3X ENGINEERING

REINFORCEKiT® 1D

COMPOSITE REPAIR SOLUTION FOR PIPE PROTECTION AND REINFORCEMENT

According to ISO 24.817 & ASME PCC-2

OIL & GAS
ONSHORE /OFFSHORE

DOC MKT 039 – B – ENG – LC – 07/2022

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1. PRODUCT BROCHURE

3XENGINEERING
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3X ENGINEERING

COMPOSITE REPAIR SOLUTION FOR PIPE PROTECTION & REINFORCEMENT

Any pipe diameters | Any pipe geometries | High pressure | -50°C to +88°C | Oil | Gas | Water

REINFORCEKiT® 1D

ISO 24.817 and ASME PCC-2 compliant

OIL & GAS
ONSHORE / OFFSHORE

INNOVATIVE REPAIR SOLUTIONS FOR YOUR INSTALLATIONS

REINFORCEKiT® 1D (R1D), is a water activated prepreg repair system wrapped around the pipe to protect and reinforce corroded pipe and restore original pipe integrity.

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This composite technology, made of fiber glass and polyurethane resin, is a great alternative to metal clamp, welded sleeve and pipe replacement. **3X ENGINEERING (3X)** developed its own software to design the repair and define the material requirements according to ISO 24.817 and ASME PCC-2 standards.

If applied as protection, the product is ready to use and does not require any calculations.

REINFORCEKiT® 1D RANGE

PROTECTION APPLICATION

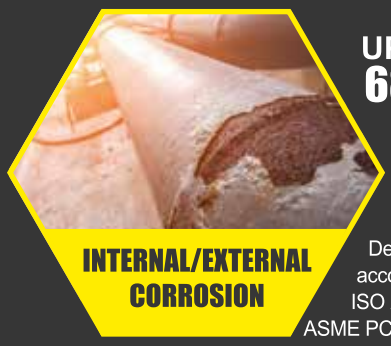
COATED PIPE PROTECTION

UP TO 88°C

No calculations required, only 2 layers necessary

IMPACT PROTECTION

REINFORCEMENT APPLICATION



INTERNAL/EXTERNAL CORROSION

UP TO 68°C

Designed according to ISO 24.817 & ASME PCC-2 standards

MECHANICAL DAMAGES

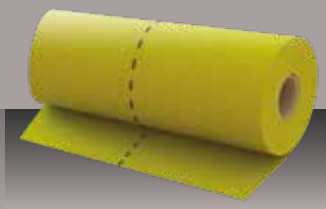
REINFORCEKiT® 1D MAIN FEATURES & BENEFITS

- Emergency Pipeline Repair System (EPRS)
- Online repair (no loss of production)
- Designed according to the standards (ISO 24.817 and ASME PCC-2 compliant) for reinforcement application
- Suitable for any pipe geometries (straight, elbow, tee) including irregularities (welds ...), without pipe size limitation
- User-friendly and time-saving (fiber already impregnated with resin, no mixing nor measuring)
- Cost-effective (2 layers max for protection and 10 layers max for reinforcement)
- Installation by trained and certified applicators recommended to increase product efficiency
- Traceability using smart tag NFC

REINFORCEKiT® 1D COMPONENTS

3 tape sizes

- **R1D-150x5** (150mm x 5m)
- **R1D-150x15** (150mm x 15m)
- **R1D-285x15** (285mm x 15m)



Needed chemicals for reinforcement application ONLY

Filler

Primer

Needed accessories for application

Water spray

Plastic wrap

Spiked roller

REINFORCEKiT® 1D IMPLEMENTATION

1 Designed as per ISO 24.817 & ASME PCC-2

2 Surface preparation Sa2½ / St3 and roughness Rz > 60 µm

3 Filler and primer applications

4 R1D wrapping (spray water continuously)

5 Identification plate positioning

6 Compression film application and perforation

For reinforcement application, steps 1 to 6

For protection application, only steps 4-5-6

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3X ENGINEERING

ISO 9001:2015 CERTIFIED

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2. TECHNICAL DATA SHEET

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REINFORCEKiT® 1D

COMPOSITE PREPREG SOLUTION FOR COATED PIPE PROTECTION AND REINFORCEMENT
Service temperature from -50°C (-58°F) to +68°C (+154°F)
Application temperature from +10°C (+50°F) to +68°C (+154°F)

OIL & GAS
ONSHORE /OFFSHORE

TECHNICAL DATA SHEET

REINFORCEKiT® 1D (R1D) DESCRIPTION

REINFORCEKiT® 1D (R1D) is an advanced permanent composite repair system for pipelines and piping suffering from corrosion defects and mechanical damage. R1D is engineered to restore pipe original integrity without shutdown. It is a non-metallic technical alternative to metal clamps, welded sleeves and pipe replacement. Thoroughly tested, R1D is a 3X ENGINEERING (3X) concept which provides the long-term required strength according to ASME B31G, ISO 24.817 and ASME PCC-2 codes and standards. R1D can also be used as protection for coated pipe.

R1D is a unique pre-saturated moisture-cured polyurethane prepreg system. The bi-directional fiberglass reinforcement provides reinforcement in the hoop and axial directions. The polyurethane resin allows binding and transferring loading through the whole composite system.
It is simple to use and does not require any mixing nor measuring. Just spray some water regularly, then apply by wrapping around the area to protect. The working time of 30 minutes allow to wrap without haste before achieving full mechanical properties within few hours.

R1D is wrapped helicoidally with 50% overlapping around the pipe in order to bring the mechanical resistance to the damaged pipe section. The number of layers, determined by calculation, is linked not only to the pipe pressure, temperature, diameter and thickness but also to the pit depth and length, the steel grade and the pipe location. The repair design and material requirements are provided by 3X software REA after information compilation according to ASME B31G, ISO 24.817 and ASME PCC-2 codes and standards. In the intended use is pipe protection, 3X ENGINEERING recommends to apply a minimum of 2 layers.

R1D is recommended to repair and reinforce pipelines operating at temperature between -50°C (-58°F) to +68°C (+154°F) subject to corrosion. The composite system restores the pipe integrity and prevents from further deterioration.

USES

- Transmission pipelines
- Process piping
- Refineries and offshore platforms
- Conform to any shape including welds, elbows and tees
- External/Internal corrosion
- Suitable for -50°C (-58°F) to +68°C (+154°F)
- Protective coating for pipes subject to impact
- Protection of coating (Epoxy, 3LPP, FBE)

BENEFITS

- Factory saturated fiber
- No heating or post-curing
- Online repair (no shutdown)
- Fast and easy implementation
- Compliant with ASME PCC-2 and ISO 24.817

REINFORCEKiT® 1D

COMPOSITE PREPREG SOLUTION FOR COATED PIPE PROTECTION AND REINFORCEMENT
Service temperature from -50°C (-58°F) to +68°C (+154°F)
Application temperature from +10°C (+50°F) to +68°C (+154°F)

OIL & GAS
ONSHORE / OFFSHORE

REINFORCEKiT® 1D SPECIFICATIONS

		R1D-285x15	R1D-150x15	R1D-150x5
COMPOSITE SPECIFICATIONS				
	To be used with	F3X8 – Epoxy filler P3X1 – Epoxy primer		
FIBER	**Fiber nature**	Fiber glass		
	Fiber directions towards structure axis	Hoop / Axial (0° / 90°)		
	Fiber type	Plain weave fabric		
	Surface weight	700 gsm		
RESIN	**Chemical family**	Moisture-cured Polyurethane		
	Color	Yellow transparent		
PREPREG SYSTEM	**Tape width**	285 mm	150 mm	150 mm
	Tape length	15 m	15 m	5 m
	Prepreg Net Weight	4.25 kg	2.25 kg	0.97 kg
	Nominal ply thickness	0.69 mm* (0.028 inch)		
	Laminate thickness	To be determined by calculations as per standards. For pipe protection, minimum number of layers is 2 plies.		
	Glass transition temperature (ASTM E 1640)	+88°C (+190°F)		
	Application temperature	From +10°C (+50°F) to +68°C (+154°F)		
	Max and Min operating temperatures for reinforcement use	From -50°C (-58°F) to +68°C (+154°F)		
	Max and Min operating temperatures for protection use	From -50°C (-58°F) to +88°C (+190°F)		
	Working time	20 minutes at +25°C (+77°F)		
	Set time	2 hours at +25°C (+77°F)		
	Curing time	24 hours at +25°C (+77°F)		
	Storage	Between +15°C (+59°F) and +27°C (+81°F)		
	Shelf life	2 years		
PROPERTIES*	**Tensile strength in hoop direction (ISO 527)**	259 MPa		
	Tensile strength in axial direction (ISO 527)	120 MPa		
	Tensile modulus in hoop direction (ISO 527)	25.17 GPa (3 500 ksi)		
	Tensile modulus in axial direction (ISO 527)	9.48 GPa (1 160 ksi)		
	Poisson ratio (ISO 527 or ASTM D3039)	0.151		
	Flexural strength (ISO 178)	100 MPa (14.5 ksi)		
	Flexural modulus (ISO 178)	14.7 GPa (2 100 ksi)		
	Resin Shore D hardness (ISO 868)	79 Shore D Resin hardness requirements: >70 Shore D		
	Impact resistance - Charpy impact (GB/T 1451)	150 kJ/m²		
	Breakdown voltage (in air) (GB/T 1408.1)	11.3 kV		

**values are given for indication and may vary depending on the environment*

SAFETY

Each applicator should read and understand the Material Safety Data Sheets (MSDS) and installation procedure before using 3X products.

WARRANTY DISCLAIMER

Every reasonable effort is made to ensure the technical information and recommendations of this data sheet are true and accurate to the best of our knowledge at the date of issuance. However, improvements being continuously implemented to 3X products, this information is subject to change without notice. Please contact your 3X distributor for the most current products specifications. This 3X technical datasheet warrants the quality of this product when used according to directions. User shall determine suitability of the product for use and assumes all risk.

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3. PIPE DEFECT REGISTER

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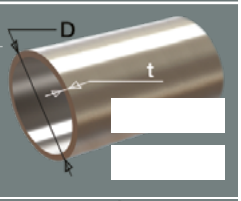
Pipe Defect Register (PDR)

Client		3X distributor	
Project		Contact details	
Defect ref.			

PIPE DIMENSION

mm ☐ inch ☐

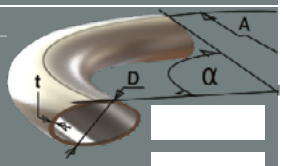
STRAIGHT



D: Original diameter

t: Wall thickness

BEND



D: Original diameter

t: Wall thickness

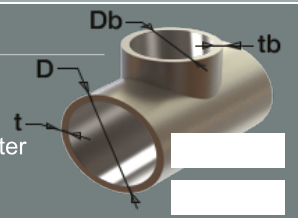
A: Medium radius of the bend

α: Opening angle bend

Bend defect location

Axial ☐ External ☐ Internal ☐

TEE



Main branch

D: Original diameter

t: Wall thickness

Secondary branch

Db: Original diameter

tb: Wall thickness

PIPE INFORMATION

Grade:

Other:

CONNECTION

Seamless (1.0) ☐
Electric Resistance Weld (1.0) ☐
Electric Flash Weld (1.0) ☐
Electric Fusion (Arc) Weld / Spiral Weld (0.8) ☐
Furnace Butt Weld / Continuous Weld (0.6) ☐
(Double) Submerged Arc Weld (1.0) ☐
Laser Beam Weld (1.0) ☐

FLUID

Oil ☐
Gas ☐
Water ☐
Chemical product ☐

If the fluid is chemical, specify its nature

FLUID SYSTEM COMPONENT

Pipeline ☐
Piping ☐
Riser ☐

ENVIRONMENT

Onshore ☐
Buried ☐
Offshore Subsea ☐
Offshore top side ☐

DESIGN FACTOR

According to the ASME B31.4 & ASME B31.8

Class 1	Class 2	Class 3	Class 4
☐ 0,72	☐ 0,6	☐ 0,5	☐ 0,4

Other

PRESSURE

Psi ☐ Bar ☐ MPa ☐

Pipe design pressure (only for information)

Pipe operating pressure (only for information)

Repair design pressure

Repair Installation pressure (plive)

Plive: pressure during application of the repair

TEMPERATURE

°C ☐ °F ☐

Pipe design temp. (only for information)

Pipe operating temp. (only for information)

Min. Max.

Repair design temp.

Repair installation temp.

Min. Max.

PIPE DEFECT

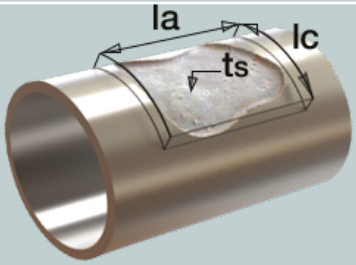
DEFECT TYPE

External ☐ Internal ☐

Metal loss ☐
Through-wall ☐
Crack ☐
Dent ☐

CALCULATION CHOICE

ISO 24.817 ☐
ASME PCC-2 ☐



REPAIR DESIGN LIFETIME Years

DEFECT DIMENSIONS

mm ☐ inch ☐

la: Defect axial length

Lc: Defect circumferential length

ts: Minimum residual wall thickness

DEFECT ORIGIN

Corrosion ☐
Abrasion / Erosion ☐
Impact ☐

PIPE ENVIRONMENT AND REPORTS

	Yes	No
Do you have an inspection report of the defect?	☐	☐
Do you have pictures of the affected zone?	☐	☐
Do you have clearance 40cm all around the pipe for working?	☐	☐
Is the defect situated close to weld, nozzle, tee, bend, support?	☐	☐
Is the defect close to habitations, machines, industries?	☐	☐
Is there a sand blasting possibility (Sa½ & 60µm (Rz))?	☐	☐

COMMENTS

Full name:

Signature & company stamp

Date : / /

In order to determine the repair technology, this document has to be fulfilled accurately. **All missing information will affect the design, quality and standard acceptance and will be treated making assumptions.** We will not be responsible for data input. We will only accept signed forms. The person fulfilling this form assumes full responsability

ERASE SEND

4. PRODUCT APPLICATIONS

REINFORCEKiT® 1D

SUITABLE FOR VARIOUS PIPE GEOMETRIES AND DEFECTS

➲ ENVIRONMENT

ONSHORE – OFFSHORE TOPSIDE

➲ PIPE DIAMETER

NO LIMITATION

➲ SERVICE TEMPERATURE

FROM -50°C TO +68°C (-58°F TO +154°F)
FOR REINFORCEMENT APPLICATION

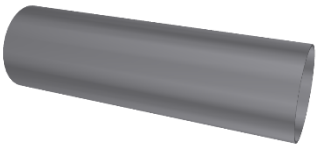
FROM -50°C TO +88°C (-58°F TO +190°F)
FOR PROTECTION APPLICATION

➲ FLUID

OIL – GAS – WATER

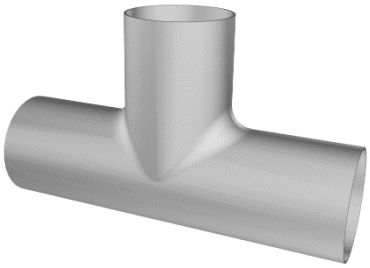
OIL & GAS
ONSHORE /OFFSHORE

➲ PIPE GEOMETRIES



STRAIGHT PIPE

ELBOW



TEE

RISER (TOPSIDE)

WELD INCLUDED

➲ PIPE DEFECTS

EXTERNAL CORROSION (REINFORCEMENT)

MECHANICAL DAMAGES (REINFORCEMENT)

INTERNAL CORROSION (REINFORCEMENT)

COATED PIPE AND IMPACT (PROTECTION)

5. CASE STUDIES

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3X ENGINEERING

INNOVATIVE REPAIR SOLUTION FOR YOUR INSTALLATIONS

OIL & GAS
ONSHORE /OFFSHORE

COMPOSITE REPAIR SOLUTION FOR PIPE PROTECTION & REINFORCEMENT

DEFECT TYPES	**External corrosion - 11 defects**
DETAILS	**8" buried gas pipe, 40 bars pressure, max op. temp. 35°C**
LOCATION	**Indonesia, Onshore**
3X SOLUTION	**REINFORCEKiT® 1D**

Fig. 1: Surface preparation on progress

Fig. 2: Filler application

Fig. 3: Primer application

Fig. 4: Wrapping completed + compression film perforation

Fig. 5: Overview of reinforcement completed

OVERVIEW

The objective of the repairs, carried out in January 2022 by **3X ENGINEERING (3X)** local distributor **SINCERITY ENERGY**, was to reinforce 11 areas of 8" buried gas pipe suffering from external corrosion. To restore the mechanical integrity of the pipe and prevent further corrosion, it was decided to install **REINFORCEKiT® 1D (R1D)** product.

SCOPE OF WORK

According to ASME PCC-2 standard and 3X design calculations, it was decided to apply **R1D composite solution** (3X water activated composite system dedicated to protect and reinforce your pipe). Four layers were determined to reinforce the straight gas line over approx. 2,20 meters total length.

Surface preparation was performed using Bristle Blaster® machine to get a good surface cleanliness roughness (superior to 60µm Rz) and ensure a good bonding between the steel pipe and the composite repairs. Hygrometric conditions were checked and the surfaces were cleaned with acetone.

The composite wrapping repairs were then completed following below stages (installation procedure is the same for the 11 areas to be reinforced).

1/ **F3X8 filler** was used to reshape the corroded areas of the pipe. **P3X1 primer** was then applied on the whole prepared areas.

2/ Once the "Dry Touch" was reached, composite wrapping was completed applying 4 layers of **R1D** for each corroded area. To do so, this water activated composite system was wrapped around the corroded areas spraying water continuously.

3/ **Compression film** was then rolled all over the wrappings and slightly pierced using perforating tool (spiked roller). Any trapped CO2 gas bubbles could thus evacuate to get optimal repair laminate quality.

RESULTS

This project was quite complicated because of many COVID restrictions, but our local partner SINCERITY ENERGY delivered a great job by completing several reinforcements using our REINFORCEKiT® 1D.

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3X ENGINEERING

INNOVATIVE REPAIR SOLUTION FOR YOUR INSTALLATIONS

OIL & GAS
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COMPOSITE REPAIR SOLUTION FOR PIPE PROTECTION & REINFORCEMENT

DEFECT TYPES	**External corrosion**
DETAILS	**36" conductors supported platform, Offshore Topside, no pressure, max op. temp. 38°C**
LOCATION	**Offshore Platform, VietNam**
3X SOLUTION	**REINFORCEKiT® 1D**

Fig. 1: Defected conductors to be reinforced

Fig. 2: Filler and primer application

Fig. 3: R1D wrapping

Fig. 4: Compression film application & perforation

Fig. 5: Overview of reinforcements completed

OVERVIEW

The objective of the repairs, carried out in November 2021 by **3X ENGINEERING (3X**) local partner PETROENERTECH, was to reinforce 18 units of 36" conductors supported platform suffering from external corrosion. To restore the structural integrity of the platform and prevent further deterioration, it was decided to install **REINFORCEKiT® 1D (R1D)** product.

SCOPE OF WORK

According to client's requirements and superfical metal loss, it was decided to apply **R1D composite solution** ==> 3X water activated composite system dedicated to protect and reinforce your installations. Two composite layers were determined to reinforce each conductor over 10 meters height.

Surface preparation was performed with gritblasting to get a good surface cleanliness roughness (superior to 60µm Rz) and ensure a good bonding between the steel pipes and the composite repairs. Hygrometric conditions were checked and the surfaces were cleaned with acetone.

The composite wrapping repairs were then completed following below stages (installation procedure is the same for the 18 units to be reinforced).

1/ In presence of extenal loss, **F3X8 filler** was used to reshape the conductors. **P3X1 primer** was then applied on the whole prepared area.

2/ Once the "Dry Touch" was reached, composite wrapping was completed applying 2 layers of **R1D** over 10 meters height. To do so, this water activated composite system was wrapped around the conductors spraying water continuously.

3/ **Compression film** was then rolled all over the wrappings and slightly pierced using perforating tool (spiked roller). Any trapped CO2 gas bubbles could thus evacuate to get optimal repair laminate quality.

4/ **Anti-UV coating application** as finishing stage.

RESULTS

This project was challenging due to the bad weather and many COVID restrictions, but our local partner PETROENERTECH delivered an outstanding performance applying our REINFORCEKiT® 1D on very high surfaces.

==> 18 CONDUCTORS WRAPPED OVER 10 METERS HEIGHT.

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