DETAILED INSTALLATION GUIDE

Product Reference:

SYNTHO-GLASS® XT

As specified in NRI's Design Proposal Documentation, the full Engineered Composite Repair (ECR) system being used is comprised of multiple products/steps and is referred to in general as the product name above. All instructions listed in the Design Proposal Documents shall be followed with regard to number of layers and length of repair required for the specific repair system being installed.

QA/QC Material Traceability:

The Product Lot Number is located on the foil pouch and on packaging of other materials being used within the system. It is required by NRI training procedures that all lot numbers are recorded before beginning the repair project either on the Quality Control Records form provided by NRI, or on other similar and approved documentation. This is required for full traceability of the materials used on site should the need arise.

Handling and Storage:

For ideal shelf life, store in a cool, shaded area at an ambient temperature of 72°F (23°C). Do not expose materials to temperatures above 110°F (44°C) or below 40°F (5°C).

Syntho-Glass® XT is a Moisture Cured Urethane (MCU) composite wrap and is packaged within a hermetically sealed foil pouch to protect the MCU composite wrap from atmospheric moisture. Because the MCU composite wrap cures when exposed to water and/or humidity, care must be taken in handling the sealed bags to prevent puncturing or scuffing. If the protective foil pouch is punctured the MCU composite wrap will be exposed to atmospheric moisture which will cause the MCU composite wrap to cure within the foil pouch. **DO NOT OPEN POUCH UNTIL READY TO INSTALL.**

Shelf Life:

NRI provides a 12 month shelf-life if Syntho-Glass® XT is stored according to proper specifications and the protective foil pouch is free from puncture or other damage.

Contact:

Should you have any questions regarding this installation guide or practical installation of any of NRI's composite materials, please contact the NRI University department at nriu@neptuneresearch.com, or by phone at +1-561-683-6992.

Current Safety Data Sheets (SDS) available for immediate download at http://www.neptuneresearch.com.

Document #: XT-DIG

Revision #:	Reason	Revision Made By:
1	Full Document Update/Creation: format, product names, part numbers, etc.	MG
2	Include max layer count per application	MG
3	Update to reflect current options for compression film	MG
4	Comp film must be removed before QC and Top Coat	TG

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CHAPTER 1: SCOPE

This chapter will outline scope of this document as it applies to the installation and verification of the ECR system, Syntho-Glass XT. This Installation Guide is provided only as a proven guideline for the successful installation of the ECR system. The User of this document assumes all responsibility for the actual material installation and responsibilities associated.

1.1. Scope

The ASME PCC-2 Article 4.1 "*Nonmetallic Composite Repair Systems: High-Risk Applications*" was used as the standard for qualification of the Syntho-Glass XT system for the repair of pipelines and piping systems. This document will focus on the installation procedures for the specified repair system, but will additionally address the various elements involved in an ECR system.

An ECR system is defined by the ASME PCC-2 Article 4.1 (as well as similarly defined by the ISO/TS 24817) "*as a combination of the following elements for which qualification testing has been completed:*

a. Substrate
b. Surface Preparation
c. Load Transfer Material
d. Primer Layer Adhesive
e. Interlaminar Adhesive (primarily of concern for pre-cured systems)
f. Composite Material
g. Application Method
h. *Curing Protocol*"

1.2. Applicability

It is the responsibility of the User of this document to insure that the material being installed per this document is correct and specified for the intended service based on the Engineering Report previously provided.

All procedures and guidelines provided in this document shall be followed by the User to insure the installation is correct and comprehensive for the specific repair scenario. It is the responsibility of the User to obtain any additional written instructions for specific repair scenarios which may fall outside of the scope of this document.

This document shall cover the following items from the above list as they are relevant to the understanding and installation of the ECR system, Syntho-Glass XT.

a. Substrate
    i. This Installation Guide may be used for the application of the Syntho-Glass XT system for pipeline remediation to any of the following surfaces: carbon, stainless and alloy steel pipe, fittings, and structural supports.
b. Surface Preparation
    i. Detailed in Chapter 4 of this document.
c. Load Transfer Material
    i. Detailed in Chapter 2 of this document.
d. Primer Layer Adhesive
    i. Detailed in Chapter 2 of this document.

e. Interlaminar Adhesive
    i. Detailed in Chapter 2 of this document.
f. Composite Material
    i. Detailed in Chapter 2 of this document.
g. Application Method
    i. Detailed in Chapter 5 of this document.
h. Curing Protocol
    i. Detailed in Chapter 6 of this document.

This document shall be applicable:

a. When the maximum continuous operating temperature of the pipe is not higher than 194°F (90°C).
b. For the repair of externally or internally corroded pipe provided the pipe is not actively leaking.
c. For the repair of dented, gouged, wrinkled, or other mechanically damaged pipe.
d. For above-ground, below-ground, and splash zone repair locations.

This document shall not be applicable:

a. When operating temperature is above 194°F (90°C).
b. If there is an active leak in the pipe (media is actively escaping the defect).
    i. This document may become applicable if the active leak is completely sealed and verification is made to insure there is no longer an active leak.
c. For subsea repair locations.
    i. Subsea repairs should be made according to the specific Installation Guide, Document ***XT-SS-DIG***.

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CHAPTER 2: PERSONAL PROTECTIVE EQUIPMENT (PPE)

This chapter will outline the general PPE as may be required when installing the ECR system. This is a general list applying to the handling of the ECR materials only and does not override any specific requirements of the site location or governing/regulating body of the project. It is the responsibility of the user/installer to know and understand the site specific PPE requirements based on the location of work being performed.

2.1. Health

Many components used within NRI's ECR systems are non-hazardous in nature and rating. Each component's SDS should be consulted to identify any possible concerns related to the handling of material. While the components may be safe to handle, each individual is unique and could possibly have an allergy (no different than a food allergy) to various resin systems, which may even be unknown to the individual until it is observed. If observed, it is the responsibility of the individual to seek aid as may or may not be needed.

2.2. Required PPE

The following list of items should always be worn when handling the components of an ECR system.

a. Protective Eyewear

i. Safety Glasses or Goggles should be worn when working with any liquid resin systems to insure adequate eye protection.

b. Protective Gloves

i. Latex or Nitrile gloves should be worn when working with the ECR systems.

a. Protective Clothing

ii. Tyvek suits or sleeves should be worn to insure that all areas of potential contact are protected during installation.

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CHAPTER 3: MATERIAL DESCRIPTIONS & SPECIFICATIONS

This chapter will outline the products manufactured by NRI which are used in order to create and comply with the qualified ECR system, Syntho-Glass XT. Descriptions and general specifications are provided in this document for quick reference only. Each individual product described shall conform to the product specifications listed on the specific product Technical Data Sheet (TDS). For most current version, please consult the NRI website at www.neptuneresearch.com, or contact your NRI Distributor.

3.1. Filler Materials

a. Syntho-Steel™

iii. NRI Part Numbers
- SS07 (7" stick)

iv. Product Description
- Two-part, steel reinforced, epoxy putty stick. It cures in minutes and will not drip or sag regardless of application location. When fully cured the material produces a durable, resilient bond resistant to hydrocarbons, ketones, alcohols, esters, halocarbons, aqueous salt solutions and dilute acids and bases. Color is one part black, one part gray, which mix to create a final color of steel gray.

v. Mechanical Properties

Test	Method	Result
Hardness, Shore D @ 75°F (24°C)	ASTM D2240	80
Lap Shear	ASTM D3163	900 psi (62 bar)
Compressive Strength	ASTM D695	12,000 psi (827.3 bar)

b. Syntho-Poxy™ HC

vi. NRI Part Numbers:
- SPHCHP (1/2 pint mx in canisters)
- SPHCPT (1 pint mix in canisters)
- SPHCQT (1 quart mix in canisters)

vii. Product Description
- Two-part, liquid epoxy filler that effectively transfers the load to the repair system over surface irregularities including pits, voids, corrosion defects, dents, etc. Color of Part A is dark gray, and color of Part B is cream, which mix to create a final color of light gray.

viii. Mechanical Properties

Test	Method	Result
Hardness, Shore D @ 75°F (24°C)	ASTM D2240	78
Lap Shear	ASTM D5868	1,006 psi (69.4 bar)
Compressive Strength	ASTM D695	9,542 psi (657.9 bar)

3.2. Primer Adhesive

a. Syntho-Subsea™ LV

i. NRI Part Numbers
- SUBLV04OZ (4 fl oz bi-pack)
- SUBLV08OZ (8 fl oz bi-pack)
- SUBLV16OZ (16 fl oz bi-pack)
- SUBLV02QT (2 quart mix in canisters)
- SUBLV02G (2 gallon mix in canisters)
- SUBLV10G (10 gallon mix in canisters)

ii. Product Description
- Two-part, 100% solids, Kevlar-reinforced tri-polymer epoxy system, which utilizes liquid epoxy, polymer, and aliphatic polyamine curing agents, in order to displace water from wet surfaces. Color of Part A is white, and color of Part B is dark green, which mix to create a final color of aqua green or teal.

iii. Mechanical Properties

Test	Method	Result
Hardness, Shore D @ 75°F (24°C)	ASTM D2240	77
Lap Shear	ASTM D3165	1,782 psi (122.9 bar)

b. Syntho-Poxy™ LV

i. NRI Part Numbers
- LV04OZ (4 fl oz bi-pack)
- LV08OZ (8 fl oz bi-pack)
- LV16OZ (16 fl oz bi-pack)
- LV02QT (2 quart mix in canisters)
- LV02G (2 gallon mix in canisters)
- LV10G (10 gallon mix in canisters)

ii. Product Description
- Two-part, 100% solid, nano-tube reinforced, epoxy system which serves to function within ECR systems to provide high adhesion between the pipe and composite wrap, effectively transfer loading over the surface covered to the composite wrap, and to provide an excellent corrosion barrier on the pipe. Color of Part A is pearl white, and color of Part B is light green, which mix to create a final color of key lime green.

iii. Mechanical Properties

Test	Method	Result
Hardness, Shore D @ 75°F (24°C)	ASTM D2240	86
Lap Shear	ASTM D3165	997 psi (68.7 bar)

3.3. Composite Material (pre-saturated which includes Interlaminar Adhesive resin)

a. Syntho-Glass XT

i. NRI Part Numbers
- XT215-X (2” x 15’ roll)
- XT330-X (3” x 30’ roll)

- XT430-X (4" x 30' roll)
- XT460-X (4" x 60' roll)
- XT615-X (6" x 15' roll)
- XT630-X (6" x 30' roll)
- XT660-X (6" x 60' roll)
- XT690-X (6" x 90' roll)
- XT830-X (8" x 30' roll)
- XT860-X (8" x 60' roll)
- XT1260-X (12" x 60' roll)

ii. Product Description
- The Syntho-Glass XT composite wrap is a unique, pre-saturated, bi-directional composite used to repair and reinforce both internal and external corrosion on pipes or structures. It uses high-grade polyurethane resin and E-glass fiberglass in a custom-woven, bidirectional architecture. Our high-tech, factory-saturation method insures correct and consistent resin-to-fiber content which is crucial to reliable performance. Color is white.

iii. Mechanical Properties

Test	Method	Result
Hardness, Shore D @ 75°F (24°C)	ASTM D2240	83
Tensile Strength	ASTM D3039	54,000 psi (3,724 bar)
Tensile Modulus	ASTM D3039	3.56 Msi (245,453 bar)
Laminate Thickness	ASTM D3039	0.013" (0.33mm)

3.4. Compression Film

a. Blue Compression Film

i. NRI Part Numbers
- COMP-05200 (5" x 200' roll)
- COMP-12700 (12" x 700' roll)

ii. Product Description
- 200 gauge Compression Film used as the final and temporary wrap over MCU systems to allow the release of excess water and CO_2 gas which is a by-product of the reaction of the resin and water. Once composite wrap is cured, the compression film is removed. Color is blue.

iii. Mechanical Properties

Test	Method	Result
Tensile Strength	ASTM D882	4,200 psi
Elongation	ASMT D882	810%

3.5. UV & Environmental Protection/Sealant

a. Syntho-Glass® UV

i. NRI Part Numbers
- UVW205 (2" x 5' roll)
- UVW309 (3" x 9' roll)
- UVW415 (4" x 15' roll)

- UVW430 (4" x 30' roll)
- UVW450 (4" x 50' roll)
- UVW830 (8" x 30' roll)
- UVW850 (8" x 50' roll)

ii. Product Description
- Specifically designed to be an aesthetically pleasing, non-yellowing, superior wrapping system top coat that provides UV stabilization to composite wraps. Syntho-Glass UV prevents UV degradation, future corrosion and abrasion due to mechanical impact, frost heave, crevice corrosion, galvanic corrosion and vibration/abrasion at soil-to-air interface, and water-to-air interface as well as pipe support areas. Color is white (but others available upon special request).

iii. Mechanical Properties

Test	Method	Result
Laminate Thickness	ASTM D3039	0.011" (2.8mm)
Hardness, Shore D @ 75°F (24°C)	ASTM D2240	70

b. Syntho-Coat™ 500

i. NRI Part Numbers
- SCHTPT (1 pint mix in canisters)
- SCHTQT (1 quart mix in canisters)
- SCHTG (1 gallon mix in canisters)

ii. Product Description
- Designed as a single component, paintable topcoat to protect the integrity and appearance of composite repairs from deterioration due to UV exposure. Color is gray.

iii. Mechanical Properties

Test	Method	Result
Hardness, Shore A @ 75°F (24°C)	ASTM D2240	70

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CHAPTER 4: QUALITY CONTROL DOCUMENTATION

This chapter will outline the requirements and process for Quality Control Documentation when performing an installation for an ECR system. Each system type will require different steps in the process due to the variance of resins used in each. It is important that each QC Hold Point be followed and noted in relevant paperwork. NRI provides a full document, ("*Quality Control Records*") for each ECR system, or the technician may use an NRI-approved equivalent as may be required by specific clients for their internal processes.

4.1. Quality Control Records

Quality documentation is an essential step in the installation process and helps to insure that all procedures and hold points are being followed correctly. NRI provides detailed Quality Control Records forms for each of the ECR systems that it manufactures. These are included in shipments of the specific ECR system, however, to obtain a copy of NRI's documents for use, please contact your NRI Distributor or email customerservice@neptuneresearch.com with your request and specify the ECR system which you will be installing. Client-specific or other third-party/outside QC documentation may also be used provided that it has been reviewed and approved by NRI and should, at a minimum, contain the following information for traceability and record keeping purposes.

a. Project Verification

All information from the Engineering Report should be recorded and verified before a project is started to insure that the materials are being installed on the correct section of pipe they were designed for.

i. Record the Engineering Calculation ID# provided
ii. Record Diameter of the Pipe
iii. Record Total Number of Layers Required
iv. Record Length of Repair Required

b. Product Lot Numbers

Product Lot Numbers must always be recorded prior to beginning the work in order to insure that containers are not lost or discarded once the project begins as is typically the case. Without records of Lot Numbers, NRI will not be able to trace materials if needed.

i. Record Lot Number of Filler Material
ii. Record Lot Number of Primer
iii. Record Lot Number of Composite Wrap

c. Surface Preparation

This is a critical component of the ECR system as defined in Chapter 1. If the recommended surface preparation method cannot be completed, a record must be kept of the method used, as well as the surface cleanliness and profile achieved. This should also be provided during the design phase, if known, in order to complete a proper design case.

i. Record solvent used for surface cleaning
ii. Record Surface Preparation method
iii. Record Surface Profile upon completion

d. Resin Mixing and Application

With any two-part resins, it is critical to achieve complete mixing or the product will not reach full hardness and material properties as designed. Application is also important in order to meet the design criteria based on tested and proven results.

i. Record mixing results
ii. Record proper geometry of application of Filler Material
iii. Record total length of Primer applied
iv. Record wet film thickness of Primer

e. Composite Wrap Application

This is a critical step in the process as the entire repair has been designed based on proper application and insuring that correct number of layers and required length has been installed.

i. Record that 1" of Primer remains on each end of the Composite Wrap
ii. For MCU wraps, record that it was fully saturated with water while wrapping
iii. For Epoxy wraps, record that it was fully saturated with epoxy resin with no dry spots
iv. Record total number of layers applied
v. Record total length of pipe wrapped

f. Final Project Inspection & Validation

The final step in the installation process is the inspection and verification that the ECR system was installed correctly and has reached the appropriate hardness as required for each system.

i. Record Shore D Hardness of Primer
ii. Record Shore D Hardness of Composite Wrap
iii. Verify length of Composite Wrap is correct as per the Design
iv. Verify the total number of layers (thickness) is correct as per the Design

g. Submit Final Paperwork

Once the project is complete, all paperwork shall be finalized and submitted as required and appropriate for record keeping requirements.

i. Installation Technician to sign the QC paperwork (include assigned NRI Training ID#)
ii. Client inspector/engineer/supervisor to sign final QC paperwork
iii. Submit copies to Client, NRI, and retain for Installation Technician's Company

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CHAPTER 5: SURFACE PREPARATION

This chapter will define the required surface preparation necessary for successful and compliant ECR system installations. Surface preparation requirements are the same for all of NRI's ECR systems. Variations and/or alterations in specified methods may be accepted based on a case by case basis, provided full details are supplied to the NRI Engineering Department during the design phase to insure proper calculations are made to account for this.

5.1. Qualified Surface Preparation Standards

NRI has tested and qualified various methods and standards of surface preparation. The below standards outline each of these options in detail. For the full standard description and detail, these may be purchased from the organizations named.

a. NACE (National Association of Corrosion Engineers)

i. NACE 2 – Near-White Blast Cleaning (equivalent to SSPC-SP10)

b. SSPC (Society for Protective Coatings)

i. SSPC-SP1 – Solvent Cleaning
ii. SSPC-SP10 – Near-White Blast Cleaning (equivalent to NACE 2)
iii. SSPC-SP11 – Power Tool Cleaning to Bare Metal

5.2. Surface Preparation Procedures

The following procedures will describe the order of steps to successfully complete the full surface preparation regimen before beginning the ECR system installation process.

a. Solvent Cleaning of Pipe

The first step is to clean the entire pipe surface with an approved solvent. No oil-based solvents should be used. Denatured alcohol, Isopropanol alcohol, or Acetone are all approved for use as a solvent with NRI's ECR systems.

b. Surface Preparation

Surface preparation may be performed after the first solvent clean is completed. Surface preparation may be done by grit blasting or by power tool provided that the specific tools are of the two which have been tested and qualified by NRI. The following are surface preparation options and typical results which may be achieved with each.

i. Grit Blasting:
Results can vary greatly with this method based on the type and size of grit being used, ranging from 1.5 mil (40 microns) up to 5 mil (127 microns). Common media types include garnet, silica (be aware of potential safety concerns), wet slurry, and dry ice.

ii. MBX Bristle Blaster:
Typical results (as published by the manufacturer) obtained yield 2.5 – 3.3 mil (63.5 – 83.8 microns) on carbon steel provided the belt is in good, working condition. Belts should be changed as needed to insure minimum results are being generated.

iii. Safety Tool Cold Grinder:

Typical results (as published by the manufacturer) obtained yield 1.5 – 3.0 mil (40 – 75 microns) on carbon steel with the Rough Boy files which are typically used for preparing pipe.

c. Solvent Cleaning of Pipe

The final step is to do a final solvent clean to remove any residual dust, grease, or other surface contaminates which remain after the surface preparation. The same solvents as given above may be used for this step as well. No oil-based solvents are allowed for use.

5.3. Surface Preparation Measurement

The final surface profile shall be measured to insure that surface preparation was completed and meets the minimum requirements as set forth by NRI based on testing and qualification. ***Minimum surface profile shall be not less than 1 mil (0.025mm, 25 micron)*** to be considered in compliance with qualification. Surface profile may be measured by various means using standard industry tools available for this purpose.

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CHAPTER 6: INSTALLATION PROCEDURES

This chapter will define the actual process and steps for carrying out the installation of the Syntho-Glass XT full repair system once the surface preparation has been completed and verified. Each product option available as part of the fully qualified system will be given for each step. This does not mean that each step will require each product, but only the choice of one product in each step.

> ***NOTE:*** *It is important to note that the ECR resin systems provided by NRI may* **NEVER** *be thinned nor thickened with additives in the field. These resins are specially designed and pre-portioned for exact mechanical properties calculated and changing or adding ingredients will have negative effects which will invalidate the material.*

6.1. Installation and Site Preparation

Prior to beginning the actual installation of the composite repair system, there are preparations which are required and will aid in the installation of the materials to insure consistent and successful results.

DO NOT OPEN* SYNTHO-GLASS XT *FOIL POUCH UNTIL READY TO USE

a. Staging

i. Insure that there is a dedicated work area for staging materials and mixing, etc.
ii. Plan work flow to insure there are no delays between steps of the installation process which would cause issues or materials to cure before the next step is accomplished.
iii. Only stage and prepare a length of pipe which can be wrapped in any given working time range.
- Ex: Do not begin priming a section of pipe, then take lunch and allow that primer to harden.
- This is not a show stopper, but will require additional steps outside the scope of this installation guide.
- Complete the full wrapping process on a given length of pipe prior to taking breaks or finishing for the day.

b. Identify the Defect and Repair Location

i. Identify the defect and repair location as designed and provided in NRI's Engineering Report package.
ii. Confirm that the pipe, defect, and site conditions are as described within the Engineering Assessment form and subsequent Engineering Report and record on quality documentation and relevant forms to verify repair location and validity.

c. Surface preparation

i. Surface preparation must be completed in accordance with procedures outlined in Chapter 4 of this document.
ii. Surface preparation must be done at least 2" beyond the calculated repair length provided by NRI's engineering department.
iii. This should be completed with at least 1" additional length on each end of the repair area with the defect centered in this area.
iv. Repair lengths may be marked by applying tape around the pipe at the repair ends (to include the 2" additional length).

v. Perform Surface Profile measurements and record on quality documentation and relevant forms to verify surface preparation meets requirements as given.



d. Repair Area Marking

i. The repair length (plus the extra 1" beyond each end) should be marked again as this is typically removed during the surface preparation stage.

ii. Only mark the area which can be completed in the given working time range to insure the full installation process can be completed.


6.2. Installing the Filler Material

a. Syntho-Steel

i. Usage

- Used as a filler material and for load transfer. Filling of all external corrosion pits, dents, to fill gaps, smooth blunt edges, and/or smooth transitional areas.
- All or part of the Syntho-Steel stick may be used depending on the amount of filler required to achieve the complete installation. More than one stick may be used as needed.
- If only using part of the putty stick, cut or pinch off the amount of putty that is needed.
- If using the entire stick, simply mix it all.
- Working time is approximately 5-7 minutes once fully mixed.

ii. Mixing

- Remove foil stickers on end of putty stick.
- Remove plastic wrapping on putty stick.
- If only using a portion of the stick, pinch off the amount required.
- Mix thoroughly by smashing, kneading, folding, twisting, etc., until there is only one, solid color with no marbling or streaking visible.
    a. ***Caution:*** Unmixed sections will never fully harden and will be soft points in the mixture that could potentially cause failure of the putty.

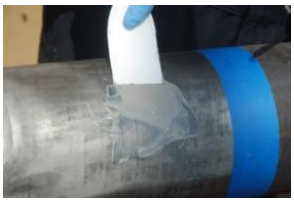
iii. Installation

- Once fully mixed, install into defect or onto surface profile within 3 minutes.
- Force into pits, dents, or profile areas to create a surface that matches as closely as possible to the original pipe geometry.

- If using as transitional filler such as over bolts, etc., be sure the transitional area is sufficient to smooth and ease the application of composite material. A 5:1 length to height ratio is recommended for best results (if possible based on repair length), but may be dictated otherwise by site specific details.
- Push firmly into all surfaces to insure no air pockets remain within the cured Syntho-Steel.
- Syntho-Steel will be fully hardened within 10-12 minutes (at 75°F / 25°C) and may be sanded if needed to help smooth the profile or remove excess putty applied.
- Once installed, record mixing and installation on quality documentation and relevant forms.

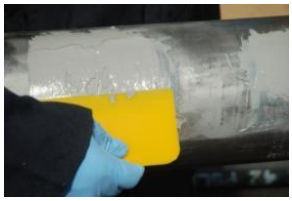
b. Syntho-Poxy HC

i. Usage



- Used as a filler material and for load transfer. Filling of all external corrosion pits, dents, to fill gaps, smooth blunt edges, and/or smooth transitional areas.
- Two-part epoxy provided in pre-measured canisters with proper mixing ratios per kit.
- Each kit will have Part A (resin base) and Part B (hardener/curing agent) with specific ratios according to requirements of the material. Material must be mixed in correct ratios.
- Working time is approximately 10-15 minutes once fully mixed.

ii. Mixing



- It is required that the mix ratio be correct and exact according to the specifications which are provided on the label of the epoxy kit.
- It is highly recommended that appropriate kit sizes are used so that all of the kit may be mixed at one time.
- Remove all of Part A and place into a clean, plastic mixing pail/bucket. Remove all of Part B and place into same mixing pail/bucket.
- Mix thoroughly either by hand and mixing stick, or by using a drill with mixer.
- Mix until there is only one, solid color with no marbling or streaking visible.
    a. ***Caution:*** Unmixed sections will never fully harden and will be soft points in the mixture that could potentially cause failure of the putty.

iii. Installation

- Once fully mixed, install into defect or onto surface profile within 5 minutes.
- Force into pits, dents, or profile areas to create a surface that matches as closely as possible to the original pipe geometry.
- If using as transitional filler such as over bolts, etc., be sure the transitional area is sufficient to smooth and ease the application of composite material. A 5:1 length to height ratio is recommended for best results (if possible based on repair length), but may be dictated otherwise by site specific details.
- Push firmly into all surfaces using a spatula, putty knife, and/or straight edge to insure no air pockets remain within the cured Syntho-Poxy HC and the putty contours to the original pipe geometry.
- Syntho-Poxy HC will be fully hardened within 20-25 minutes (at 75°F / 25°C) and may be sanded if needed to help smooth the profile or remove excess putty applied.
- Once installed, record mixing and installation on quality documentation and relevant forms.

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6.3. Installing the Primer

a. Syntho-Subsea LV

i. Usage

- Used as the primer adhesive and primary corrosion coating aspect for the composite system.
- May be used subsea/underwater, as the product name suggests (see specific installation guide for application in underwater and/or subsea environments, as that is not covered in this installation guide).
- Provides a bond promoter, corrosion-resistant barrier, and load transfer (fills small surface defects) between the host pipe and the composite wrap.
- Two-part epoxy provided in pre-measured canisters or within smaller bi-packs with proper mixing ratios per kit.
- Each kit will have Part A (resin base) and Part B (hardener/curing agent) with specific ratios according to requirements of the material. Material must be mixed in correct ratios.
- Working time is approximately 25-30 minutes once fully mixed.

ii. Mixing

- It is required that the mix ratio be correct and exact according to the specifications which are provided on the label of the epoxy kit.
- It is recommended that appropriate kit sizes are used so that all of the kit may be mixed at one time.
- If using two-part canisters, remove all of Part A and place into a clean, plastic mixing pail/bucket. Remove all of Part B and place into same mixing pail/bucket.
    a. Mix thoroughly either by hand and mixing stick, or by using a drill with mixer.
- If using bi-packs, remove the plastic divider and mix the two parts within the plastic bag before the plastic bag is opened by massaging and forcing each part together.
    a. The bi-packs may also be opened and put into a mixing pail/bucket to fully mix as described above if desired.
- Mix until there is only one, solid color with no marbling or streaking visible.
    a. ***Caution:*** Unmixed sections will never fully harden and will be soft points in the mixture that could potentially cause failure of the putty.

iii. Installation

- Once fully mixed, install Syntho-Subsea LV primer over the entire area as previously marked for installation.
- Force the mixed epoxy onto the pipe surface using a brush, roller, or your hand to fully saturate the surface and fill small pits which may be present.
- Use back-and-forth and circular motions to insure complete saturation of the pipe surface with no air pockets.
- The Syntho-Subsea LV epoxy should be applied at a wet thickness of 30-60 mils (0.8-1.5 mm) over the entire marked surface.
- Measure thickness using a wet film thickness gauge in multiple locations around the pipe and over the length of the marked surface to insure a uniform coverage within the thickness range.
- Record measurements and verify installation on quality documentation and relevant forms.
- The tape used to mark the repair ends may now be removed.

b. Syntho-Poxy LV

i. Usage

- Used as the primer adhesive and primary corrosion coating aspect for the composite system.
- Provides a bond promoter, corrosion-resistant barrier, and load transfer (fills small surface defects) between the host pipe and the composite wrap.
- Two-part epoxy provided in pre-measured canisters or within smaller bi-packs with proper mixing ratios per kit.
- Each kit will have Part A (resin base) and Part B (hardener/curing agent) with specific ratios according to requirements of the material. Material must be mixed in correct ratios.
- Working time is approximately 12-15 minutes once fully mixed.

ii. Mixing

- It is required that the mix ratio be correct and exact according to the specifications which are provided on the label of the epoxy kit.
- It is recommended that appropriate kit sizes are used so that all of the kit may be mixed at one time.
- If using two-part canisters, remove all of Part A and place into a clean, plastic mixing pail/bucket. Remove all of Part B and place into same mixing pail/bucket.
    a. Mix thoroughly either by hand and mixing stick, or by using a drill with mixer.
- If using bi-packs, remove the plastic divider and mix the two parts within the plastic bag before the plastic bag is opened by massaging and forcing each part together.
    a. The bi-packs may also be opened and put into a mixing pail/bucket to fully mix as described above if desired.
- Mix until there is only one, solid color with no marbling or streaking visible.
    a. ***Caution:*** Unmixed sections will never fully harden and will be soft points in the mixture that could potentially cause failure of the putty.

iii. Installation

- Once fully mixed, install Syntho-Poxy LV primer over the entire area as previously marked for installation.
- Force the mixed epoxy onto the pipe surface using a brush, roller, or your hand to fully saturate the surface and fill small pits which may be present.
- Use back-and-forth and circular motions to insure complete saturation of the pipe surface with no air pockets.
- The Syntho-Poxy LV epoxy should be applied at a wet thickness of 15-30 mils (0.4-0.8 mm) over the entire marked surface.
- Measure thickness using a wet film thickness gauge in multiple locations around the pipe and over the length of the marked surface to insure a uniform coverage within the thickness range.
- Record measurements and verify installation on quality documentation and relevant forms.
- The tape used to mark the repair ends may now be removed.

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6.4. Installing the Composite Wrap

a. Syntho-Glass XT

i. Usage

DO NOT OPEN FOIL POUCH UNTIL READY TO USE

- Used as the composite wrap, this provides the structural strength and pressure retaining capacity of the ECR system.
- Supplied in rolls of fiberglass which are pre-saturated with a moisture-curing polyurethane resin system.
- May be used subsea/underwater as the composite wrap is moisture-cured (see specific installation guide for application in underwater and/or subsea environments, as that is not covered in this installation guide).
- Working time is approximately 20-25 minutes once opened/exposed to moisture.
- The total number of layers applied and total length repaired shall be that as specified by NRI's Engineering Report document provided for the specific repair being conducted. Each pass at 50% overlap provides two (2) layers towards your total repair thickness. For example: to achieve a 10 layer application, apply five (5) passes using a 50% overlap.
- If the layer count required is higher than 16 layers, the repair must be done in stages of 16 layers at a time. Once 16 layers has been installed, move to the compression film installation, allow the Syntho-Glass XT to fully complete the off-gassing cycle, then remove film and continue on. No more than 16 layers should be applied at any one time.

ii. Installation

- **<u>Straight Pipe Installation</u>**
  a. Insure the Primer layer has had sufficient time to gel to a firm, but still wet consistency to insure it is not "squeezed" out during the wrapping of the pipe.
  b. Hold the end of the roll firmly to the surface of the pipe at the starting point which shall be 1" (2.54cm) within the borders of the Primer layer on either side. Begin the wrap using 100% overlap to assure complete coverage at the starting point.
  c. Unroll the tape, keeping it as close to the surface of the pipe as possible. Do not use a long lead of tape. The roll of tape shall always be in an upright position, with the tape being applied from the lower edge of the roll to maintain proper pressure.
  d. Apply sufficient tension by pulling on the roll of tape as the layers are being applied in a spiral manner using a 50% overlap.
  e. The tape shall be spirally wrapped around the pipe from right to left or left to right using a 50% overlap.
  f. At the end of the first wrap pass, spray the applied Syntho-Glass XT with water until fully wetted.
  g. Once applied material has been sprayed with water, apply a 100% overlap leaving 1" (2.54cm) of Primer on the end before reversing the direction of the wrap and continue to apply the Syntho-Glass XT.
  h. As wrapping is continued, spray with water during the wrapping process for the remainder of the application.

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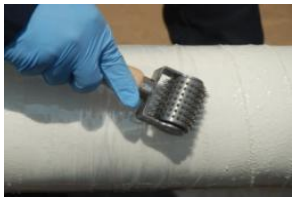

i. Do not reverse the direction of the application without completing an entire wrap along the length of the defined repair area. The length shall be staged in order to allow complete wrapping for the specific length without working time issues arising.

Compression Film:

j. The completed Syntho-Glass XT application shall be overwrapped by four (4) layers of compression film and perforated using the perforator tool.

k. Begin the Compression Film application on the outside of the Primer layer to fully wrap 100% overlap on the pipe itself.

l. Overwrap the entire length of the repair going beyond the other end to fully encapsulate the repair area with the compression film.

m. Apply enough tension to the compression film that you see the film begin to stretch and get narrower as it is applied.

n. Once four (4) layers have been applied (two [2] passes with 50% overlap), perforate to allow the release of the CO_2 gas byproduct and excess water and resin.

o. The compression film may be removed when Syntho-Glass XT has reached its initial cure time.

p. Compression film MUST be removed to complete QC and apply any UV top coating.

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- **Elbow Joint Installation**
  a. Insure the Primer layer has had sufficient time to gel to a firm, but still wet consistency to insure it is not “squeezed” out during the wrapping of the pipe.
  b. Hold the end of the tape firmly to the surface of the pipe at the starting point. The starting point shall be 1" (2.54cm) within the borders of the Primer layer on either side. Begin the wrap using 100% overlap to assure complete coverage at the starting point.
  c. Unroll the tape, keeping it as close to the surface of the pipe as possible. Do not use a long lead of tape. The roll of tape shall always be in an upright position, with the tape being applied from the lower edge of the roll to maintain proper pressure.
  d. Apply sufficient tension by pulling on the roll of tape as the layers are being applied in a spiral manner using a 50% overlap.
  e. The 50% overlap should be strictly maintained on the outer radius of the elbow and a 75-80% overlap on the inner radius of the elbow in order to keep the wrap perpendicular to the pipe as you proceed through the bend.
  f. At the end of the first wrap pass, spray the applied Syntho-Glass XT with water until fully wetted.
  g. Once applied material has been sprayed with water, apply a 100% overlap leaving 1” (2.54cm) of primer on the end before reversing the direction of the wrap and continue to apply the Syntho-Glass XT.
  h. As wrapping is continued, spray with water during the wrapping process for the remainder of the application.
  i. Do not reverse the direction of the application without completing an entire wrap along the length of the defined repair area. The length shall be staged in order to allow complete wrapping for the specific length without working time issues arising.

  Compression Film:

  j. The completed Syntho-Glass XT application shall be overwrapped by four (4) layers of compression film and perforated using the perforator tool.
  k. Begin the Compression Film application on the outside of the Primer layer to fully wrap 100% overlap on the pipe itself.
  l. Overwrap the entire length of the repair going beyond the other end to fully encapsulate the repair area with the compression film.
  m. Apply enough tension to the compression film that you see the film begin to stretch and get narrower as it is applied.
  n. Once four (4) layers have been applied (two [2] passes with 50% overlap), perforate to allow the release of the CO_2 gas byproduct and excess water and resin.
  o. The compression film may be removed when Syntho-Glass XT has reached its initial cure time.
  p. Compression film MUST be removed to complete QC and apply any UV top coating.

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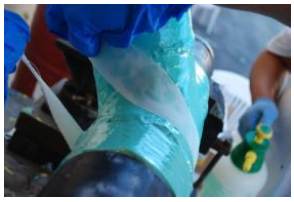




- **Tee Joint Installation**

  NOTE: Due to the increased installation time by nature of the geometry, it is important to work quickly and efficiently to insure the material is applied and cures properly for successful performance.

  a. Insure the Primer layer has had sufficient time to gel to a firm, but still wet consistency to insure it is not "squeezed" out during the wrapping of the pipe.
  b. Cut the Syntho-Glass XT roll into strips long enough to wrap the full circumference of the pipe with 4-6" (10.2-15.2cm) of overlap.
     i. Open bag only when ready to begin application and do not spray with water to increase the working time available.
  c. The number of strips to cut shall be determined by the diameter of the branch stem and should be enough to extend beyond the tee branch.
     i. For example, if it is a 4" tee and you have 2" wide strips, you should have at least six (6) strips, which will allow you to apply these at a 50% overlap and cover the area below the tee branch. Having extra will not hurt the application.
  d. Wrap the first two (2) strips around the main line on either side of the branch in a ribbon format using a 50% overlap and ensure that the entire pipe surface around the branch is covered, taking care to achieve complete coverage of the inside bends of the branch. Press firmly onto pipe, without squeezing out the primer below. Use a gloved hand to smooth the wrap as it is being applied to work out any air pockets.
  e. Spray with water once all strips are in place on the pipe.
  f. Begin the wrapping of the main pipe on either side of the branch as the site allows/dictates for ease of installation.
  g. Hold the end of the tape firmly to the surface of the pipe at the starting point. The starting point shall be 1" (2.54cm) within the borders of the Primer layer.
  h. Begin the wrap using 100% overlap to assure complete coverage, then proceed using 50% overlap working towards the tee.
     i. ***NOTE:*** It is important that no tension is applied when crossing over the branch piece to the other side. Pulling tension will cause the wrap to wrinkle in the bend and will be very difficult to fix. Simply lay the material onto the pipe and smooth with a gloved hand until you reach the other side and complete at least one full wrap around the pipe on the other side.
  i. When you reach the tee, wrap at an angle across the tee to transition across the branch area to reach the opposite side of the main line. Continue wrapping using a 50% overlap until reaching 1" (25.4mm) from the Primer layer edge.
  j. Apply slight tension by pulling on the roll of tape as the layers are being applied. Do not pull excessively so that the fiberglass tape is distorted or slips around the pipe, but simply enough to lay the material flat on the pipe surface.
  k. Use a gloved hand or roller to smooth the wrap as it is being applied and to work out any remaining air pockets as you wrap. Waiting to try and remove trapped air at the end of the wrap will be difficult, if possible at all.
  l. At the end of the first wrap along the main line, apply a 100% overlap. The roll may now be cut at this point. Do not reverse the direction of the application without completing an entire wrap along the length of the repair area.

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m. Proceed to wrap the branch section of the tee beginning at 1" (2.54cm) from the Primer layer edge and using 100% overlap to assure complete coverage, then proceed using 50% overlap working towards the tee.
n. Once the tee joint is reached, the material may be transitioned onto the main pipe if needed to secure the end.
o. The entire repair should now be sprayed with water to fully activate the material.
p. Repeat all steps from the cutting of the strips then proceeding in the same manner as before, but spraying with water as you go for the remainder of the repair until the total required number of layers have been applied.

Compression Film:

q. The completed Syntho-Glass XT application shall be overwrapped by four (4) layers of compression film and perforated using the perforator tool.
r. Begin the Compression Film application on the outside of the Primer layer to fully wrap 100% overlap on the pipe itself.
s. Overwrap the entire length of the repair going beyond the other end to fully encapsulate the repair area with the compression film.
t. Apply enough tension to the compression film that you see the film begin to stretch and get narrower as it is applied.
u. Once four (4) layers have been applied (two [2] passes with 50% overlap), perforate to allow the release of the CO_2 gas byproduct and excess water and resin.
v. On Tee Joints, it is helpful to apply a piece of folded over film in the "triangle" area where compression is not achieved to help provide the pressure on that point of the tee joint for uniform results.
w. The compression film may be removed when Syntho-Glass XT has reached its initial cure time.
x. Compression film MUST be removed to complete QC and apply any UV top coating.

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CHAPTER 7: INSTALLATION INSPECTION & VERIFICATION

This chapter will outline the inspection and validation process for Quality Control Records that should be completed by the site inspector or supervisor (depending on who is assigned this role by the client). This is the final step to insure that the installation was completed successfully and to the proper specifications as defined by the Engineering Report for the repair which was carried out. NRI provides a detailed document for use in the final inspection and QC hold points to help facilitate this process entitled, Syntho-Glass XT Quality Control Records. This chapter does not go into full detail and the Quality Control document may be used to record all hold points and measurements, or the site-specific documents may be used provided they meet the minimum required documentation as outlined by NRI.

> ***NOTE:*** *It is recommended that the client's official personnel be the final inspector of the installation provided that they have completed the proper training to perform the inspections. If the final inspection is completed by the contractor, it is required that the client's official personnel attend the inspection and sign off on the completed job to close out the proper paperwork.*

7.1. Inspection of Engineering Documentation

a. Engineering Review

i. Confirm the Engineering Report provided for the repair matches the repair location and note the following items:
   - Engineering Design ID Number
   - Pipe Diameter
   - Operating Conditions
   - Length of Repair

b. Material Review

i. Confirm all product Lot Numbers were recorded prior to usage
ii. Confirm proper quantities were utilized as per the required material estimates as a minimum

7.2. Inspection of Surface Preparation

a. Surface Preparation Review

i. Confirm Surface Preparation methods were followed as instructed
ii. Note any deviations which were mandated or allowed on site
iii. Confirm surface profile measurements were taken and recorded

7.3. Inspection of Composite Repair

a. Composite Repair Installation Review

i. Confirm each hold point during the installation was followed and documented
ii. Confirm the calculated repair length was met at a minimum
iii. Confirm the calculated number of layers was met at a minimum

b. Composite Repair Inspection

i. Take photos of the completed repair for record keeping purposes

ii. Inspect the composite repair for visible defects including, but not limited to:
    - Delamination at ends of repair
    - Cracks in the matrix resin
    - Foreign objects within the repair system
    - Wrinkles
    - Noticeable color changes or swirling
    - Dry spots or fiber fraying out of resin
iii. Measure and record the Shore D Hardness of the Primer layer to insure it is fully cured for service (required values are found on the Quality Control Records document)
iv. Validate cure schedule time and temperatures have been met for ECR System
v. Measure and record the Shore D Hardness of the Composite Wrap to insure it is fully cured for service (required values are found on the Quality Control Records document)

7.4. Completion and Filing of Paperwork

a. Final Inspection Records

i. Complete the Syntho-Glass XT Quality Control Records document (or approved equivalent) to submit.
ii. Documentation is not complete until it has been duly signed by the installation supervisor and the approved client representative.
iii. Final copies of the paperwork should be supplied to each of the following for record keeping:
    - The client
    - The contractor
    - NRI

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CHAPTER 8: ADDITIONAL INSTALLATION CONSIDERATIONS

This chapter will provide some useful information for some typical application scenarios which may be outside of the scope of normal operation as defined in the previous chapters of this installation guide. It is critical that any of these which may be noted for a specific repair application is communicated to NRI prior to the engineering design process so that all proper considerations may be given throughout the whole process.

8.1. Additional Considerations

a. High Layer Counts

i. If the layer count required is higher than 16 layers, the repair must be done in stages of 16 layers at a time. Once 16 layers has been installed, move to the compression film installation, allow the Syntho-Glass XT to fully complete the off-gassing cycle, then remove film and continue on. No more than 16 layers should be applied at any one time.

b. For Vertical Installations

i. Begin the wrapping portion of the installation at the bottom of the repair area and proceed upwards.

c. For Sub-sea and Splash Zone Installations

i. The Syntho-Subsea LV primer system must be used in these areas to insure proper and successful installation and effectiveness.

ii. The final (outer) wrap edge may be tied down or overwrapped in a manner that will ensure that the currents or wave action will not affect the adhesion of the last layer of fiberglass tape before the resin has reached its initial cure.

- If Compression Film is immediately available, it may be started on the same end as the wrap ending to assist with this as well.

iii. Open the pouch of Syntho-Glass XT underwater, at the repair site, only after all surface preparation is completed and all Filler and Primer have been applied.

d. For Impact or Abrasion Resistance for the Installation

i. Additional layers of Syntho-Glass® 24 or Syntho-Support™ over the Syntho-Glass XT.

e. For Non-Buried Installations

i. The Syntho-Glass XT repair ***must*** be coated with a UV-stable and environmentally resistant topcoat.

ii. NRI has Syntho-Glass® UV and Syntho-Coat™ 500 which have both been approved for use with the system as topcoats.

f. For Buried Installations

i. The repair may be coated with an approved coating system should the usage require it.

ii. If the pipeline is inspected by ILI, marker bands may be installed at each end of the repair area to indicate that a composite repair has been installed.

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g. For Cold Weather Installations

i. Keep all components in a climate-controlled environment at room temperature or higher for at least 24 hours before using on site, and continue to keep them warm on site until use.

ii. Warm water may be used when spraying the Syntho-Glass XT which will help to speed the process to provide a faster curing time.

iii. Salt water, or a mixture of water and ethylene glycol, may be used to keep the water from freezing before activating with the resin.

iv. Once the initial setting has occurred, a heat blanket may be applied over the repair length (do not put on uncured resin or it will bond to the pipe) to insure the curing is achieved.

- The Syntho-Glass XT composite system will not cure by itself at temperatures below 40°F (5°C) and will require an external heat source to insure the curing process is completed.
- Do not heat to a temperature above 194°F (90°C).

h. For Hot Weather Installations

i. Keep all components in a climate-controlled environment at room temperature for at least 24 hours before using on site, and continue to keep them cool on site until use.

ii. Cold water may be used when spraying the Syntho-Glass XT which will help to slow the curing process, providing longer working time.

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CHAPTER 9: WARRANTY/DISCLAIMER STATEMENT

9.1. Warranty/Disclaimer Statement:

All proposed repairs to pipeline and piping systems using the Syntho-Glass® XT system must be installed by or supervised by properly trained and experienced technicians. NRI®, Syntho-Glass® XT, Viper Skin®, Syntho-Glass® 24, and Syntho-Glass® UV are registered trademarks; and Syntho-Poxy™ HC, Syntho-Subsea™ LV, Syntho-Poxy™ LV, Syntho-Support™, Syntho-Coat™ 500, and Syntho-Steel™ are trademarks of NRI. NRI, the Manufacturer of Syntho-Glass® XT (and other aforementioned products) will replace at no charge to the purchaser any product proved to be defective. Responsibility of the Manufacturer and the Distributor is limited to replacement of the product only. Neither the Manufacturer nor the Distributor shall be liable for consequential or incidental damage or loss of any kind as they do not have any control over the conditions under which these products may be used or over the methods of application. Users should test the product for their particular need and suitability. Users should consult with the Manufacturer or the Distributor for all proposed repairs using the Syntho-Glass® XT system. Written procedures for specific repairs are available upon request from the Manufacturer or Distributor. Syntho-Glass® XT is not an approved coating system. Failing to coat per standard procedures can lead to atmospheric corrosion damage or degradation of the Syntho-Glass® XT system. Apply protective coatings per company standards. Kevlar® is a registered trademark of E. I. du Pont Nemours and Company.