic or soil loading that may surround the pipe. These minimum properties are the numbers by which the minimum design thickness is determined for the installed CIPP or part liner.

As a side note it is my experience that the curing strategy is chosen for handling and transportation purposes. Large liners for CIPP require long catalyzed stability so the product can be processed, transported, and installed. For short runs or tubes processed at a job site, it was common to use ambient or semi-ambient cure formulations to reduce the time at the job site and the associated inconvenience to the surrounding community.

I hope this has provided some additional clarification.

Doug Kleweno
(423) 413-8529

NSF International

August 24, 2005

# TEST REPORT

Send To: 1P790
NU FLOW TECHNOLOGIES 2000 INC.
1010 THORNTON ROAD SOUTH
OSHAWA ON L1J 7E2
CANADA
Attn: MR. BOB FOWLE

Customer: 1P790
NU FLOW TECHNOLOGIES 2000 INC.
1010 THORNTON ROAD SOUTH
OSHAWA ON L1J 7E2
CANADA
Attn: MR. BOB FOWLE

Plant: 1P790
NU FLOW TECHNOLOGIES 2000 INC.
1010 THORNTON ROAD SOUTH
OSHAWA ON L1J 7E2
CANADA
Attn: MR. BOB FOWLE

Sample Description: Nu Flow #2000 Pipe Lining - Liner
Test Type: AA - Annual Collection

Thank you for having your product tested by NSF.

The enclosed report details the result of the testing performed on your product. Your program representative will be contacting you in the near future if there are any remaining issues concerning the status of this product.

Please do not hesitate to contact us if you have any immediate questions pertaining to your product.

Reviewer: ______________ Status: **Pass**

Atabek Ciechanowski - Manager, Engineering Laboratory

CC: Program: 010 - Plumbing and Related Programs
Program Rep: AMY CHOKSEY
Region: 01 - Domestic
PA Project: 224520

FI20050824120213 J-00012414 Page 1 of 4



789 N. Dixboro Road, Ann Arbor, Michigan 48105-9723 USA
1-800-NSF-MARK 734-769-8010
www.nsf.org

General Information

Standard: 014 - PLASTICS PIPING SYSTEM COMPONENTS AND RELATED MATERIALS

DCC Number / Tracking ID PL04249
Family Code A
Material Type Epoxy
Monitor Code A
Performance Standard F1216
Performance Standard Year 2003
Product Identifier Part A Batch # 030904, Part B Batch # 040405_3
Sample Description Liner
Trade Designation Nu Flow #2000 Pipe Lining

Sample Id: **S-0000161582**
Description: Nu Flow #2000 Pipe Lining - Liner
Sampled Date: 05/19/2005
Received Date: 05/23/2005

| Testing Parameter | Result | Units |
|---|---|---|
| | | |
| **Engineering Lab** | | |
| Gravity Pipe Leakage Test | | |
| Initial water column: | 10 | feet |
| Final water column: | 10 | feet |
| Time: | 60 | minutes |
| Leakage rate: | 0 | g/in/day |
| Required maximum leakage rate: | 50 | g/in/day |
| Actual leakage rate: | 0 | g/in/day |
| Gravity Pipe Leakage Test: | Pass | |
| Flex Modulus | | |
| Specimens conditioned for | 40 | hours |
| Specimens conditioned at | 73 | degrees F |
| Relative humidity | 50 | % |
| Test temperature Required | 73 | degrees F |
| Test temperature Actual | 73 | degrees F |
| Required crosshead speed | 0.22 | in/min |
| Actual crosshead speed | 0.22 | in/min |
| Deflection | <5 | % |
| Specimen 1 | 280000 | psi |
| Specimen 2 | 315000 | psi |
| Specimen 3 | 275000 | psi |
| Specimen 4 | 242000 | psi |
| Specimen 5 | 257000 | psi |
| Required Average Modulus (minimum) | 250000 psi | |
| Actual Average Modulus | 274000 | psi |
| Flex Modulus Test | PASS | |
| Flexural Strength Test | | |
| Specimens conditioned for | 40 | hours |
| Specimens conditioned at | 73 | degrees F |
| Relative Humidity | 50 | percent |
| Test Temperature | 73 | degrees F |
| Cross Head Speed | 0.22 | in/min. |
| Specimen 1 Flexural Strength | 6280 | psi |
| Specimen 2 Flexural Strength | 6480 | psi |
| Specimen 3 Flexural Strength | 6010 | psi |
| Specimen 4 Flexural Strength | 5210 | psi |

Sample Id: S-0000161582

| Testing Parameter | Result | Units |
|---|---|---|
| | | |
| **Engineering Lab ( Cont'd )** | | |
| Specimen 5 Flexural Strength | 5820 | psi |
| Average Flexural Strength | 5960 | psi |
| Required Flexural Strength | 4500 | psi |
| Flexural Strength Test | Pass | |
| Strength, Tensile | | |
| Specimens conditioned for | 40 | hours |
| Specimens conditioned at | 73 | degrees F |
| Relative humidity | 50 | % |
| Test Temperature | 73 | degrees F |
| Actual Crosshead Speed | 0.2 | in/min. |
| Required Crosshead Speed | 0.2 | in/min. |
| Specimen 1: Tensile Strength | 3930 | psi |
| Specimen 2: Tensile Strength | 4540 | psi |
| Specimen 3: Tensile Strength | 4010 | psi |
| Specimen 4: Tensile Strength | 3690 | psi |
| Specimen 5: Tensile Strength | 3920 | psi |
| Req'd Average Tensile Strength (minimum) | 3000 | |
| Actual Average Tensile Strength | 4020 | psi |
| Tensile Strength Test | PASS | |
| Specimen Fabrication | | |
| Specimen Fabrication | COMPLETE | |
| Time | 1 | hours |
| Technician | 3356 | |

*Testing Laboratories:*

| | Id | Address |
|---|---|---|
| All work performed at: → | NSF_AA | NSF International<br>789 Dixboro Road<br>Ann Arbor MI 48105-0140<br>USA |

*References to Testing Procedures:*

| NSF Reference | Parameter / Test Description |
|---|---|
| P3084 | Gravity Pipe Leakage Test |
| P3122 | Flex Modulus |
| P3123 | Flexural Strength Test |
| P3127 | Strength, Tensile |
| P3172 | Specimen Fabrication |

ACUREN

*Client*

NU FLOW TECHNOLOGIES 2000 INC.
1010 Thornton Road South
Oshawa, Ontario
L1J 7E2

# Laboratory Report

| *Attention* | *Client's Order Number* | *Date* | *Report Number* |
|---|---|---|---|
| Sinan Omari | 9282 | 16 March 2007 | **07-845** |

| *Client's Material / Product Description* | *Date Sample Received* | *Material / Product Specification* |
|---|---|---|
| (1) Sample | 06 March 2007 | ASTM D5813-04 |

**Test Performed** — **Result**

1. Tangent Flexural Modulus (ASTM D790)
   - Crosshead speed: 0.05"/min
   - 1000 lbf Load cell
   - 2 inch support span
   - L/D = 16
   - Specimen Geometry: 1/8" x 1/2" x 4"
   - 5 specimens tested
   - Units: psi

| Sample # | Result | Specification |
|---|---|---|
| 1 | 384400 | 250,000 psi Minimum |
| 2 | 420900 | |
| 3 | 304600 | |
| 4 | 425400 | |
| 5 | 397100 | |
| Average | 386500 | |

2. Flexural Strength (ASTM D790)
   - 5 specimens tested
   - Units: psi

| Sample # | Result | Specification |
|---|---|---|
| 1 | 6 070 | 4,500 psi Minimum |
| 2 | 6 670 | |
| 3 | 5 400 | |
| 4 | 6 200 | |
| 5 | 6 440 | |
| Average | 6 160 | |

3. Wall Thickness
   - Units: mm
   - Four measurements taken on each side

| Side A | Side B |
|---|---|
| 3.56 | 3.26 |
| 3.62 | 3.45 |
| 3.67 | 3.50 |
| 3.79 | 3.74 |

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Corrine Dimnik, B.Sc.
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Dr. Erhan Ulvan, Ph. D, P. Eng.,
Laboratory Manager.

Standards Council of Canada Accredited Laboratory Scope of Accreditation 60
Conseil canadien des normes Laboratoire accrédité Portée d'accréditation 60 TM

NU FLOW
RELINE REPAIR RENEW

# Flow Comparisons

## Comparison between a new pipe and a rehabilitated pipe

| Diameter | | Hazen Williams Coefficient (C) | Flow for new pipe ($m^3/s$) | Thickness of Liner (mm) | Resulting internal diameter (m) | Hazen Williams coefficient (C) | Flow for rehabilitated pipe ($m^3/s$) | % Loss |
|---|---|---|---|---|---|---|---|---|
| (m) | (in) | | | | | | | |
| 0.15 | 6 | 140 | 0.27 | 2 | 0.146 | 140 | 0.25 | -6.86 |
| 0.20 | 8 | 140 | 0.57 | 2 | 0.196 | 140 | 0.54 | -5.17 |
| 0.30 | 10 | 140 | 1.02 | 2 | 0.246 | 140 | 0.98 | -4.15 |
| 0.40 | 12 | 140 | 1.65 | 2.5 | 0.295 | 140 | 1.57 | -4.32 |

## Comparison between old pipe and a rehabilitated pipe

| Old Pipe Diameter | | Hazen Williams Coefficient (C) | Flow for old pipe ($m^3/s$) | Thickness of Liner (mm) | Old Pipe diameter (m) | Hazen Williams coefficient (C) | Flow for rehabilitated pipe ($m^3/s$) | % Increase |
|---|---|---|---|---|---|---|---|---|
| (m) | (in) | | | | | | | |
| 0.13 | 6 | 60 | 0.08 | 2 | 0.146 | 140 | 0.25 | 216.63 |
| 0.18 | 8 | 60 | 0.18 | 2 | 0.196 | 140 | 0.54 | 191.91 |
| 0.23 | 10 | 60 | 0.35 | 2 | 0.246 | 140 | 0.98 | 178.48 |
| 0.27 | 12 | 60 | 0.53 | 2.5 | 0.295 | 140 | 1.57 | 194.52 |

## P4315

| | | | | | |
|---|---|---|---|---|---|
| **Date Submitted** | 4/1/2010 | **Section** | 702.3 | **Proponent** | Allen Johnson |
| **Chapter** | 7 | **Affects HVHZ** | No | **Attachments** | Yes |

**TAC Recommendation** No Affirmative Recommendation with a Second
**Commission Action** Pending Review

**Related Modifications**

702.1, 702.2, 1102.1, 1102.2, 1102.3, 1102.4

**Summary of Modification**

Modify the current building materials list to include Cure-In Place (CIPP) Thermosetting Resin Conduit Liner that meets ASTM F-1743, ASTM F-1216, ASTM D790, ASTM D638 and ASTM D543. in sections 702.1,702.2, 702.3, 1102.1, 1102.2, 1102.3 and 1102.4 for building drains and building sewer pipes.

**Rationale**

CIPP liners are an alternative to traditional pipe replacement that increases the flow charicteristics of the pipe.

**Fiscal Impact Statement**

**Impact to local entity relative to enforcement of code**

There are no additional costs relative to enforcement compared to tradional pipe replacement.

**Impact to building and property owners relative to cost of compliance with code**

There is a significant cost savings to building and property owners as well as reducing potentially hazardous materials left undisturbed as compared to traditional pipe replacement.

**Impact to industry relative to the cost of compliance with code**

There is no impact to the industry relative to the cost of compliance with code.

**Requirements**

**Has a reasonable and substantial connection with the health, safety, and welfare of the general public**

CIPP lining eliminates the destruction of landscapes and property as well as the health dangers associated with removing of sewer pipes in need of repair.

**Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction**

CIPP liners provide a repair solution that allows drain, waste and sewer pipes to be repaired without the digging and destruction required for traditional pipe repairs or replacement. CIPP liners are seamless and jointless, reducing the number of potential failures. More resistant to corrosion.

**Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities**

CIPP lining can be installed in any type of host pipe used for Building drains and Building sewer pipes for residential, commercial and industrial applications.

**Does not degrade the effectiveness of the code**

CIPP lining does not degrade the effectiveness of the code.

## SECTION 702 MATERIALS

**702.1 Above-ground sanitary drainage and vent pipe.** Above-ground soil, waste and vent pipe shall conform to one of the standards listed in Table 702.1.

### TABLE 702.1 ABOVE-GROUND DRAINAGE AND VENT PIPE

| MATERIAL | STANDARD |
|---|---|
| Acrylonitrile butadiene styrene (ABS) plastic pipe in IPS diameters, including Schedule 40, DR 22 (PS 200) and DR 24 (PS 140); with a solid, cellular core or composite wall | ASTM D 2661; ASTM F 628; ASTM F 1488; CSA B181.1 |
| Brass pipe | ASTM B 43 |
| Cast-iron pipe | ASTM A 74; ASTM A 888; CISPI 301 |
| Copper or copper-alloy pipe | ASTM B 42; ASTM B 302 |
| Copper or copper-alloy tubing (Type K, L, M or DWV) | ASTM B 75; ASTM B 88; ASTM B 251; ASTM B 306 |
| Galvanized steel pipe | ASTM A 53 |
| Glass pipe | ASTM C 1053 |
| Polyolefin pipe | ASTM F 1412; CAN/CSA B181.3 |
| Polyvinyl chloride (PVC) plastic pipe in IPS diameters, including schedule 40, DR 22 (PS 200), and DR 24 (PS 140); with a solid, cellular core or composite wall | ASTM D 2665; ASTM F 891; ASTM F 1488; CSA B181.2 |
| Polyvinyl chloride (PVC) plastic pipe with a 3.25-inch O.D. and a solid, cellular core or composite wall | ASTM D 2949, ASTM F 1488 |
| Polyvinylidene fluoride (PVDF) plastic pipe | ASTM F 1673; CAN/CSA B181.3 |
| Stainless steel drainage systems, Types 304 and 316L | ASME A112. |
| Cured-In Place Thermosetting Resin Conduit Liner (CIPP) | ASTM F 1743, ASTM F 1216, ASTM D 790, ASTM D 638, ASTM D 543 |

Designation: F 1743 – 96 (Reapproved 2003)

An American National Standard

# Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe (CIPP)[1]

This standard is issued under the fixed designation F 1743; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This practice describes the procedures for the reconstruction of pipelines and conduits (4 to 96 in. (10 to 244 cm) diameter) by the pulled-in-place installation of a resin-impregnated, flexible fabric tube into an existing conduit and secondarily inflated through the inversion of a calibration hose by the use of a hydrostatic head or air pressure (see Fig. 1). The resin is cured by circulating hot water or by the introduction of controlled steam into the tube. When cured, the finished cured-in-place pipe will be continuous and tight fitting. This reconstruction process may be used in a variety of gravity and pressure applications such as sanitary sewers, storm sewers, process piping, electrical conduits, and ventilation systems.

1.2 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for informational purposes only.

NOTE 1—There are no ISO standards covering the primary subject matter of this practice.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

2.1 *ASTM Standards:*

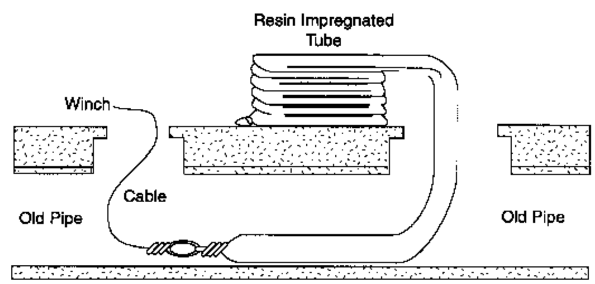
D 543 Test Method of Resistance of Plastics to Chemical Reagents[2]

D 638 Test Method for Tensile Properties of Plastics[2]

D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials[2]

D 903 Test Method for Peel or Stripping Strength of Adhesive Bonds[3]

**Step 1 – Pull resin-impregnated tube into existing pipe.**




**Step 2 – Calibration hose inversion**

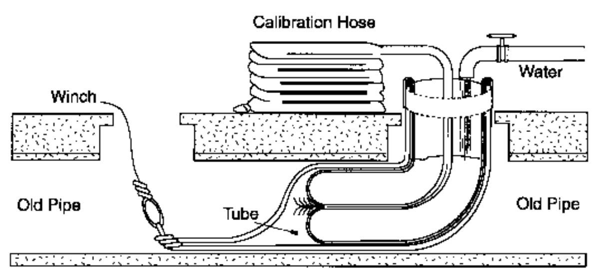



FIG. 1 Cured-in-Place Pipe Installation Methods

D 1600 Terminology for Abbreviated Terms Relating to Plastics[2]

D 1682 Test Method for Breaking Load and Elongation of Textile Fabrics[4]

D 3039/D3039M Test Method for Tensile Properties of Polymer Matrix Composite Materials[5]

[1] This practice is under the jurisdiction of ASTM Committee F-17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.67 on Trenchless Plastic Pipeline Technology.

Current edition approved Feb. 10, 2003. Published April 2003. Last previous edition approved in 1996 as F1743–96.

[2] *Annual Book of ASTM Standards*, Vol 08.01.

[3] *Annual Book of ASTM Standards*, Vol 15.06.

[4] *Discontinued: See 1991 Annual Book of ASTM Standards*, Vol 07.01.

[5] *Annual Book of ASTM Standards*, Vol 15.03.

D 3567 Practice for Determining Dimensions of Reinforced Thermosetting Resin Pipe (RTRP) and Fittings[6]
D 4814 Specification for Automotive Spark—Ignition Engine Fuel[7]
D 5813 Specification for Cured-in-Place Thermosetting Resin Sewer Pipe[6]
F 412 Terminology Relating to Plastic Piping Systems[6]
F 1216 Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube[6]
2.2 *AWWA Standard:*
M28 Manual on Cleaning and Lining Water Mains[8]
2.3 *NASSCO Standard:*
Recommended Specifications for Sewer Collection System Rehabilitation[9]

NOTE 2—An ASTM specification for cured-in-place pipe materials appropriate for use in this practice is under preparation and will be referenced in this practice when published.

## 3. Terminology

3.1 *General*—Definitions are in accordance with Terminology F 412. Abbreviations are in accordance with Terminology D 1600, unless otherwise indicated.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *calibration hose*—an impermeable bladder which is inverted within the resin-impregnated fabric tube by hydrostatic head or air pressure and may optionally be removed or remain in place as a permanent part of the installed cured-in-place pipe as described in 5.2.2.

3.2.2 *cured-in-place pipe (CIPP)*—a hollow cylinder consisting of a fabric tube with cured (cross-linked) thermosetting resin. Interior or exterior plastic coatings, or both, may be included. The CIPP is formed within an existing pipe and takes the shape of and fits tightly to the pipe.

3.2.3 *delamination*—separation of layers of the CIPP.

3.2.4 *dry spot*—an area of fabric of the finished CIPP which is deficient or devoid of resin.

3.2.5 *fabric tube*—flexible needled felt, or equivalent, woven or nonwoven material(s), or both, formed into a tubular shape which during the installation process is saturated with resin and holds the resin in place during the installation and curing process.

3.2.6 *inversion*—the process of turning the calibration hose inside out by the use of water pressure or air pressure.

3.2.7 *lift*—a portion of the CIPP that is a departure from the existing conduit wall forming a section of reverse curvature in the CIPP.

## 4. Significance and Use

4.1 This practice is for use by designers and specifiers, regulatory agencies, owners, and inspection organizations who are involved in the rehabilitation of conduits through the use of a resin-impregnated fabric tube pulled-in-place through an existing conduit and secondarily inflated through the inversion of a calibration hose. Modifications may be required for specific job conditions.

## 5. Recommended Materials and Manufacture

5.1 *General*—The resins, fabric tube, tube coatings, or other materials, such as the permanent calibration hose when combined as a composite structure, shall produce CIPP that meets the requirements of this specification.

5.2 *CIPP Wall Composition*—The wall shall consist of a plastic coated fabric tube filled with a thermosetting (cross-linked) resin, and if used, a filler.

5.2.1 *Fabric Tube*—The fabric tube should consist of one or more layers of flexible needled felt, or equivalent, woven or nonwoven material(s), or both, capable of carrying resin, withstanding installation pressures, and curing temperatures. The material(s) of construction should be able to stretch to fit irregular pipe sections and negotiate bends. Longitudinal and circumferential joints between multiple layers of fabric should be staggered so as not to overlap. The outside layer of the fabric tube should have an impermeable flexible coating(s) whose function is to contain the resin during and after fabric tube impregnation. The outer coating(s) must facilitate monitoring of resin saturation of the material(s) of construction of the fabric tube. The fabric tube should be fabricated to a size that, when installed, will tightly fit the internal circumference and the length of the original conduit. Allowance should be made for circumferential and longitudinal stretching of the fabric tube during installation. As required, the fabric tube should meet minimum tensile strength requirements in the longitudinal and transverse directions as specified in 7.1. All the material(s) of construction for the fabric tube should be compatible with the resin system used.

5.2.2 *Calibration Hose*:

5.2.2.1 *Removable Calibration Hose*—The removable calibration hose should consist of an impermeable plastic, or impermeable plastic coating(s) on flexible woven or nonwoven material(s), or both, that do not absorb resin and are capable of being removed from the CIPP.

5.2.2.2 *Permanent Calibration Hose*—The permanent calibration hose should consist of an impermeable plastic coating on a flexible needled felt or equivalent woven or nonwoven material(s), or both, that are capable of absorbing resin and are of a thickness to become fully saturated with resin. The calibration hose should be translucent to facilitate post-installation inspection. The calibration hose should be fabricated to a size that, when installed, will tightly fit the internal circumference and the length of the resin saturated fabric tube. Once inverted, the calibration hose becomes part of the fabric tube, and once properly cured, should bond permanently with the fabric tube. The properties of the calibration hose should meet minimum tensile strength requirements in the longitudinal and transverse directions as specified in 7.1. All the material(s) of construction for the calibration hose should be compatible with the resin system used.

5.2.3 *Resin*—A chemically resistant isophthalic based polyester, or vinyl ester thermoset resin and catalyst system or an

[6] *Annual Book of ASTM Standards*, Vol 08.04.
[7] *Annual Book of ASTM Standards*, Vol 05.03.
[8] Available from the American Water Works Association, 6666 W. Quincey Ave., Denver, CO 80235.
[9] Available from the National Association of Sewer Service Companies, 101 Wymore Rd., Suite 501, Altamonte, FL 32714.

epoxy resin and hardener that is compatible with the installation process should be used. The resin should be able to cure in the presence of water and the initiation temperature for cure should be less than 180°F (82.2°C). The cured resin/fabric tube system, with or without the calibration hose, shall be expected to have as a minimum the initial structural properties given in Table 1. These physical properties should be determined in accordance with Section 8. The cured resin/fabric tube system, with or without the calibration hose, should meet the minimum chemical resistance requirements as specified in 7.2.

## 6. Installation Recommendations

6.1 *Cleaning and Pre-Inspection*:

6.1.1 Prior to entering access areas, such as manholes, and performing inspection or cleaning operations, 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.

6.1.2 *Cleaning of Pipeline*—All internal debris should be removed from the original pipeline. Gravity pipes should be cleaned with hydraulically powered equipment, high-velocity jet cleaners, or mechanically powered equipment in accordance with NASSCO Recommended Specifications for Sewer Collection System Rehabilitation. Pressure pipelines should be cleaned with cable attached devices or fluid propelled devices in accordance with AWWA M28.

6.1.3 *Inspection of Pipelines*—Inspection of pipelines should be performed by experienced personnel trained in locating breaks, obstacles, and service connections by closed-circuit television or man entry. The interior of the pipeline should be carefully inspected to determine the location of any conditions that may prevent proper installation of the impregnated tube, such as protruding service taps, collapsed or crushed pipe, and reductions in the cross-sectional area of more than 40 %. These conditions should be noted so that they can be corrected.

6.1.4 *Line Obstructions*—The original pipeline should be clear of obstructions such as solids, dropped joints, protruding service connections, crushed or collapsed pipe, and reductions in the cross-sectional area of more than 40 % that may hinder or prevent the installation of the resin-impregnated fabric tube. If inspection reveals an obstruction that cannot be removed by conventional sewer-cleaning equipment, then a point-repair excavation should be made to uncover and remove or repair the obstruction.

6.2 *Resin Impregnation*—The fabric tube should be totally impregnated with resin (wet-out) and run through a set of rollers separated by a space, calibrated under controlled conditions to ensure proper distribution of resin. The volume of resin used should be sufficient to fully saturate all the voids of the fabric tube material, as well as all resin-absorbing material of the calibration hose at nominal thickness and diameter. The volume should be adjusted by adding 3 to 15 % excess resin to allow for the change in resin volume due to polymerization, the change in resin volume due to thermal expansion or contraction, and resin migration through the perforations of the fabric tube and out onto the host pipe.

6.3 *Bypassing*—If bypassing of the flow is required around the sections of pipe designated for reconstruction, the bypass should be made by plugging the line at a point upstream of the pipe to be reconstructed and pumping the flow to a downstream point or adjacent system. The pump and bypass lines should be of adequate capacity and size to handle the flow. Services within this reach will be temporarily out of service.

6.3.1 Public advisory services shall notify all parties whose service laterals will be out of commission and advise against water usage until the main line is back in service.

6.4 *Installation Methods*:

6.4.1 *Perforation of Resin-Impregnated Tube*—Prior to pulling the resin-impregnated fabric tube in place, the outer impermeable plastic coating may optionally be perforated. When the resin-impregnated fabric tube is perforated, this should allow resin to be forced through the perforations and out against the existing conduit by the force of the hydrostatic head or air pressure against the inner wall of the calibration hose. The perforation should be done after fabric tube impregnation with a perforating roller device at the point of manufacture or at the jobsite. Perforations should be made on both sides of the lay-flat fabric tube covering the full circumference with a spacing no less than 1.5 in. (38.1 mm) apart. Perforating slits should be a minimum of 0.25 in. (6.4 mm) long.

6.4.2 *Pulling Resin-Impregnated Tube into Position*—The wet-out fabric tube should be pulled into place using a power winch. The saturated fabric tube should be pulled through an existing manhole or other approved access to fully extend to the next designated manhole or termination point. Care should be exercised not to damage the tube as a result of friction during pull-in, especially where curvilinear alignments, multilinear alignments, multiple offsets, protruding services, and other friction-producing host pipe conditions are present. Once the fabric tube is in place, it should be attached to a vertical standpipe so that the calibration hose can invert into the center of the resin-impregnated fabric tube. The vertical standpipe should be of sufficient height of water head to hold the fabric tube tight to the existing pipe wall, producing dimples at side connections. A device such as a dynamometer or load cell should be provided on the winch or cable to monitor the pulling force. Measure the overall elongation of the fabric tube after pull-in completion. The acceptable longitudinal elongation shall not be more than 5 % of the overall length measured after the calibration hose has been installed, or exceed the recommended pulling force.

6.4.3 *Hydrostatic Head Calibration Hose Inversion*—The calibration hose should be inserted into the vertical inversion standpipe, with the impermeable plastic membrane side out. At the lower end of the inversion standpipe, the calibration hose should be turned inside out and attached to the standpipe so

**TABLE 1 CIPP Initial Structural Properties**[A]

| Property | Test Method | Minimum Value psi | Minimum Value (MPa) |
|---|---|---|---|
| Flexural strength | D 790 | 4 500 | (31) |
| Flexural modulus | D 790 | 250 000 | (1724) |
| Tensile strength (for pressure pipes only) | D 638 | 3 000 | (21) |

[A]The values in Table 1 are for field inspection. The purchaser should consult the manufacturer for the long-term structural properties.

that a leakproof seal is created. The resin-impregnated fabric tube should also be attached to the standpipe so that the calibration hose can invert into the center of the resin-impregnated tube. The inversion head should be adjusted to be of sufficient height of water head to cause the calibration hose to invert from the initial point of inversion to the point of termination and hold the resin-impregnated fabric tube tight to the pipe wall, producing dimples at side connections. Care should be taken during the inversion so as not to overstress the felt fiber. At the request of the purchaser, the fabric tube manufacturer should provide information on the maximum allowable axial and longitudinal tensile stress for the fabric tube.

6.4.3.1 An alternative method of installation is top inversion. In this case, the calibration hose and resin-impregnated fabric tube are attached to a top ring. In this case, the tube itself forms the standpipe for generation of the hydrostatic head. Other methods of installation are also available and should be submitted for acceptance by the purchaser.

6.4.4 *Using Air Pressure*—The resin-impregnated fabric tube should be perforated as described in 6.4.1. Once perforated, the wet-out fabric tube should be pulled into place using a power winch as described in 6.4.2. The calibration hose should be inserted through the guide chute or tube of the pressure containment device in which the calibration hose has been loaded, with the impermeable plastic membrane side out. At the end of the guide chute, the calibration hose should be turned inside out and attached so that a leakproof seal is created. The resin-impregnated tube should also be attached to the guide chute so that the calibration hose can invert into the center of the resin-impregnated tube. The inversion air pressure should be adjusted to be of sufficient pressure to cause the calibration hose to invert from point of inversion to point of termination and hold the resin saturated fabric tube tight to the pipe wall, producing dimples at side connections. Care should be taken during the inversion so as not to overstress the woven and nonwoven materials. Take suitable precautions to eliminate hazards to personnel in the proximity of the construction when pressurized air is being used.

6.5 *Lubricant During Installation*—The use of a lubricant during installation is recommended to reduce friction during inversion. This lubricant should be poured into the fluid in the standpipe in order to coat the calibration hose during inversion. When air is used to invert the calibration hose, the lubricant should be applied directly to the calibration hose. The lubricant used should be a nontoxic, oil-based product that has no detrimental effects on the tube or boiler and pump system, and will not adversely affect the fluid to be transported.

6.6 *Curing*:

6.6.1 *Using Circulating Heated Water*—After installation is completed, suitable heat source and water recirculation equipment are required to circulate heated water throughout the section to uniformly raise the water temperature above the temperature required to effect a cure of the resin. The water temperature in the line during the cure period should be as recommended by the resin manufacturer or seller.

6.6.1.1 The heat source should be fitted with suitable monitors to measure the temperature of the incoming and outgoing water supply. Temperature sensors should also be placed between the resin-impregnated tube and the host pipe invert at both termination points to monitor the temperatures during cure.

6.6.1.2 Initial cure will occur during temperature heat-up and is completed when exposed portions of the CIPP appear to be hard and sound and the remote temperature sensor indicates that the temperature is of a magnitude to realize an exotherm or cure in the resin. After initial cure is reached, the temperature should be raised to the post-cure temperature and held there for a period recommended by the resin manufacturer or seller. During post-cure, the recirculation of the water and cycling of the boiler to maintain the temperature continues. The curing of the CIPP must take into account the existing pipe material, the resin system, and ground conditions (temperature, moisture level, and thermal conductivity of soil).

6.6.2 *Using Steam*—After installation is completed, suitable steam-generating equipment is required to distribute steam throughout the pipe. The equipment should be capable of delivering steam throughout the section to uniformly raise the temperature within the pipe above the temperature required to effect a cure of the resin. The temperature in the line during the cure period should be as recommended by the resin manufacturer or seller.

6.6.2.1 The steam-generating equipment should be fitted with a suitable monitor to measure the temperature of the outgoing steam. Temperature sensors should also be placed between the resin-impregnated tube and the host pipe invert at both termination points to monitor the temperatures during cure.

6.6.2.2 Initial cure will occur during temperature heat-up and is completed when exposed portions of the new pipe appear to be hard and sound and the remote temperature sensor indicates that the temperature is of a magnitude to realize an exotherm or cure in the resin. After initial cure is reached, the temperature should be raised to the post-cure temperature and held there for a period recommended by the resin manufacturer or seller, during which time the distribution and control of steam to maintain the temperature continues. The curing of the CIPP must take into account the existing pipe material, the resin system, and ground conditions (temperature, moisture level, and thermal conductivity of soil).

6.6.3 *Required Pressures*—As required by the purchase agreement, the estimated maximum and minimum pressure required to hold the flexible tube tight against the existing conduit during the curing process should be provided by the seller and shall be increased to include consideration of external ground water, if present. Once the cure has started and dimpling for laterals is completed, the required pressures should be maintained until the cure has been completed. For water or steam, the pressure should be maintained within the estimated maximum and minimum pressure during the curing process. If the steam pressure or hydrostatic head drops below the recommended minimum during the cure, the CIPP should be inspected for lifts or delaminations and evaluated for its ability to fully meet the applicable requirements of 6.8 and Section 8.

6.7 *Cool-Down*:

6.7.1 *Using Cool Water after Heated Water Cure*—The new CIPP should be cooled to a temperature below 100°F (38°C) before relieving the static head in the inversion standpipe. Cool-down may be accomplished by the introduction of cool water into the inversion standpipe to replace water being drained from a small hole made in the downstream end. Take care to cool down the CIPP in a controlled manner, as recommended by the resin manufacturer or the seller. Care should be taken to release the static head so that a vacuum will not be developed that could damage the newly installed CIPP.

6.7.2 *Using Cool Water after Steam Cure*—The new CIPP should be cooled to a temperature below 100°F (38°C) before relieving the internal pressure within the section. Cool-down may be accomplished by the introduction of cool water into the section to replace the mixture of air and steam being drained from a small hole made in the downstream end. Take care to cool the CIPP in a controlled manner as recommended by the resin manufacturer or the seller. Care should be taken to release the air pressure so that a vacuum will not be developed that could damage the newly installed CIPP.

6.8 *Workmanship*—The finished CIPP should be continuous over the entire length of an installation and be free of dry spots, lifts, and delaminations. If these conditions are present, the CIPP will be evaluated for its ability to meet the applicable requirements of Section 8. Where the CIPP does not meet the requirements of Section 8 or specifically stated requirements of the purchase agreement, or both, the affected portions of CIPP will be removed and replaced with an equivalent repair.

6.8.1 If the CIPP does not fit tightly against the original pipe at its termination point(s), the full circumference of the CIPP exiting the existing host pipe or conduit should be sealed by filling with a resin mixture compatible with the CIPP.

6.9 *Service Connections*—After the new CIPP has been installed, the existing active (or inactive) service connections should be reinstated. This should generally be done without excavation, and in the case of non-man entry pipes, from the interior of the pipeline by means of a television camera and a remote-control cutting device. Service connections shall be reinstated to at least 90 % of the original area as it enters the host pipe or conduit.

NOTE 3—In many cases, a seal is provided where the formed CIPP dimples at service connections. However, this practice should not be construed to provide a 100 % watertight seal at all service connections. If total elimination of infiltration and inflow is desired, other means, which are beyond the scope of this practice, may be necessary to seal service connections and to rehabilitate service lines and manholes.

## 7. Material Requirements

7.1 *Fabric Tube Strength*—If required by the purchaser in the purchase agreement, the fabric tube, and seam (if applicable) as a quality control test, when tested in accordance with Test Method D 1682 shall have a minimum tensile strength of 750 psi (5 MPa) in both the longitudinal and transverse directions.

7.2 *Chemical Resistance*:

7.2.1 *Chemical Resistance Requirements*—The cured resin/fabric tube matrix, with or without the calibration hose, shall be evaluated in a laminate form for qualification testing of long-term chemical exposure to a variety of chemical effluents and should be evaluated in a manner consistent with 6.4.1 of Specification D 5813. The specimens shall be capable of exposure to the solutions in Table 2 at a temperature of 73.4 ± 3.6°F (23 ± 2°C), with a percentage retention of flexural modulus of elasticity of at least 80 % after one year exposure. Flexural properties, after exposure to the chemical solution(s), shall be based on dimensions of the specimens after exposure.

7.2.2 *Chemical Resistance Procedures*—The CIPP laminates should be constructed of identical fabric and resin components that will be used for anticipated in-field installations. The cured resin/fabric tube laminates, with or without the calibration hose should be exposed to the chemical agents in a manner consistent with Test Method D 543. The edges of the test coupons should be left exposed and not treated with resin, unless otherwise specified by the purchaser. The specimen thicknesses should be in the range of 0.125 to 0.25 in. (3.2 to 6.4 mm), with the sample dimensions suitable for preparing a minimum of five specimens for flexural testing as described in 8.1.4. Flexural properties after exposure to the chemical solutions should be based on the dimensions of the specimen after exposure.

7.2.2.1 For applications other than standard domestic sewerage, it is recommended that chemical resistance tests be conducted with actual samples of the fluid flowing in the pipe. These tests can also be accomplished by depositing CIPP test samples in the active pipe.

7.2.2.2 As required by the purchaser, additional chemical resistance requirements for the CIPP may be evaluated as described in 6.4 of Specification D 5813.

## 8. Recommended Inspection Practices

8.1 For each installation length designated by the purchaser in the purchase agreement, the preparation of CIPP samples is required from one or both of the following two methods:

8.1.1 The samples should be cut from a section of cured CIPP at an intermediate manhole or at the termination point that has been installed through a like diameter section of pipe or other tubular restraining means which has been held in place by a suitable heat sink, such as sandbags.

8.1.2 The sample should be fabricated from material taken from the fabric tube and the resin/catalyst system used, and cured in a clamped mold, placed in the downtube when heated circulated water is used, and in the silencer when steam is used. When the CIPP is constructed of oriented continuous or discontinuous fibers to enhance the physical properties of the CIPP, this method of sample preparation is recommended in order to allow testing in the axial (that is, along the length) and

TABLE 2 Minimum Chemical Resistance Requirements for Domestic Sanitary Sewer Applications

| Chemical Solution | Concentration, % |
|---|---|
| Nitric acid | 1 |
| Sulfuric acid | 5 |
| ASTM Fuel C[A] | 100 |
| Vegetable oil[B] | 100 |
| Detergent[C] | 0.1 |
| Soap[C] | 0.1 |

[A] In accordance with Specification D 4814.
[B] Cottonseed, corn, or mineral oil.
[C] In accordance with Test Method D 543.

circumferential (that is, hoop) directions of the CIPP. This method is also recommended when large-diameter CIPP is installed that may otherwise not be prepared with a tubular restraint.

8.1.3 The CIPP samples for each of these cases should be large enough to provide a minimum of three specimens and a recommended five specimens for flexural testing and also for tensile testing for internal pressure applications. The flexural and tensile specimens should be prepared in a manner consistent with 8.3.1 of Specification D 5813. For flexural and tensile properties, the full wall thickness of the CIPP samples shall be tested. Any plastic coatings or other CIPP layers not included in the structural design of the CIPP may be carefully ground off of the specimens prior to testing. If the sample is irregular or distorted such that proper testing is inhibited, attempts shall be made to machine any wall thickness from the inside pipe face of the sample. Any machining of the outside pipe face of the sample shall be done carefully so as to minimize the removal of material from the outer structural wall of the sample. Individual specimens should be clearly marked for easy identification and retained until final disposition or CIPP acceptance, or both, has been given.

8.1.4 *Short-Term Flexural (Bending) Properties*—The initial tangent flexural modulus of elasticity and flexural stress should be measured for gravity and pressure pipe applications in accordance with Test Method D 790, Test Method I, Procedure A and should meet the requirements of Table 1 within the 16:1 length to depth constraints. For specimens greater than 0.5 in. (12.7 mm) in depth, the width-to-depth ratio of the specimen should be increased to a minimum of 1:1 and should not exceed 4:1. For samples prepared in accordance with 8.1.1, determine flexural properties in the axial direction where the length of the test specimen is cut along the longitudinal axis of the pipe. Special consideration should be given to the preparation of flexural specimens to ensure opposite sides are parallel and adjacent edges are perpendicular. Flexural specimens should be tested such that the inside pipe face is tested in tension and the outside pipe face is in compression.

8.1.4.1 *Fiber-Reinforced CIPP Flexural Properties*—Where the CIPP is reinforced with oriented continuous or discontinuous fibers to enhance the physical properties of the CIPP, specimens should be sampled in accordance with 8.1.2, and flexural properties should be determined in accordance with 8.1.3 along the longitudinal axis and circumferential axis of the installed CIPP.

8.1.5 *Short-Term Tensile Properties*—The tensile strength should be measured for pressure pipe applications in accordance with Test Method D 638. Specimens should be prepared in accordance with Types I, II, and III of Fig. 1 of Test Method D 638. Specimens greater than 0.55 in. (14 mm) thick should maintain all dimensions for a Type III specimen, except the thickness will be that of the CIPP sample obtained. The rate of specimen testing should be carried out in accordance with Table 1 of Test Method D 638. Specimens should be prepared in accordance with 8.1.1 and tested along the longitudinal axis of the installed CIPP.

8.1.5.1 *Fiber-Reinforced CIPP Tensile Testing*—Where the CIPP is reinforced with oriented continuous or discontinuous fibers to enhance the physical properties of the CIPP, specimens should be sampled in accordance with 8.1.2 and tensile properties should be determined in accordance with Test Method D 3039 and tested along the longitudinal axis and circumferential axis of the installed CIPP.

8.1.6 *CIPP Wall Thickness*—The method of obtaining CIPP wall thickness measurements should be determined in a manner consistent with 8.1.2 of Specification D 5813. Thickness measurements should be made in accordance with Practice D 3567 for samples prepared in accordance with 8.1. Make a minimum of eight measurements at evenly spaced intervals around the circumference of the sample to ensure that minimum and maximum thicknesses have been determined. Deduct from the measured values the thickness of any plastic coatings or CIPP layers not included in the structural design of the CIPP. The average thickness should be calculated using all measured values and shall meet or exceed minimum design thickness as agreed upon between purchaser and seller. The minimum wall thickness at any point shall not be less than 87.5 % of the specified design thickness as agreed upon between purchaser and seller.

8.2 *Gravity Pipe Leakage Testing*—If required by the owner in the contract documents or purchase order, gravity pipes should be tested using an exfiltration test method where the CIPP is plugged at both ends and filled with water. This test should take place after the CIPP has cooled down to ambient temperature. This test is limited to pipe lengths with no service laterals and diameters of 36 in. or less. The allowable water exfiltration for any length of pipe between termination points should not exceed 50 U.S. gallons per inch of internal pipe diameter per mile per day, providing that all air has been bled from the line. During exfiltration testing, the maximum internal pipe pressure at the lowest end should not exceed 10 ft (3.0 m) of water or 4.3 psi (29.7 kPa), and the water level inside of the inversion standpipe should be 2 ft (0.6 m) higher than the top of the pipe or 2 ft (0.6 m) higher than groundwater level, whichever is greater. The leakage quantity should be gaged by the water level in a temporary standpipe placed in the upstream plug. The test should be conducted for a minimum of 1 h.

NOTE 4—It is impractical to test pipes above 36 in. diameter for leakage due to the technology available in the pipe rehabilitation industry. Post inspection of larger pipes will detect major leaks or blockages.

8.3 *Pressure Pipe Testing*—If required by the purchaser in the purchase agreement, pressure pipes should be subjected to a hydrostatic pressure test. A pressure and leakage test at twice the known working pressure or at the working pressure plus 50 psi, whichever is less, is recommended. The pressure should initially be held at the known working pressure for a period not less than 12 h, then increased to the test pressure for an additional period of 2 to 3 h to allow for stabilization of the CIPP. After this period, the pressure test will begin for a minimum of 1 h. The allowable leakage during the pressure test should be 20 U.S. gallons per inch of internal pipe diameter per mile per day, providing that all air has been evacuated from the line prior to testing and the CIPP has cooled down to ambient temperature.

NOTE 5—The allowable leakage for gravity and pressure pipe testing is a function of water loss at the end seals and trapped air in the pipe.

8.4 *Delamination Test*—If required by the purchaser in the purchase agreement, a delamination test should be performed on each installation length specified. CIPP samples should be prepared in accordance with 8.1.2, except that a portion of the fabric tube material in the sample should be dry and isolated from the resin in order to separate tube layers for testing (consult the tube manufacturer for further information). Delamination testing should be in accordance with Test Method D 903 with the following exceptions:

8.4.1 The rate of travel of the power-actuated grip should be 1 in. (25 mm)/min.

8.4.2 Five test specimens should be tested for each installation specified.

8.4.3 The thickness of the test specimen should be minimized, but should be sufficient to adequately test delamination of nonhomogeneous CIPP layers.

8.5 The peel or stripping strength between any nonhomogeneous layers of the CIPP laminate should be a minimum of 10 lb/in. (178.60 g/mm) for typical CIPP applications.

NOTE 6—The purchaser may designate the similar layers between which the delamination test will be conducted.

NOTE 7—For additional details on conducting the delamination test, contact the seller.

8.6 *Inspection and Acceptance*—The installation may be inspected visually if appropriate, or by closed-circuit television if visual inspection cannot be accomplished. Variations from true line and grade may be inherent because of the conditions of the original piping. No infiltration of groundwater should be observed. All service entrances should be accounted for and be unobstructed.

## 9. Keywords

9.1 cured-in-place pipe; installation—underground; plastic pipe—thermoset; rehabilitation; thermosetting resin pipe

## APPENDIX

### (Nonmandatory Information)

### X1. DESIGN CONSIDERATIONS

X1.1 *General Guidelines*—The design thickness of the CIPP is a function of the resin, materials of construction of the fabric tube, and the condition of the existing pipe. In addition, depending on the condition of the pipe, the design thickness of the CIPP may also be a function of groundwater, soil type, and influence of live loading surrounding the host pipe. For guidance relating to terminology of piping conditions and related design equations, see Appendix X1 of Practice F 1216.

**Amendment to ASTM F1743-96**
**Author: Doug Kleweno of DGK Technologies**

Douglas Kleweno
25124 235th Way SE
Maple Valley, WA 93038-5905

May 22, 2001

Whom it may concern:

I am writing this letter at the request of Mr. David Ratliff (Nu Flow Installer, Abilene, Texas) in order to provide clarification for ASTM F1743 "Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-In-Place Thermosetting Resin Pipe (CIPP)" and similar pulled-in-place products. In my previous position I was the Technical Manager for InLiner USA CIPP products and am the author of ASTM F1743. I have also been involved in editing ASTM F1216 and ASTM D5813, which are also CIPP installation and material specifications, respectively.

When writing an ASTM specification it is necessary to provide enough minimum requirements so that the product can meet or exceed engineering and design criteria. However, ASTM specifications also must be generalized enough to accommodate the majority of products and processes that may want to reference it. F1743 was generally written for most CIPP applications where heated cures predominate in the market. There are many resin applications for CIPP and other products (boat building, automotive, heavy truck) where ambient cure resin formulations are common and used successfully. Technically speaking, an ambient cure formulation for CIPP does initiate at a temperature less that 180F, which is recommended in Section 5.2.3 or F1743.

More critical to CIPP and other applications is whether the product (CIPP in this case) meets the minimum initial structural property recommendations. The minimum properties for the CIPP were provided in Section 4.2.3 of ASTM F1743 and this is probably the most important aspect for the product to meet the requirements for external hydrostatic or soil loading that may surround the pipe. These minimum properties are the numbers by which the minimum design thickness is determined for the installed CIPP or part liner.

As a side note it is my experience that the curing strategy is chosen for handling and transportation purposes. Large liners for CIPP require long catalyzed stability so the product can be processed, transported, and installed. For short runs or tubes processed at a job site, it was common to use ambient or semi-ambient cure formulations to reduce the time at the job site and the associated inconvenience to the surrounding community.

I hope this has provided some additional clarification.

Doug Kleweno
(423) 413-8529

NSF International

August 24, 2005

# TEST REPORT

Send To: 1P790
NU FLOW TECHNOLOGIES 2000 INC.
1010 THORNTON ROAD SOUTH
OSHAWA ON L1J 7E2
CANADA
Attn: MR. BOB FOWLE

Customer: 1P790
NU FLOW TECHNOLOGIES 2000 INC.
1010 THORNTON ROAD SOUTH
OSHAWA ON L1J 7E2
CANADA
Attn: MR. BOB FOWLE

Plant: 1P790
NU FLOW TECHNOLOGIES 2000 INC.
1010 THORNTON ROAD SOUTH
OSHAWA ON L1J 7E2
CANADA
Attn: MR. BOB FOWLE

Sample Description: Nu Flow #2000 Pipe Lining - Liner
Test Type: AA - Annual Collection

Thank you for having your product tested by NSF.

The enclosed report details the result of the testing performed on your product. Your program representative will be contacting you in the near future if there are any remaining issues concerning the status of this product.

Please do not hesitate to contact us if you have any immediate questions pertaining to your product.

Reviewer: Ata C.

Atabek Ciechanowski - Manager, Engineering Laboratory

Status: **Pass**

CC: Program: 010 - Plumbing and Related Programs
Program Rep: AMY CHOKSEY
Region: 01 - Domestic
PA Project: 224520

FI20050824120213 J-00012414 Page 1 of 4



789 N. Dixboro Road, Ann Arbor, Michigan 48105-9723 USA
1-800-NSF-MARK 734-769-8010
www.nsf.org

General Information

Standard: 014 - PLASTICS PIPING SYSTEM COMPONENTS AND RELATED MATERIALS

DCC Number / Tracking ID PL04249
Family Code A
Material Type Epoxy
Monitor Code A
Performance Standard F1216
Performance Standard Year 2003
Product Identifier Part A Batch # 030904, Part B Batch # 040405_3
Sample Description Liner
Trade Designation Nu Flow #2000 Pipe Lining

Sample Id: S-0000161582
Description: Nu Flow #2000 Pipe Lining - Liner
Sampled Date: 05/19/2005
Received Date: 05/23/2005

| Testing Parameter | Result | Units |
|---|---|---|
| | | |
| **Engineering Lab** | | |
| Gravity Pipe Leakage Test | | |
| Initial water column: | 10 | feet |
| Final water column: | 10 | feet |
| Time: | 60 | minutes |
| Leakage rate: | 0 | g/in/day |
| Required maximum leakage rate: | 50 | g/in/day |
| Actual leakage rate: | 0 | g/in/day |
| Gravity Pipe Leakage Test: | Pass | |
| Flex Modulus | | |
| Specimens conditioned for | 40 | hours |
| Specimens conditioned at | 73 | degrees F |
| Relative humidity | 50 | % |
| Test temperature Required | 73 | degrees F |
| Test temperature Actual | 73 | degrees F |
| Required crosshead speed | 0.22 | in/min |
| Actual crosshead speed | 0.22 | in/min |
| Deflection | <5 | % |
| Specimen 1 | 280000 | psi |
| Specimen 2 | 315000 | psi |
| Specimen 3 | 275000 | psi |
| Specimen 4 | 242000 | psi |
| Specimen 5 | 257000 | psi |
| Required Average Modulus (minimum) | 250000 psi | |
| Actual Average Modulus | 274000 | psi |
| Flex Modulus Test | PASS | |
| Flexural Strength Test | | |
| Specimens conditioned for | 40 | hours |
| Specimens conditioned at | 73 | degrees F |
| Relative Humidity | 50 | percent |
| Test Temperature | 73 | degrees F |
| Cross Head Speed | 0.22 | in/min. |
| Specimen 1 Flexural Strength | 6280 | psi |
| Specimen 2 Flexural Strength | 6480 | psi |
| Specimen 3 Flexural Strength | 6010 | psi |
| Specimen 4 Flexural Strength | 5210 | psi |

Sample Id: S-0000161582

| Testing Parameter | Result | Units |
|---|---|---|
| | | |
| **Engineering Lab ( Cont'd )** | | |
| Specimen 5 Flexural Strength | 5820 | psi |
| Average Flexural Strength | 5960 | psi |
| Required Flexural Strength | 4500 | psi |
| Flexural Strength Test | Pass | |
| Strength, Tensile | | |
| Specimens conditioned for | 40 | hours |
| Specimens conditioned at | 73 | degrees F |
| Relative humidity | 50 | % |
| Test Temperature | 73 | degrees F |
| Actual Crosshead Speed | 0.2 | in/min. |
| Required Crosshead Speed | 0.2 | in/min. |
| Specimen 1: Tensile Strength | 3930 | psi |
| Specimen 2: Tensile Strength | 4540 | psi |
| Specimen 3: Tensile Strength | 4010 | psi |
| Specimen 4: Tensile Strength | 3690 | psi |
| Specimen 5: Tensile Strength | 3920 | psi |
| Req'd Average Tensile Strength (minimum) | 3000 | |
| Actual Average Tensile Strength | 4020 | psi |
| Tensile Strength Test | PASS | |
| Specimen Fabrication | | |
| Specimen Fabrication | COMPLETE | |
| Time | 1 | hours |
| Technician | 3356 | |

*Testing Laboratories:*

| | Id | Address |
|---|---|---|
| All work performed at: → | NSF_AA | NSF International<br>789 Dixboro Road<br>Ann Arbor MI 48105-0140<br>USA |

*References to Testing Procedures:*

| NSF Reference | Parameter / Test Description |
|---|---|
| P3084 | Gravity Pipe Leakage Test |
| P3122 | Flex Modulus |
| P3123 | Flexural Strength Test |
| P3127 | Strength, Tensile |
| P3172 | Specimen Fabrication |

03/16/2007 FRI 14:39 FAX 905 673 8394 ACUREN GROUP INC. 002/002

**ACUREN**

# Laboratory Report

*Client*

NU FLOW TECHNOLOGIES 2000 INC.
1010 Thornton Road South
Oshawa, Ontario
L1J 7E2

| *Attention* | *Client's Order Number* | *Date* | *Report Number* |
|---|---|---|---|
| Sinan Omari | 9282 | 16 March 2007 | **07-845** |

| *Client's Material / Product Description* | *Date Sample Received* | *Material / Product Specification* |
|---|---|---|
| (1) Sample | 06 March 2007 | ASTM D5813-04 |

**Test Performed** — **Result**

1. Tangent Flexural Modulus
   (ASTM D790)
   - Crosshead speed: 0.05"/min
   - 1000 lbf Load cell
   - 2 inch support span
   - L/D = 16
   - Specimen Geometry: 1/8" x 1/2" x 4"
   - 5 specimens tested
   - Units: psi

| Sample # | | |
|---|---|---|
| 1 | 384400 | |
| 2 | 420900 | 250,000 psi Minimum |
| 3 | 304600 | |
| 4 | 425400 | |
| 5 | 397100 | |
| Average | 386500 | |

2. Flexural Strength
   (ASTM D790)
   - 5 specimens tested
   - Units: psi

| Sample # | | |
|---|---|---|
| 1 | 6 070 | |
| 2 | 6 670 | |
| 3 | 5 400 | 4,500 psi Minimum |
| 4 | 6 200 | |
| 5 | 6 440 | |
| Average | 6 160 | |

3. Wall Thickness
   - Units: mm
   - Four measurements taken on each side

| Side A | Side B |
|---|---|
| 3.56 | 3.26 |
| 3.62 | 3.45 |
| 3.67 | 3.50 |
| 3.79 | 3.74 |

Corrine Dimnik, B.Sc.
Certified Inspector.

Dr. Erhan Ulvan, Ph. D, P. Eng.,
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Page 1 of 1

# Flow Comparisons

## Comparison between a new pipe and a rehabilitated pipe

| Diameter | | Hazen Williams Coefficient (C) | Flow for new pipe ($m^3/s$) | Thickness of Liner (mm) | Resulting internal diameter (m) | Hazen Williams coefficient (C) | Flow for rehabilitated pipe ($m^3/s$) | % Loss |
|---|---|---|---|---|---|---|---|---|
| (m) | (in) | | | | | | | |
| 0.15 | 6 | 140 | 0.27 | 2 | 0.146 | 140 | 0.25 | -6.86 |
| 0.20 | 8 | 140 | 0.57 | 2 | 0.196 | 140 | 0.54 | -5.17 |
| 0.30 | 10 | 140 | 1.02 | 2 | 0.246 | 140 | 0.98 | -4.15 |
| 0.40 | 12 | 140 | 1.65 | 2.5 | 0.295 | 140 | 1.57 | -4.32 |

## Comparison between old pipe and a rehabilitated pipe

| Old Pipe Diameter | | Hazen Williams Coefficient (C) | Flow for old pipe ($m^3/s$) | Thickness of Liner (mm) | Old Pipe diameter (m) | Hazen Williams coefficient (C) | Flow for rehabilitated pipe ($m^3/s$) | % Increase |
|---|---|---|---|---|---|---|---|---|
| (m) | (in) | | | | | | | |
| 0.13 | 6 | 60 | 0.08 | 2 | 0.146 | 140 | 0.25 | 216.63 |
| 0.18 | 8 | 60 | 0.18 | 2 | 0.196 | 140 | 0.54 | 191.91 |
| 0.23 | 10 | 60 | 0.35 | 2 | 0.246 | 140 | 0.98 | 178.48 |
| 0.27 | 12 | 60 | 0.53 | 2.5 | 0.295 | 140 | 1.57 | 194.52 |

## P4432



| | | | | | |
|---|---|---|---|---|---|
| **Date Submitted** | 4/2/2010 | **Section** | 1003.3.4 | **Proponent** | Paul Bohres |
| **Chapter** | 10 | **Affects HVHZ** | No | **Attachments** | No |

**TAC Recommendation** No Affirmative Recommendation with a Second
**Commission Action** Pending Review

**Related Modifications**

None.

**Summary of Modification**

Provides a level of environmental protection from decomposition of these devices from both the interior and exterior environments that these devices are subject to.

**Rationale**

Failures of existing grease interceptors pose a risk to contamination of our environment. This proposal attempts to set a standard by which the decomposition of these devices will be significantly decreased.

**Fiscal Impact Statement**

**Impact to local entity relative to enforcement of code**

None.

**Impact to building and property owners relative to cost of compliance with code**

Unknown.

**Impact to industry relative to the cost of compliance with code**

Unknown.

**Requirements**

**Has a reasonable and substantial connection with the health, safety, and welfare of the general public**

Helps to further prevent decompostion of these devices and further prevent contamination of our environment.

**Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction**

Strengthens the code by setting a higher standard of performance.

**Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities**

No.

**Does not degrade the effectiveness of the code**

This proposal seeks to set a measurable level of performance.

**1003.3.4 Grease interceptors and automatic grease removal devices.** Grease interceptors and automatic grease removal devices shall be sized in accordance with PDI G101, ASME A112.14.3 Appendix A, or ASME A112.14.4. Grease interceptors and automatic grease removal devices shall be designed and tested in accordance with PDI G101, ASME A112.14.3 or ASME A112.14.4. Grease interceptors and automatic grease removal devices shall be installed in accordance with the manufacturer's instructions. Grease interceptors shall be constructed to withstand a water-hydrogen ion concentration (pH value) of 1.5 to 14 on all interior surfaces and exterior surfaces.

~~**Exception:** Interceptors that have a volume of not less than 500 gallons (1893 L) and that are located outdoors shall not be required to meet the requirements of this section.~~

| | | | | | |
|---|---|---|---|---|---|
| **Date Submitted** | 4/1/2010 | **Section** | 1102.1 | **Proponent** | Allen Johnson |
| **Chapter** | 11 | **Affects HVHZ** | No | **Attachments** | Yes |

**TAC Recommendation** No Affirmative Recommendation with a Second

**Commission Action** Pending Review

**Related Modifications**

702.1, 702.2, 702.3, 1102.2, 1102.3, 1102.4

**Summary of Modification**

Modify the current building materials list to include Cure-In Place (CIPP) Thermosetting Resin Conduit Liner that meets ASTM F-1743, ASTM F-1216, ASTM D790, ASTM D638 and ASTM D543. in sections 702.1,702.2, 702.3, 1102.1, 1102.2, 1102.3 and 1102.4 for building drains and building sewer pipes.

**Rationale**

CIPP liners are an alternative to traditional pipe replacement that increases the flow charicteristics of the pipe.

**Fiscal Impact Statement**

**Impact to local entity relative to enforcement of code**

There are no additional costs relative to enforcement compared to traditional replacement.

**Impact to building and property owners relative to cost of compliance with code**

There is a significant cost savings to building and property owners as well as reducing potentially hazardous materials left undisturbed as compared to traditional pipe replacement CIPP liners are seamless and jointless, reducing the number of potential failures.

**Impact to industry relative to the cost of compliance with code**

There is no impact to the industry relative to the cost of compliance with code.

**Requirements**

**Has a reasonable and substantial connection with the health, safety, and welfare of the general public**

CIPP lining eliminates the destruction of landscapes and property as well as the health dangers associated with removing of sewer pipes in need of repair.

**Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction**

CIPP liners provide a repair solution that allows drain, waste and sewer pipes to be repaired without the digging and destruction required for traditional pipe repairs or replacement.

**Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities**

CIPP lining can be installed in any type of host pipe used for Building drains and Building sewer pipes for residential, commercial and industrial applications.

**Does not degrade the effectiveness of the code**

CIPP lining does not degrade the effectiveness of the code.

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**SECTION 702 MATERIALS**

**702.1 Above-ground sanitary drainage and vent pipe.** Above-ground soil, waste and vent pipe shall conform to one of the standards listed in Table 702.1.

**TABLE 702.1 ABOVE-GROUND DRAINAGE AND VENT PIPE**

| MATERIAL | STANDARD |
|---|---|
| Acrylonitrile butadiene styrene (ABS) plastic pipe in IPS diameters, including Schedule 40, DR 22 (PS 200) and DR 24 (PS 140); with a solid, cellular core or composite wall | ASTM D 2661; ASTM F 628; ASTM F 1488; CSA B181.1 |
| Brass pipe | ASTM B 43 |
| Cast-iron pipe | ASTM A 74; ASTM A 888; CISPI 301 |
| Copper or copper-alloy pipe | ASTM B 42; ASTM B 302 |
| Copper or copper-alloy tubing (Type K, L, M or DWV) | ASTM B 75; ASTM B 88; ASTM B 251; ASTM B 306 |
| Galvanized steel pipe | ASTM A 53 |
| Glass pipe | ASTM C 1053 |
| Polyolefin pipe | ASTM F 1412; CAN/CSA B181.3 |
| Polyvinyl chloride (PVC) plastic pipe in IPS diameters, including schedule 40, DR 22 (PS 200), and DR 24 (PS 140); with a solid, cellular core or composite wall | ASTM D 2665; ASTM F 891; ASTM F 1488; CSA B181.2 |
| Polyvinyl chloride (PVC) plastic pipe with a 3.25-inch O.D. and a solid, cellular core or composite wall | ASTM D 2949, ASTM F 1488 |
| Polyvinylidene fluoride (PVDF) plastic pipe | ASTM F 1673; CAN/CSA B181.3 |
| Stainless steel drainage systems, Types 304 and 316L | ASME A112. |
| Cured-In Place Thermosetting Resin Conduit Liner (CIPP) | ASTM F1743, ASTM F1216, ASTM D790, ASTM D638, ASTM D543 |

Designation: F 1743 – 96 (Reapproved 2003)

An American National Standard

INTERNATIONAL

# Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe (CIPP)[1]

This standard is issued under the fixed designation F 1743; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This practice describes the procedures for the reconstruction of pipelines and conduits (4 to 96 in. (10 to 244 cm) diameter) by the pulled-in-place installation of a resin-impregnated, flexible fabric tube into an existing conduit and secondarily inflated through the inversion of a calibration hose by the use of a hydrostatic head or air pressure (see Fig. 1). The resin is cured by circulating hot water or by the introduction of controlled steam into the tube. When cured, the finished cured-in-place pipe will be continuous and tight fitting. This reconstruction process may be used in a variety of gravity and pressure applications such as sanitary sewers, storm sewers, process piping, electrical conduits, and ventilation systems.

1.2 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for informational purposes only.

NOTE 1—There are no ISO standards covering the primary subject matter of this practice.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

2.1 *ASTM Standards:*

D 543 Test Method of Resistance of Plastics to Chemical Reagents[2]

D 638 Test Method for Tensile Properties of Plastics[2]

D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials[2]

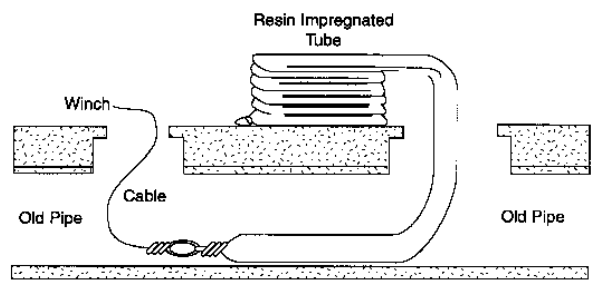
D 903 Test Method for Peel or Stripping Strength of Adhesive Bonds[3]

D 1600 Terminology for Abbreviated Terms Relating to Plastics[2]

D 1682 Test Method for Breaking Load and Elongation of Textile Fabrics[4]

D 3039/D3039M Test Method for Tensile Properties of Polymer Matrix Composite Materials[5]

**Step 1 – Pull resin-impregnated tube into existing pipe.**




**Step 2 – Calibration hose inversion**

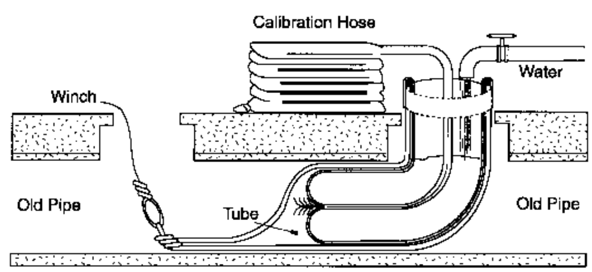



FIG. 1 Cured-in-Place Pipe Installation Methods

[1] This practice is under the jurisdiction of ASTM Committee F-17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.67 on Trenchless Plastic Pipeline Technology.

Current edition approved Feb. 10, 2003. Published April 2003. Last previous edition approved in 1996 as F1743–96.

[2] *Annual Book of ASTM Standards*, Vol 08.01.

[3] *Annual Book of ASTM Standards*, Vol 15.06.

[4] *Discontinued: See 1991 Annual Book of ASTM Standards*, Vol 07.01.

[5] *Annual Book of ASTM Standards*, Vol 15.03.

D 3567 Practice for Determining Dimensions of Reinforced Thermosetting Resin Pipe (RTRP) and Fittings[6]
D 4814 Specification for Automotive Spark—Ignition Engine Fuel[7]
D 5813 Specification for Cured-in-Place Thermosetting Resin Sewer Pipe[6]
F 412 Terminology Relating to Plastic Piping Systems[6]
F 1216 Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube[6]

2.2 *AWWA Standard:*
M28 Manual on Cleaning and Lining Water Mains[8]

2.3 *NASSCO Standard:*
Recommended Specifications for Sewer Collection System Rehabilitation[9]

NOTE 2—An ASTM specification for cured-in-place pipe materials appropriate for use in this practice is under preparation and will be referenced in this practice when published.

## 3. Terminology

3.1 *General*—Definitions are in accordance with Terminology F 412. Abbreviations are in accordance with Terminology D 1600, unless otherwise indicated.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *calibration hose*—an impermeable bladder which is inverted within the resin-impregnated fabric tube by hydrostatic head or air pressure and may optionally be removed or remain in place as a permanent part of the installed cured-in-place pipe as described in 5.2.2.

3.2.2 *cured-in-place pipe (CIPP)*—a hollow cylinder consisting of a fabric tube with cured (cross-linked) thermosetting resin. Interior or exterior plastic coatings, or both, may be included. The CIPP is formed within an existing pipe and takes the shape of and fits tightly to the pipe.

3.2.3 *delamination*—separation of layers of the CIPP.

3.2.4 *dry spot*—an area of fabric of the finished CIPP which is deficient or devoid of resin.

3.2.5 *fabric tube*—flexible needled felt, or equivalent, woven or nonwoven material(s), or both, formed into a tubular shape which during the installation process is saturated with resin and holds the resin in place during the installation and curing process.

3.2.6 *inversion*—the process of turning the calibration hose inside out by the use of water pressure or air pressure.

3.2.7 *lift*—a portion of the CIPP that is a departure from the existing conduit wall forming a section of reverse curvature in the CIPP.

## 4. Significance and Use

4.1 This practice is for use by designers and specifiers, regulatory agencies, owners, and inspection organizations who are involved in the rehabilitation of conduits through the use of a resin-impregnated fabric tube pulled-in-place through an existing conduit and secondarily inflated through the inversion of a calibration hose. Modifications may be required for specific job conditions.

## 5. Recommended Materials and Manufacture

5.1 *General*—The resins, fabric tube, tube coatings, or other materials, such as the permanent calibration hose when combined as a composite structure, shall produce CIPP that meets the requirements of this specification.

5.2 *CIPP Wall Composition*—The wall shall consist of a plastic coated fabric tube filled with a thermosetting (cross-linked) resin, and if used, a filler.

5.2.1 *Fabric Tube*—The fabric tube should consist of one or more layers of flexible needled felt, or equivalent, woven or nonwoven material(s), or both, capable of carrying resin, withstanding installation pressures, and curing temperatures. The material(s) of construction should be able to stretch to fit irregular pipe sections and negotiate bends. Longitudinal and circumferential joints between multiple layers of fabric should be staggered so as not to overlap. The outside layer of the fabric tube should have an impermeable flexible coating(s) whose function is to contain the resin during and after fabric tube impregnation. The outer coating(s) must facilitate monitoring of resin saturation of the material(s) of construction of the fabric tube. The fabric tube should be fabricated to a size that, when installed, will tightly fit the internal circumference and the length of the original conduit. Allowance should be made for circumferential and longitudinal stretching of the fabric tube during installation. As required, the fabric tube should meet minimum tensile strength requirements in the longitudinal and transverse directions as specified in 7.1. All the material(s) of construction for the fabric tube should be compatible with the resin system used.

5.2.2 *Calibration Hose*:

5.2.2.1 *Removable Calibration Hose*—The removable calibration hose should consist of an impermeable plastic, or impermeable plastic coating(s) on flexible woven or nonwoven material(s), or both, that do not absorb resin and are capable of being removed from the CIPP.

5.2.2.2 *Permanent Calibration Hose*—The permanent calibration hose should consist of an impermeable plastic coating on a flexible needled felt or equivalent woven or nonwoven material(s), or both, that are capable of absorbing resin and are of a thickness to become fully saturated with resin. The calibration hose should be translucent to facilitate post-installation inspection. The calibration hose should be fabricated to a size that, when installed, will tightly fit the internal circumference and the length of the resin saturated fabric tube. Once inverted, the calibration hose becomes part of the fabric tube, and once properly cured, should bond permanently with the fabric tube. The properties of the calibration hose should meet minimum tensile strength requirements in the longitudinal and transverse directions as specified in 7.1. All the material(s) of construction for the calibration hose should be compatible with the resin system used.

5.2.3 *Resin*—A chemically resistant isophthalic based polyester, or vinyl ester thermoset resin and catalyst system or an

[6] *Annual Book of ASTM Standards*, Vol 08.04.
[7] *Annual Book of ASTM Standards*, Vol 05.03.
[8] Available from the American Water Works Association, 6666 W. Quincey Ave., Denver, CO 80235.
[9] Available from the National Association of Sewer Service Companies, 101 Wymore Rd., Suite 501, Altamonte, FL 32714.

epoxy resin and hardener that is compatible with the installation process should be used. The resin should be able to cure in the presence of water and the initiation temperature for cure should be less than 180°F (82.2°C). The cured resin/fabric tube system, with or without the calibration hose, shall be expected to have as a minimum the initial structural properties given in Table 1. These physical properties should be determined in accordance with Section 8. The cured resin/fabric tube system, with or without the calibration hose, should meet the minimum chemical resistance requirements as specified in 7.2.

## 6. Installation Recommendations

6.1 *Cleaning and Pre-Inspection*:

6.1.1 Prior to entering access areas, such as manholes, and performing inspection or cleaning operations, 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.

6.1.2 *Cleaning of Pipeline*—All internal debris should be removed from the original pipeline. Gravity pipes should be cleaned with hydraulically powered equipment, high-velocity jet cleaners, or mechanically powered equipment in accordance with NASSCO Recommended Specifications for Sewer Collection System Rehabilitation. Pressure pipelines should be cleaned with cable attached devices or fluid propelled devices in accordance with AWWA M28.

6.1.3 *Inspection of Pipelines*—Inspection of pipelines should be performed by experienced personnel trained in locating breaks, obstacles, and service connections by closed-circuit television or man entry. The interior of the pipeline should be carefully inspected to determine the location of any conditions that may prevent proper installation of the impregnated tube, such as protruding service taps, collapsed or crushed pipe, and reductions in the cross-sectional area of more than 40 %. These conditions should be noted so that they can be corrected.

6.1.4 *Line Obstructions*—The original pipeline should be clear of obstructions such as solids, dropped joints, protruding service connections, crushed or collapsed pipe, and reductions in the cross-sectional area of more than 40 % that may hinder or prevent the installation of the resin-impregnated fabric tube. If inspection reveals an obstruction that cannot be removed by conventional sewer-cleaning equipment, then a point-repair excavation should be made to uncover and remove or repair the obstruction.

6.2 *Resin Impregnation*—The fabric tube should be totally impregnated with resin (wet-out) and run through a set of rollers separated by a space, calibrated under controlled conditions to ensure proper distribution of resin. The volume of resin used should be sufficient to fully saturate all the voids of the fabric tube material, as well as all resin-absorbing material of the calibration hose at nominal thickness and diameter. The volume should be adjusted by adding 3 to 15 % excess resin to allow for the change in resin volume due to polymerization, the change in resin volume due to thermal expansion or contraction, and resin migration through the perforations of the fabric tube and out onto the host pipe.

**TABLE 1 CIPP Initial Structural Properties[A]**

| Property | Test Method | Minimum Value | |
|---|---|---|---|
| | | psi | (MPa) |
| Flexural strength | D 790 | 4 500 | (31) |
| Flexural modulus | D 790 | 250 000 | (1724) |
| Tensile strength (for pressure pipes only) | D 638 | 3 000 | (21) |

[A]The values in Table 1 are for field inspection. The purchaser should consult the manufacturer for the long-term structural properties.

6.3 *Bypassing*—If bypassing of the flow is required around the sections of pipe designated for reconstruction, the bypass should be made by plugging the line at a point upstream of the pipe to be reconstructed and pumping the flow to a downstream point or adjacent system. The pump and bypass lines should be of adequate capacity and size to handle the flow. Services within this reach will be temporarily out of service.

6.3.1 Public advisory services shall notify all parties whose service laterals will be out of commission and advise against water usage until the main line is back in service.

6.4 *Installation Methods*:

6.4.1 *Perforation of Resin-Impregnated Tube*—Prior to pulling the resin-impregnated fabric tube in place, the outer impermeable plastic coating may optionally be perforated. When the resin-impregnated fabric tube is perforated, this should allow resin to be forced through the perforations and out against the existing conduit by the force of the hydrostatic head or air pressure against the inner wall of the calibration hose. The perforation should be done after fabric tube impregnation with a perforating roller device at the point of manufacture or at the jobsite. Perforations should be made on both sides of the lay-flat fabric tube covering the full circumference with a spacing no less than 1.5 in. (38.1 mm) apart. Perforating slits should be a minimum of 0.25 in. (6.4 mm) long.

6.4.2 *Pulling Resin-Impregnated Tube into Position*—The wet-out fabric tube should be pulled into place using a power winch. The saturated fabric tube should be pulled through an existing manhole or other approved access to fully extend to the next designated manhole or termination point. Care should be exercised not to damage the tube as a result of friction during pull-in, especially where curvilinear alignments, multilinear alignments, multiple offsets, protruding services, and other friction-producing host pipe conditions are present. Once the fabric tube is in place, it should be attached to a vertical standpipe so that the calibration hose can invert into the center of the resin-impregnated fabric tube. The vertical standpipe should be of sufficient height of water head to hold the fabric tube tight to the existing pipe wall, producing dimples at side connections. A device such as a dynamometer or load cell should be provided on the winch or cable to monitor the pulling force. Measure the overall elongation of the fabric tube after pull-in completion. The acceptable longitudinal elongation shall not be more than 5 % of the overall length measured after the calibration hose has been installed, or exceed the recommended pulling force.

6.4.3 *Hydrostatic Head Calibration Hose Inversion*—The calibration hose should be inserted into the vertical inversion standpipe, with the impermeable plastic membrane side out. At the lower end of the inversion standpipe, the calibration hose should be turned inside out and attached to the standpipe so

that a leakproof seal is created. The resin-impregnated fabric tube should also be attached to the standpipe so that the calibration hose can invert into the center of the resin-impregnated tube. The inversion head should be adjusted to be of sufficient height of water head to cause the calibration hose to invert from the initial point of inversion to the point of termination and hold the resin-impregnated fabric tube tight to the pipe wall, producing dimples at side connections. Care should be taken during the inversion so as not to overstress the felt fiber. At the request of the purchaser, the fabric tube manufacturer should provide information on the maximum allowable axial and longitudinal tensile stress for the fabric tube.

6.4.3.1 An alternative method of installation is top inversion. In this case, the calibration hose and resin-impregnated fabric tube are attached to a top ring. In this case, the tube itself forms the standpipe for generation of the hydrostatic head. Other methods of installation are also available and should be submitted for acceptance by the purchaser.

6.4.4 *Using Air Pressure*—The resin-impregnated fabric tube should be perforated as described in 6.4.1. Once perforated, the wet-out fabric tube should be pulled into place using a power winch as described in 6.4.2. The calibration hose should be inserted through the guide chute or tube of the pressure containment device in which the calibration hose has been loaded, with the impermeable plastic membrane side out. At the end of the guide chute, the calibration hose should be turned inside out and attached so that a leakproof seal is created. The resin-impregnated tube should also be attached to the guide chute so that the calibration hose can invert into the center of the resin-impregnated tube. The inversion air pressure should be adjusted to be of sufficient pressure to cause the calibration hose to invert from point of inversion to point of termination and hold the resin saturated fabric tube tight to the pipe wall, producing dimples at side connections. Care should be taken during the inversion so as not to overstress the woven and nonwoven materials. Take suitable precautions to eliminate hazards to personnel in the proximity of the construction when pressurized air is being used.

6.5 *Lubricant During Installation*—The use of a lubricant during installation is recommended to reduce friction during inversion. This lubricant should be poured into the fluid in the standpipe in order to coat the calibration hose during inversion. When air is used to invert the calibration hose, the lubricant should be applied directly to the calibration hose. The lubricant used should be a nontoxic, oil-based product that has no detrimental effects on the tube or boiler and pump system, and will not adversely affect the fluid to be transported.

6.6 *Curing*:

6.6.1 *Using Circulating Heated Water*—After installation is completed, suitable heat source and water recirculation equipment are required to circulate heated water throughout the section to uniformly raise the water temperature above the temperature required to effect a cure of the resin. The water temperature in the line during the cure period should be as recommended by the resin manufacturer or seller.

6.6.1.1 The heat source should be fitted with suitable monitors to measure the temperature of the incoming and outgoing water supply. Temperature sensors should also be placed between the resin-impregnated tube and the host pipe invert at both termination points to monitor the temperatures during cure.

6.6.1.2 Initial cure will occur during temperature heat-up and is completed when exposed portions of the CIPP appear to be hard and sound and the remote temperature sensor indicates that the temperature is of a magnitude to realize an exotherm or cure in the resin. After initial cure is reached, the temperature should be raised to the post-cure temperature and held there for a period recommended by the resin manufacturer or seller. During post-cure, the recirculation of the water and cycling of the boiler to maintain the temperature continues. The curing of the CIPP must take into account the existing pipe material, the resin system, and ground conditions (temperature, moisture level, and thermal conductivity of soil).

6.6.2 *Using Steam*—After installation is completed, suitable steam-generating equipment is required to distribute steam throughout the pipe. The equipment should be capable of delivering steam throughout the section to uniformly raise the temperature within the pipe above the temperature required to effect a cure of the resin. The temperature in the line during the cure period should be as recommended by the resin manufacturer or seller.

6.6.2.1 The steam-generating equipment should be fitted with a suitable monitor to measure the temperature of the outgoing steam. Temperature sensors should also be placed between the resin-impregnated tube and the host pipe invert at both termination points to monitor the temperatures during cure.

6.6.2.2 Initial cure will occur during temperature heat-up and is completed when exposed portions of the new pipe appear to be hard and sound and the remote temperature sensor indicates that the temperature is of a magnitude to realize an exotherm or cure in the resin. After initial cure is reached, the temperature should be raised to the post-cure temperature and held there for a period recommended by the resin manufacturer or seller, during which time the distribution and control of steam to maintain the temperature continues. The curing of the CIPP must take into account the existing pipe material, the resin system, and ground conditions (temperature, moisture level, and thermal conductivity of soil).

6.6.3 *Required Pressures*—As required by the purchase agreement, the estimated maximum and minimum pressure required to hold the flexible tube tight against the existing conduit during the curing process should be provided by the seller and shall be increased to include consideration of external ground water, if present. Once the cure has started and dimpling for laterals is completed, the required pressures should be maintained until the cure has been completed. For water or steam, the pressure should be maintained within the estimated maximum and minimum pressure during the curing process. If the steam pressure or hydrostatic head drops below the recommended minimum during the cure, the CIPP should be inspected for lifts or delaminations and evaluated for its ability to fully meet the applicable requirements of 6.8 and Section 8.

6.7 *Cool-Down*:

6.7.1 *Using Cool Water after Heated Water Cure*—The new CIPP should be cooled to a temperature below 100°F (38°C) before relieving the static head in the inversion standpipe. Cool-down may be accomplished by the introduction of cool water into the inversion standpipe to replace water being drained from a small hole made in the downstream end. Take care to cool down the CIPP in a controlled manner, as recommended by the resin manufacturer or the seller. Care should be taken to release the static head so that a vacuum will not be developed that could damage the newly installed CIPP.

6.7.2 *Using Cool Water after Steam Cure*—The new CIPP should be cooled to a temperature below 100°F (38°C) before relieving the internal pressure within the section. Cool-down may be accomplished by the introduction of cool water into the section to replace the mixture of air and steam being drained from a small hole made in the downstream end. Take care to cool the CIPP in a controlled manner as recommended by the resin manufacturer or the seller. Care should be taken to release the air pressure so that a vacuum will not be developed that could damage the newly installed CIPP.

6.8 *Workmanship*—The finished CIPP should be continuous over the entire length of an installation and be free of dry spots, lifts, and delaminations. If these conditions are present, the CIPP will be evaluated for its ability to meet the applicable requirements of Section 8. Where the CIPP does not meet the requirements of Section 8 or specifically stated requirements of the purchase agreement, or both, the affected portions of CIPP will be removed and replaced with an equivalent repair.

6.8.1 If the CIPP does not fit tightly against the original pipe at its termination point(s), the full circumference of the CIPP exiting the existing host pipe or conduit should be sealed by filling with a resin mixture compatible with the CIPP.

6.9 *Service Connections*—After the new CIPP has been installed, the existing active (or inactive) service connections should be reinstated. This should generally be done without excavation, and in the case of non-man entry pipes, from the interior of the pipeline by means of a television camera and a remote-control cutting device. Service connections shall be reinstated to at least 90 % of the original area as it enters the host pipe or conduit.

NOTE 3—In many cases, a seal is provided where the formed CIPP dimples at service connections. However, this practice should not be construed to provide a 100 % watertight seal at all service connections. If total elimination of infiltration and inflow is desired, other means, which are beyond the scope of this practice, may be necessary to seal service connections and to rehabilitate service lines and manholes.

## 7. Material Requirements

7.1 *Fabric Tube Strength*—If required by the purchaser in the purchase agreement, the fabric tube, and seam (if applicable) as a quality control test, when tested in accordance with Test Method D 1682 shall have a minimum tensile strength of 750 psi (5 MPa) in both the longitudinal and transverse directions.

7.2 *Chemical Resistance*:

7.2.1 *Chemical Resistance Requirements*—The cured resin/fabric tube matrix, with or without the calibration hose, shall be evaluated in a laminate form for qualification testing of long-term chemical exposure to a variety of chemical effluents and should be evaluated in a manner consistent with 6.4.1 of Specification D 5813. The specimens shall be capable of exposure to the solutions in Table 2 at a temperature of 73.4 ± 3.6°F (23 ± 2°C), with a percentage retention of flexural modulus of elasticity of at least 80 % after one year exposure. Flexural properties, after exposure to the chemical solution(s), shall be based on dimensions of the specimens after exposure.

7.2.2 *Chemical Resistance Procedures*—The CIPP laminates should be constructed of identical fabric and resin components that will be used for anticipated in-field installations. The cured resin/fabric tube laminates, with or without the calibration hose should be exposed to the chemical agents in a manner consistent with Test Method D 543. The edges of the test coupons should be left exposed and not treated with resin, unless otherwise specified by the purchaser. The specimen thicknesses should be in the range of 0.125 to 0.25 in. (3.2 to 6.4 mm), with the sample dimensions suitable for preparing a minimum of five specimens for flexural testing as described in 8.1.4. Flexural properties after exposure to the chemical solutions should be based on the dimensions of the specimen after exposure.

7.2.2.1 For applications other than standard domestic sewerage, it is recommended that chemical resistance tests be conducted with actual samples of the fluid flowing in the pipe. These tests can also be accomplished by depositing CIPP test samples in the active pipe.

7.2.2.2 As required by the purchaser, additional chemical resistance requirements for the CIPP may be evaluated as described in 6.4 of Specification D 5813.

## 8. Recommended Inspection Practices

8.1 For each installation length designated by the purchaser in the purchase agreement, the preparation of CIPP samples is required from one or both of the following two methods:

8.1.1 The samples should be cut from a section of cured CIPP at an intermediate manhole or at the termination point that has been installed through a like diameter section of pipe or other tubular restraining means which has been held in place by a suitable heat sink, such as sandbags.

8.1.2 The sample should be fabricated from material taken from the fabric tube and the resin/catalyst system used, and cured in a clamped mold, placed in the downtube when heated circulated water is used, and in the silencer when steam is used. When the CIPP is constructed of oriented continuous or discontinuous fibers to enhance the physical properties of the CIPP, this method of sample preparation is recommended in order to allow testing in the axial (that is, along the length) and

TABLE 2 Minimum Chemical Resistance Requirements for Domestic Sanitary Sewer Applications

| Chemical Solution | Concentration, % |
|---|---|
| Nitric acid | 1 |
| Sulfuric acid | 5 |
| ASTM Fuel C[A] | 100 |
| Vegetable oil[B] | 100 |
| Detergent[C] | 0.1 |
| Soap[C] | 0.1 |

[A] In accordance with Specification D 4814.
[B] Cottonseed, corn, or mineral oil.
[C] In accordance with Test Method D 543.

circumferential (that is, hoop) directions of the CIPP. This method is also recommended when large-diameter CIPP is installed that may otherwise not be prepared with a tubular restraint.

8.1.3 The CIPP samples for each of these cases should be large enough to provide a minimum of three specimens and a recommended five specimens for flexural testing and also for tensile testing for internal pressure applications. The flexural and tensile specimens should be prepared in a manner consistent with 8.3.1 of Specification D 5813. For flexural and tensile properties, the full wall thickness of the CIPP samples shall be tested. Any plastic coatings or other CIPP layers not included in the structural design of the CIPP may be carefully ground off of the specimens prior to testing. If the sample is irregular or distorted such that proper testing is inhibited, attempts shall be made to machine any wall thickness from the inside pipe face of the sample. Any machining of the outside pipe face of the sample shall be done carefully so as to minimize the removal of material from the outer structural wall of the sample. Individual specimens should be clearly marked for easy identification and retained until final disposition or CIPP acceptance, or both, has been given.

8.1.4 *Short-Term Flexural (Bending) Properties*—The initial tangent flexural modulus of elasticity and flexural stress should be measured for gravity and pressure pipe applications in accordance with Test Method D 790, Test Method I, Procedure A and should meet the requirements of Table 1 within the 16:1 length to depth constraints. For specimens greater than 0.5 in. (12.7 mm) in depth, the width-to-depth ratio of the specimen should be increased to a minimum of 1:1 and should not exceed 4:1. For samples prepared in accordance with 8.1.1, determine flexural properties in the axial direction where the length of the test specimen is cut along the longitudinal axis of the pipe. Special consideration should be given to the preparation of flexural specimens to ensure opposite sides are parallel and adjacent edges are perpendicular. Flexural specimens should be tested such that the inside pipe face is tested in tension and the outside pipe face is in compression.

8.1.4.1 *Fiber-Reinforced CIPP Flexural Properties*—Where the CIPP is reinforced with oriented continuous or discontinuous fibers to enhance the physical properties of the CIPP, specimens should be sampled in accordance with 8.1.2, and flexural properties should be determined in accordance with 8.1.3 along the longitudinal axis and circumferential axis of the installed CIPP.

8.1.5 *Short-Term Tensile Properties*—The tensile strength should be measured for pressure pipe applications in accordance with Test Method D 638. Specimens should be prepared in accordance with Types I, II, and III of Fig. 1 of Test Method D 638. Specimens greater than 0.55 in. (14 mm) thick should maintain all dimensions for a Type III specimen, except the thickness will be that of the CIPP sample obtained. The rate of specimen testing should be carried out in accordance with Table 1 of Test Method D 638. Specimens should be prepared in accordance with 8.1.1 and tested along the longitudinal axis of the installed CIPP.

8.1.5.1 *Fiber-Reinforced CIPP Tensile Testing*—Where the CIPP is reinforced with oriented continuous or discontinuous fibers to enhance the physical properties of the CIPP, specimens should be sampled in accordance with 8.1.2 and tensile properties should be determined in accordance with Test Method D 3039 and tested along the longitudinal axis and circumferential axis of the installed CIPP.

8.1.6 *CIPP Wall Thickness*—The method of obtaining CIPP wall thickness measurements should be determined in a manner consistent with 8.1.2 of Specification D 5813. Thickness measurements should be made in accordance with Practice D 3567 for samples prepared in accordance with 8.1. Make a minimum of eight measurements at evenly spaced intervals around the circumference of the sample to ensure that minimum and maximum thicknesses have been determined. Deduct from the measured values the thickness of any plastic coatings or CIPP layers not included in the structural design of the CIPP. The average thickness should be calculated using all measured values and shall meet or exceed minimum design thickness as agreed upon between purchaser and seller. The minimum wall thickness at any point shall not be less than 87.5 % of the specified design thickness as agreed upon between purchaser and seller.

8.2 *Gravity Pipe Leakage Testing*—If required by the owner in the contract documents or purchase order, gravity pipes should be tested using an exfiltration test method where the CIPP is plugged at both ends and filled with water. This test should take place after the CIPP has cooled down to ambient temperature. This test is limited to pipe lengths with no service laterals and diameters of 36 in. or less. The allowable water exfiltration for any length of pipe between termination points should not exceed 50 U.S. gallons per inch of internal pipe diameter per mile per day, providing that all air has been bled from the line. During exfiltration testing, the maximum internal pipe pressure at the lowest end should not exceed 10 ft (3.0 m) of water or 4.3 psi (29.7 kPa), and the water level inside of the inversion standpipe should be 2 ft (0.6 m) higher than the top of the pipe or 2 ft (0.6 m) higher than groundwater level, whichever is greater. The leakage quantity should be gaged by the water level in a temporary standpipe placed in the upstream plug. The test should be conducted for a minimum of 1 h.

NOTE 4—It is impractical to test pipes above 36 in. diameter for leakage due to the technology available in the pipe rehabilitation industry. Post inspection of larger pipes will detect major leaks or blockages.

8.3 *Pressure Pipe Testing*—If required by the purchaser in the purchase agreement, pressure pipes should be subjected to a hydrostatic pressure test. A pressure and leakage test at twice the known working pressure or at the working pressure plus 50 psi, whichever is less, is recommended. The pressure should initially be held at the known working pressure for a period not less than 12 h, then increased to the test pressure for an additional period of 2 to 3 h to allow for stabilization of the CIPP. After this period, the pressure test will begin for a minimum of 1 h. The allowable leakage during the pressure test should be 20 U.S. gallons per inch of internal pipe diameter per mile per day, providing that all air has been evacuated from the line prior to testing and the CIPP has cooled down to ambient temperature.

NOTE 5—The allowable leakage for gravity and pressure pipe testing is a function of water loss at the end seals and trapped air in the pipe.

8.4 *Delamination Test*—If required by the purchaser in the purchase agreement, a delamination test should be performed on each installation length specified. CIPP samples should be prepared in accordance with 8.1.2, except that a portion of the fabric tube material in the sample should be dry and isolated from the resin in order to separate tube layers for testing (consult the tube manufacturer for further information). Delamination testing should be in accordance with Test Method D 903 with the following exceptions:

8.4.1 The rate of travel of the power-actuated grip should be 1 in. (25 mm)/min.

8.4.2 Five test specimens should be tested for each installation specified.

8.4.3 The thickness of the test specimen should be minimized, but should be sufficient to adequately test delamination of nonhomogeneous CIPP layers.

8.5 The peel or stripping strength between any nonhomogeneous layers of the CIPP laminate should be a minimum of 10 lb/in. (178.60 g/mm) for typical CIPP applications.

NOTE 6—The purchaser may designate the similar layers between which the delamination test will be conducted.

NOTE 7—For additional details on conducting the delamination test, contact the seller.

8.6 *Inspection and Acceptance*—The installation may be inspected visually if appropriate, or by closed-circuit television if visual inspection cannot be accomplished. Variations from true line and grade may be inherent because of the conditions of the original piping. No infiltration of groundwater should be observed. All service entrances should be accounted for and be unobstructed.

## 9. Keywords

9.1 cured-in-place pipe; installation—underground; plastic pipe—thermoset; rehabilitation; thermosetting resin pipe

## APPENDIX

### (Nonmandatory Information)

### X1. DESIGN CONSIDERATIONS

X1.1 *General Guidelines*—The design thickness of the CIPP is a function of the resin, materials of construction of the fabric tube, and the condition of the existing pipe. In addition, depending on the condition of the pipe, the design thickness of the CIPP may also be a function of groundwater, soil type, and influence of live loading surrounding the host pipe. For guidance relating to terminology of piping conditions and related design equations, see Appendix X1 of Practice F 1216.

**Amendment to ASTM F1743-96**
**Author: Doug Kleweno of DGK Technologies**

Douglas Kleweno
25124 235$^{th}$ Way SE
Maple Valley, WA 93038-5905

May 22, 2001

Whom it may concern:

I am writing this letter at the request of Mr. David Ratliff (Nu Flow Installer, Abilene, Texas) in order to provide clarification for ASTM F1743 "Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-In-Place Thermosetting Resin Pipe (CIPP)" and similar pulled-in-place products. In my previous position I was the Technical Manager for InLiner USA CIPP products and am the author of ASTM F1743. I have also been involved in editing ASTM F1216 and ASTM D5813, which are also CIPP installation and material specifications, respectively.

When writing an ASTM specification it is necessary to provide enough minimum requirements so that the product can meet or exceed engineering and design criteria. However, ASTM specifications also must be generalized enough to accommodate the majority of products and processes that may want to reference it. F1743 was generally written for most CIPP applications where heated cures predominate in the market. There are many resin applications for CIPP and other products (boat building, automotive, heavy truck) where ambient cure resin formulations are common and used successfully. Technically speaking, an ambient cure formulation for CIPP does initiate at a temperature less that 180F, which is recommended in Section 5.2.3 or F1743.

More critical to CIPP and other applications is whether the product (CIPP in this case) meets the minimum initial structural property recommendations. The minimum properties for the CIPP were provided in Section 4.2.3 of ASTM F1743 and this is probably the most important aspect for the product to meet the requirements for external hydrostatic or soil loading that may surround the pipe. These minimum properties are the numbers by which the minimum design thickness is determined for the installed CIPP or part liner.

As a side note it is my experience that the curing strategy is chosen for handling and transportation purposes. Large liners for CIPP require long catalyzed stability so the product can be processed, transported, and installed. For short runs or tubes processed at a job site, it was common to use ambient or semi-ambient cure formulations to reduce the time at the job site and the associated inconvenience to the surrounding community.

I hope this has provided some additional clarification.

Doug Kleweno
(423) 413-8529

NSF International

August 24, 2005

# TEST REPORT

Send To: 1P790
NU FLOW TECHNOLOGIES 2000 INC.
1010 THORNTON ROAD SOUTH
OSHAWA ON L1J 7E2
CANADA
Attn: MR. BOB FOWLE

Customer: 1P790
NU FLOW TECHNOLOGIES 2000 INC.
1010 THORNTON ROAD SOUTH
OSHAWA ON L1J 7E2
CANADA
Attn: MR. BOB FOWLE

Plant: 1P790
NU FLOW TECHNOLOGIES 2000 INC.
1010 THORNTON ROAD SOUTH
OSHAWA ON L1J 7E2
CANADA
Attn: MR. BOB FOWLE

Sample Description: Nu Flow #2000 Pipe Lining - Liner
Test Type: AA - Annual Collection

Thank you for having your product tested by NSF.

The enclosed report details the result of the testing performed on your product. Your program representative will be contacting you in the near future if there are any remaining issues concerning the status of this product.

Please do not hesitate to contact us if you have any immediate questions pertaining to your product.

Reviewer: ____________ Status: **Pass**

Atabek Ciechanowski - Manager, Engineering Laboratory

CC: Program: 010 - Plumbing and Related Programs
Program Rep: AMY CHOKSEY
Region: 01 - Domestic
PA Project: 224520

FI20050824120213 J-00012414 Page 1 of 4



789 N. Dixboro Road, Ann Arbor, Michigan 48105-9723 USA
1-800-NSF-MARK 734-769-8010
www.nsf.org

General Information

Standard: 014 - PLASTICS PIPING SYSTEM COMPONENTS AND RELATED MATERIALS

DCC Number / Tracking ID PL04249
Family Code A
Material Type Epoxy
Monitor Code A
Performance Standard F1216
Performance Standard Year 2003
Product Identifier Part A Batch # 030904, Part B Batch # 040405_3
Sample Description Liner
Trade Designation Nu Flow #2000 Pipe Lining

Sample Id: S-0000161582
Description: Nu Flow #2000 Pipe Lining - Liner
Sampled Date: 05/19/2005
Received Date: 05/23/2005

| Testing Parameter | Result | Units |
|---|---|---|
| | | |
| **Engineering Lab** | | |
| Gravity Pipe Leakage Test | | |
| Initial water column: | 10 | feet |
| Final water column: | 10 | feet |
| Time: | 60 | minutes |
| Leakage rate: | 0 | g/in/day |
| Required maximum leakage rate: | 50 | g/in/day |
| Actual leakage rate: | 0 | g/in/day |
| Gravity Pipe Leakage Test: | Pass | |
| Flex Modulus | | |
| Specimens conditioned for | 40 | hours |
| Specimens conditioned at | 73 | degrees F |
| Relative humidity | 50 | % |
| Test temperature Required | 73 | degrees F |
| Test temperature Actual | 73 | degrees F |
| Required crosshead speed | 0.22 | in/min |
| Actual crosshead speed | 0.22 | in/min |
| Deflection | <5 | % |
| Specimen 1 | 280000 | psi |
| Specimen 2 | 315000 | psi |
| Specimen 3 | 275000 | psi |
| Specimen 4 | 242000 | psi |
| Specimen 5 | 257000 | psi |
| Required Average Modulus (minimum) | 250000 psi | |
| Actual Average Modulus | 274000 | psi |
| Flex Modulus Test | PASS | |
| Flexural Strength Test | | |
| Specimens conditioned for | 40 | hours |
| Specimens conditioned at | 73 | degrees F |
| Relative Humidity | 50 | percent |
| Test Temperature | 73 | degrees F |
| Cross Head Speed | 0.22 | in/min. |
| Specimen 1 Flexural Strength | 6280 | psi |
| Specimen 2 Flexural Strength | 6480 | psi |
| Specimen 3 Flexural Strength | 6010 | psi |
| Specimen 4 Flexural Strength | 5210 | psi |

Sample Id: S-0000161582

| Testing Parameter | Result | Units |
|---|---|---|
| | | |
| **Engineering Lab ( Cont'd )** | | |
| Specimen 5 Flexural Strength | 5820 | psi |
| Average Flexural Strength | 5960 | psi |
| Required Flexural Strength | 4500 | psi |
| Flexural Strength Test | Pass | |
| Strength, Tensile | | |
| Specimens conditioned for | 40 | hours |
| Specimens conditioned at | 73 | degrees F |
| Relative humidity | 50 | % |
| Test Temperature | 73 | degrees F |
| Actual Crosshead Speed | 0.2 | in/min. |
| Required Crosshead Speed | 0.2 | in/min. |
| Specimen 1: Tensile Strength | 3930 | psi |
| Specimen 2: Tensile Strength | 4540 | psi |
| Specimen 3: Tensile Strength | 4010 | psi |
| Specimen 4: Tensile Strength | 3690 | psi |
| Specimen 5: Tensile Strength | 3920 | psi |
| Req'd Average Tensile Strength (minimum) | 3000 | |
| Actual Average Tensile Strength | 4020 | psi |
| Tensile Strength Test | PASS | |
| Specimen Fabrication | | |
| Specimen Fabrication | COMPLETE | |
| Time | 1 | hours |
| Technician | 3356 | |

*Testing Laboratories:*

| | Id | Address |
|---|---|---|
| All work performed at: → | NSF_AA | NSF International<br>789 Dixboro Road<br>Ann Arbor MI 48105-0140<br>USA |

*References to Testing Procedures:*

| NSF Reference | Parameter / Test Description |
|---|---|
| P3084 | Gravity Pipe Leakage Test |
| P3122 | Flex Modulus |
| P3123 | Flexural Strength Test |
| P3127 | Strength, Tensile |
| P3172 | Specimen Fabrication |

ACUREN

*Client*

NU FLOW TECHNOLOGIES 2000 INC.
1010 Thornton Road South
Oshawa, Ontario
L1J 7E2

# Laboratory Report

| *Attention* | *Client's Order Number* | *Date* | *Report Number* |
|---|---|---|---|
| Sinan Omari | 9282 | 16 March 2007 | **07-845** |

| *Client's Material / Product Description* | *Date Sample Received* | *Material / Product Specification* |
|---|---|---|
| (1) Sample | 06 March 2007 | ASTM D5813-04 |

## Test Performed / Result

1. Tangent Flexural Modulus
   (ASTM D790)
   - Crosshead speed: 0.05"/min
   - 1000 lbf Load cell
   - 2 inch support span
   - L/D = 16
   - Specimen Geometry: 1/8" x 1/2" x 4"
   - 5 specimens tested
   - Units: psi

| Sample # | Result | Specification |
|---|---|---|
| 1 | 384400 | |
| 2 | 420900 | 250,000 psi Minimum |
| 3 | 304600 | |
| 4 | 425400 | |
| 5 | 397100 | |
| Average | 386500 | |

2. Flexural Strength
   (ASTM D790)
   - 5 specimens tested
   - Units: psi

| Sample # | Result | Specification |
|---|---|---|
| 1 | 6 070 | |
| 2 | 6 670 | |
| 3 | 5 400 | 4,500 psi Minimum |
| 4 | 6 200 | |
| 5 | 6 440 | |
| Average | 6 160 | |

3. Wall Thickness
   - Units: mm
   - Four measurements taken on each side

| Side A | Side B |
|---|---|
| 3.56 | 3.26 |
| 3.62 | 3.45 |
| 3.67 | 3.50 |
| 3.79 | 3.74 |

Corrine Dimnik, B.Sc.
Certified Inspector.

Dr. Erhan Ulvan, Ph. D, P. Eng.,
Laboratory Manager.

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NU FLOW RELINE REPAIR RENEW®

# Flow Comparisons

## Comparison between a new pipe and a rehabilitated pipe

| Diameter (m) | Diameter (in) | Hazen Williams Coefficient (C) | Flow for new pipe ($m^3/s$) | Thickness of Liner (mm) | Resulting internal diameter (m) | Hazen Williams coefficient (C) | Flow for rehabilitated pipe ($m^3/s$) | % Loss |
|---|---|---|---|---|---|---|---|---|
| 0.15 | 6 | 140 | 0.27 | 2 | 0.146 | 140 | 0.25 | -6.86 |
| 0.20 | 8 | 140 | 0.57 | 2 | 0.196 | 140 | 0.54 | -5.17 |
| 0.30 | 10 | 140 | 1.02 | 2 | 0.246 | 140 | 0.98 | -4.15 |
| 0.40 | 12 | 140 | 1.65 | 2.5 | 0.295 | 140 | 1.57 | -4.32 |

## Comparison between old pipe and a rehabilitated pipe

| Old Pipe Diameter (m) | Old Pipe Diameter (in) | Hazen Williams Coefficient (C) | Flow for old pipe ($m^3/s$) | Thickness of Liner (mm) | Old Pipe diameter (m) | Hazen Williams coefficient (C) | Flow for rehabilitated pipe ($m^3/s$) | % Increase |
|---|---|---|---|---|---|---|---|---|
| 0.13 | 6 | 60 | 0.08 | 2 | 0.146 | 140 | 0.25 | 216.63 |
| 0.18 | 8 | 60 | 0.18 | 2 | 0.196 | 140 | 0.54 | 191.91 |
| 0.23 | 10 | 60 | 0.35 | 2 | 0.246 | 140 | 0.98 | 178.48 |
| 0.27 | 12 | 60 | 0.53 | 2.5 | 0.295 | 140 | 1.57 | 194.52 |

**P4318**

29

| | | | | | |
|---|---|---|---|---|---|
| **Date Submitted** | 4/1/2010 | **Section** | 1102.2 | **Proponent** | Allen Johnson |
| **Chapter** | 11 | **Affects HVHZ** | No | **Attachments** | Yes |

**TAC Recommendation** No Affirmative Recommendation with a Second

**Commission Action** Pending Review

**Related Modifications**

702.1, 702.2, 702.3, 1102.1, 1102.3, 1102.4

**Summary of Modification**

Modify the current building materials list to include Cure-In Place (CIPP) Thermosetting Resin Conduit Liner that meets ASTM F-1743, ASTM F-1216, ASTM D790, ASTM D638 and ASTM D543. in sections 702.1,702.2, 702.3, 1102.1, 1102.2, 1102.3 and 1102.4 for building drains and building sewer pipes.

**Rationale**

CIPP liners are an alternative to traditional pipe replacement that increases the flow charicteristics of the pipe.

**Fiscal Impact Statement**

**Impact to local entity relative to enforcement of code**

There are no additional costs relative to enforcement compared to traditional replacement.

**Impact to building and property owners relative to cost of compliance with code**

There is a significant cost savings to building and property owners as well as reducing potentially hazardous materials left undisturbed as compared to traditional pipe replacement CIPP liners are seamless and jointless, reducing the number of potential failures.

**Impact to industry relative to the cost of compliance with code**

There is no impact to the industry relative to the cost of compliance with code.

**Requirements**

**Has a reasonable and substantial connection with the health, safety, and welfare of the general public**

CIPP lining eliminates the destruction of landscapes and property as well as the health dangers associated with removing of sewer pipes in need of repair.

**Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction**

CIPP liners provide a repair solution that allows drain, waste and sewer pipes to be repaired without the digging and destruction required for traditional pipe repairs or replacement.

**Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities**

CIPP lining can be installed in any type of host pipe used for Building drains and Building sewer pipes for residential, commercial and industrial applications.

**Does not degrade the effectiveness of the code**

CIPP lining does not degrade the effectiveness of the code.

TopPrevious SectionNext Section

## SECTION 702 MATERIALS

**702.1 Above-ground sanitary drainage and vent pipe.** Above-ground soil, waste and vent pipe shall conform to one of the standards listed in Table 702.1.

### TABLE 702.1 ABOVE-GROUND DRAINAGE AND VENT PIPE

| MATERIAL | STANDARD |
|---|---|
| Acrylonitrile butadiene styrene (ABS) plastic pipe in IPS diameters, including Schedule 40, DR 22 (PS 200) and DR 24 (PS 140); with a solid, cellular core or composite wall | ASTM D 2661; ASTM F 628; ASTM F 1488; CSA B181.1 |
| Brass pipe | ASTM B 43 |
| Cast-iron pipe | ASTM A 74; ASTM A 888; CISPI 301 |
| Copper or copper-alloy pipe | ASTM B 42; ASTM B 302 |
| Copper or copper-alloy tubing (Type K, L, M or DWV) | ASTM B 75; ASTM B 88; ASTM B 251; ASTM B 306 |
| Galvanized steel pipe | ASTM A 53 |
| Glass pipe | ASTM C 1053 |
| Polyolefin pipe | ASTM F 1412; CAN/CSA B181.3 |
| Polyvinyl chloride (PVC) plastic pipe in IPS diameters, including schedule 40, DR 22 (PS 200), and DR 24 (PS 140); with a solid, cellular core or composite wall | ASTM D 2665; ASTM F 891; ASTM F 1488; CSA B181.2 |
| Polyvinyl chloride (PVC) plastic pipe with a 3.25-inch O.D. and a solid, cellular core or composite wall | ASTM D 2949, ASTM F 1488 |
| Polyvinylidene fluoride (PVDF) plastic pipe | ASTM F 1673; CAN/CSA B181.3 |
| Stainless steel drainage systems, Types 304 and 316L | ASME A112. |
| Cured-In Place Thermosetting Resin Conduit Liner (CIPP) | ASTM F1743, ASTM F1216, ASTM D790, ASTM D638, ASTM D543 |

Designation: F 1743 – 96 (Reapproved 2003)

An American National Standard

# Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe (CIPP)[1]

This standard is issued under the fixed designation F 1743; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

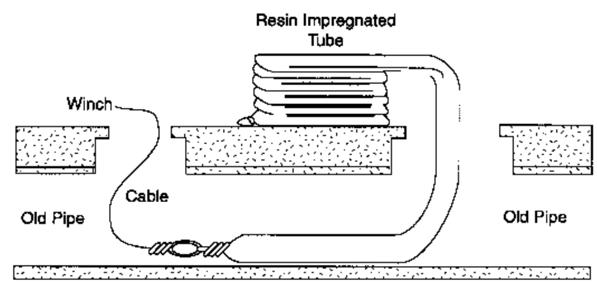
1.1 This practice describes the procedures for the reconstruction of pipelines and conduits (4 to 96 in. (10 to 244 cm) diameter) by the pulled-in-place installation of a resin-impregnated, flexible fabric tube into an existing conduit and secondarily inflated through the inversion of a calibration hose by the use of a hydrostatic head or air pressure (see Fig. 1). The resin is cured by circulating hot water or by the introduction of controlled steam into the tube. When cured, the finished cured-in-place pipe will be continuous and tight fitting. This reconstruction process may be used in a variety of gravity and pressure applications such as sanitary sewers, storm sewers, process piping, electrical conduits, and ventilation systems.

1.2 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for informational purposes only.

NOTE 1—There are no ISO standards covering the primary subject matter of this practice.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

**Step 1 – Pull resin-impregnated tube into existing pipe.**




**Step 2 – Calibration hose inversion**

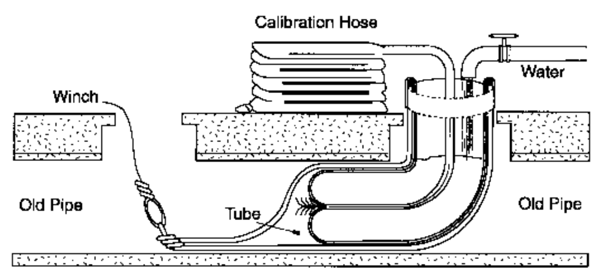



FIG. 1 Cured-in-Place Pipe Installation Methods

## 2. Referenced Documents

2.1 *ASTM Standards:*

D 543 Test Method of Resistance of Plastics to Chemical Reagents[2]

D 638 Test Method for Tensile Properties of Plastics[2]

D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials[2]

D 903 Test Method for Peel or Stripping Strength of Adhesive Bonds[3]

D 1600 Terminology for Abbreviated Terms Relating to Plastics[2]

D 1682 Test Method for Breaking Load and Elongation of Textile Fabrics[4]

D 3039/D3039M Test Method for Tensile Properties of Polymer Matrix Composite Materials[5]

[1] This practice is under the jurisdiction of ASTM Committee F-17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.67 on Trenchless Plastic Pipeline Technology.

Current edition approved Feb. 10, 2003. Published April 2003. Last previous edition approved in 1996 as F1743–96.

[2] *Annual Book of ASTM Standards*, Vol 08.01.

[3] *Annual Book of ASTM Standards*, Vol 15.06.

[4] *Discontinued: See 1991 Annual Book of ASTM Standards*, Vol 07.01.

[5] *Annual Book of ASTM Standards*, Vol 15.03.

D 3567 Practice for Determining Dimensions of Reinforced Thermosetting Resin Pipe (RTRP) and Fittings[6]
D 4814 Specification for Automotive Spark—Ignition Engine Fuel[7]
D 5813 Specification for Cured-in-Place Thermosetting Resin Sewer Pipe[6]
F 412 Terminology Relating to Plastic Piping Systems[6]
F 1216 Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube[6]

2.2 *AWWA Standard:*
M28 Manual on Cleaning and Lining Water Mains[8]

2.3 *NASSCO Standard:*
Recommended Specifications for Sewer Collection System Rehabilitation[9]

NOTE 2—An ASTM specification for cured-in-place pipe materials appropriate for use in this practice is under preparation and will be referenced in this practice when published.

## 3. Terminology

3.1 *General*—Definitions are in accordance with Terminology F 412. Abbreviations are in accordance with Terminology D 1600, unless otherwise indicated.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *calibration hose*—an impermeable bladder which is inverted within the resin-impregnated fabric tube by hydrostatic head or air pressure and may optionally be removed or remain in place as a permanent part of the installed cured-in-place pipe as described in 5.2.2.

3.2.2 *cured-in-place pipe (CIPP)*—a hollow cylinder consisting of a fabric tube with cured (cross-linked) thermosetting resin. Interior or exterior plastic coatings, or both, may be included. The CIPP is formed within an existing pipe and takes the shape of and fits tightly to the pipe.

3.2.3 *delamination*—separation of layers of the CIPP.

3.2.4 *dry spot*—an area of fabric of the finished CIPP which is deficient or devoid of resin.

3.2.5 *fabric tube*—flexible needled felt, or equivalent, woven or nonwoven material(s), or both, formed into a tubular shape which during the installation process is saturated with resin and holds the resin in place during the installation and curing process.

3.2.6 *inversion*—the process of turning the calibration hose inside out by the use of water pressure or air pressure.

3.2.7 *lift*—a portion of the CIPP that is a departure from the existing conduit wall forming a section of reverse curvature in the CIPP.

## 4. Significance and Use

4.1 This practice is for use by designers and specifiers, regulatory agencies, owners, and inspection organizations who are involved in the rehabilitation of conduits through the use of a resin-impregnated fabric tube pulled-in-place through an existing conduit and secondarily inflated through the inversion of a calibration hose. Modifications may be required for specific job conditions.

## 5. Recommended Materials and Manufacture

5.1 *General*—The resins, fabric tube, tube coatings, or other materials, such as the permanent calibration hose when combined as a composite structure, shall produce CIPP that meets the requirements of this specification.

5.2 *CIPP Wall Composition*—The wall shall consist of a plastic coated fabric tube filled with a thermosetting (cross-linked) resin, and if used, a filler.

5.2.1 *Fabric Tube*—The fabric tube should consist of one or more layers of flexible needled felt, or equivalent, woven or nonwoven material(s), or both, capable of carrying resin, withstanding installation pressures, and curing temperatures. The material(s) of construction should be able to stretch to fit irregular pipe sections and negotiate bends. Longitudinal and circumferential joints between multiple layers of fabric should be staggered so as not to overlap. The outside layer of the fabric tube should have an impermeable flexible coating(s) whose function is to contain the resin during and after fabric tube impregnation. The outer coating(s) must facilitate monitoring of resin saturation of the material(s) of construction of the fabric tube. The fabric tube should be fabricated to a size that, when installed, will tightly fit the internal circumference and the length of the original conduit. Allowance should be made for circumferential and longitudinal stretching of the fabric tube during installation. As required, the fabric tube should meet minimum tensile strength requirements in the longitudinal and transverse directions as specified in 7.1. All the material(s) of construction for the fabric tube should be compatible with the resin system used.

5.2.2 *Calibration Hose*:

5.2.2.1 *Removable Calibration Hose*—The removable calibration hose should consist of an impermeable plastic, or impermeable plastic coating(s) on flexible woven or nonwoven material(s), or both, that do not absorb resin and are capable of being removed from the CIPP.

5.2.2.2 *Permanent Calibration Hose*—The permanent calibration hose should consist of an impermeable plastic coating on a flexible needled felt or equivalent woven or nonwoven material(s), or both, that are capable of absorbing resin and are of a thickness to become fully saturated with resin. The calibration hose should be translucent to facilitate post-installation inspection. The calibration hose should be fabricated to a size that, when installed, will tightly fit the internal circumference and the length of the resin saturated fabric tube. Once inverted, the calibration hose becomes part of the fabric tube, and once properly cured, should bond permanently with the fabric tube. The properties of the calibration hose should meet minimum tensile strength requirements in the longitudinal and transverse directions as specified in 7.1. All the material(s) of construction for the calibration hose should be compatible with the resin system used.

5.2.3 *Resin*—A chemically resistant isophthalic based polyester, or vinyl ester thermoset resin and catalyst system or an

[6] *Annual Book of ASTM Standards*, Vol 08.04.
[7] *Annual Book of ASTM Standards*, Vol 05.03.
[8] Available from the American Water Works Association, 6666 W. Quincey Ave., Denver, CO 80235.
[9] Available from the National Association of Sewer Service Companies, 101 Wymore Rd., Suite 501, Altamonte, FL 32714.

epoxy resin and hardener that is compatible with the installation process should be used. The resin should be able to cure in the presence of water and the initiation temperature for cure should be less than 180°F (82.2°C). The cured resin/fabric tube system, with or without the calibration hose, shall be expected to have as a minimum the initial structural properties given in Table 1. These physical properties should be determined in accordance with Section 8. The cured resin/fabric tube system, with or without the calibration hose, should meet the minimum chemical resistance requirements as specified in 7.2.

## 6. Installation Recommendations

6.1 *Cleaning and Pre-Inspection*:

6.1.1 Prior to entering access areas, such as manholes, and performing inspection or cleaning operations, 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.

6.1.2 *Cleaning of Pipeline*—All internal debris should be removed from the original pipeline. Gravity pipes should be cleaned with hydraulically powered equipment, high-velocity jet cleaners, or mechanically powered equipment in accordance with NASSCO Recommended Specifications for Sewer Collection System Rehabilitation. Pressure pipelines should be cleaned with cable attached devices or fluid propelled devices in accordance with AWWA M28.

6.1.3 *Inspection of Pipelines*—Inspection of pipelines should be performed by experienced personnel trained in locating breaks, obstacles, and service connections by closed-circuit television or man entry. The interior of the pipeline should be carefully inspected to determine the location of any conditions that may prevent proper installation of the impregnated tube, such as protruding service taps, collapsed or crushed pipe, and reductions in the cross-sectional area of more than 40 %. These conditions should be noted so that they can be corrected.

6.1.4 *Line Obstructions*—The original pipeline should be clear of obstructions such as solids, dropped joints, protruding service connections, crushed or collapsed pipe, and reductions in the cross-sectional area of more than 40 % that may hinder or prevent the installation of the resin-impregnated fabric tube. If inspection reveals an obstruction that cannot be removed by conventional sewer-cleaning equipment, then a point-repair excavation should be made to uncover and remove or repair the obstruction.

6.2 *Resin Impregnation*—The fabric tube should be totally impregnated with resin (wet-out) and run through a set of rollers separated by a space, calibrated under controlled conditions to ensure proper distribution of resin. The volume of resin used should be sufficient to fully saturate all the voids of the fabric tube material, as well as all resin-absorbing material of the calibration hose at nominal thickness and diameter. The volume should be adjusted by adding 3 to 15 % excess resin to allow for the change in resin volume due to polymerization, the change in resin volume due to thermal expansion or contraction, and resin migration through the perforations of the fabric tube and out onto the host pipe.

**TABLE 1 CIPP Initial Structural Properties[A]**

| Property | Test Method | Minimum Value | |
|---|---|---|---|
| | | psi | (MPa) |
| Flexural strength | D 790 | 4 500 | (31) |
| Flexural modulus | D 790 | 250 000 | (1724) |
| Tensile strength (for pressure pipes only) | D 638 | 3 000 | (21) |

[A]The values in Table 1 are for field inspection. The purchaser should consult the manufacturer for the long-term structural properties.

6.3 *Bypassing*—If bypassing of the flow is required around the sections of pipe designated for reconstruction, the bypass should be made by plugging the line at a point upstream of the pipe to be reconstructed and pumping the flow to a downstream point or adjacent system. The pump and bypass lines should be of adequate capacity and size to handle the flow. Services within this reach will be temporarily out of service.

6.3.1 Public advisory services shall notify all parties whose service laterals will be out of commission and advise against water usage until the main line is back in service.

6.4 *Installation Methods*:

6.4.1 *Perforation of Resin-Impregnated Tube*—Prior to pulling the resin-impregnated fabric tube in place, the outer impermeable plastic coating may optionally be perforated. When the resin-impregnated fabric tube is perforated, this should allow resin to be forced through the perforations and out against the existing conduit by the force of the hydrostatic head or air pressure against the inner wall of the calibration hose. The perforation should be done after fabric tube impregnation with a perforating roller device at the point of manufacture or at the jobsite. Perforations should be made on both sides of the lay-flat fabric tube covering the full circumference with a spacing no less than 1.5 in. (38.1 mm) apart. Perforating slits should be a minimum of 0.25 in. (6.4 mm) long.

6.4.2 *Pulling Resin-Impregnated Tube into Position*—The wet-out fabric tube should be pulled into place using a power winch. The saturated fabric tube should be pulled through an existing manhole or other approved access to fully extend to the next designated manhole or termination point. Care should be exercised not to damage the tube as a result of friction during pull-in, especially where curvilinear alignments, multilinear alignments, multiple offsets, protruding services, and other friction-producing host pipe conditions are present. Once the fabric tube is in place, it should be attached to a vertical standpipe so that the calibration hose can invert into the center of the resin-impregnated fabric tube. The vertical standpipe should be of sufficient height of water head to hold the fabric tube tight to the existing pipe wall, producing dimples at side connections. A device such as a dynamometer or load cell should be provided on the winch or cable to monitor the pulling force. Measure the overall elongation of the fabric tube after pull-in completion. The acceptable longitudinal elongation shall not be more than 5 % of the overall length measured after the calibration hose has been installed, or exceed the recommended pulling force.

6.4.3 *Hydrostatic Head Calibration Hose Inversion*—The calibration hose should be inserted into the vertical inversion standpipe, with the impermeable plastic membrane side out. At the lower end of the inversion standpipe, the calibration hose should be turned inside out and attached to the standpipe so

that a leakproof seal is created. The resin-impregnated fabric tube should also be attached to the standpipe so that the calibration hose can invert into the center of the resin-impregnated tube. The inversion head should be adjusted to be of sufficient height of water head to cause the calibration hose to invert from the initial point of inversion to the point of termination and hold the resin-impregnated fabric tube tight to the pipe wall, producing dimples at side connections. Care should be taken during the inversion so as not to overstress the felt fiber. At the request of the purchaser, the fabric tube manufacturer should provide information on the maximum allowable axial and longitudinal tensile stress for the fabric tube.

6.4.3.1 An alternative method of installation is top inversion. In this case, the calibration hose and resin-impregnated fabric tube are attached to a top ring. In this case, the tube itself forms the standpipe for generation of the hydrostatic head. Other methods of installation are also available and should be submitted for acceptance by the purchaser.

6.4.4 *Using Air Pressure*—The resin-impregnated fabric tube should be perforated as described in 6.4.1. Once perforated, the wet-out fabric tube should be pulled into place using a power winch as described in 6.4.2. The calibration hose should be inserted through the guide chute or tube of the pressure containment device in which the calibration hose has been loaded, with the impermeable plastic membrane side out. At the end of the guide chute, the calibration hose should be turned inside out and attached so that a leakproof seal is created. The resin-impregnated tube should also be attached to the guide chute so that the calibration hose can invert into the center of the resin-impregnated tube. The inversion air pressure should be adjusted to be of sufficient pressure to cause the calibration hose to invert from point of inversion to point of termination and hold the resin saturated fabric tube tight to the pipe wall, producing dimples at side connections. Care should be taken during the inversion so as not to overstress the woven and nonwoven materials. Take suitable precautions to eliminate hazards to personnel in the proximity of the construction when pressurized air is being used.

6.5 *Lubricant During Installation*—The use of a lubricant during installation is recommended to reduce friction during inversion. This lubricant should be poured into the fluid in the standpipe in order to coat the calibration hose during inversion. When air is used to invert the calibration hose, the lubricant should be applied directly to the calibration hose. The lubricant used should be a nontoxic, oil-based product that has no detrimental effects on the tube or boiler and pump system, and will not adversely affect the fluid to be transported.

6.6 *Curing*:

6.6.1 *Using Circulating Heated Water*—After installation is completed, suitable heat source and water recirculation equipment are required to circulate heated water throughout the section to uniformly raise the water temperature above the temperature required to effect a cure of the resin. The water temperature in the line during the cure period should be as recommended by the resin manufacturer or seller.

6.6.1.1 The heat source should be fitted with suitable monitors to measure the temperature of the incoming and outgoing water supply. Temperature sensors should also be placed between the resin-impregnated tube and the host pipe invert at both termination points to monitor the temperatures during cure.

6.6.1.2 Initial cure will occur during temperature heat-up and is completed when exposed portions of the CIPP appear to be hard and sound and the remote temperature sensor indicates that the temperature is of a magnitude to realize an exotherm or cure in the resin. After initial cure is reached, the temperature should be raised to the post-cure temperature and held there for a period recommended by the resin manufacturer or seller. During post-cure, the recirculation of the water and cycling of the boiler to maintain the temperature continues. The curing of the CIPP must take into account the existing pipe material, the resin system, and ground conditions (temperature, moisture level, and thermal conductivity of soil).

6.6.2 *Using Steam*—After installation is completed, suitable steam-generating equipment is required to distribute steam throughout the pipe. The equipment should be capable of delivering steam throughout the section to uniformly raise the temperature within the pipe above the temperature required to effect a cure of the resin. The temperature in the line during the cure period should be as recommended by the resin manufacturer or seller.

6.6.2.1 The steam-generating equipment should be fitted with a suitable monitor to measure the temperature of the outgoing steam. Temperature sensors should also be placed between the resin-impregnated tube and the host pipe invert at both termination points to monitor the temperatures during cure.

6.6.2.2 Initial cure will occur during temperature heat-up and is completed when exposed portions of the new pipe appear to be hard and sound and the remote temperature sensor indicates that the temperature is of a magnitude to realize an exotherm or cure in the resin. After initial cure is reached, the temperature should be raised to the post-cure temperature and held there for a period recommended by the resin manufacturer or seller, during which time the distribution and control of steam to maintain the temperature continues. The curing of the CIPP must take into account the existing pipe material, the resin system, and ground conditions (temperature, moisture level, and thermal conductivity of soil).

6.6.3 *Required Pressures*—As required by the purchase agreement, the estimated maximum and minimum pressure required to hold the flexible tube tight against the existing conduit during the curing process should be provided by the seller and shall be increased to include consideration of external ground water, if present. Once the cure has started and dimpling for laterals is completed, the required pressures should be maintained until the cure has been completed. For water or steam, the pressure should be maintained within the estimated maximum and minimum pressure during the curing process. If the steam pressure or hydrostatic head drops below the recommended minimum during the cure, the CIPP should be inspected for lifts or delaminations and evaluated for its ability to fully meet the applicable requirements of 6.8 and Section 8.

6.7 *Cool-Down*:

6.7.1 *Using Cool Water after Heated Water Cure*—The new CIPP should be cooled to a temperature below 100°F (38°C) before relieving the static head in the inversion standpipe. Cool-down may be accomplished by the introduction of cool water into the inversion standpipe to replace water being drained from a small hole made in the downstream end. Take care to cool down the CIPP in a controlled manner, as recommended by the resin manufacturer or the seller. Care should be taken to release the static head so that a vacuum will not be developed that could damage the newly installed CIPP.

6.7.2 *Using Cool Water after Steam Cure*—The new CIPP should be cooled to a temperature below 100°F (38°C) before relieving the internal pressure within the section. Cool-down may be accomplished by the introduction of cool water into the section to replace the mixture of air and steam being drained from a small hole made in the downstream end. Take care to cool the CIPP in a controlled manner as recommended by the resin manufacturer or the seller. Care should be taken to release the air pressure so that a vacuum will not be developed that could damage the newly installed CIPP.

6.8 *Workmanship*—The finished CIPP should be continuous over the entire length of an installation and be free of dry spots, lifts, and delaminations. If these conditions are present, the CIPP will be evaluated for its ability to meet the applicable requirements of Section 8. Where the CIPP does not meet the requirements of Section 8 or specifically stated requirements of the purchase agreement, or both, the affected portions of CIPP will be removed and replaced with an equivalent repair.

6.8.1 If the CIPP does not fit tightly against the original pipe at its termination point(s), the full circumference of the CIPP exiting the existing host pipe or conduit should be sealed by filling with a resin mixture compatible with the CIPP.

6.9 *Service Connections*—After the new CIPP has been installed, the existing active (or inactive) service connections should be reinstated. This should generally be done without excavation, and in the case of non-man entry pipes, from the interior of the pipeline by means of a television camera and a remote-control cutting device. Service connections shall be reinstated to at least 90 % of the original area as it enters the host pipe or conduit.

NOTE 3—In many cases, a seal is provided where the formed CIPP dimples at service connections. However, this practice should not be construed to provide a 100 % watertight seal at all service connections. If total elimination of infiltration and inflow is desired, other means, which are beyond the scope of this practice, may be necessary to seal service connections and to rehabilitate service lines and manholes.

## 7. Material Requirements

7.1 *Fabric Tube Strength*—If required by the purchaser in the purchase agreement, the fabric tube, and seam (if applicable) as a quality control test, when tested in accordance with Test Method D 1682 shall have a minimum tensile strength of 750 psi (5 MPa) in both the longitudinal and transverse directions.

7.2 *Chemical Resistance*:

7.2.1 *Chemical Resistance Requirements*—The cured resin/fabric tube matrix, with or without the calibration hose, shall be evaluated in a laminate form for qualification testing of long-term chemical exposure to a variety of chemical effluents and should be evaluated in a manner consistent with 6.4.1 of Specification D 5813. The specimens shall be capable of exposure to the solutions in Table 2 at a temperature of 73.4 ± 3.6°F (23 ± 2°C), with a percentage retention of flexural modulus of elasticity of at least 80 % after one year exposure. Flexural properties, after exposure to the chemical solution(s), shall be based on dimensions of the specimens after exposure.

7.2.2 *Chemical Resistance Procedures*—The CIPP laminates should be constructed of identical fabric and resin components that will be used for anticipated in-field installations. The cured resin/fabric tube laminates, with or without the calibration hose should be exposed to the chemical agents in a manner consistent with Test Method D 543. The edges of the test coupons should be left exposed and not treated with resin, unless otherwise specified by the purchaser. The specimen thicknesses should be in the range of 0.125 to 0.25 in. (3.2 to 6.4 mm), with the sample dimensions suitable for preparing a minimum of five specimens for flexural testing as described in 8.1.4. Flexural properties after exposure to the chemical solutions should be based on the dimensions of the specimen after exposure.

7.2.2.1 For applications other than standard domestic sewerage, it is recommended that chemical resistance tests be conducted with actual samples of the fluid flowing in the pipe. These tests can also be accomplished by depositing CIPP test samples in the active pipe.

7.2.2.2 As required by the purchaser, additional chemical resistance requirements for the CIPP may be evaluated as described in 6.4 of Specification D 5813.

## 8. Recommended Inspection Practices

8.1 For each installation length designated by the purchaser in the purchase agreement, the preparation of CIPP samples is required from one or both of the following two methods:

8.1.1 The samples should be cut from a section of cured CIPP at an intermediate manhole or at the termination point that has been installed through a like diameter section of pipe or other tubular restraining means which has been held in place by a suitable heat sink, such as sandbags.

8.1.2 The sample should be fabricated from material taken from the fabric tube and the resin/catalyst system used, and cured in a clamped mold, placed in the downtube when heated circulated water is used, and in the silencer when steam is used. When the CIPP is constructed of oriented continuous or discontinuous fibers to enhance the physical properties of the CIPP, this method of sample preparation is recommended in order to allow testing in the axial (that is, along the length) and

TABLE 2 Minimum Chemical Resistance Requirements for Domestic Sanitary Sewer Applications

| Chemical Solution | Concentration, % |
|---|---|
| Nitric acid | 1 |
| Sulfuric acid | 5 |
| ASTM Fuel C[A] | 100 |
| Vegetable oil[B] | 100 |
| Detergent[C] | 0.1 |
| Soap[C] | 0.1 |

[A] In accordance with Specification D 4814.
[B] Cottonseed, corn, or mineral oil.
[C] In accordance with Test Method D 543.

circumferential (that is, hoop) directions of the CIPP. This method is also recommended when large-diameter CIPP is installed that may otherwise not be prepared with a tubular restraint.

8.1.3 The CIPP samples for each of these cases should be large enough to provide a minimum of three specimens and a recommended five specimens for flexural testing and also for tensile testing for internal pressure applications. The flexural and tensile specimens should be prepared in a manner consistent with 8.3.1 of Specification D 5813. For flexural and tensile properties, the full wall thickness of the CIPP samples shall be tested. Any plastic coatings or other CIPP layers not included in the structural design of the CIPP may be carefully ground off of the specimens prior to testing. If the sample is irregular or distorted such that proper testing is inhibited, attempts shall be made to machine any wall thickness from the inside pipe face of the sample. Any machining of the outside pipe face of the sample shall be done carefully so as to minimize the removal of material from the outer structural wall of the sample. Individual specimens should be clearly marked for easy identification and retained until final disposition or CIPP acceptance, or both, has been given.

8.1.4 *Short-Term Flexural (Bending) Properties*—The initial tangent flexural modulus of elasticity and flexural stress should be measured for gravity and pressure pipe applications in accordance with Test Method D 790, Test Method I, Procedure A and should meet the requirements of Table 1 within the 16:1 length to depth constraints. For specimens greater than 0.5 in. (12.7 mm) in depth, the width-to-depth ratio of the specimen should be increased to a minimum of 1:1 and should not exceed 4:1. For samples prepared in accordance with 8.1.1, determine flexural properties in the axial direction where the length of the test specimen is cut along the longitudinal axis of the pipe. Special consideration should be given to the preparation of flexural specimens to ensure opposite sides are parallel and adjacent edges are perpendicular. Flexural specimens should be tested such that the inside pipe face is tested in tension and the outside pipe face is in compression.

8.1.4.1 *Fiber-Reinforced CIPP Flexural Properties*—Where the CIPP is reinforced with oriented continuous or discontinuous fibers to enhance the physical properties of the CIPP, specimens should be sampled in accordance with 8.1.2, and flexural properties should be determined in accordance with 8.1.3 along the longitudinal axis and circumferential axis of the installed CIPP.

8.1.5 *Short-Term Tensile Properties*—The tensile strength should be measured for pressure pipe applications in accordance with Test Method D 638. Specimens should be prepared in accordance with Types I, II, and III of Fig. 1 of Test Method D 638. Specimens greater than 0.55 in. (14 mm) thick should maintain all dimensions for a Type III specimen, except the thickness will be that of the CIPP sample obtained. The rate of specimen testing should be carried out in accordance with Table 1 of Test Method D 638. Specimens should be prepared in accordance with 8.1.1 and tested along the longitudinal axis of the installed CIPP.

8.1.5.1 *Fiber-Reinforced CIPP Tensile Testing*—Where the CIPP is reinforced with oriented continuous or discontinuous fibers to enhance the physical properties of the CIPP, specimens should be sampled in accordance with 8.1.2 and tensile properties should be determined in accordance with Test Method D 3039 and tested along the longitudinal axis and circumferential axis of the installed CIPP.

8.1.6 *CIPP Wall Thickness*—The method of obtaining CIPP wall thickness measurements should be determined in a manner consistent with 8.1.2 of Specification D 5813. Thickness measurements should be made in accordance with Practice D 3567 for samples prepared in accordance with 8.1. Make a minimum of eight measurements at evenly spaced intervals around the circumference of the sample to ensure that minimum and maximum thicknesses have been determined. Deduct from the measured values the thickness of any plastic coatings or CIPP layers not included in the structural design of the CIPP. The average thickness should be calculated using all measured values and shall meet or exceed minimum design thickness as agreed upon between purchaser and seller. The minimum wall thickness at any point shall not be less than 87.5 % of the specified design thickness as agreed upon between purchaser and seller.

8.2 *Gravity Pipe Leakage Testing*—If required by the owner in the contract documents or purchase order, gravity pipes should be tested using an exfiltration test method where the CIPP is plugged at both ends and filled with water. This test should take place after the CIPP has cooled down to ambient temperature. This test is limited to pipe lengths with no service laterals and diameters of 36 in. or less. The allowable water exfiltration for any length of pipe between termination points should not exceed 50 U.S. gallons per inch of internal pipe diameter per mile per day, providing that all air has been bled from the line. During exfiltration testing, the maximum internal pipe pressure at the lowest end should not exceed 10 ft (3.0 m) of water or 4.3 psi (29.7 kPa), and the water level inside of the inversion standpipe should be 2 ft (0.6 m) higher than the top of the pipe or 2 ft (0.6 m) higher than groundwater level, whichever is greater. The leakage quantity should be gaged by the water level in a temporary standpipe placed in the upstream plug. The test should be conducted for a minimum of 1 h.

NOTE 4—It is impractical to test pipes above 36 in. diameter for leakage due to the technology available in the pipe rehabilitation industry. Post inspection of larger pipes will detect major leaks or blockages.

8.3 *Pressure Pipe Testing*—If required by the purchaser in the purchase agreement, pressure pipes should be subjected to a hydrostatic pressure test. A pressure and leakage test at twice the known working pressure or at the working pressure plus 50 psi, whichever is less, is recommended. The pressure should initially be held at the known working pressure for a period not less than 12 h, then increased to the test pressure for an additional period of 2 to 3 h to allow for stabilization of the CIPP. After this period, the pressure test will begin for a minimum of 1 h. The allowable leakage during the pressure test should be 20 U.S. gallons per inch of internal pipe diameter per mile per day, providing that all air has been evacuated from the line prior to testing and the CIPP has cooled down to ambient temperature.

NOTE 5—The allowable leakage for gravity and pressure pipe testing is a function of water loss at the end seals and trapped air in the pipe.

8.4 *Delamination Test*—If required by the purchaser in the purchase agreement, a delamination test should be performed on each installation length specified. CIPP samples should be prepared in accordance with 8.1.2, except that a portion of the fabric tube material in the sample should be dry and isolated from the resin in order to separate tube layers for testing (consult the tube manufacturer for further information). Delamination testing should be in accordance with Test Method D 903 with the following exceptions:

8.4.1 The rate of travel of the power-actuated grip should be 1 in. (25 mm)/min.

8.4.2 Five test specimens should be tested for each installation specified.

8.4.3 The thickness of the test specimen should be minimized, but should be sufficient to adequately test delamination of nonhomogeneous CIPP layers.

8.5 The peel or stripping strength between any nonhomogeneous layers of the CIPP laminate should be a minimum of 10 lb/in. (178.60 g/mm) for typical CIPP applications.

NOTE 6—The purchaser may designate the similar layers between which the delamination test will be conducted.

NOTE 7—For additional details on conducting the delamination test, contact the seller.

8.6 *Inspection and Acceptance*—The installation may be inspected visually if appropriate, or by closed-circuit television if visual inspection cannot be accomplished. Variations from true line and grade may be inherent because of the conditions of the original piping. No infiltration of groundwater should be observed. All service entrances should be accounted for and be unobstructed.

## 9. Keywords

9.1 cured-in-place pipe; installation—underground; plastic pipe—thermoset; rehabilitation; thermosetting resin pipe

## APPENDIX

**(Nonmandatory Information)**

### X1. DESIGN CONSIDERATIONS

X1.1 *General Guidelines*—The design thickness of the CIPP is a function of the resin, materials of construction of the fabric tube, and the condition of the existing pipe. In addition, depending on the condition of the pipe, the design thickness of the CIPP may also be a function of groundwater, soil type, and influence of live loading surrounding the host pipe. For guidance relating to terminology of piping conditions and related design equations, see Appendix X1 of Practice F 1216.

**Amendment to ASTM F1743-96**
**Author: Doug Kleweno of DGK Technologies**

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May 22, 2001

Whom it may concern:

I am writing this letter at the request of Mr. David Ratliff (Nu Flow Installer, Abilene, Texas) in order to provide clarification for ASTM F1743 "Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-In-Place Thermosetting Resin Pipe (CIPP)" and similar pulled-in-place products. In my previous position I was the Technical Manager for InLiner USA CIPP products and am the author of ASTM F1743. I have also been involved in editing ASTM F1216 and ASTM D5813, which are also CIPP installation and material specifications, respectively.

When writing an ASTM specification it is necessary to provide enough minimum requirements so that the product can meet or exceed engineering and design criteria. However, ASTM specifications also must be generalized enough to accommodate the majority of products and processes that may want to reference it. F1743 was generally written for most CIPP applications where heated cures predominate in the market. There are many resin applications for CIPP and other products (boat building, automotive, heavy truck) where ambient cure resin formulations are common and used successfully. Technically speaking, an ambient cure formulation for CIPP does initiate at a temperature less that 180F, which is recommended in Section 5.2.3 or F1743.

More critical to CIPP and other applications is whether the product (CIPP in this case) meets the minimum initial structural property recommendations. The minimum properties for the CIPP were provided in Section 4.2.3 of ASTM F1743 and this is probably the most important aspect for the product to meet the requirements for external hydrostatic or soil loading that may surround the pipe. These minimum properties are the numbers by which the minimum design thickness is determined for the installed CIPP or part liner.

As a side note it is my experience that the curing strategy is chosen for handling and transportation purposes. Large liners for CIPP require long catalyzed stability so the product can be processed, transported, and installed. For short runs or tubes processed at a job site, it was common to use ambient or semi-ambient cure formulations to reduce the time at the job site and the associated inconvenience to the surrounding community.

I hope this has provided some additional clarification.

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NSF International

August 24, 2005

# TEST REPORT

Send To: 1P790
NU FLOW TECHNOLOGIES 2000 INC.
1010 THORNTON ROAD SOUTH
OSHAWA ON L1J 7E2
CANADA
Attn: MR. BOB FOWLE

Customer: 1P790
NU FLOW TECHNOLOGIES 2000 INC.
1010 THORNTON ROAD SOUTH
OSHAWA ON L1J 7E2
CANADA
Attn: MR. BOB FOWLE

Plant: 1P790
NU FLOW TECHNOLOGIES 2000 INC.
1010 THORNTON ROAD SOUTH
OSHAWA ON L1J 7E2
CANADA
Attn: MR. BOB FOWLE

Sample Description: Nu Flow #2000 Pipe Lining - Liner
Test Type: AA - Annual Collection

Thank you for having your product tested by NSF.

The enclosed report details the result of the testing performed on your product. Your program representative will be contacting you in the near future if there are any remaining issues concerning the status of this product.

Please do not hesitate to contact us if you have any immediate questions pertaining to your product.

Reviewer: ______________________  Status: **Pass**

Atabek Ciechanowski - Manager, Engineering Laboratory

CC: Program: 010 - Plumbing and Related Programs
Program Rep: AMY CHOKSEY
Region: 01 - Domestic
PA Project: 224520

FI20050824120213  J-00012414  Page 1 of 4



789 N. Dixboro Road, Ann Arbor, Michigan 48105-9723 USA
1-800-NSF-MARK 734-769-8010
www.nsf.org

General Information

Standard: 014 - PLASTICS PIPING SYSTEM COMPONENTS AND RELATED MATERIALS

DCC Number / Tracking ID PL04249
Family Code A
Material Type Epoxy
Monitor Code A
Performance Standard F1216
Performance Standard Year 2003
Product Identifier Part A Batch # 030904, Part B Batch # 040405_3
Sample Description Liner
Trade Designation Nu Flow #2000 Pipe Lining

Sample Id: S-0000161582
Description: Nu Flow #2000 Pipe Lining - Liner
Sampled Date: 05/19/2005
Received Date: 05/23/2005

| Testing Parameter | Result | Units |
|---|---|---|
| | | |
| **Engineering Lab** | | |
| Gravity Pipe Leakage Test | | |
| Initial water column: | 10 | feet |
| Final water column: | 10 | feet |
| Time: | 60 | minutes |
| Leakage rate: | 0 | g/in/day |
| Required maximum leakage rate: | 50 | g/in/day |
| Actual leakage rate: | 0 | g/in/day |
| Gravity Pipe Leakage Test: | Pass | |
| Flex Modulus | | |
| Specimens conditioned for | 40 | hours |
| Specimens conditioned at | 73 | degrees F |
| Relative humidity | 50 | % |
| Test temperature Required | 73 | degrees F |
| Test temperature Actual | 73 | degrees F |
| Required crosshead speed | 0.22 | in/min |
| Actual crosshead speed | 0.22 | in/min |
| Deflection | <5 | % |
| Specimen 1 | 280000 | psi |
| Specimen 2 | 315000 | psi |
| Specimen 3 | 275000 | psi |
| Specimen 4 | 242000 | psi |
| Specimen 5 | 257000 | psi |
| Required Average Modulus (minimum) | 250000 psi | |
| Actual Average Modulus | 274000 | psi |
| Flex Modulus Test | PASS | |
| Flexural Strength Test | | |
| Specimens conditioned for | 40 | hours |
| Specimens conditioned at | 73 | degrees F |
| Relative Humidity | 50 | percent |
| Test Temperature | 73 | degrees F |
| Cross Head Speed | 0.22 | in/min. |
| Specimen 1 Flexural Strength | 6280 | psi |
| Specimen 2 Flexural Strength | 6480 | psi |
| Specimen 3 Flexural Strength | 6010 | psi |
| Specimen 4 Flexural Strength | 5210 | psi |

Sample Id: S-0000161582

| Testing Parameter | Result | Units |
|---|---|---|
| | | |
| **Engineering Lab ( Cont'd )** | | |
| Specimen 5 Flexural Strength | 5820 | psi |
| Average Flexural Strength | 5960 | psi |
| Required Flexural Strength | 4500 | psi |
| Flexural Strength Test | Pass | |
| Strength, Tensile | | |
| Specimens conditioned for | 40 | hours |
| Specimens conditioned at | 73 | degrees F |
| Relative humidity | 50 | % |
| Test Temperature | 73 | degrees F |
| Actual Crosshead Speed | 0.2 | in/min. |
| Required Crosshead Speed | 0.2 | in/min. |
| Specimen 1: Tensile Strength | 3930 | psi |
| Specimen 2: Tensile Strength | 4540 | psi |
| Specimen 3: Tensile Strength | 4010 | psi |
| Specimen 4: Tensile Strength | 3690 | psi |
| Specimen 5: Tensile Strength | 3920 | psi |
| Req'd Average Tensile Strength (minimum) | 3000 | |
| Actual Average Tensile Strength | 4020 | psi |
| Tensile Strength Test | PASS | |
| Specimen Fabrication | | |
| Specimen Fabrication | COMPLETE | |
| Time | 1 | hours |
| Technician | 3356 | |

*Testing Laboratories:*

| | Id | Address |
|---|---|---|
| All work performed at: → | NSF_AA | NSF International<br>789 Dixboro Road<br>Ann Arbor MI 48105-0140<br>USA |

*References to Testing Procedures:*

| NSF Reference | Parameter / Test Description |
|---|---|
| P3084 | Gravity Pipe Leakage Test |
| P3122 | Flex Modulus |
| P3123 | Flexural Strength Test |
| P3127 | Strength, Tensile |
| P3172 | Specimen Fabrication |

ACUREN

*Client*

NU FLOW TECHNOLOGIES 2000 INC.
1010 Thornton Road South
Oshawa, Ontario
L1J 7E2

# Laboratory Report

| *Attention* | *Client's Order Number* | *Date* | *Report Number* |
|---|---|---|---|
| Sinan Omari | 9282 | 16 March 2007 | **07-845** |

| *Client's Material / Product Description* | *Date Sample Received* | *Material / Product Specification* |
|---|---|---|
| (1) Sample | 06 March 2007 | ASTM D5813-04 |

## Test Performed — Result

1. Tangent Flexural Modulus
   (ASTM D790)
   - Crosshead speed: 0.05"/min
   - 1000 lbf Load cell
   - 2 inch support span
   - L/D = 16
   - Specimen Geometry: 1/8" x 1/2" x 4"
   - 5 specimens tested
   - Units: psi

| Sample # | Result | Specification |
|---|---|---|
| 1 | 384400 | |
| 2 | 420900 | 250,000 psi Minimum |
| 3 | 304600 | |
| 4 | 425400 | |
| 5 | 397100 | |
| Average | 386500 | |

2. Flexural Strength
   (ASTM D790)
   - 5 specimens tested
   - Units: psi

| Sample # | Result | Specification |
|---|---|---|
| 1 | 6 070 | |
| 2 | 6 670 | |
| 3 | 5 400 | 4,500 psi Minimum |
| 4 | 6 200 | |
| 5 | 6 440 | |
| Average | 6 160 | |

3. Wall Thickness
   - Units: mm
   - Four measurements taken on each side

| Side A | Side B |
|---|---|
| 3.56 | 3.26 |
| 3.62 | 3.45 |
| 3.67 | 3.50 |
| 3.79 | 3.74 |

Corrine Dimnik, B.Sc.
Certified Inspector.

Dr. Erhan Ulvan, Ph. D, P. Eng.,
Laboratory Manager.

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L5S 1A1

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Standards Council of Canada Accredited Laboratory Scope of Accreditation 60
Conseil canadien des normes Laboratoire accrédité Portée d'accréditation 60 TM

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NU FLOW RELINE REPAIR RENEW ®

# Flow Comparisons

## Comparison between a new pipe and a rehabilitated pipe

| Diameter | | Hazen Williams Coefficient (C) | Flow for new pipe ($m^3/s$) | Thickness of Liner (mm) | Resulting internal diameter (m) | Hazen Williams coefficient (C) | Flow for rehabilitated pipe ($m^3/s$) | % Loss |
|---|---|---|---|---|---|---|---|---|
| (m) | (in) | | | | | | | |
| 0.15 | 6 | 140 | 0.27 | 2 | 0.146 | 140 | 0.25 | -6.86 |
| 0.20 | 8 | 140 | 0.57 | 2 | 0.196 | 140 | 0.54 | -5.17 |
| 0.30 | 10 | 140 | 1.02 | 2 | 0.246 | 140 | 0.98 | -4.15 |
| 0.40 | 12 | 140 | 1.65 | 2.5 | 0.295 | 140 | 1.57 | -4.32 |

## Comparison between old pipe and a rehabilitated pipe

| Old Pipe Diameter | | Hazen Williams Coefficient (C) | Flow for old pipe ($m^3/s$) | Thickness of Liner (mm) | Old Pipe diameter (m) | Hazen Williams coefficient (C) | Flow for rehabilitated pipe ($m^3/s$) | % Increase |
|---|---|---|---|---|---|---|---|---|
| (m) | (in) | | | | | | | |
| 0.13 | 6 | 60 | 0.08 | 2 | 0.146 | 140 | 0.25 | 216.63 |
| 0.18 | 8 | 60 | 0.18 | 2 | 0.196 | 140 | 0.54 | 191.91 |
| 0.23 | 10 | 60 | 0.35 | 2 | 0.246 | 140 | 0.98 | 178.48 |
| 0.27 | 12 | 60 | 0.53 | 2.5 | 0.295 | 140 | 1.57 | 194.52 |

**Date Submitted** 4/1/2010
**Chapter** 11
**Section** 1102.3
**Affects HVHZ** No
**Proponent** Allen Johnson
**Attachments** Yes
**TAC Recommendation** No Affirmative Recommendation with a Second
**Commission Action** Pending Review

**Related Modifications**

702.1, 702.2, 702.3, 1102.1, 1102.2, 1102.4

**Summary of Modification**

Modify the current building materials list to include Cure-In Place (CIPP) Thermosetting Resin Conduit Liner that meets ASTM F-1743, ASTM F-1216, ASTM D790, ASTM D638 and ASTM D543. in sections 702.1,702.2, 702.3, 1102.1, 1102.2, 1102.3 and 1102.4 for building drains and building sewer pipes.

**Rationale**

CIPP liners are an alternative to traditional pipe replacement that increases the flow charicteristics of the pipe.

**Fiscal Impact Statement**

**Impact to local entity relative to enforcement of code**

There are no additional costs relative to enforcement compared to traditional replacement.

**Impact to building and property owners relative to cost of compliance with code**

There is a significant cost savings to building and property owners as well as reducing potentially hazardous materials left undisturbed as compared to traditional pipe replacement CIPP liners are seamless and jointless, reducing the number of potential failures.

**Impact to industry relative to the cost of compliance with code**

There is no impact to the industry relative to the cost of compliance with code.

**Requirements**

**Has a reasonable and substantial connection with the health, safety, and welfare of the general public**

CIPP lining eliminates the destruction of landscapes and property as well as the health dangers associated with removing of sewer pipes in need of repair.

**Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction**

CIPP liners provide a repair solution that allows drain, waste and sewer pipes to be repaired without the digging and destruction required for traditional pipe repairs or replacement.

**Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities**

CIPP lining can be installed in any type of host pipe used for Building drains and Building sewer pipes for residential, commercial and industrial applications.

**Does not degrade the effectiveness of the code**

CIPP lining does not degrade the effectiveness of the code.

TopPrevious SectionNext Section

**SECTION 702 MATERIALS**

**702.1 Above-ground sanitary drainage and vent pipe.** Above-ground soil, waste and vent pipe shall conform to one of the standards listed in Table 702.1.

**TABLE 702.1 ABOVE-GROUND DRAINAGE AND VENT PIPE**

| MATERIAL | STANDARD |
|---|---|
| Acrylonitrile butadiene styrene (ABS) plastic pipe in IPS diameters, including Schedule 40, DR 22 (PS 200) and DR 24 (PS 140); with a solid, cellular core or composite wall | ASTM D 2661; ASTM F 628; ASTM F 1488; CSA B181.1 |
| Brass pipe | ASTM B 43 |
| Cast-iron pipe | ASTM A 74; ASTM A 888; CISPI 301 |
| Copper or copper-alloy pipe | ASTM B 42; ASTM B 302 |
| Copper or copper-alloy tubing (Type K, L, M or DWV) | ASTM B 75; ASTM B 88; ASTM B 251; ASTM B 306 |
| Galvanized steel pipe | ASTM A 53 |
| Glass pipe | ASTM C 1053 |
| Polyolefin pipe | ASTM F 1412; CAN/CSA B181.3 |
| Polyvinyl chloride (PVC) plastic pipe in IPS diameters, including schedule 40, DR 22 (PS 200), and DR 24 (PS 140); with a solid, cellular core or composite wall | ASTM D 2665; ASTM F 891; ASTM F 1488; CSA B181.2 |
| Polyvinyl chloride (PVC) plastic pipe with a 3.25-inch O.D. and a solid, cellular core or composite wall | ASTM D 2949, ASTM F 1488 |
| Polyvinylidene fluoride (PVDF) plastic pipe | ASTM F 1673; CAN/CSA B181.3 |
| Stainless steel drainage systems, Types 304 and 316L | ASME A112. |
| Cured-In Place Thermosetting Resin Conduit Liner (CIPP) | ASTM F1743, ASTM F1216, ASTM D790, ASTM D638, ASTM D543 |

Designation: F 1743 – 96 (Reapproved 2003)

An American National Standard

# Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe (CIPP)[1]

This standard is issued under the fixed designation F 1743; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This practice describes the procedures for the reconstruction of pipelines and conduits (4 to 96 in. (10 to 244 cm) diameter) by the pulled-in-place installation of a resin-impregnated, flexible fabric tube into an existing conduit and secondarily inflated through the inversion of a calibration hose by the use of a hydrostatic head or air pressure (see Fig. 1). The resin is cured by circulating hot water or by the introduction of controlled steam into the tube. When cured, the finished cured-in-place pipe will be continuous and tight fitting. This reconstruction process may be used in a variety of gravity and pressure applications such as sanitary sewers, storm sewers, process piping, electrical conduits, and ventilation systems.

1.2 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for informational purposes only.

NOTE 1—There are no ISO standards covering the primary subject matter of this practice.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

2.1 *ASTM Standards:*

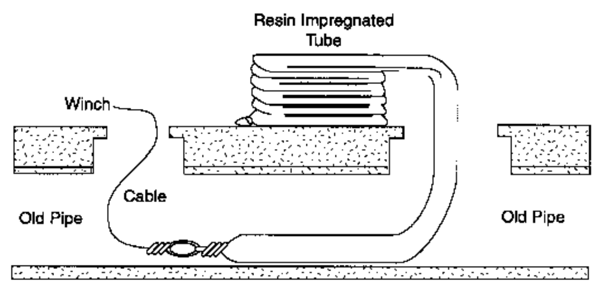
D 543 Test Method of Resistance of Plastics to Chemical Reagents[2]

D 638 Test Method for Tensile Properties of Plastics[2]

D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials[2]

D 903 Test Method for Peel or Stripping Strength of Adhesive Bonds[3]

**Step 1 – Pull resin-impregnated tube into existing pipe.**




**Step 2 – Calibration hose inversion**

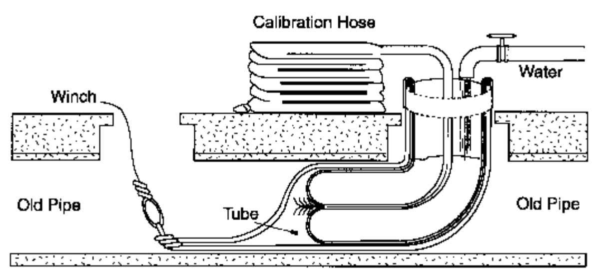



FIG. 1 Cured-in-Place Pipe Installation Methods

D 1600 Terminology for Abbreviated Terms Relating to Plastics[2]

D 1682 Test Method for Breaking Load and Elongation of Textile Fabrics[4]

D 3039/D3039M Test Method for Tensile Properties of Polymer Matrix Composite Materials[5]

[1] This practice is under the jurisdiction of ASTM Committee F-17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.67 on Trenchless Plastic Pipeline Technology.

Current edition approved Feb. 10, 2003. Published April 2003. Last previous edition approved in 1996 as F1743–96.

[2] *Annual Book of ASTM Standards*, Vol 08.01.

[3] *Annual Book of ASTM Standards*, Vol 15.06.

[4] *Discontinued: See 1991 Annual Book of ASTM Standards*, Vol 07.01.

[5] *Annual Book of ASTM Standards*, Vol 15.03.

D 3567 Practice for Determining Dimensions of Reinforced Thermosetting Resin Pipe (RTRP) and Fittings[6]
D 4814 Specification for Automotive Spark—Ignition Engine Fuel[7]
D 5813 Specification for Cured-in-Place Thermosetting Resin Sewer Pipe[6]
F 412 Terminology Relating to Plastic Piping Systems[6]
F 1216 Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube[6]
2.2 *AWWA Standard:*
M28 Manual on Cleaning and Lining Water Mains[8]
2.3 *NASSCO Standard:*
Recommended Specifications for Sewer Collection System Rehabilitation[9]

NOTE 2—An ASTM specification for cured-in-place pipe materials appropriate for use in this practice is under preparation and will be referenced in this practice when published.

## 3. Terminology

3.1 *General*—Definitions are in accordance with Terminology F 412. Abbreviations are in accordance with Terminology D 1600, unless otherwise indicated.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *calibration hose*—an impermeable bladder which is inverted within the resin-impregnated fabric tube by hydrostatic head or air pressure and may optionally be removed or remain in place as a permanent part of the installed cured-in-place pipe as described in 5.2.2.

3.2.2 *cured-in-place pipe (CIPP)*—a hollow cylinder consisting of a fabric tube with cured (cross-linked) thermosetting resin. Interior or exterior plastic coatings, or both, may be included. The CIPP is formed within an existing pipe and takes the shape of and fits tightly to the pipe.

3.2.3 *delamination*—separation of layers of the CIPP.

3.2.4 *dry spot*—an area of fabric of the finished CIPP which is deficient or devoid of resin.

3.2.5 *fabric tube*—flexible needled felt, or equivalent, woven or nonwoven material(s), or both, formed into a tubular shape which during the installation process is saturated with resin and holds the resin in place during the installation and curing process.

3.2.6 *inversion*—the process of turning the calibration hose inside out by the use of water pressure or air pressure.

3.2.7 *lift*—a portion of the CIPP that is a departure from the existing conduit wall forming a section of reverse curvature in the CIPP.

## 4. Significance and Use

4.1 This practice is for use by designers and specifiers, regulatory agencies, owners, and inspection organizations who are involved in the rehabilitation of conduits through the use of a resin-impregnated fabric tube pulled-in-place through an existing conduit and secondarily inflated through the inversion of a calibration hose. Modifications may be required for specific job conditions.

## 5. Recommended Materials and Manufacture

5.1 *General*—The resins, fabric tube, tube coatings, or other materials, such as the permanent calibration hose when combined as a composite structure, shall produce CIPP that meets the requirements of this specification.

5.2 *CIPP Wall Composition*—The wall shall consist of a plastic coated fabric tube filled with a thermosetting (cross-linked) resin, and if used, a filler.

5.2.1 *Fabric Tube*—The fabric tube should consist of one or more layers of flexible needled felt, or equivalent, woven or nonwoven material(s), or both, capable of carrying resin, withstanding installation pressures, and curing temperatures. The material(s) of construction should be able to stretch to fit irregular pipe sections and negotiate bends. Longitudinal and circumferential joints between multiple layers of fabric should be staggered so as not to overlap. The outside layer of the fabric tube should have an impermeable flexible coating(s) whose function is to contain the resin during and after fabric tube impregnation. The outer coating(s) must facilitate monitoring of resin saturation of the material(s) of construction of the fabric tube. The fabric tube should be fabricated to a size that, when installed, will tightly fit the internal circumference and the length of the original conduit. Allowance should be made for circumferential and longitudinal stretching of the fabric tube during installation. As required, the fabric tube should meet minimum tensile strength requirements in the longitudinal and transverse directions as specified in 7.1. All the material(s) of construction for the fabric tube should be compatible with the resin system used.

5.2.2 *Calibration Hose*:

5.2.2.1 *Removable Calibration Hose*—The removable calibration hose should consist of an impermeable plastic, or impermeable plastic coating(s) on flexible woven or nonwoven material(s), or both, that do not absorb resin and are capable of being removed from the CIPP.

5.2.2.2 *Permanent Calibration Hose*—The permanent calibration hose should consist of an impermeable plastic coating on a flexible needled felt or equivalent woven or nonwoven material(s), or both, that are capable of absorbing resin and are of a thickness to become fully saturated with resin. The calibration hose should be translucent to facilitate post-installation inspection. The calibration hose should be fabricated to a size that, when installed, will tightly fit the internal circumference and the length of the resin saturated fabric tube. Once inverted, the calibration hose becomes part of the fabric tube, and once properly cured, should bond permanently with the fabric tube. The properties of the calibration hose should meet minimum tensile strength requirements in the longitudinal and transverse directions as specified in 7.1. All the material(s) of construction for the calibration hose should be compatible with the resin system used.

5.2.3 *Resin*—A chemically resistant isophthalic based polyester, or vinyl ester thermoset resin and catalyst system or an

[6] *Annual Book of ASTM Standards*, Vol 08.04.
[7] *Annual Book of ASTM Standards*, Vol 05.03.
[8] Available from the American Water Works Association, 6666 W. Quincey Ave., Denver, CO 80235.
[9] Available from the National Association of Sewer Service Companies, 101 Wymore Rd., Suite 501, Altamonte, FL 32714.

epoxy resin and hardener that is compatible with the installation process should be used. The resin should be able to cure in the presence of water and the initiation temperature for cure should be less than 180°F (82.2°C). The cured resin/fabric tube system, with or without the calibration hose, shall be expected to have as a minimum the initial structural properties given in Table 1. These physical properties should be determined in accordance with Section 8. The cured resin/fabric tube system, with or without the calibration hose, should meet the minimum chemical resistance requirements as specified in 7.2.

## 6. Installation Recommendations

6.1 *Cleaning and Pre-Inspection*:

6.1.1 Prior to entering access areas, such as manholes, and performing inspection or cleaning operations, 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.

6.1.2 *Cleaning of Pipeline*—All internal debris should be removed from the original pipeline. Gravity pipes should be cleaned with hydraulically powered equipment, high-velocity jet cleaners, or mechanically powered equipment in accordance with NASSCO Recommended Specifications for Sewer Collection System Rehabilitation. Pressure pipelines should be cleaned with cable attached devices or fluid propelled devices in accordance with AWWA M28.

6.1.3 *Inspection of Pipelines*—Inspection of pipelines should be performed by experienced personnel trained in locating breaks, obstacles, and service connections by closed-circuit television or man entry. The interior of the pipeline should be carefully inspected to determine the location of any conditions that may prevent proper installation of the impregnated tube, such as protruding service taps, collapsed or crushed pipe, and reductions in the cross-sectional area of more than 40 %. These conditions should be noted so that they can be corrected.

6.1.4 *Line Obstructions*—The original pipeline should be clear of obstructions such as solids, dropped joints, protruding service connections, crushed or collapsed pipe, and reductions in the cross-sectional area of more than 40 % that may hinder or prevent the installation of the resin-impregnated fabric tube. If inspection reveals an obstruction that cannot be removed by conventional sewer-cleaning equipment, then a point-repair excavation should be made to uncover and remove or repair the obstruction.

6.2 *Resin Impregnation*—The fabric tube should be totally impregnated with resin (wet-out) and run through a set of rollers separated by a space, calibrated under controlled conditions to ensure proper distribution of resin. The volume of resin used should be sufficient to fully saturate all the voids of the fabric tube material, as well as all resin-absorbing material of the calibration hose at nominal thickness and diameter. The volume should be adjusted by adding 3 to 15 % excess resin to allow for the change in resin volume due to polymerization, the change in resin volume due to thermal expansion or contraction, and resin migration through the perforations of the fabric tube and out onto the host pipe.

**TABLE 1 CIPP Initial Structural Properties[A]**

| Property | Test Method | Minimum Value | |
|---|---|---|---|
| | | psi | (MPa) |
| Flexural strength | D 790 | 4 500 | (31) |
| Flexural modulus | D 790 | 250 000 | (1724) |
| Tensile strength (for pressure pipes only) | D 638 | 3 000 | (21) |

[A]The values in Table 1 are for field inspection. The purchaser should consult the manufacturer for the long-term structural properties.

6.3 *Bypassing*—If bypassing of the flow is required around the sections of pipe designated for reconstruction, the bypass should be made by plugging the line at a point upstream of the pipe to be reconstructed and pumping the flow to a downstream point or adjacent system. The pump and bypass lines should be of adequate capacity and size to handle the flow. Services within this reach will be temporarily out of service.

6.3.1 Public advisory services shall notify all parties whose service laterals will be out of commission and advise against water usage until the main line is back in service.

6.4 *Installation Methods*:

6.4.1 *Perforation of Resin-Impregnated Tube*—Prior to pulling the resin-impregnated fabric tube in place, the outer impermeable plastic coating may optionally be perforated. When the resin-impregnated fabric tube is perforated, this should allow resin to be forced through the perforations and out against the existing conduit by the force of the hydrostatic head or air pressure against the inner wall of the calibration hose. The perforation should be done after fabric tube impregnation with a perforating roller device at the point of manufacture or at the jobsite. Perforations should be made on both sides of the lay-flat fabric tube covering the full circumference with a spacing no less than 1.5 in. (38.1 mm) apart. Perforating slits should be a minimum of 0.25 in. (6.4 mm) long.

6.4.2 *Pulling Resin-Impregnated Tube into Position*—The wet-out fabric tube should be pulled into place using a power winch. The saturated fabric tube should be pulled through an existing manhole or other approved access to fully extend to the next designated manhole or termination point. Care should be exercised not to damage the tube as a result of friction during pull-in, especially where curvilinear alignments, multilinear alignments, multiple offsets, protruding services, and other friction-producing host pipe conditions are present. Once the fabric tube is in place, it should be attached to a vertical standpipe so that the calibration hose can invert into the center of the resin-impregnated fabric tube. The vertical standpipe should be of sufficient height of water head to hold the fabric tube tight to the existing pipe wall, producing dimples at side connections. A device such as a dynamometer or load cell should be provided on the winch or cable to monitor the pulling force. Measure the overall elongation of the fabric tube after pull-in completion. The acceptable longitudinal elongation shall not be more than 5 % of the overall length measured after the calibration hose has been installed, or exceed the recommended pulling force.

6.4.3 *Hydrostatic Head Calibration Hose Inversion*—The calibration hose should be inserted into the vertical inversion standpipe, with the impermeable plastic membrane side out. At the lower end of the inversion standpipe, the calibration hose should be turned inside out and attached to the standpipe so

that a leakproof seal is created. The resin-impregnated fabric tube should also be attached to the standpipe so that the calibration hose can invert into the center of the resin-impregnated tube. The inversion head should be adjusted to be of sufficient height of water head to cause the calibration hose to invert from the initial point of inversion to the point of termination and hold the resin-impregnated fabric tube tight to the pipe wall, producing dimples at side connections. Care should be taken during the inversion so as not to overstress the felt fiber. At the request of the purchaser, the fabric tube manufacturer should provide information on the maximum allowable axial and longitudinal tensile stress for the fabric tube.

6.4.3.1 An alternative method of installation is top inversion. In this case, the calibration hose and resin-impregnated fabric tube are attached to a top ring. In this case, the tube itself forms the standpipe for generation of the hydrostatic head. Other methods of installation are also available and should be submitted for acceptance by the purchaser.

6.4.4 *Using Air Pressure*—The resin-impregnated fabric tube should be perforated as described in 6.4.1. Once perforated, the wet-out fabric tube should be pulled into place using a power winch as described in 6.4.2. The calibration hose should be inserted through the guide chute or tube of the pressure containment device in which the calibration hose has been loaded, with the impermeable plastic membrane side out. At the end of the guide chute, the calibration hose should be turned inside out and attached so that a leakproof seal is created. The resin-impregnated tube should also be attached to the guide chute so that the calibration hose can invert into the center of the resin-impregnated tube. The inversion air pressure should be adjusted to be of sufficient pressure to cause the calibration hose to invert from point of inversion to point of termination and hold the resin saturated fabric tube tight to the pipe wall, producing dimples at side connections. Care should be taken during the inversion so as not to overstress the woven and nonwoven materials. Take suitable precautions to eliminate hazards to personnel in the proximity of the construction when pressurized air is being used.

6.5 *Lubricant During Installation*—The use of a lubricant during installation is recommended to reduce friction during inversion. This lubricant should be poured into the fluid in the standpipe in order to coat the calibration hose during inversion. When air is used to invert the calibration hose, the lubricant should be applied directly to the calibration hose. The lubricant used should be a nontoxic, oil-based product that has no detrimental effects on the tube or boiler and pump system, and will not adversely affect the fluid to be transported.

6.6 *Curing*:

6.6.1 *Using Circulating Heated Water*—After installation is completed, suitable heat source and water recirculation equipment are required to circulate heated water throughout the section to uniformly raise the water temperature above the temperature required to effect a cure of the resin. The water temperature in the line during the cure period should be as recommended by the resin manufacturer or seller.

6.6.1.1 The heat source should be fitted with suitable monitors to measure the temperature of the incoming and outgoing water supply. Temperature sensors should also be placed between the resin-impregnated tube and the host pipe invert at both termination points to monitor the temperatures during cure.

6.6.1.2 Initial cure will occur during temperature heat-up and is completed when exposed portions of the CIPP appear to be hard and sound and the remote temperature sensor indicates that the temperature is of a magnitude to realize an exotherm or cure in the resin. After initial cure is reached, the temperature should be raised to the post-cure temperature and held there for a period recommended by the resin manufacturer or seller. During post-cure, the recirculation of the water and cycling of the boiler to maintain the temperature continues. The curing of the CIPP must take into account the existing pipe material, the resin system, and ground conditions (temperature, moisture level, and thermal conductivity of soil).

6.6.2 *Using Steam*—After installation is completed, suitable steam-generating equipment is required to distribute steam throughout the pipe. The equipment should be capable of delivering steam throughout the section to uniformly raise the temperature within the pipe above the temperature required to effect a cure of the resin. The temperature in the line during the cure period should be as recommended by the resin manufacturer or seller.

6.6.2.1 The steam-generating equipment should be fitted with a suitable monitor to measure the temperature of the outgoing steam. Temperature sensors should also be placed between the resin-impregnated tube and the host pipe invert at both termination points to monitor the temperatures during cure.

6.6.2.2 Initial cure will occur during temperature heat-up and is completed when exposed portions of the new pipe appear to be hard and sound and the remote temperature sensor indicates that the temperature is of a magnitude to realize an exotherm or cure in the resin. After initial cure is reached, the temperature should be raised to the post-cure temperature and held there for a period recommended by the resin manufacturer or seller, during which time the distribution and control of steam to maintain the temperature continues. The curing of the CIPP must take into account the existing pipe material, the resin system, and ground conditions (temperature, moisture level, and thermal conductivity of soil).

6.6.3 *Required Pressures*—As required by the purchase agreement, the estimated maximum and minimum pressure required to hold the flexible tube tight against the existing conduit during the curing process should be provided by the seller and shall be increased to include consideration of external ground water, if present. Once the cure has started and dimpling for laterals is completed, the required pressures should be maintained until the cure has been completed. For water or steam, the pressure should be maintained within the estimated maximum and minimum pressure during the curing process. If the steam pressure or hydrostatic head drops below the recommended minimum during the cure, the CIPP should be inspected for lifts or delaminations and evaluated for its ability to fully meet the applicable requirements of 6.8 and Section 8.

6.7 *Cool-Down*:

6.7.1 *Using Cool Water after Heated Water Cure*—The new CIPP should be cooled to a temperature below 100°F (38°C) before relieving the static head in the inversion standpipe. Cool-down may be accomplished by the introduction of cool water into the inversion standpipe to replace water being drained from a small hole made in the downstream end. Take care to cool down the CIPP in a controlled manner, as recommended by the resin manufacturer or the seller. Care should be taken to release the static head so that a vacuum will not be developed that could damage the newly installed CIPP.

6.7.2 *Using Cool Water after Steam Cure*—The new CIPP should be cooled to a temperature below 100°F (38°C) before relieving the internal pressure within the section. Cool-down may be accomplished by the introduction of cool water into the section to replace the mixture of air and steam being drained from a small hole made in the downstream end. Take care to cool the CIPP in a controlled manner as recommended by the resin manufacturer or the seller. Care should be taken to release the air pressure so that a vacuum will not be developed that could damage the newly installed CIPP.

6.8 *Workmanship*—The finished CIPP should be continuous over the entire length of an installation and be free of dry spots, lifts, and delaminations. If these conditions are present, the CIPP will be evaluated for its ability to meet the applicable requirements of Section 8. Where the CIPP does not meet the requirements of Section 8 or specifically stated requirements of the purchase agreement, or both, the affected portions of CIPP will be removed and replaced with an equivalent repair.

6.8.1 If the CIPP does not fit tightly against the original pipe at its termination point(s), the full circumference of the CIPP exiting the existing host pipe or conduit should be sealed by filling with a resin mixture compatible with the CIPP.

6.9 *Service Connections*—After the new CIPP has been installed, the existing active (or inactive) service connections should be reinstated. This should generally be done without excavation, and in the case of non-man entry pipes, from the interior of the pipeline by means of a television camera and a remote-control cutting device. Service connections shall be reinstated to at least 90 % of the original area as it enters the host pipe or conduit.

NOTE 3—In many cases, a seal is provided where the formed CIPP dimples at service connections. However, this practice should not be construed to provide a 100 % watertight seal at all service connections. If total elimination of infiltration and inflow is desired, other means, which are beyond the scope of this practice, may be necessary to seal service connections and to rehabilitate service lines and manholes.

## 7. Material Requirements

7.1 *Fabric Tube Strength*—If required by the purchaser in the purchase agreement, the fabric tube, and seam (if applicable) as a quality control test, when tested in accordance with Test Method D 1682 shall have a minimum tensile strength of 750 psi (5 MPa) in both the longitudinal and transverse directions.

7.2 *Chemical Resistance*:

7.2.1 *Chemical Resistance Requirements*—The cured resin/fabric tube matrix, with or without the calibration hose, shall be evaluated in a laminate form for qualification testing of long-term chemical exposure to a variety of chemical effluents and should be evaluated in a manner consistent with 6.4.1 of Specification D 5813. The specimens shall be capable of exposure to the solutions in Table 2 at a temperature of 73.4 ± 3.6°F (23 ± 2°C), with a percentage retention of flexural modulus of elasticity of at least 80 % after one year exposure. Flexural properties, after exposure to the chemical solution(s), shall be based on dimensions of the specimens after exposure.

7.2.2 *Chemical Resistance Procedures*—The CIPP laminates should be constructed of identical fabric and resin components that will be used for anticipated in-field installations. The cured resin/fabric tube laminates, with or without the calibration hose should be exposed to the chemical agents in a manner consistent with Test Method D 543. The edges of the test coupons should be left exposed and not treated with resin, unless otherwise specified by the purchaser. The specimen thicknesses should be in the range of 0.125 to 0.25 in. (3.2 to 6.4 mm), with the sample dimensions suitable for preparing a minimum of five specimens for flexural testing as described in 8.1.4. Flexural properties after exposure to the chemical solutions should be based on the dimensions of the specimen after exposure.

7.2.2.1 For applications other than standard domestic sewerage, it is recommended that chemical resistance tests be conducted with actual samples of the fluid flowing in the pipe. These tests can also be accomplished by depositing CIPP test samples in the active pipe.

7.2.2.2 As required by the purchaser, additional chemical resistance requirements for the CIPP may be evaluated as described in 6.4 of Specification D 5813.

## 8. Recommended Inspection Practices

8.1 For each installation length designated by the purchaser in the purchase agreement, the preparation of CIPP samples is required from one or both of the following two methods:

8.1.1 The samples should be cut from a section of cured CIPP at an intermediate manhole or at the termination point that has been installed through a like diameter section of pipe or other tubular restraining means which has been held in place by a suitable heat sink, such as sandbags.

8.1.2 The sample should be fabricated from material taken from the fabric tube and the resin/catalyst system used, and cured in a clamped mold, placed in the downtube when heated circulated water is used, and in the silencer when steam is used. When the CIPP is constructed of oriented continuous or discontinuous fibers to enhance the physical properties of the CIPP, this method of sample preparation is recommended in order to allow testing in the axial (that is, along the length) and

**TABLE 2 Minimum Chemical Resistance Requirements for Domestic Sanitary Sewer Applications**

| Chemical Solution | Concentration, % |
|---|---|
| Nitric acid | 1 |
| Sulfuric acid | 5 |
| ASTM Fuel C[A] | 100 |
| Vegetable oil[B] | 100 |
| Detergent[C] | 0.1 |
| Soap[C] | 0.1 |

[A] In accordance with Specification D 4814.
[B] Cottonseed, corn, or mineral oil.
[C] In accordance with Test Method D 543.

circumferential (that is, hoop) directions of the CIPP. This method is also recommended when large-diameter CIPP is installed that may otherwise not be prepared with a tubular restraint.

8.1.3 The CIPP samples for each of these cases should be large enough to provide a minimum of three specimens and a recommended five specimens for flexural testing and also for tensile testing for internal pressure applications. The flexural and tensile specimens should be prepared in a manner consistent with 8.3.1 of Specification D 5813. For flexural and tensile properties, the full wall thickness of the CIPP samples shall be tested. Any plastic coatings or other CIPP layers not included in the structural design of the CIPP may be carefully ground off of the specimens prior to testing. If the sample is irregular or distorted such that proper testing is inhibited, attempts shall be made to machine any wall thickness from the inside pipe face of the sample. Any machining of the outside pipe face of the sample shall be done carefully so as to minimize the removal of material from the outer structural wall of the sample. Individual specimens should be clearly marked for easy identification and retained until final disposition or CIPP acceptance, or both, has been given.

8.1.4 *Short-Term Flexural (Bending) Properties*—The initial tangent flexural modulus of elasticity and flexural stress should be measured for gravity and pressure pipe applications in accordance with Test Method D 790, Test Method I, Procedure A and should meet the requirements of Table 1 within the 16:1 length to depth constraints. For specimens greater than 0.5 in. (12.7 mm) in depth, the width-to-depth ratio of the specimen should be increased to a minimum of 1:1 and should not exceed 4:1. For samples prepared in accordance with 8.1.1, determine flexural properties in the axial direction where the length of the test specimen is cut along the longitudinal axis of the pipe. Special consideration should be given to the preparation of flexural specimens to ensure opposite sides are parallel and adjacent edges are perpendicular. Flexural specimens should be tested such that the inside pipe face is tested in tension and the outside pipe face is in compression.

8.1.4.1 *Fiber-Reinforced CIPP Flexural Properties*—Where the CIPP is reinforced with oriented continuous or discontinuous fibers to enhance the physical properties of the CIPP, specimens should be sampled in accordance with 8.1.2, and flexural properties should be determined in accordance with 8.1.3 along the longitudinal axis and circumferential axis of the installed CIPP.

8.1.5 *Short-Term Tensile Properties*—The tensile strength should be measured for pressure pipe applications in accordance with Test Method D 638. Specimens should be prepared in accordance with Types I, II, and III of Fig. 1 of Test Method D 638. Specimens greater than 0.55 in. (14 mm) thick should maintain all dimensions for a Type III specimen, except the thickness will be that of the CIPP sample obtained. The rate of specimen testing should be carried out in accordance with Table 1 of Test Method D 638. Specimens should be prepared in accordance with 8.1.1 and tested along the longitudinal axis of the installed CIPP.

8.1.5.1 *Fiber-Reinforced CIPP Tensile Testing*—Where the CIPP is reinforced with oriented continuous or discontinuous fibers to enhance the physical properties of the CIPP, specimens should be sampled in accordance with 8.1.2 and tensile properties should be determined in accordance with Test Method D 3039 and tested along the longitudinal axis and circumferential axis of the installed CIPP.

8.1.6 *CIPP Wall Thickness*—The method of obtaining CIPP wall thickness measurements should be determined in a manner consistent with 8.1.2 of Specification D 5813. Thickness measurements should be made in accordance with Practice D 3567 for samples prepared in accordance with 8.1. Make a minimum of eight measurements at evenly spaced intervals around the circumference of the sample to ensure that minimum and maximum thicknesses have been determined. Deduct from the measured values the thickness of any plastic coatings or CIPP layers not included in the structural design of the CIPP. The average thickness should be calculated using all measured values and shall meet or exceed minimum design thickness as agreed upon between purchaser and seller. The minimum wall thickness at any point shall not be less than 87.5 % of the specified design thickness as agreed upon between purchaser and seller.

8.2 *Gravity Pipe Leakage Testing*—If required by the owner in the contract documents or purchase order, gravity pipes should be tested using an exfiltration test method where the CIPP is plugged at both ends and filled with water. This test should take place after the CIPP has cooled down to ambient temperature. This test is limited to pipe lengths with no service laterals and diameters of 36 in. or less. The allowable water exfiltration for any length of pipe between termination points should not exceed 50 U.S. gallons per inch of internal pipe diameter per mile per day, providing that all air has been bled from the line. During exfiltration testing, the maximum internal pipe pressure at the lowest end should not exceed 10 ft (3.0 m) of water or 4.3 psi (29.7 kPa), and the water level inside of the inversion standpipe should be 2 ft (0.6 m) higher than the top of the pipe or 2 ft (0.6 m) higher than groundwater level, whichever is greater. The leakage quantity should be gaged by the water level in a temporary standpipe placed in the upstream plug. The test should be conducted for a minimum of 1 h.

NOTE 4—It is impractical to test pipes above 36 in. diameter for leakage due to the technology available in the pipe rehabilitation industry. Post inspection of larger pipes will detect major leaks or blockages.

8.3 *Pressure Pipe Testing*—If required by the purchaser in the purchase agreement, pressure pipes should be subjected to a hydrostatic pressure test. A pressure and leakage test at twice the known working pressure or at the working pressure plus 50 psi, whichever is less, is recommended. The pressure should initially be held at the known working pressure for a period not less than 12 h, then increased to the test pressure for an additional period of 2 to 3 h to allow for stabilization of the CIPP. After this period, the pressure test will begin for a minimum of 1 h. The allowable leakage during the pressure test should be 20 U.S. gallons per inch of internal pipe diameter per mile per day, providing that all air has been evacuated from the line prior to testing and the CIPP has cooled down to ambient temperature.

NOTE 5—The allowable leakage for gravity and pressure pipe testing is a function of water loss at the end seals and trapped air in the pipe.

8.4 *Delamination Test*—If required by the purchaser in the purchase agreement, a delamination test should be performed on each installation length specified. CIPP samples should be prepared in accordance with 8.1.2, except that a portion of the fabric tube material in the sample should be dry and isolated from the resin in order to separate tube layers for testing (consult the tube manufacturer for further information). Delamination testing should be in accordance with Test Method D 903 with the following exceptions:

8.4.1 The rate of travel of the power-actuated grip should be 1 in. (25 mm)/min.

8.4.2 Five test specimens should be tested for each installation specified.

8.4.3 The thickness of the test specimen should be minimized, but should be sufficient to adequately test delamination of nonhomogeneous CIPP layers.

8.5 The peel or stripping strength between any nonhomogeneous layers of the CIPP laminate should be a minimum of 10 lb/in. (178.60 g/mm) for typical CIPP applications.

NOTE 6—The purchaser may designate the similar layers between which the delamination test will be conducted.

NOTE 7—For additional details on conducting the delamination test, contact the seller.

8.6 *Inspection and Acceptance*—The installation may be inspected visually if appropriate, or by closed-circuit television if visual inspection cannot be accomplished. Variations from true line and grade may be inherent because of the conditions of the original piping. No infiltration of groundwater should be observed. All service entrances should be accounted for and be unobstructed.

## 9. Keywords

9.1 cured-in-place pipe; installation—underground; plastic pipe—thermoset; rehabilitation; thermosetting resin pipe

## APPENDIX

### (Nonmandatory Information)

### X1. DESIGN CONSIDERATIONS

X1.1 *General Guidelines*—The design thickness of the CIPP is a function of the resin, materials of construction of the fabric tube, and the condition of the existing pipe. In addition, depending on the condition of the pipe, the design thickness of the CIPP may also be a function of groundwater, soil type, and influence of live loading surrounding the host pipe. For guidance relating to terminology of piping conditions and related design equations, see Appendix X1 of Practice F 1216.

**Amendment to ASTM F1743-96**
**Author: Doug Kleweno of DGK Technologies**

Douglas Kleweno
25124 235th Way SE
Maple Valley, WA 93038-5905

May 22, 2001

Whom it may concern:

I am writing this letter at the request of Mr. David Ratliff (Nu Flow Installer, Abilene, Texas) in order to provide clarification for ASTM F1743 "Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-In-Place Thermosetting Resin Pipe (CIPP)" and similar pulled-in-place products. In my previous position I was the Technical Manager for InLiner USA CIPP products and am the author of ASTM F1743. I have also been involved in editing ASTM F1216 and ASTM D5813, which are also CIPP installation and material specifications, respectively.

When writing an ASTM specification it is necessary to provide enough minimum requirements so that the product can meet or exceed engineering and design criteria. However, ASTM specifications also must be generalized enough to accommodate the majority of products and processes that may want to reference it. F1743 was generally written for most CIPP applications where heated cures predominate in the market. There are many resin applications for CIPP and other products (boat building, automotive, heavy truck) where ambient cure resin formulations are common and used successfully. Technically speaking, an ambient cure formulation for CIPP does initiate at a temperature less that 180F, which is recommended in Section 5.2.3 or F1743.

More critical to CIPP and other applications is whether the product (CIPP in this case) meets the minimum initial structural property recommendations. The minimum properties for the CIPP were provided in Section 4.2.3 of ASTM F1743 and this is probably the most important aspect for the product to meet the requirements for external hydrostatic or soil loading that may surround the pipe. These minimum properties are the numbers by which the minimum design thickness is determined for the installed CIPP or part liner.

As a side note it is my experience that the curing strategy is chosen for handling and transportation purposes. Large liners for CIPP require long catalyzed stability so the product can be processed, transported, and installed. For short runs or tubes processed at a job site, it was common to use ambient or semi-ambient cure formulations to reduce the time at the job site and the associated inconvenience to the surrounding community.

I hope this has provided some additional clarification.

Doug Kleweno
(423) 413-8529

NSF International

August 24, 2005

# TEST REPORT

Send To: 1P790
NU FLOW TECHNOLOGIES 2000 INC.
1010 THORNTON ROAD SOUTH
OSHAWA ON L1J 7E2
CANADA
Attn: MR. BOB FOWLE

Customer: 1P790
NU FLOW TECHNOLOGIES 2000 INC.
1010 THORNTON ROAD SOUTH
OSHAWA ON L1J 7E2
CANADA
Attn: MR. BOB FOWLE

Plant: 1P790
NU FLOW TECHNOLOGIES 2000 INC.
1010 THORNTON ROAD SOUTH
OSHAWA ON L1J 7E2
CANADA
Attn: MR. BOB FOWLE

Sample Description: Nu Flow #2000 Pipe Lining - Liner
Test Type: AA - Annual Collection

Thank you for having your product tested by NSF.

The enclosed report details the result of the testing performed on your product. Your program representative will be contacting you in the near future if there are any remaining issues concerning the status of this product.

Please do not hesitate to contact us if you have any immediate questions pertaining to your product.

Reviewer: ______________ Status: **Pass**

Atabek Ciechanowski - Manager, Engineering Laboratory

CC: Program: 010 - Plumbing and Related Programs
Program Rep: AMY CHOKSEY
Region: 01 - Domestic
PA Project: 224520





789 N. Dixboro Road, Ann Arbor, Michigan 48105-9723 USA
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General Information

Standard: 014 - PLASTICS PIPING SYSTEM COMPONENTS AND RELATED MATERIALS

DCC Number / Tracking ID PL04249
Family Code A
Material Type Epoxy
Monitor Code A
Performance Standard F1216
Performance Standard Year 2003
Product Identifier Part A Batch # 030904, Part B Batch # 040405_3
Sample Description Liner
Trade Designation Nu Flow #2000 Pipe Lining

Sample Id: S-0000161582
Description: Nu Flow #2000 Pipe Lining - Liner
Sampled Date: 05/19/2005
Received Date: 05/23/2005

| Testing Parameter | Result | Units |
|---|---|---|
| | | |
| **Engineering Lab** | | |
| Gravity Pipe Leakage Test | | |
| Initial water column: | 10 | feet |
| Final water column: | 10 | feet |
| Time: | 60 | minutes |
| Leakage rate: | 0 | g/in/day |
| Required maximum leakage rate: | 50 | g/in/day |
| Actual leakage rate: | 0 | g/in/day |
| Gravity Pipe Leakage Test: | Pass | |
| Flex Modulus | | |
| Specimens conditioned for | 40 | hours |
| Specimens conditioned at | 73 | degrees F |
| Relative humidity | 50 | % |
| Test temperature Required | 73 | degrees F |
| Test temperature Actual | 73 | degrees F |
| Required crosshead speed | 0.22 | in/min |
| Actual crosshead speed | 0.22 | in/min |
| Deflection | <5 | % |
| Specimen 1 | 280000 | psi |
| Specimen 2 | 315000 | psi |
| Specimen 3 | 275000 | psi |
| Specimen 4 | 242000 | psi |
| Specimen 5 | 257000 | psi |
| Required Average Modulus (minimum) | 250000 psi | |
| Actual Average Modulus | 274000 | psi |
| Flex Modulus Test | PASS | |
| Flexural Strength Test | | |
| Specimens conditioned for | 40 | hours |
| Specimens conditioned at | 73 | degrees F |
| Relative Humidity | 50 | percent |
| Test Temperature | 73 | degrees F |
| Cross Head Speed | 0.22 | in/min. |
| Specimen 1 Flexural Strength | 6280 | psi |
| Specimen 2 Flexural Strength | 6480 | psi |
| Specimen 3 Flexural Strength | 6010 | psi |
| Specimen 4 Flexural Strength | 5210 | psi |

Sample Id: S-0000161582

| Testing Parameter | Result | Units |
|---|---|---|
| | | |
| **Engineering Lab ( Cont'd )** | | |
| Specimen 5 Flexural Strength | 5820 | psi |
| Average Flexural Strength | 5960 | psi |
| Required Flexural Strength | 4500 | psi |
| Flexural Strength Test | Pass | |
| Strength, Tensile | | |
| Specimens conditioned for | 40 | hours |
| Specimens conditioned at | 73 | degrees F |
| Relative humidity | 50 | % |
| Test Temperature | 73 | degrees F |
| Actual Crosshead Speed | 0.2 | in/min. |
| Required Crosshead Speed | 0.2 | in/min. |
| Specimen 1: Tensile Strength | 3930 | psi |
| Specimen 2: Tensile Strength | 4540 | psi |
| Specimen 3: Tensile Strength | 4010 | psi |
| Specimen 4: Tensile Strength | 3690 | psi |
| Specimen 5: Tensile Strength | 3920 | psi |
| Req'd Average Tensile Strength (minimum) | 3000 | |
| Actual Average Tensile Strength | 4020 | psi |
| Tensile Strength Test | PASS | |
| Specimen Fabrication | | |
| Specimen Fabrication | COMPLETE | |
| Time | 1 | hours |
| Technician | 3356 | |

*Testing Laboratories:*

| | Id | Address |
|---|---|---|
| All work performed at: → | NSF_AA | NSF International<br>789 Dixboro Road<br>Ann Arbor MI 48105-0140<br>USA |

*References to Testing Procedures:*

| NSF Reference | Parameter / Test Description |
|---|---|
| P3084 | Gravity Pipe Leakage Test |
| P3122 | Flex Modulus |
| P3123 | Flexural Strength Test |
| P3127 | Strength, Tensile |
| P3172 | Specimen Fabrication |

03/16/2007 FRI 14:39 FAX 905 673 8394 ACUREN GROUP INC. 002/002

ACUREN

*Client*

NU FLOW TECHNOLOGIES 2000 INC.
1010 Thornton Road South
Oshawa, Ontario
L1J 7E2

# Laboratory Report

| *Attention* | *Client's Order Number* | *Date* | *Report Number* |
|---|---|---|---|
| Sinan Omari | 9282 | 16 March 2007 | **07-845** |

| *Client's Material / Product Description* | *Date Sample Received* | *Material / Product Specification* |
|---|---|---|
| (1) Sample | 06 March 2007 | ASTM D5813-04 |

| Test Performed | | Result | |
|---|---|---|---|
| 1. Tangent Flexural Modulus (ASTM D790) | Sample # | | |
| • Crosshead speed: 0.05"/min | 1 | 384400 | |
| • 1000 lbf Load cell | 2 | 420900 | 250,000 psi Minimum |
| • 2 inch support span | 3 | 304600 | |
| • L/D = 16 | 4 | 425400 | |
| • Specimen Geometry: 1/8" x 1/2" x 4" | 5 | 397100 | |
| • 5 specimens tested | Average | 386500 | |
| • Units: psi | | | |
| 2. Flexural Strength (ASTM D790) | Sample # | | |
| | 1 | 6 070 | |
| • 5 specimens tested | 2 | 6 670 | |
| • Units: psi | 3 | 5 400 | 4,500 psi Minimum |
| | 4 | 6 200 | |
| | 5 | 6 440 | |
| | Average | 6 160 | |
| 3. Wall Thickness | Side A | Side B | |
| • Units: mm | 3.56 | 3.26 | |
| • Four measurements taken on each side | 3.62 | 3.45 | |
| | 3.67 | 3.50 | |
| | 3.79 | 3.74 | |

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Standards Council of Canada
Accredited Laboratory
Scope of Accreditation 60

Conseil canadien des normes
Laboratoire accrédité
Portée d'accréditation 60
TM

Page 1 of 1

RELINE REPAIR RENEW

# Flow Comparisons

## Comparison between a new pipe and a rehabilitated pipe

| Diameter | | Hazen Williams Coefficient (C) | Flow for new pipe ($m^3/s$) | Thickness of Liner (mm) | Resulting internal diameter (m) | Hazen Williams coefficient (C) | Flow for rehabilitated pipe ($m^3/s$) | % Loss |
|---|---|---|---|---|---|---|---|---|
| (m) | (in) | | | | | | | |
| 0.15 | 6 | 140 | 0.27 | 2 | 0.146 | 140 | 0.25 | -6.86 |
| 0.20 | 8 | 140 | 0.57 | 2 | 0.196 | 140 | 0.54 | -5.17 |
| 0.30 | 10 | 140 | 1.02 | 2 | 0.246 | 140 | 0.98 | -4.15 |
| 0.40 | 12 | 140 | 1.65 | 2.5 | 0.295 | 140 | 1.57 | -4.32 |

## Comparison between old pipe and a rehabilitated pipe

| Old Pipe Diameter | | Hazen Williams Coefficient (C) | Flow for old pipe ($m^3/s$) | Thickness of Liner (mm) | Old Pipe diameter (m) | Hazen Williams coefficient (C) | Flow for rehabilitated pipe ($m^3/s$) | % Increase |
|---|---|---|---|---|---|---|---|---|
| (m) | (in) | | | | | | | |
| 0.13 | 6 | 60 | 0.08 | 2 | 0.146 | 140 | 0.25 | 216.63 |
| 0.18 | 8 | 60 | 0.18 | 2 | 0.196 | 140 | 0.54 | 191.91 |
| 0.23 | 10 | 60 | 0.35 | 2 | 0.246 | 140 | 0.98 | 178.48 |
| 0.27 | 12 | 60 | 0.53 | 2.5 | 0.295 | 140 | 1.57 | 194.52 |

## P4321



| | | | | | |
|---|---|---|---|---|---|
| **Date Submitted** | 4/1/2010 | **Section** | 1102.4 | **Proponent** | Allen Johnson |
| **Chapter** | 11 | **Affects HVHZ** | No | **Attachments** | Yes |

**TAC Recommendation** No Affirmative Recommendation with a Second
**Commission Action** Pending Review

**Related Modifications**

702.1, 702.2, 702.3, 1102.1, 1102.2, 1102.3

**Summary of Modification**

Modify the current building materials list to include Cure-In Place (CIPP) Thermosetting Resin Conduit Liner that meets ASTM F-1743, ASTM F-1216, ASTM D790, ASTM D638 and ASTM D543. in sections 702.1,702.2, 702.3, 1102.1, 1102.2, 1102.3 and 1102.4 for building drains and building sewer pipes.

**Rationale**

CIPP liners are an alternative to traditional pipe replacement that increases the flow charicteristics of the pipe.

**Fiscal Impact Statement**

**Impact to local entity relative to enforcement of code**

There are no additional costs relative to enforcement compared to traditional replacement.

**Impact to building and property owners relative to cost of compliance with code**

There is a significant cost savings to building and property owners as well as reducing potentially hazardous materials left undisturbed as compared to traditional pipe replacement CIPP liners are seamless and jointless, reducing the number of potential failures.

**Impact to industry relative to the cost of compliance with code**

There is no impact to the industry relative to the cost of compliance with code.

**Requirements**

**Has a reasonable and substantial connection with the health, safety, and welfare of the general public**

CIPP lining eliminates the destruction of landscapes and property as well as the health dangers associated with removing of sewer pipes in need of repair.

**Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction**

CIPP liners provide a repair solution that allows drain, waste and sewer pipes to be repaired without the digging and destruction required for traditional pipe repairs or replacement.

**Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities**

CIPP lining can be installed in any type of host pipe used for Building drains and Building sewer pipes for residential, commercial and industrial applications.

**Does not degrade the effectiveness of the code**

CIPP lining does not degrade the effectiveness of the code.

TopPrevious SectionNext Section

## SECTION 702 MATERIALS

**702.1 Above-ground sanitary drainage and vent pipe.** Above-ground soil, waste and vent pipe shall conform to one of the standards listed in Table 702.1.

### TABLE 702.1 ABOVE-GROUND DRAINAGE AND VENT PIPE

| MATERIAL | STANDARD |
|---|---|
| Acrylonitrile butadiene styrene (ABS) plastic pipe in IPS diameters, including Schedule 40, DR 22 (PS 200) and DR 24 (PS 140); with a solid, cellular core or composite wall | ASTM D 2661; ASTM F 628; ASTM F 1488; CSA B181.1 |
| Brass pipe | ASTM B 43 |
| Cast-iron pipe | ASTM A 74; ASTM A 888; CISPI 301 |
| Copper or copper-alloy pipe | ASTM B 42; ASTM B 302 |
| Copper or copper-alloy tubing (Type K, L, M or DWV) | ASTM B 75; ASTM B 88; ASTM B 251; ASTM B 306 |
| Galvanized steel pipe | ASTM A 53 |
| Glass pipe | ASTM C 1053 |
| Polyolefin pipe | ASTM F 1412; CAN/CSA B181.3 |
| Polyvinyl chloride (PVC) plastic pipe in IPS diameters, including schedule 40, DR 22 (PS 200), and DR 24 (PS 140); with a solid, cellular core or composite wall | ASTM D 2665; ASTM F 891; ASTM F 1488; CSA B181.2 |
| Polyvinyl chloride (PVC) plastic pipe with a 3.25-inch O.D. and a solid, cellular core or composite wall | ASTM D 2949, ASTM F 1488 |
| Polyvinylidene fluoride (PVDF) plastic pipe | ASTM F 1673; CAN/CSA B181.3 |
| Stainless steel drainage systems, Types 304 and 316L | ASME A112. |
| Cured-In Place Thermosetting Resin Conduit Liner (CIPP) | ASTM F1743, ASTM F1216, ASTM D790, ASTM D638, ASTM D543 |

Designation: F 1743 – 96 (Reapproved 2003)

An American National Standard

# Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe (CIPP)[1]

This standard is issued under the fixed designation F 1743; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This practice describes the procedures for the reconstruction of pipelines and conduits (4 to 96 in. (10 to 244 cm) diameter) by the pulled-in-place installation of a resin-impregnated, flexible fabric tube into an existing conduit and secondarily inflated through the inversion of a calibration hose by the use of a hydrostatic head or air pressure (see Fig. 1). The resin is cured by circulating hot water or by the introduction of controlled steam into the tube. When cured, the finished cured-in-place pipe will be continuous and tight fitting. This reconstruction process may be used in a variety of gravity and pressure applications such as sanitary sewers, storm sewers, process piping, electrical conduits, and ventilation systems.

1.2 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for informational purposes only.

NOTE 1—There are no ISO standards covering the primary subject matter of this practice.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

2.1 *ASTM Standards:*

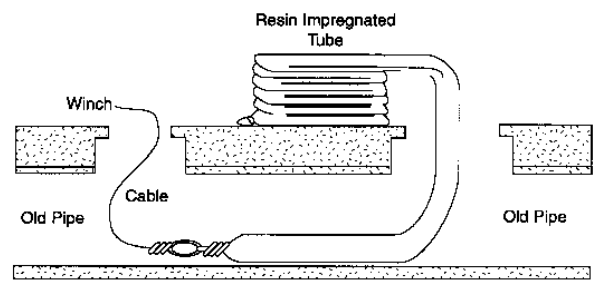
D 543 Test Method of Resistance of Plastics to Chemical Reagents[2]

D 638 Test Method for Tensile Properties of Plastics[2]

D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials[2]

D 903 Test Method for Peel or Stripping Strength of Adhesive Bonds[3]

**Step 1 – Pull resin-impregnated tube into existing pipe.**




**Step 2 – Calibration hose inversion**

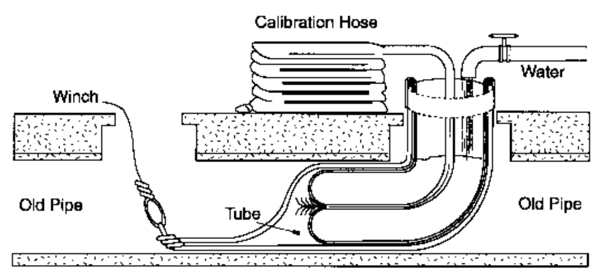



FIG. 1 Cured-in-Place Pipe Installation Methods

D 1600 Terminology for Abbreviated Terms Relating to Plastics[2]

D 1682 Test Method for Breaking Load and Elongation of Textile Fabrics[4]

D 3039/D3039M Test Method for Tensile Properties of Polymer Matrix Composite Materials[5]

[1] This practice is under the jurisdiction of ASTM Committee F-17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.67 on Trenchless Plastic Pipeline Technology.

Current edition approved Feb. 10, 2003. Published April 2003. Last previous edition approved in 1996 as F1743–96.

[2] *Annual Book of ASTM Standards*, Vol 08.01.

[3] *Annual Book of ASTM Standards*, Vol 15.06.

[4] *Discontinued: See 1991 Annual Book of ASTM Standards*, Vol 07.01.

[5] *Annual Book of ASTM Standards*, Vol 15.03.

D 3567 Practice for Determining Dimensions of Reinforced Thermosetting Resin Pipe (RTRP) and Fittings[6]
D 4814 Specification for Automotive Spark—Ignition Engine Fuel[7]
D 5813 Specification for Cured-in-Place Thermosetting Resin Sewer Pipe[6]
F 412 Terminology Relating to Plastic Piping Systems[6]
F 1216 Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube[6]
2.2 *AWWA Standard:*
M28 Manual on Cleaning and Lining Water Mains[8]
2.3 *NASSCO Standard:*
Recommended Specifications for Sewer Collection System Rehabilitation[9]

NOTE 2—An ASTM specification for cured-in-place pipe materials appropriate for use in this practice is under preparation and will be referenced in this practice when published.

## 3. Terminology

3.1 *General*—Definitions are in accordance with Terminology F 412. Abbreviations are in accordance with Terminology D 1600, unless otherwise indicated.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *calibration hose*—an impermeable bladder which is inverted within the resin-impregnated fabric tube by hydrostatic head or air pressure and may optionally be removed or remain in place as a permanent part of the installed cured-in-place pipe as described in 5.2.2.

3.2.2 *cured-in-place pipe (CIPP)*—a hollow cylinder consisting of a fabric tube with cured (cross-linked) thermosetting resin. Interior or exterior plastic coatings, or both, may be included. The CIPP is formed within an existing pipe and takes the shape of and fits tightly to the pipe.

3.2.3 *delamination*—separation of layers of the CIPP.

3.2.4 *dry spot*—an area of fabric of the finished CIPP which is deficient or devoid of resin.

3.2.5 *fabric tube*—flexible needled felt, or equivalent, woven or nonwoven material(s), or both, formed into a tubular shape which during the installation process is saturated with resin and holds the resin in place during the installation and curing process.

3.2.6 *inversion*—the process of turning the calibration hose inside out by the use of water pressure or air pressure.

3.2.7 *lift*—a portion of the CIPP that is a departure from the existing conduit wall forming a section of reverse curvature in the CIPP.

## 4. Significance and Use

4.1 This practice is for use by designers and specifiers, regulatory agencies, owners, and inspection organizations who are involved in the rehabilitation of conduits through the use of a resin-impregnated fabric tube pulled-in-place through an existing conduit and secondarily inflated through the inversion of a calibration hose. Modifications may be required for specific job conditions.

## 5. Recommended Materials and Manufacture

5.1 *General*—The resins, fabric tube, tube coatings, or other materials, such as the permanent calibration hose when combined as a composite structure, shall produce CIPP that meets the requirements of this specification.

5.2 *CIPP Wall Composition*—The wall shall consist of a plastic coated fabric tube filled with a thermosetting (cross-linked) resin, and if used, a filler.

5.2.1 *Fabric Tube*—The fabric tube should consist of one or more layers of flexible needled felt, or equivalent, woven or nonwoven material(s), or both, capable of carrying resin, withstanding installation pressures, and curing temperatures. The material(s) of construction should be able to stretch to fit irregular pipe sections and negotiate bends. Longitudinal and circumferential joints between multiple layers of fabric should be staggered so as not to overlap. The outside layer of the fabric tube should have an impermeable flexible coating(s) whose function is to contain the resin during and after fabric tube impregnation. The outer coating(s) must facilitate monitoring of resin saturation of the material(s) of construction of the fabric tube. The fabric tube should be fabricated to a size that, when installed, will tightly fit the internal circumference and the length of the original conduit. Allowance should be made for circumferential and longitudinal stretching of the fabric tube during installation. As required, the fabric tube should meet minimum tensile strength requirements in the longitudinal and transverse directions as specified in 7.1. All the material(s) of construction for the fabric tube should be compatible with the resin system used.

5.2.2 *Calibration Hose*:

5.2.2.1 *Removable Calibration Hose*—The removable calibration hose should consist of an impermeable plastic, or impermeable plastic coating(s) on flexible woven or nonwoven material(s), or both, that do not absorb resin and are capable of being removed from the CIPP.

5.2.2.2 *Permanent Calibration Hose*—The permanent calibration hose should consist of an impermeable plastic coating on a flexible needled felt or equivalent woven or nonwoven material(s), or both, that are capable of absorbing resin and are of a thickness to become fully saturated with resin. The calibration hose should be translucent to facilitate post-installation inspection. The calibration hose should be fabricated to a size that, when installed, will tightly fit the internal circumference and the length of the resin saturated fabric tube. Once inverted, the calibration hose becomes part of the fabric tube, and once properly cured, should bond permanently with the fabric tube. The properties of the calibration hose should meet minimum tensile strength requirements in the longitudinal and transverse directions as specified in 7.1. All the material(s) of construction for the calibration hose should be compatible with the resin system used.

5.2.3 *Resin*—A chemically resistant isophthalic based polyester, or vinyl ester thermoset resin and catalyst system or an

[6] *Annual Book of ASTM Standards*, Vol 08.04.
[7] *Annual Book of ASTM Standards*, Vol 05.03.
[8] Available from the American Water Works Association, 6666 W. Quincey Ave., Denver, CO 80235.
[9] Available from the National Association of Sewer Service Companies, 101 Wymore Rd., Suite 501, Altamonte, FL 32714.

epoxy resin and hardener that is compatible with the installation process should be used. The resin should be able to cure in the presence of water and the initiation temperature for cure should be less than 180°F (82.2°C). The cured resin/fabric tube system, with or without the calibration hose, shall be expected to have as a minimum the initial structural properties given in Table 1. These physical properties should be determined in accordance with Section 8. The cured resin/fabric tube system, with or without the calibration hose, should meet the minimum chemical resistance requirements as specified in 7.2.

## 6. Installation Recommendations

6.1 *Cleaning and Pre-Inspection*:

6.1.1 Prior to entering access areas, such as manholes, and performing inspection or cleaning operations, 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.

6.1.2 *Cleaning of Pipeline*—All internal debris should be removed from the original pipeline. Gravity pipes should be cleaned with hydraulically powered equipment, high-velocity jet cleaners, or mechanically powered equipment in accordance with NASSCO Recommended Specifications for Sewer Collection System Rehabilitation. Pressure pipelines should be cleaned with cable attached devices or fluid propelled devices in accordance with AWWA M28.

6.1.3 *Inspection of Pipelines*—Inspection of pipelines should be performed by experienced personnel trained in locating breaks, obstacles, and service connections by closed-circuit television or man entry. The interior of the pipeline should be carefully inspected to determine the location of any conditions that may prevent proper installation of the impregnated tube, such as protruding service taps, collapsed or crushed pipe, and reductions in the cross-sectional area of more than 40 %. These conditions should be noted so that they can be corrected.

6.1.4 *Line Obstructions*—The original pipeline should be clear of obstructions such as solids, dropped joints, protruding service connections, crushed or collapsed pipe, and reductions in the cross-sectional area of more than 40 % that may hinder or prevent the installation of the resin-impregnated fabric tube. If inspection reveals an obstruction that cannot be removed by conventional sewer-cleaning equipment, then a point-repair excavation should be made to uncover and remove or repair the obstruction.

6.2 *Resin Impregnation*—The fabric tube should be totally impregnated with resin (wet-out) and run through a set of rollers separated by a space, calibrated under controlled conditions to ensure proper distribution of resin. The volume of resin used should be sufficient to fully saturate all the voids of the fabric tube material, as well as all resin-absorbing material of the calibration hose at nominal thickness and diameter. The volume should be adjusted by adding 3 to 15 % excess resin to allow for the change in resin volume due to polymerization, the change in resin volume due to thermal expansion or contraction, and resin migration through the perforations of the fabric tube and out onto the host pipe.

**TABLE 1 CIPP Initial Structural Properties**[A]

| Property | Test Method | Minimum Value psi | Minimum Value (MPa) |
|---|---|---|---|
| Flexural strength | D 790 | 4 500 | (31) |
| Flexural modulus | D 790 | 250 000 | (1724) |
| Tensile strength (for pressure pipes only) | D 638 | 3 000 | (21) |

[A]The values in Table 1 are for field inspection. The purchaser should consult the manufacturer for the long-term structural properties.

6.3 *Bypassing*—If bypassing of the flow is required around the sections of pipe designated for reconstruction, the bypass should be made by plugging the line at a point upstream of the pipe to be reconstructed and pumping the flow to a downstream point or adjacent system. The pump and bypass lines should be of adequate capacity and size to handle the flow. Services within this reach will be temporarily out of service.

6.3.1 Public advisory services shall notify all parties whose service laterals will be out of commission and advise against water usage until the main line is back in service.

6.4 *Installation Methods*:

6.4.1 *Perforation of Resin-Impregnated Tube*—Prior to pulling the resin-impregnated fabric tube in place, the outer impermeable plastic coating may optionally be perforated. When the resin-impregnated fabric tube is perforated, this should allow resin to be forced through the perforations and out against the existing conduit by the force of the hydrostatic head or air pressure against the inner wall of the calibration hose. The perforation should be done after fabric tube impregnation with a perforating roller device at the point of manufacture or at the jobsite. Perforations should be made on both sides of the lay-flat fabric tube covering the full circumference with a spacing no less than 1.5 in. (38.1 mm) apart. Perforating slits should be a minimum of 0.25 in. (6.4 mm) long.

6.4.2 *Pulling Resin-Impregnated Tube into Position*—The wet-out fabric tube should be pulled into place using a power winch. The saturated fabric tube should be pulled through an existing manhole or other approved access to fully extend to the next designated manhole or termination point. Care should be exercised not to damage the tube as a result of friction during pull-in, especially where curvilinear alignments, multilinear alignments, multiple offsets, protruding services, and other friction-producing host pipe conditions are present. Once the fabric tube is in place, it should be attached to a vertical standpipe so that the calibration hose can invert into the center of the resin-impregnated fabric tube. The vertical standpipe should be of sufficient height of water head to hold the fabric tube tight to the existing pipe wall, producing dimples at side connections. A device such as a dynamometer or load cell should be provided on the winch or cable to monitor the pulling force. Measure the overall elongation of the fabric tube after pull-in completion. The acceptable longitudinal elongation shall not be more than 5 % of the overall length measured after the calibration hose has been installed, or exceed the recommended pulling force.

6.4.3 *Hydrostatic Head Calibration Hose Inversion*—The calibration hose should be inserted into the vertical inversion standpipe, with the impermeable plastic membrane side out. At the lower end of the inversion standpipe, the calibration hose should be turned inside out and attached to the standpipe so

that a leakproof seal is created. The resin-impregnated fabric tube should also be attached to the standpipe so that the calibration hose can invert into the center of the resin-impregnated tube. The inversion head should be adjusted to be of sufficient height of water head to cause the calibration hose to invert from the initial point of inversion to the point of termination and hold the resin-impregnated fabric tube tight to the pipe wall, producing dimples at side connections. Care should be taken during the inversion so as not to overstress the felt fiber. At the request of the purchaser, the fabric tube manufacturer should provide information on the maximum allowable axial and longitudinal tensile stress for the fabric tube.

6.4.3.1 An alternative method of installation is top inversion. In this case, the calibration hose and resin-impregnated fabric tube are attached to a top ring. In this case, the tube itself forms the standpipe for generation of the hydrostatic head. Other methods of installation are also available and should be submitted for acceptance by the purchaser.

6.4.4 *Using Air Pressure*—The resin-impregnated fabric tube should be perforated as described in 6.4.1. Once perforated, the wet-out fabric tube should be pulled into place using a power winch as described in 6.4.2. The calibration hose should be inserted through the guide chute or tube of the pressure containment device in which the calibration hose has been loaded, with the impermeable plastic membrane side out. At the end of the guide chute, the calibration hose should be turned inside out and attached so that a leakproof seal is created. The resin-impregnated tube should also be attached to the guide chute so that the calibration hose can invert into the center of the resin-impregnated tube. The inversion air pressure should be adjusted to be of sufficient pressure to cause the calibration hose to invert from point of inversion to point of termination and hold the resin saturated fabric tube tight to the pipe wall, producing dimples at side connections. Care should be taken during the inversion so as not to overstress the woven and nonwoven materials. Take suitable precautions to eliminate hazards to personnel in the proximity of the construction when pressurized air is being used.

6.5 *Lubricant During Installation*—The use of a lubricant during installation is recommended to reduce friction during inversion. This lubricant should be poured into the fluid in the standpipe in order to coat the calibration hose during inversion. When air is used to invert the calibration hose, the lubricant should be applied directly to the calibration hose. The lubricant used should be a nontoxic, oil-based product that has no detrimental effects on the tube or boiler and pump system, and will not adversely affect the fluid to be transported.

6.6 *Curing*:

6.6.1 *Using Circulating Heated Water*—After installation is completed, suitable heat source and water recirculation equipment are required to circulate heated water throughout the section to uniformly raise the water temperature above the temperature required to effect a cure of the resin. The water temperature in the line during the cure period should be as recommended by the resin manufacturer or seller.

6.6.1.1 The heat source should be fitted with suitable monitors to measure the temperature of the incoming and outgoing water supply. Temperature sensors should also be placed between the resin-impregnated tube and the host pipe invert at both termination points to monitor the temperatures during cure.

6.6.1.2 Initial cure will occur during temperature heat-up and is completed when exposed portions of the CIPP appear to be hard and sound and the remote temperature sensor indicates that the temperature is of a magnitude to realize an exotherm or cure in the resin. After initial cure is reached, the temperature should be raised to the post-cure temperature and held there for a period recommended by the resin manufacturer or seller. During post-cure, the recirculation of the water and cycling of the boiler to maintain the temperature continues. The curing of the CIPP must take into account the existing pipe material, the resin system, and ground conditions (temperature, moisture level, and thermal conductivity of soil).

6.6.2 *Using Steam*—After installation is completed, suitable steam-generating equipment is required to distribute steam throughout the pipe. The equipment should be capable of delivering steam throughout the section to uniformly raise the temperature within the pipe above the temperature required to effect a cure of the resin. The temperature in the line during the cure period should be as recommended by the resin manufacturer or seller.

6.6.2.1 The steam-generating equipment should be fitted with a suitable monitor to measure the temperature of the outgoing steam. Temperature sensors should also be placed between the resin-impregnated tube and the host pipe invert at both termination points to monitor the temperatures during cure.

6.6.2.2 Initial cure will occur during temperature heat-up and is completed when exposed portions of the new pipe appear to be hard and sound and the remote temperature sensor indicates that the temperature is of a magnitude to realize an exotherm or cure in the resin. After initial cure is reached, the temperature should be raised to the post-cure temperature and held there for a period recommended by the resin manufacturer or seller, during which time the distribution and control of steam to maintain the temperature continues. The curing of the CIPP must take into account the existing pipe material, the resin system, and ground conditions (temperature, moisture level, and thermal conductivity of soil).

6.6.3 *Required Pressures*—As required by the purchase agreement, the estimated maximum and minimum pressure required to hold the flexible tube tight against the existing conduit during the curing process should be provided by the seller and shall be increased to include consideration of external ground water, if present. Once the cure has started and dimpling for laterals is completed, the required pressures should be maintained until the cure has been completed. For water or steam, the pressure should be maintained within the estimated maximum and minimum pressure during the curing process. If the steam pressure or hydrostatic head drops below the recommended minimum during the cure, the CIPP should be inspected for lifts or delaminations and evaluated for its ability to fully meet the applicable requirements of 6.8 and Section 8.

6.7 *Cool-Down*:

6.7.1 *Using Cool Water after Heated Water Cure*—The new CIPP should be cooled to a temperature below 100°F (38°C) before relieving the static head in the inversion standpipe. Cool-down may be accomplished by the introduction of cool water into the inversion standpipe to replace water being drained from a small hole made in the downstream end. Take care to cool down the CIPP in a controlled manner, as recommended by the resin manufacturer or the seller. Care should be taken to release the static head so that a vacuum will not be developed that could damage the newly installed CIPP.

6.7.2 *Using Cool Water after Steam Cure*—The new CIPP should be cooled to a temperature below 100°F (38°C) before relieving the internal pressure within the section. Cool-down may be accomplished by the introduction of cool water into the section to replace the mixture of air and steam being drained from a small hole made in the downstream end. Take care to cool the CIPP in a controlled manner as recommended by the resin manufacturer or the seller. Care should be taken to release the air pressure so that a vacuum will not be developed that could damage the newly installed CIPP.

6.8 *Workmanship*—The finished CIPP should be continuous over the entire length of an installation and be free of dry spots, lifts, and delaminations. If these conditions are present, the CIPP will be evaluated for its ability to meet the applicable requirements of Section 8. Where the CIPP does not meet the requirements of Section 8 or specifically stated requirements of the purchase agreement, or both, the affected portions of CIPP will be removed and replaced with an equivalent repair.

6.8.1 If the CIPP does not fit tightly against the original pipe at its termination point(s), the full circumference of the CIPP exiting the existing host pipe or conduit should be sealed by filling with a resin mixture compatible with the CIPP.

6.9 *Service Connections*—After the new CIPP has been installed, the existing active (or inactive) service connections should be reinstated. This should generally be done without excavation, and in the case of non-man entry pipes, from the interior of the pipeline by means of a television camera and a remote-control cutting device. Service connections shall be reinstated to at least 90 % of the original area as it enters the host pipe or conduit.

NOTE 3—In many cases, a seal is provided where the formed CIPP dimples at service connections. However, this practice should not be construed to provide a 100 % watertight seal at all service connections. If total elimination of infiltration and inflow is desired, other means, which are beyond the scope of this practice, may be necessary to seal service connections and to rehabilitate service lines and manholes.

## 7. Material Requirements

7.1 *Fabric Tube Strength*—If required by the purchaser in the purchase agreement, the fabric tube, and seam (if applicable) as a quality control test, when tested in accordance with Test Method D 1682 shall have a minimum tensile strength of 750 psi (5 MPa) in both the longitudinal and transverse directions.

7.2 *Chemical Resistance*:

7.2.1 *Chemical Resistance Requirements*—The cured resin/fabric tube matrix, with or without the calibration hose, shall be evaluated in a laminate form for qualification testing of long-term chemical exposure to a variety of chemical effluents and should be evaluated in a manner consistent with 6.4.1 of Specification D 5813. The specimens shall be capable of exposure to the solutions in Table 2 at a temperature of 73.4 ± 3.6°F (23 ± 2°C), with a percentage retention of flexural modulus of elasticity of at least 80 % after one year exposure. Flexural properties, after exposure to the chemical solution(s), shall be based on dimensions of the specimens after exposure.

7.2.2 *Chemical Resistance Procedures*—The CIPP laminates should be constructed of identical fabric and resin components that will be used for anticipated in-field installations. The cured resin/fabric tube laminates, with or without the calibration hose should be exposed to the chemical agents in a manner consistent with Test Method D 543. The edges of the test coupons should be left exposed and not treated with resin, unless otherwise specified by the purchaser. The specimen thicknesses should be in the range of 0.125 to 0.25 in. (3.2 to 6.4 mm), with the sample dimensions suitable for preparing a minimum of five specimens for flexural testing as described in 8.1.4. Flexural properties after exposure to the chemical solutions should be based on the dimensions of the specimen after exposure.

7.2.2.1 For applications other than standard domestic sewerage, it is recommended that chemical resistance tests be conducted with actual samples of the fluid flowing in the pipe. These tests can also be accomplished by depositing CIPP test samples in the active pipe.

7.2.2.2 As required by the purchaser, additional chemical resistance requirements for the CIPP may be evaluated as described in 6.4 of Specification D 5813.

## 8. Recommended Inspection Practices

8.1 For each installation length designated by the purchaser in the purchase agreement, the preparation of CIPP samples is required from one or both of the following two methods:

8.1.1 The samples should be cut from a section of cured CIPP at an intermediate manhole or at the termination point that has been installed through a like diameter section of pipe or other tubular restraining means which has been held in place by a suitable heat sink, such as sandbags.

8.1.2 The sample should be fabricated from material taken from the fabric tube and the resin/catalyst system used, and cured in a clamped mold, placed in the downtube when heated circulated water is used, and in the silencer when steam is used. When the CIPP is constructed of oriented continuous or discontinuous fibers to enhance the physical properties of the CIPP, this method of sample preparation is recommended in order to allow testing in the axial (that is, along the length) and

TABLE 2 Minimum Chemical Resistance Requirements for Domestic Sanitary Sewer Applications

| Chemical Solution | Concentration, % |
|---|---|
| Nitric acid | 1 |
| Sulfuric acid | 5 |
| ASTM Fuel C[A] | 100 |
| Vegetable oil[B] | 100 |
| Detergent[C] | 0.1 |
| Soap[C] | 0.1 |

[A]In accordance with Specification D 4814.
[B]Cottonseed, corn, or mineral oil.
[C]In accordance with Test Method D 543.

circumferential (that is, hoop) directions of the CIPP. This method is also recommended when large-diameter CIPP is installed that may otherwise not be prepared with a tubular restraint.

8.1.3 The CIPP samples for each of these cases should be large enough to provide a minimum of three specimens and a recommended five specimens for flexural testing and also for tensile testing for internal pressure applications. The flexural and tensile specimens should be prepared in a manner consistent with 8.3.1 of Specification D 5813. For flexural and tensile properties, the full wall thickness of the CIPP samples shall be tested. Any plastic coatings or other CIPP layers not included in the structural design of the CIPP may be carefully ground off of the specimens prior to testing. If the sample is irregular or distorted such that proper testing is inhibited, attempts shall be made to machine any wall thickness from the inside pipe face of the sample. Any machining of the outside pipe face of the sample shall be done carefully so as to minimize the removal of material from the outer structural wall of the sample. Individual specimens should be clearly marked for easy identification and retained until final disposition or CIPP acceptance, or both, has been given.

8.1.4 *Short-Term Flexural (Bending) Properties*—The initial tangent flexural modulus of elasticity and flexural stress should be measured for gravity and pressure pipe applications in accordance with Test Method D 790, Test Method I, Procedure A and should meet the requirements of Table 1 within the 16:1 length to depth constraints. For specimens greater than 0.5 in. (12.7 mm) in depth, the width-to-depth ratio of the specimen should be increased to a minimum of 1:1 and should not exceed 4:1. For samples prepared in accordance with 8.1.1, determine flexural properties in the axial direction where the length of the test specimen is cut along the longitudinal axis of the pipe. Special consideration should be given to the preparation of flexural specimens to ensure opposite sides are parallel and adjacent edges are perpendicular. Flexural specimens should be tested such that the inside pipe face is tested in tension and the outside pipe face is in compression.

8.1.4.1 *Fiber-Reinforced CIPP Flexural Properties*—Where the CIPP is reinforced with oriented continuous or discontinuous fibers to enhance the physical properties of the CIPP, specimens should be sampled in accordance with 8.1.2, and flexural properties should be determined in accordance with 8.1.3 along the longitudinal axis and circumferential axis of the installed CIPP.

8.1.5 *Short-Term Tensile Properties*—The tensile strength should be measured for pressure pipe applications in accordance with Test Method D 638. Specimens should be prepared in accordance with Types I, II, and III of Fig. 1 of Test Method D 638. Specimens greater than 0.55 in. (14 mm) thick should maintain all dimensions for a Type III specimen, except the thickness will be that of the CIPP sample obtained. The rate of specimen testing should be carried out in accordance with Table 1 of Test Method D 638. Specimens should be prepared in accordance with 8.1.1 and tested along the longitudinal axis of the installed CIPP.

8.1.5.1 *Fiber-Reinforced CIPP Tensile Testing*—Where the CIPP is reinforced with oriented continuous or discontinuous fibers to enhance the physical properties of the CIPP, specimens should be sampled in accordance with 8.1.2 and tensile properties should be determined in accordance with Test Method D 3039 and tested along the longitudinal axis and circumferential axis of the installed CIPP.

8.1.6 *CIPP Wall Thickness*—The method of obtaining CIPP wall thickness measurements should be determined in a manner consistent with 8.1.2 of Specification D 5813. Thickness measurements should be made in accordance with Practice D 3567 for samples prepared in accordance with 8.1. Make a minimum of eight measurements at evenly spaced intervals around the circumference of the sample to ensure that minimum and maximum thicknesses have been determined. Deduct from the measured values the thickness of any plastic coatings or CIPP layers not included in the structural design of the CIPP. The average thickness should be calculated using all measured values and shall meet or exceed minimum design thickness as agreed upon between purchaser and seller. The minimum wall thickness at any point shall not be less than 87.5 % of the specified design thickness as agreed upon between purchaser and seller.

8.2 *Gravity Pipe Leakage Testing*—If required by the owner in the contract documents or purchase order, gravity pipes should be tested using an exfiltration test method where the CIPP is plugged at both ends and filled with water. This test should take place after the CIPP has cooled down to ambient temperature. This test is limited to pipe lengths with no service laterals and diameters of 36 in. or less. The allowable water exfiltration for any length of pipe between termination points should not exceed 50 U.S. gallons per inch of internal pipe diameter per mile per day, providing that all air has been bled from the line. During exfiltration testing, the maximum internal pipe pressure at the lowest end should not exceed 10 ft (3.0 m) of water or 4.3 psi (29.7 kPa), and the water level inside of the inversion standpipe should be 2 ft (0.6 m) higher than the top of the pipe or 2 ft (0.6 m) higher than groundwater level, whichever is greater. The leakage quantity should be gaged by the water level in a temporary standpipe placed in the upstream plug. The test should be conducted for a minimum of 1 h.

NOTE 4—It is impractical to test pipes above 36 in. diameter for leakage due to the technology available in the pipe rehabilitation industry. Post inspection of larger pipes will detect major leaks or blockages.

8.3 *Pressure Pipe Testing*—If required by the purchaser in the purchase agreement, pressure pipes should be subjected to a hydrostatic pressure test. A pressure and leakage test at twice the known working pressure or at the working pressure plus 50 psi, whichever is less, is recommended. The pressure should initially be held at the known working pressure for a period not less than 12 h, then increased to the test pressure for an additional period of 2 to 3 h to allow for stabilization of the CIPP. After this period, the pressure test will begin for a minimum of 1 h. The allowable leakage during the pressure test should be 20 U.S. gallons per inch of internal pipe diameter per mile per day, providing that all air has been evacuated from the line prior to testing and the CIPP has cooled down to ambient temperature.

NOTE 5—The allowable leakage for gravity and pressure pipe testing is a function of water loss at the end seals and trapped air in the pipe.

8.4 *Delamination Test*—If required by the purchaser in the purchase agreement, a delamination test should be performed on each installation length specified. CIPP samples should be prepared in accordance with 8.1.2, except that a portion of the fabric tube material in the sample should be dry and isolated from the resin in order to separate tube layers for testing (consult the tube manufacturer for further information). Delamination testing should be in accordance with Test Method D 903 with the following exceptions:

8.4.1 The rate of travel of the power-actuated grip should be 1 in. (25 mm)/min.

8.4.2 Five test specimens should be tested for each installation specified.

8.4.3 The thickness of the test specimen should be minimized, but should be sufficient to adequately test delamination of nonhomogeneous CIPP layers.

8.5 The peel or stripping strength between any nonhomogeneous layers of the CIPP laminate should be a minimum of 10 lb/in. (178.60 g/mm) for typical CIPP applications.

NOTE 6—The purchaser may designate the similar layers between which the delamination test will be conducted.

NOTE 7—For additional details on conducting the delamination test, contact the seller.

8.6 *Inspection and Acceptance*—The installation may be inspected visually if appropriate, or by closed-circuit television if visual inspection cannot be accomplished. Variations from true line and grade may be inherent because of the conditions of the original piping. No infiltration of groundwater should be observed. All service entrances should be accounted for and be unobstructed.

## 9. Keywords

9.1 cured-in-place pipe; installation—underground; plastic pipe—thermoset; rehabilitation; thermosetting resin pipe

# APPENDIX

**(Nonmandatory Information)**

## X1. DESIGN CONSIDERATIONS

X1.1 *General Guidelines*—The design thickness of the CIPP is a function of the resin, materials of construction of the fabric tube, and the condition of the existing pipe. In addition, depending on the condition of the pipe, the design thickness of the CIPP may also be a function of groundwater, soil type, and influence of live loading surrounding the host pipe. For guidance relating to terminology of piping conditions and related design equations, see Appendix X1 of Practice F 1216.

**Amendment to ASTM F1743-96**
**Author: Doug Kleweno of DGK Technologies**

Douglas Kleweno
25124 235$^{th}$ Way SE
Maple Valley, WA 93038-5905

May 22, 2001

Whom it may concern:

I am writing this letter at the request of Mr. David Ratliff (Nu Flow Installer, Abilene, Texas) in order to provide clarification for ASTM F1743 "Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-In-Place Thermosetting Resin Pipe (CIPP)" and similar pulled-in-place products. In my previous position I was the Technical Manager for InLiner USA CIPP products and am the author of ASTM F1743. I have also been involved in editing ASTM F1216 and ASTM D5813, which are also CIPP installation and material specifications, respectively.

When writing an ASTM specification it is necessary to provide enough minimum requirements so that the product can meet or exceed engineering and design criteria. However, ASTM specifications also must be generalized enough to accommodate the majority of products and processes that may want to reference it. F1743 was generally written for most CIPP applications where heated cures predominate in the market. There are many resin applications for CIPP and other products (boat building, automotive, heavy truck) where ambient cure resin formulations are common and used successfully. Technically speaking, an ambient cure formulation for CIPP does initiate at a temperature less that 180F, which is recommended in Section 5.2.3 or F1743.

More critical to CIPP and other applications is whether the product (CIPP in this case) meets the minimum initial structural property recommendations. The minimum properties for the CIPP were provided in Section 4.2.3 of ASTM F1743 and this is probably the most important aspect for the product to meet the requirements for external hydrostatic or soil loading that may surround the pipe. These minimum properties are the numbers by which the minimum design thickness is determined for the installed CIPP or part liner.

As a side note it is my experience that the curing strategy is chosen for handling and transportation purposes. Large liners for CIPP require long catalyzed stability so the product can be processed, transported, and installed. For short runs or tubes processed at a job site, it was common to use ambient or semi-ambient cure formulations to reduce the time at the job site and the associated inconvenience to the surrounding community.

I hope this has provided some additional clarification.

Doug Kleweno
(423) 413-8529

NSF International

August 24, 2005

# TEST REPORT

Send To: 1P790
NU FLOW TECHNOLOGIES 2000 INC.
1010 THORNTON ROAD SOUTH
OSHAWA ON L1J 7E2
CANADA
Attn: MR. BOB FOWLE

Customer: 1P790
NU FLOW TECHNOLOGIES 2000 INC.
1010 THORNTON ROAD SOUTH
OSHAWA ON L1J 7E2
CANADA
Attn: MR. BOB FOWLE

Plant: 1P790
NU FLOW TECHNOLOGIES 2000 INC.
1010 THORNTON ROAD SOUTH
OSHAWA ON L1J 7E2
CANADA
Attn: MR. BOB FOWLE

Sample Description: Nu Flow #2000 Pipe Lining - Liner
Test Type: AA - Annual Collection

Thank you for having your product tested by NSF.

The enclosed report details the result of the testing performed on your product. Your program representative will be contacting you in the near future if there are any remaining issues concerning the status of this product.

Please do not hesitate to contact us if you have any immediate questions pertaining to your product.

Reviewer: ____________________ Status: **Pass**

Atabek Ciechanowski - Manager, Engineering Laboratory

CC: Program: 010 - Plumbing and Related Programs
Program Rep: AMY CHOKSEY
Region: 01 - Domestic
PA Project: 224520

FI20050824120213 J-00012414 Page 1 of 4



789 N. Dixboro Road, Ann Arbor, Michigan 48105-9723 USA
1-800-NSF-MARK 734-769-8010
www.nsf.org

General Information

Standard: 014 - PLASTICS PIPING SYSTEM COMPONENTS AND RELATED MATERIALS

DCC Number / Tracking ID PL04249
Family Code A
Material Type Epoxy
Monitor Code A
Performance Standard F1216
Performance Standard Year 2003
Product Identifier Part A Batch # 030904, Part B Batch # 040405_3
Sample Description Liner
Trade Designation Nu Flow #2000 Pipe Lining

Sample Id: **S-0000161582**
Description: Nu Flow #2000 Pipe Lining - Liner
Sampled Date: 05/19/2005
Received Date: 05/23/2005

| Testing Parameter | Result | Units |
|---|---|---|
| | | |
| **Engineering Lab** | | |
| Gravity Pipe Leakage Test | | |
| Initial water column: | 10 | feet |
| Final water column: | 10 | feet |
| Time: | 60 | minutes |
| Leakage rate: | 0 | g/in/day |
| Required maximum leakage rate: | 50 | g/in/day |
| Actual leakage rate: | 0 | g/in/day |
| Gravity Pipe Leakage Test: | Pass | |
| Flex Modulus | | |
| Specimens conditioned for | 40 | hours |
| Specimens conditioned at | 73 | degrees F |
| Relative humidity | 50 | % |
| Test temperature Required | 73 | degrees F |
| Test temperature Actual | 73 | degrees F |
| Required crosshead speed | 0.22 | in/min |
| Actual crosshead speed | 0.22 | in/min |
| Deflection | <5 | % |
| Specimen 1 | 280000 | psi |
| Specimen 2 | 315000 | psi |
| Specimen 3 | 275000 | psi |
| Specimen 4 | 242000 | psi |
| Specimen 5 | 257000 | psi |
| Required Average Modulus (minimum) | 250000 psi | |
| Actual Average Modulus | 274000 | psi |
| Flex Modulus Test | PASS | |
| Flexural Strength Test | | |
| Specimens conditioned for | 40 | hours |
| Specimens conditioned at | 73 | degrees F |
| Relative Humidity | 50 | percent |
| Test Temperature | 73 | degrees F |
| Cross Head Speed | 0.22 | in/min. |
| Specimen 1 Flexural Strength | 6280 | psi |
| Specimen 2 Flexural Strength | 6480 | psi |
| Specimen 3 Flexural Strength | 6010 | psi |
| Specimen 4 Flexural Strength | 5210 | psi |

Sample Id: S-0000161582

| Testing Parameter | Result | Units |
|---|---|---|
| | | |
| **Engineering Lab ( Cont'd )** | | |
| Specimen 5 Flexural Strength | 5820 | psi |
| Average Flexural Strength | 5960 | psi |
| Required Flexural Strength | 4500 | psi |
| Flexural Strength Test | Pass | |
| Strength, Tensile | | |
| Specimens conditioned for | 40 | hours |
| Specimens conditioned at | 73 | degrees F |
| Relative humidity | 50 | % |
| Test Temperature | 73 | degrees F |
| Actual Crosshead Speed | 0.2 | in/min. |
| Required Crosshead Speed | 0.2 | in/min. |
| Specimen 1: Tensile Strength | 3930 | psi |
| Specimen 2: Tensile Strength | 4540 | psi |
| Specimen 3: Tensile Strength | 4010 | psi |
| Specimen 4: Tensile Strength | 3690 | psi |
| Specimen 5: Tensile Strength | 3920 | psi |
| Req'd Average Tensile Strength (minimum) | 3000 | |
| Actual Average Tensile Strength | 4020 | psi |
| Tensile Strength Test | PASS | |
| Specimen Fabrication | | |
| Specimen Fabrication | COMPLETE | |
| Time | 1 | hours |
| Technician | 3356 | |

*Testing Laboratories:*

| | Id | Address |
|---|---|---|
| All work performed at: → | NSF_AA | NSF International<br>789 Dixboro Road<br>Ann Arbor MI 48105-0140<br>USA |

*References to Testing Procedures:*

| NSF Reference | Parameter / Test Description |
|---|---|
| P3084 | Gravity Pipe Leakage Test |
| P3122 | Flex Modulus |
| P3123 | Flexural Strength Test |
| P3127 | Strength, Tensile |
| P3172 | Specimen Fabrication |

ACUREN

*Client*

NU FLOW TECHNOLOGIES 2000 INC.
1010 Thornton Road South
Oshawa, Ontario
L1J 7E2

# Laboratory Report

| *Attention* | *Client's Order Number* | *Date* | *Report Number* |
|---|---|---|---|
| Sinan Omari | 9282 | 16 March 2007 | **07-845** |

| *Client's Material / Product Description* | *Date Sample Received* | *Material / Product Specification* |
|---|---|---|
| (1) Sample | 06 March 2007 | ASTM D5813-04 |

| Test Performed | Result |
|---|---|

1. Tangent Flexural Modulus
   (ASTM D790)
   - Crosshead speed: 0.05"/min
   - 1000 lbf Load cell
   - 2 inch support span
   - L/D = 16
   - Specimen Geometry: 1/8" x 1/2" x 4"
   - 5 specimens tested
   - Units: psi

| Sample # | | |
|---|---|---|
| 1 | 384400 | |
| 2 | 420900 | 250,000 psi Minimum |
| 3 | 304600 | |
| 4 | 425400 | |
| 5 | 397100 | |
| Average | 386500 | |

2. Flexural Strength
   (ASTM D790)
   - 5 specimens tested
   - Units: psi

| Sample # | | |
|---|---|---|
| 1 | 6 070 | |
| 2 | 6 670 | |
| 3 | 5 400 | 4,500 psi Minimum |
| 4 | 6 200 | |
| 5 | 6 440 | |
| Average | 6 160 | |

3. Wall Thickness
   - Units: mm
   - Four measurements taken on each side

| Side A | Side B |
|---|---|
| 3.56 | 3.26 |
| 3.62 | 3.45 |
| 3.67 | 3.50 |
| 3.79 | 3.74 |

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Corrine Dimnik, B.Sc.
Certified Inspector.

Dr. Erhan Ulvan, Ph. D, P. Eng.,
Laboratory Manager.

Standards Council of Canada Accredited Laboratory Scope of Accreditation 60
Conseil canadien des normes Laboratoire accrédité Portée d'accréditation 60 TM

Page 1 of 1

NU FLOW RELINE REPAIR RENEW ®

# Flow Comparisons

## Comparison between a new pipe and a rehabilitated pipe

| Diameter (m) | Diameter (in) | Hazen Williams Coefficient (C) | Flow for new pipe ($m^3/s$) | Thickness of Liner (mm) | Resulting internal diameter (m) | Hazen Williams coefficient (C) | Flow for rehabilitated pipe ($m^3/s$) | % Loss |
|---|---|---|---|---|---|---|---|---|
| 0.15 | 6 | 140 | 0.27 | 2 | 0.146 | 140 | 0.25 | -6.86 |
| 0.20 | 8 | 140 | 0.57 | 2 | 0.196 | 140 | 0.54 | -5.17 |
| 0.30 | 10 | 140 | 1.02 | 2 | 0.246 | 140 | 0.98 | -4.15 |
| 0.40 | 12 | 140 | 1.65 | 2.5 | 0.295 | 140 | 1.57 | -4.32 |

## Comparison between old pipe and a rehabilitated pipe

| Old Pipe Diameter (m) | Old Pipe Diameter (in) | Hazen Williams Coefficient (C) | Flow for old pipe ($m^3/s$) | Thickness of Liner (mm) | Old Pipe diameter (m) | Hazen Williams coefficient (C) | Flow for rehabilitated pipe ($m^3/s$) | % Increase |
|---|---|---|---|---|---|---|---|---|
| 0.13 | 6 | 60 | 0.08 | 2 | 0.146 | 140 | 0.25 | 216.63 |
| 0.18 | 8 | 60 | 0.18 | 2 | 0.196 | 140 | 0.54 | 191.91 |
| 0.23 | 10 | 60 | 0.35 | 2 | 0.246 | 140 | 0.98 | 178.48 |
| 0.27 | 12 | 60 | 0.53 | 2.5 | 0.295 | 140 | 1.57 | 194.52 |

| | | | | | |
|---|---|---|---|---|---|
| **Date Submitted** | 4/2/2010 | **Section** | 1107 | **Proponent** | scott waltz |
| **Chapter** | 11 | **Affects HVHZ** | No | **Attachments** | No |

**TAC Recommendation** No Affirmative Recommendation with a Second
**Commission Action** Pending Review

**Related Modifications**

**Summary of Modification**

1107.1 (Add) Secondary drain inlet shall be not less than 2 inches (51 mm) nor more than 4 inches (102 mm) above the finish roof covering and shall be located as close as practical to the required vertical leaders or downspouts.

**Rationale**

(emergency) to (overflow) is for consistency with FBC 1503.4.3. The new text is to require the secondary drains to truly function as a separate system as FPC 1107.2 intends. If the inlet is at the same elev. as that of the primary drains the discharge of storm water at the observable location required by FPC 1107.2 will not be a unique occurrence signaling that the primary drains are obstructed. The addition would be consistent with language in FBC1503.4.3 for overflow scuppers.

**Fiscal Impact Statement**

**Impact to local entity relative to enforcement of code**

Little if any. A similar provision was a part of 2001 Florida Building Code and still standard practice.

**Impact to building and property owners relative to cost of compliance with code**

Little if any. A similar provision was a part of 2001 Florida Building Code and still standard practice.

**Impact to industry relative to the cost of compliance with code**

Little if any. A similar provision was a part of 2001 Florida Building Code and still standard practice.

**Requirements**

**Has a reasonable and substantial connection with the health, safety, and welfare of the general public**

The change would insure that secondary roof drains are properly installed and contribute to public safety.

**Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction**

It would streghten and improve the code.

**Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities**

I do not believe it discriminate against any materials, methods or systems.

**Does not degrade the effectiveness of the code**

No.

## SECTION 1107 SECONDARY (~~EMERGENCY~~ OVERFLOW) ROOF DRAINS

**1107.1 Secondary drainage required.** Secondary (~~emergency~~ overflow) roof drains or scuppers shall be provided where the roof perimeter construction extends above the roof in such a manner that water will be entrapped if the primary drains allow buildup for any reason. Secondary drain inlets shall be not less than 2 inches (51 mm) nor more than 4 inches (102 mm) above the finish roof covering and shall be located as close as practical to the required vertical leaders or downspouts.

# P4212

| | | | | | |
|---|---|---|---|---|---|
| **Date Submitted** | 3/31/2010 | **Section** | P2603.2 | **Proponent** | T Stafford |
| **Chapter** | 26 | **Affects HVHZ** | No | **Attachments** | Yes |

**TAC Recommendation** No Affirmative Recommendation with a Second

**Commission Action** Pending Review

**Related Modifications**

See modifications to Sections R301.3, R301.5, R404,R502, R503, R505, R602, R603, R604, R605, R611, R702, R802, R803, R804, M1308.1, M2101.6 in the FBC Residential.

**Summary of Modification**

This modification is a correlation with the modification that deletes the prescriptive construction requirements in the code that do not apply to the design of buildings in Florida.

**Rationale**

This modification is a correlation with the modification that deletes the prescriptive construction techniques in the FBCR that do not apply in Florida due to wind speed limitations. See attached supporting documentation.

**Fiscal Impact Statement**

**Impact to local entity relative to enforcement of code**

This modification will improve local entities in their efforts to enforce the code by removing requirements that are not applicable in Florida due to wind speed limitations.

**Impact to building and property owners relative to cost of compliance with code**

This modification will have a negligible impact to building and property owners relative to cost of compliance with the code.

**Impact to industry relative to the cost of compliance with code**

This modification will have a negligible impact to the industry relative to cost of compliance with the code.

**Requirements**

**Has a reasonable and substantial connection with the health, safety, and welfare of the general public**

This modification removes provisions that do not apply to the construction of buildings in Florida thereby reducing confusion associated with understanding the code requirements and ensuring that the appropriate provisions of the code are being used and applied.

**Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction**

This modification strengthens the code by deleting requirements that are only applicable for lower design wind speed areas that are not applicable to the construction of buildings in Florida.

**Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities**

The proposed changes are performance based and therefore do not discriminate against any other material, product, method, or system of construction.

**Does not degrade the effectiveness of the code**

This modification improves the effectiveness of the code by deleting requirements that are not applicable to the construction of buildings in Florida, which ensures that the code is more focuse on the methods appropriate for the applicable design wind speeds.

**27.**

**P2603.2 Drilling and notching**. Wood-framed structural members shall not be drilled, notched or altered in any manner except as provided in Sections R502.1.5 ~~R502.2.6~~, R602.1.4 ~~R602.1.3.1, R602.2.7~~, R802.1.8 ~~R802.2.6 and R802.2.6.1~~. Holes, cutting, and notching in cold-formed steel-framed members shall be in accordance with AISI 230 ~~load-bearing members shall only be permitted in accordance with Sections R506.2, R603.2 and R804.2. In accordance with the provisions of Sections R603.3.4 and R804.3.5 cutting and notching of flanges and lips of cold-formed steel-framed load-bearing members shall not be permitted~~. Structural insulated panels (SIPs) shall be drilled and notched or altered in accordance with the provisions of Section R613.7.

Reason: This proposal is essentially a clean-up and clarification of the prescriptive requirements in the code. Many of the requirements in the base code (2009 IRC) are only applicable where the basic wind speed is less than 100 mph. According to the Figure R301.2(4), areas where the wind speed is less than 100 mph is very limited in Florida. Section R301.2.1.1 requires buildings to be designed by some other standard where the wind speed equals or exceeds 100 mph. Even though Figure R301.2(4) does show some areas with a wind speed less than 100 mph, we are not aware of any jurisdiction in Florida that has established a wind speed of less than 100 mph. In fact, the county maps that were required to be drawn all indicate a design wind speed of at least 100 mph. Therefore, the less than 100 mph provisions that are shown stricken through in this proposal do not apply anywhere in Florida. By removing these provisions will improve understanding of the code and will prevent someone from inadvertently using prescriptive provisions that will not satisfy the required design wind loads.

| | | | | | |
|---|---|---|---|---|---|
| **Date Submitted** | 4/1/2010 | **Section** | New 510.1 | **Proponent** | Duren Gary |
| **Chapter** | 5 | **Affects HVHZ** | No | **Attachments** | No |

**TAC Recommendation** No Affirmative Recommendation without a Second
**Commission Action** Pending Review

**Related Modifications**

See companion modification to chapter 3

**Summary of Modification**

Add language to address residential swimming pool and spa issues

**Rationale**

This code change is intended address residential swimming pools and spas under the existing residential building code - there are many pools and spas that do not meet the current FBC requirements entrapment prevention.

**Fiscal Impact Statement**

**Impact to local entity relative to enforcement of code**

local authorities having jurisdiction will need to implement measures to permit swimming pool and spa repair and renovations

**Impact to building and property owners relative to cost of compliance with code**

there will be moderate costs associated with bringing existing pools and spas up to current minimum safety standards

**Impact to industry relative to the cost of compliance with code**

Industry will not be adversely impacted by this code change

**Requirements**

**Has a reasonable and substantial connection with the health, safety, and welfare of the general public**

Public safety and wlefare will be improved as many sub-standard pools and spas will be brought into compliance with exsisting rules

**Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction**

The exisiting building code is improved by including swimming pools and spas in its scope

**Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities**

The code change does not discriminate against any product, method, system of construction or material

**Does not degrade the effectiveness of the code**

The inclusion of swimming pool and spa verbiage improves the effectiveness of the existing building code

## Alternate Language

### 1st Comment Period History 04/15/2010 - 06/01/2010

**P4338-A1**

**Proponent** Jennifer Hatfield **Submitted** 6/1/2010 **Attachments** Yes

**Rationale**

The modification as written implies that when repairing (or replacing in the case of the modification wording) a circulation system component the entire circulation system must comply with the current code. This goes well beyond the current code requirements that exist when making a repair on any building or structure. This alternative language still may go somewhat beyond what is required when making a repair; however, the language addresses a specific safety component, drain covers, which wo

**Fiscal Impact Statement**

**Impact to local entity relative to enforcement of code**

AHJ will need to implement measures to permit for these repairs.

**Impact to building and property owners relative to cost of compliance with code**

There will be moderate costs associated with installing the new ASME drain cover.

**Impact to industry relative to the cost of compliance with code**

The industry should not be adversely affected, it will ensure a proper drain cover is installed.

**Requirements**

**Has a reasonable and substantial connection with the health, safety, and welfare of the general public**

The alternative language improves the public safety and welfare by requiring a proper drain cover is installed when repairing any part of the circulation system of an existing pool or spa.

**Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction**

The alternative language improves the code by requiring a key safety component.

**Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities**

The alternative language does not discriminate against materials, products, methods, or systems.

**Does not degrade the effectiveness of the code**

The alternative language does not degrade the effectivenes of the code.

ADD A NEW SECTION TO CHAPTER 5 REPAIRS, OF THE *FLORIDA BUILDING CODE, EXISTING BUILDINGS*

Section 510 RESIDENTIAL SWIMMING POOLS AND SPAS

510.1 Pool and Spa Circulation System Components. When any pool or spa circulation system component is replaced, including suction fittings, pumps, skimmers, filters, and the like, the circulation system shall comply with Section R4101 of the *Florida Building Code, Residential.*

Delete the proposed modification language and replace it with the following:

Section 510 RESIDENTIAL SWIMMING POOLS AND SPAS

R510 Pool or Spa Suction Fittings. When any pool or spa circulation system or component under goes a repair, all suction fittings of that pool or spa shall comply with ANSI/ASME A112.19.8 - 2007 and shall be installed in accordance with the manufacturers' instructions.