3X ENGINEERING

REINFORCEKiT® PATCH

LONG-TERM
COMPOSITE REPAIR SOLUTION
FOR TANK AND PRESSURE VESSEL

According to ISO 24.817, ASME PCC-2 and API 653

OIL & GAS
ONSHORE /OFFSHORE

DOC MKT 009 – D – ENG – LC – 07/2022

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3XENGINEERING
OIL & GAS
ONSHORE /OFFSHORE

3X ENGINEERING

LONG-TERM COMPOSITE REPAIR SOLUTION FOR TANK AND PRESSURE VESSEL REINFORCEMENT

Any designs | Any diameters | Any defect sizes | Storage and pressure | -50°C to +150°C | Oil | Gas | Water

REINFORCEKiT® PATCH

ISO 24.817, ASME PCC-2 and API 653 compliant

OIL & GAS
ONSHORE / OFFSHORE

INNOVATIVE REPAIR SOLUTIONS FOR YOUR INSTALLATIONS

REINFORCEKiT® PATCH is a wet lay-up patching repair system designed to reinforce tanks and pressure vessels, restore original asset integrity and prevent further deterioration.

3X ENGINEERING
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ONSHORE /OFFSHORE

This composite technology, made of several Kevlar® patches and bi-component epoxy resin, is a great alternative to welded metal plate and equipment replacement.

3X ENGINEERING (3X) developed its own software to design the repair and define the material requirements according to ISO 24.817, ASME PCC-2 and API 653 standards.

REINFORCEKiT® PATCH RANGE

REINFORCEKiT® PATCH MAIN FEATURES & BENEFITS

- Tailor-made for each repair
- Online repair (no loss of production)
- Long-term performance (up to 20-year lifetime)
- Designed according to the standards (ISO 24.817, ASME PCC-2 and API 653 COMPLIANT)
- Versatile product with a large range of applications (storage and GRP tanks, pressure vessels, separators, columns ...)
- Suitable for any tank (wall, roof and bottom plate) and pressure vessel designs and diameters
- No limitation in pressure and defect size
- User-friendly (no hot work, non conductive repair, light product)
- Installation by trained and certified applicators only
- Traceability using smart tag NFC

REINFORCEKiT® PATCH IMPLEMENTATION


1. Designed as per ISO 24.817 & ASME PCC-2


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


3. 3X filler application


4. 3X bi-component epoxy resin preparation


5. Kevlar® patching with 3X resin application


6. Final protection and traceability tag

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2. TECHNICAL DATA SHEET

REINFORCEKiT® PATCH

LONG-TERM COMPOSITE REPAIR SOLUTION FOR TANK AND PRESSURE VESSEL REINFORCEMENT
Service temperature from-50°C (-58°F) up to +150°C (+302°F)

OIL & GAS
ONSHORE / OFFSHORE

TECHNICAL DATA SHEET

REINFORCEKiT® PATCH DESCRIPTION

REINFORCEKiT® PATCH is an advanced permanent composite repair system for tanks and pressured vessels suffering from corrosion defects and mechanical damage. REINFORCEKiT® PATCH is engineered to restore tank original integrity without shutdown, unless active leakage. It is a composite technical alternative to welded metal plate and equipment replacement. Thoroughly tested by third-party laboratories, REINFORCEKiT® PATCH is a 3X ENGINEERING (3X) concept which provides the required strength according to ASME B31G, ISO 24.817 and ASME PCC-2 codes and standards.

The original 3X concept is a combination of Kevlar® tape patching and specific epoxy resin. The bi-directional woven high-strength aramid-fiber material provides reinforcement in the hoop and axial directions. The epoxy resin allows binding and transferring loading through the whole composite system.

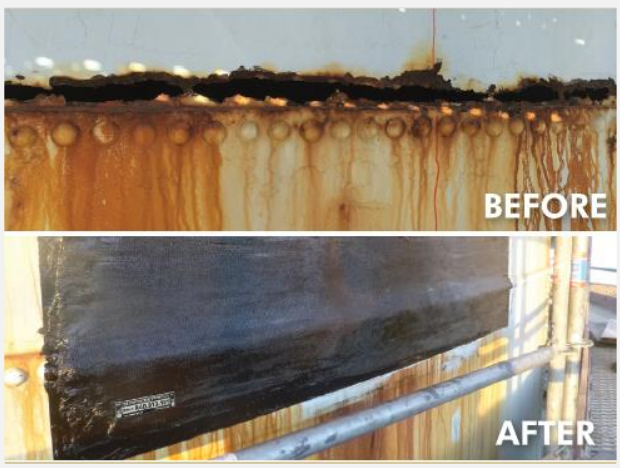
REINFORCEKiT® PATCH is a wet lay-up system made of several Kevlar® patches. The number of patches/layers, determined by calculation, is linked not only to the tank pressure, temperature, diameter and thickness but also to the pit depth and length and the steel grade. The repair design and material requirements are provided by 3X software REA after information compilation according to ASME B31G, ISO 24.817 and ASME PCC-2 codes and standards.

REINFORCEKiT® PATCH FEATURES

REINFORCEKiT® PATCH is recommended to repair and reinforce tanks and pressured vessels operating at temperature between **-50°C (-58°F) to +150°C (+302°F)** subject to external and internal corrosion, dents, mechanical damages and leaking defects. The system restores the tank integrity and prevents from further deterioration. This composite patch is made of 320 g/m² Kevlar® patches and ceramic reinforced epoxy resin. This specific resin composition provides good anti-abrasion and chemical features. The dimensions and number of patches, the type and quantity of resin will depend on the defect (no limitation in defect size).

USES

- External & internal corrosion
- Pitting
- Dents
- Weld defects
- Mechanical damages
- Through-wall defects
- Pinholes
- Cracks
- Leaks (if stopped prior to composite application
- Severe abrasion & erosion
- Suitable for -50°C (-58°F) up to +150°C (+302°F)



BENEFITS

- Online repair (no shutdown required except if leakage)
- Permanent repair for external defect (up to 20 years)
- Conform to all tank designs and sizes
- Compatible with most common fluids and gases
- In accordance with standards
- No limitation in pressure and defect size
- No overload on corroded tanks
- Fiber not hazardous for users
- No hot work

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REINFORCEKiT® PATCH

LONG-TERM COMPOSITE REPAIR SOLUTION FOR TANK AND PRESSURE VESSEL REINFORCEMENT
Service temperature from-50°C (-58°F) up to +55°C (+131°F)
Application temperature from +10°C (+50°F) up to +55°C (+131°F)

R3X55

RESIN SPECIFICATIONS	
Commercial name	**R3X55**
Chemical family	Epoxy (bi-component)
Color	Black
Mixing ratio by weight	(Part A : Part B) = 2 : 1
Pack size	1.28 kg/set
Solids	100%
VOCs	none
Storage	Between +15°C (+59°F) and +32°C (+90°F) if long-term storage
Shelf life	2 years in unopened containers

PATCH SPECIFICATIONS	
Fiber nature	Aramid Kevlar® 49
Fiber directions towards pipe axis	Hoop/axial (0° / 90°)
Fiber type	Woven type
Tensile strength	2 900 MPa (420.5 ksi)
Tensile modulus	110 GPa (15 950 ksi)
Weight per square meter	320 g/m2

COMPOSITE SPECIFICATIONS							
Percentage of fiber in volume	Up to 30%						
Nominal ply thickness	0.82 mm* (0.032 inch)						
Laminate thickness	To be determined using calculations according to standards FYI, minimum laminate thickness is 2 plies and/or 2mm						
Tensile strength in hoop direction (ISO 527 or ASTM D3039)	264 MPa (38 290 psi)						
Tensile strength in axial direction (ISO 527 or ASTM D3039)	264 MPa (38 290 psi)						
Tensile modulus in hoop direction (ISO 527 or ASTM D3039)	15.7 GPa (2 270 ksi)						
Tensile modulus in axial direction (ISO 527or ASTM D3039)	15.7 GPa (2 270 ksi)						
Poisson's ratio (ISO 527 or ASTM D3039)	0.12						
Shear modulus (ASTM D5379)	0.78 GPa (113 ksi)						
Resin Shore D hardness (ISO 868 or ASTM D2583)	78 Shore D, Resin hardness requirement: >71 Shore D						
Lap shear strength (BS EN 1465 or ASTM D3165)	18 MPa (2 610 psi)						
Cathodic disbondment (ASTM G8)	Passed						
Application temperature	From +10°C (+50°F) to +55°C (+131°F)						
Service temperature	From -50°C (-58°F) to +55°C (+131°F) - Fully cured						
Ultimate Glass transition temperature (ASTM D7426)	+75°C (+167°F) – Fully cured with post-curing						
Curing time after job completion: - **Given values could be shorten by using ATEX approved heating belts.** - **In case of process shutdown, it is required to post-cure the composite at temperature superior or equal to service temperature.** - **Values just given as information.**		+10°C +50°F	+16°C +61°F	+25°C +77°F	+32°C +90°F	+40°C +104°F	+50°C +122°F
	Light load	2 days	32 hrs	20 hrs	18 hrs	15 hrs	12 hrs
	Full load	6 days	90 hrs	56 hrs	52 hrs	48 hrs	40 hrs
Applicable for Through-Wall (Type B) defect	No						

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

REINFORCEKiT® PATCH

LONG-TERM COMPOSITE REPAIR SOLUTION FOR TANK AND PRESSURE VESSEL REINFORCEMENT
Service temperature from-50°C (-58°F) up to +95°C (+203°F)
Application temperature from +15°C (+59°F) up to +95°C (+203°F)

R3X95

RESIN SPECIFICATIONS	
Commercial name	**R3X95**
Chemical family	Epoxy (bi-component)
Color	Black
Mixing ratio by weight	(Part A : Part B) = 100 : 21.2
Pack size	1.3 kg/set
Solids	100%
VOCs	none
Storage	Between +15°C (+59°F) and +32°C (+90°F) if long-term storage
Shelf life	2 years in unopened containers

PATCH SPECIFICATIONS	
Fiber nature	Aramid Kevlar® 49
Fiber directions towards pipe axis	Hoop/axial (0° / 90°)
Fiber type	Woven type
Tensile strength	2 900 MPa (420.5 ksi)
Tensile modulus	110 GPa (15 950 ksi)
Weight per square meter	320 g/m2

COMPOSITE SPECIFICATIONS						
Percentage of fiber in volume	Up to 30%					
Nominal ply thickness	0.82 mm* (0.028 inch)					
Laminate thickness	To be determined using calculations according to standards FYI, minimum laminate thickness is 2 plies and/or 2mm					
Tensile strength in hoop direction (ISO 527 or ASTM D3039)	231 MPa (33 500 psi)					
Tensile strength in axial direction (ISO 527 or ASTM D3039)	231 MPa (33 500 psi)					
Tensile modulus in hoop direction (ISO 527 or ASTM D3039)	16 GPa (2 320 ksi)					
Tensile modulus in axial direction (ISO 527or ASTM D3039)	16 GPa (2 320 ksi)					
Poisson's ratio (ISO 527 or ASTM D3039)	0.10					
Shear modulus (ASTM D5379)	1.16 GPa (168 ksi)					
Resin Shore D hardness (ISO 868 or ASTM D2583)	82 Shore D, Resin hardness requirement: >74 Shore D					
Lap shear strength (BS EN 1465 or ASTM D3165)	12.9 MPa (1 870 psi)					
Cathodic disbondment (ASTM G8)	Passed					
Application temperature	From +15°C (+59°F) up to +95°C (+203°F)					
Service temperature	From -50°C (-58°F) to +95°C (+203°F) - Fully cured					
Ultimate Glass transition temperature (ASTM D7426)	+75°C (+167°F) – Fully cured with post-curing					
Curing time after job completion: - **Given values could be shorten by using ATEX approved heating belts.** - **In case of process shutdown, it is required to post-cure the composite at temperature superior or equal to service temperature.** - **Values just given as information.**		+15°C +59°F	+20°C +68°F	+30°C +86°F	+40°C +104°F	+70°C +158°F
	Light load	36 hrs	24 hrs	8 hrs	5 hrs	4 hrs
	Full load	96 hrs	48 hrs	32 hrs	30 hrs	24 hrs
Applicable for Through-Wall (Type B) defect	Under condition					

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

REINFORCEKiT® PATCH

LONG-TERM COMPOSITE REPAIR SOLUTION FOR TANK AND PRESSURE VESSEL REINFORCEMENT
Service temperature from-50°C (-58°F) up to +110°C (+230°F)
Application temperature from +70°C (+158°F) up to +110°C (+230°F)

R3X110

RESIN SPECIFICATIONS	
Commercial name	**R3X110**
Chemical family	Epoxy (bi-component)
Color	Black
Mixing ratio by weight	(Part A : Part B) = 4.66 : 1
Pack size	1.04 kg/set
Solids	100%
VOCs	none
Storage	Between +15°C (+59°F) and +32°C (+90°F) if long-term storage
Shelf life	2 years in unopened containers

PATCH SPECIFICATIONS	
Fiber nature	Aramid Kevlar® 49
Fiber directions towards pipe axis	Hoop/axial (0° / 90°)
Fiber type	Woven type
Tensile strength	2 900 MPa (420.5 ksi)
Tensile modulus	110 GPa (15 950 ksi)
Weight per square meter	320 g/m2

COMPOSITE SPECIFICATIONS				
Percentage of fiber in volume	Up to 30%			
Nominal ply thickness	0.75 mm* (0.030 inch)			
Laminate thickness	To be determined using calculations according to standards FYI, minimum laminate thickness is 2 plies and/or 2mm			
Tensile strength in hoop direction (ISO 527 or ASTM D3039)	247 MPa (35 820 psi)			
Tensile strength in axial direction (ISO 527 or ASTM D3039)	247 MPa (35 820 psi)			
Tensile modulus in hoop direction (ISO 527 or ASTM D3039)	16.5 GPa (2 390 ksi)			
Tensile modulus in axial direction (ISO 527or ASTM D3039)	16.5 GPa (2 390 ksi)			
Poisson's ratio (ISO 527 or ASTM D3039)	0.08			
Shear modulus (ASTM D5379)	1.1 GPa (160 ksi)			
Resin Shore D hardness (ISO 868 or ASTM D2583)	80 Shore D, Resin hardness requirement: >73 Shore D			
Lap shear strength (BS EN 1465 or ASTM D3165)	14.7 MPa (2 130 psi)			
Cathodic disbondment (ASTM G8)	Passed			
Application temperature	From +70°C (+158°F) to +110°C (+230°F) *If $T°_{pipe}$ <+70°C (+158°F), heating device needed*			
Service temperature	From -50°C (-58°F) to +110°C (+230°F) - Fully cured *If difference between application and service temperature is bigger than 100°C, the repair integrity may be affected.*			
Ultimate Glass transition temperature (ASTM D7426)	+130°C (+266°F) – Fully cured with post-curing			
Curing time after job completion: - **Given values could be shorten by using ATEX approved heating belts.** - **In case of process shutdown, it is required to post-cure the composite at temperature superior or equal to service temperature.** - **Values just given as information.**		+70°C +158°F	+90°C +194°F	+110°C +230°F
	Light load	10 hrs	7 hrs	5 hrs
	Full load	24 hrs	14 hrs	10 hrs
Applicable for Through-Wall (Type B) defect	No			

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

REINFORCEKiT® PATCH

LONG-TERM COMPOSITE REPAIR SOLUTION FOR TANK AND PRESSURE VESSEL REINFORCEMENT

Service temperature from-50°C (-58°F) up to +130°C (+266°F)

Application temperature from +70°C (+158°F) up to +130°C (+266°F)

R3X130

RESIN SPECIFICATIONS	
Commercial name	**R3X130**
Chemical family	Epoxy (bi-component)
Color	Transparent Yellow
Mixing ratio by weight	(Part A : Part B) = 3.37 : 1
Pack size	1.25 kg/set
Solids	100%
VOCs	none
Storage	Between +15°C (+59°F) and +32°C (+90°F) if long-term storage
Shelf life	2 years in unopened containers

PATCH SPECIFICATIONS	
Fiber nature	Aramid Kevlar® 49
Fiber directions towards pipe axis	Hoop/axial (0° / 90°)
Fiber type	Woven type
Tensile strength	2 900 MPa (420.5 ksi)
Tensile modulus	110 GPa (15 950 ksi)
Weight per square meter	320 g/m2

COMPOSITE SPECIFICATIONS				
Percentage of fiber in volume	Up to 30%			
Nominal ply thickness	0.82 mm* (0.032 inch)			
Laminate thickness	To be determined using calculations according to standards FYI, minimum laminate thickness is 2 plies and/or 2mm			
Tensile strength in hoop direction (ISO 527 or ASTM D3039)	205 MPa (30 100 psi)			
Tensile strength in axial direction (ISO 527 or ASTM D3039)	205 MPa (30 100 psi)			
Tensile modulus in hoop direction (ISO 527 or ASTM D3039)	16 GPa (2 320 ksi)			
Tensile modulus in axial direction (ISO 527or ASTM D3039)	16 GPa (2 320 ksi)			
Poisson's ratio (ISO 527 or ASTM D3039)	0.11			
Shear modulus (ASTM D5379)	1.15 GPa (167 ksi)			
Resin Shore D hardness (ISO 868 or ASTM D2583)	79 Shore D, Resin hardness requirement: >73 Shore D			
Lap shear strength (BS EN 1465 or ASTM D3165)	14.2 MPa (2 090 psi)			
Cathodic disbondment (ASTM G8)	Passed			
Application temperature	From +70°C (+158°F) to +130°C (+266°F) *If $T°_{pipe}$ <+70°C (+158°F), heating device needed*			
Service temperature	From -50°C (-58°F) to +130°C (+266°F) – Fully cured *If difference between application and service temperature is bigger than 100°C, the repair integrity may be affected.*			
Ultimate Glass transition temperature (ASTM D7426)	+150°C (+302°F) – Fully cured with post-curing			
Curing time after job completion: - **Given values could be shorten by using ATEX approved heating belts.** - **In case of process shutdown, it is required to post-cure the composite at temperature superior or equal to service temperature.** - **Values just given as information.**		+70°C +158°F	+90°C +194°F	+110°C +230°F
	Light load	24 hrs	10 hrs	5 hrs
	Full load	36 hrs	20 hrs	10 hrs
Applicable for Through-Wall (Type B) defect	No			

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REINFORCEKiT® PATCH

LONG-TERM COMPOSITE REPAIR SOLUTION FOR TANK AND PRESSURE VESSEL REINFORCEMENT

Service temperature from-50°C (-58°F) up to +70°C (+158°F)

Application temperature from +10°C (+50°F) up to +70°C (+158°F)

R3X70+

RESIN SPECIFICATIONS	
Commercial name	**R3X70+**
Chemical family	Epoxy (bi-component)
Color	Black or Grey
Mixing ratio by weight	(Part A : Part B) = 6.8 : 1
Pack size	1,28 kg/set
Solids	100%
VOCs	none
Storage	Between +15°C (+59°F) and +32°C (+90°F) if long-term storage
Shelf life	2 years in unopened containers

PATCH SPECIFICATIONS	
Fiber nature	Aramid Kevlar® 49
Fiber directions towards pipe axis	Hoop/axial (0° / 90°)
Fiber type	Woven type
Tensile strength	2 900 MPa (420.5 ksi)
Tensile modulus	110 GPa (15 950 ksi)
Weight per square meter	320 g/m2

COMPOSITE SPECIFICATIONS							
Percentage of fiber in volume	Up to 30%						
Nominal ply thickness	1.00 mm* (0.04 inch)						
Laminate thickness	To be determined using calculations according to standards FYI, minimum laminate thickness is 2 plies and/or 2mm						
Tensile strength in hoop direction (ISO 527 or ASTM D3039)	198 MPa (28 700 psi)						
Tensile strength in axial direction (ISO 527 or ASTM D3039)	198 MPa (28 700 psi)						
Tensile modulus in hoop direction (ISO 527 or ASTM D3039)	17.2 GPa (2 490 ksi)						
Tensile modulus in axial direction (ISO 527or ASTM D3039)	17.2 GPa (2 490 ksi)						
Poisson's ratio (ISO 527 or ASTM D3039)	0.14						
Shear modulus (ASTM D5379)	1.65 GPa (239 ksi)						
Resin Shore D hardness (ISO 868 or ASTM D2583)	83 Shore D, Resin hardness requirement: >76 Shore D						
Lap shear strength (BS EN 1465 or ASTM D3165)	12.5 MPa (1 810 psi)						
Cathodic disbondment (ASTM G8)	Passed						
Application temperature	From +10°C (+50°F) to +70°C (+158°F)						
Service temperature	From -50°C (-58°F) to +70°C (+158°F) – Type A defect From -50°C (-58°F) to +60°C (+140°F) – Type B defect						
Ultimate Glass transition temperature (ASTM D7426)	+90°C (+194°F) – Fully cured with post-curing						
Curing time after job completion: - **Given values could be shorten by using ATEX approved heating belts.** - **In case of process shutdown, it is required to post-cure the composite at temperature superior or equal to service temperature.** - **Values just given as information.**		+10°C +50°F	+16°C +61°F	+25°C +77°F	+32°C +90°F	+40°C +104°F	+50°C +122°F
	Light load	3 days	36 hrs	30 hrs	24 hrs	16 hrs	8 hrs
	Full load	6 days	72 hrs	60 hrs	48 hrs	32 hrs	24 hrs
Resistance to pH	From 3 to 12						
Chemical resistance	Excellent (check chemical resistance chart for more information)						
Applicable for Through-Wall (Type B) defect	Yes						

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

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REINFORCEKiT® PATCH

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Service temperature from-50°C (-58°F) up to +150°C (+302°F)
Application temperature from +20°C (+68°F) up to +90°C (+194°F)

R3X150+

RESIN SPECIFICATIONS	
Commercial name	**R3X150+**
Chemical family	Epoxy (bi-component)
Color	Grey or Blue
Mixing ratio by weight	(Part A : Part B) = 8.4 : 1
Pack size	1,5 kg/set
Solids	100%
VOCs	none
Storage	Between +15°C (+59°F) and +32°C (+90°F) if long-term storage
Shelf life	2 years in unopened containers

PATCH SPECIFICATIONS	
Fiber nature	Aramid Kevlar® 49
Fiber directions towards pipe axis	Hoop/axial (0° / 90°)
Fiber type	Woven type
Tensile strength	2 900 MPa (420.5 ksi)
Tensile modulus	110 GPa (15 950 ksi)
Weight per square meter	320 g/m2

COMPOSITE SPECIFICATIONS						
Percentage of fiber in volume	Up to 30%					
Nominal ply thickness	0.95 mm* (0.037 inch)					
Laminate thickness	To be determined using calculations according to standards FYI, minimum laminate thickness is 2 plies and/or 2mm					
Tensile strength in hoop direction (ISO 527 or ASTM D3039)	178 MPa (25 810 psi)					
Tensile strength in axial direction (ISO 527 or ASTM D3039)	178 MPa (25 810 psi)					
Tensile modulus in hoop direction (ISO 527 or ASTM D3039)	15.4 GPa (2 230 ksi)					
Tensile modulus in axial direction (ISO 527or ASTM D3039)	15.4 GPa (2 230 ksi)					
Poisson's ratio (ISO 527 or ASTM D3039)	0.11					
Shear modulus (ASTM D5379)	1.35 GPa (196 ksi)					
Resin Shore D hardness (ISO 868 or ASTM D2583)	87 Shore D, Resin hardness requirement: >81 Shore D					
Lap shear strength (BS EN 1465 or ASTM D3165)	15.8 MPa (2 290 psi)					
Cathodic disbondment (ASTM G8)	Passed					
Application temperature	From +20°C (+68°F) to +90°C (+194°F) *If $T°_{pipe}$ <+20°C (+68°F), heating device needed*					
Service temperature	From -50°C (-58°F) to +150°C (+302°F) – Type A defect From -50°C (-58°F) to +140°C (+284°F) – Type B defect					
Ultimate Glass transition temperature (ASTM D7426)	+170°C (+338°F) – Fully cured with post-curing					
Curing time after job completion: - **Given values could be shorten by using ATEX approved heating belts.** - **In case of process shutdown, it is required to post-cure the composite at temperature superior or equal to service temperature.** - **Values just given as information.**		+20°C +68°F	+25°C +77°F	+40°C +104°F	+60°C +140°F	+80°C +176°F
	Light load	2 days	24 hrs	14 hrs	12 hrs	8 hrs
	Full load	6 days	72 hrs	48 hrs	32 hrs	24 hrs
Resistance to pH	From 3 to 12					
Chemical resistance	Excellent (check chemical resistance chart for more information)					
Applicable for Through-Wall (Type B) defect	Yes					

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

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Service temperature from-50°C (-58°F) up to +150°C (+302°F)

OIL & GAS
ONSHORE /OFFSHORE

APPLICATION NOTES

KIT COMPOSITION

REINFORCEKiT® PATCH components are defined using 3X software REA. The dimensions and number of patches, the type and quantity of resin will depend on the defect.

SURFACE PREPARATION

Proper surface preparation is critical to the long-term performance of the composite. All rust, mill scale, corrosion products and foreign matter must be removed from the surface by a combination of solvent washing and bristle blasting or abrasive blasting. After surface preparation, roughness should achieve a minimum of 60µm and match with SA 2 ½ or ST3 standards. Then the surface must be cleaned and rinsed using an adequate solvent which evaporates leaving no film residue.

APPLICATION

See installation procedure.

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 last updated product 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.

3X ENGINEERING

INNOVATIVE REPAIR SOLUTIONS FOR YOUR INSTALLATIONS

3. TANK DEFECT REGISTER

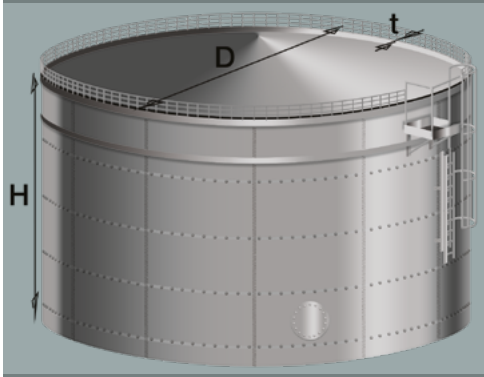
Tank Defect Register (TDR)

3X ENGINEERING
+377 92 05 79 81
www.3xeng.com

Client | Project | Defect ref. | 3X distributor | Contact details

TANK DIMENSION
mm ☐ inch ☐

D: Tank diameter
t: Wall thickness
H: Wall height



ROOF INFORMATION
What kind of tank roof do you have ?
Floating roof ☐
Immobile roof ☐

ACCESSIBILITY
If an internal tank repair is required, is it possible to access inside ?
Yes ☐ No ☐

TANK INFORMATION
Grade:
Other:

CONNECTION
Bolted ☐
Riveted ☐
Seamless ☐
Electric Resistance Weld ☐
Electric Flash Weld ☐
Electric Fusion (Arc) Weld / Spiral Weld ☐
Furnace Butt Weld / Continuous Weld.. ☐
(Double) Submerged Arc Weld ☐
Laser Beam Weld ☐
If you have a required Joint Efficiency factor:

FLUID
Oil ☐
Gas ☐
Water ☐
Chemical product ☐
If the fluid is chemical, specify its nature:

FLUID SYSTEM COMPONENT
Storage ☐
Pressurized Vessel ☐

ENVIRONMENT
Onshore ☐
Offshore top side ☐

If you have a design factor required :

PRESSURE
Psi ☐ Bar ☐ MPa ☐

Tank design pressure (only for information)
Tank operating pressure (only for information)
Repair design pressure
Repair Installation pressure (plive)
Plive: pressure during application of the repair

TEMPERATURE
°C ☐ °F ☐

Tank design temp. (only for information)
Tank operating temp. (only for information)
Min. Max.
Repair design temp.
Repair installation temp.
Min. Max.

TANK DEFECT

DEFECT TYPE
Internal ☐ External ☐
Metal loss ☐
Through-wall ☐
Crack ☐
Dent ☐

DEFECT ORIGIN
Corrosion ☐
Abrasion / Erosion ☐
Impact ☐

REPAIR DESIGN LIFETIME
Years

CALCULATION CHOICE
ISO 24.817 ☐
ASME PCC-2 ☐

DEFECT DIMENSIONS
mm ☐ inch ☐
la: Defect axial length
lc: Defect circumferential length
ts: Minimum residual wall thickness

DEFECT LOCATION
Roof ☐
Wall ☐
Between 2 welded sheets ☐
Near a screw ☐

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 all around the defect?	☐	☐
Is the defect situated close to weld, to a rivet?	☐	☐
Is the tank close to habitations, machines, industries?	☐	☐
Is there a sand blasting possibility (Sa½ & 60µm (Rz))?	☐	☐

COMMENTS

Full name:
Signature & company stamp
Date / /

ERASE SEND

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

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4. PRODUCT APPLICATIONS

REINFORCEKiT® PATCH

SUITABLE FOR VARIOUS TANK AND PRESSURE VESSEL DESIGNS AND SIZES

➲ ENVIRONMENT

ONSHORE – OFFSHORE

➲ TANK DIAMETER

NO LIMITATION

➲ DEFECT SIZE

NO LIMITATION

➲ MAX. PRESSURE

NO LIMITATION

➲ SERVICE TEMPERATURE

FROM -50°C TO +150°C (-58°F TO +302°F)

➲ FLUID

OIL – GAS – WATER

OIL & GAS
ONSHORE /OFFSHORE

FOR VARIOUS TANK DESIGNS

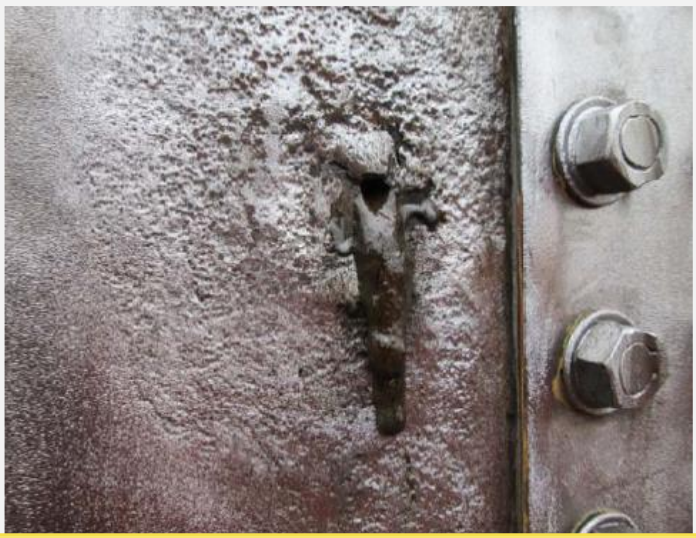
ALSO FOR PRESSURE VESSELS

TANK TO BE REPAIRED – GENERAL VIEW

EXAMPLES OF DEFECTS TO BE REPAIRED – BEFORE REINFORCEKiT® PATCH

EXAMPLE OF PATCHING COMPLETED – AFTER REINFORCEKiT® PATCH

REINFORCEKiT® PATCH INSTALLED ON REBOILER (VIETNAM)



REINFORCEKiT® PATCH INSTALLED ON STORAGE OIL TANK (GABON) – BEFORE / AFTER

REINFORCEKiT® PATCH INSTALLED ON FPSO DECK (VIETNAM)

5. CASE STUDIES

INNOVATIVE REPAIR SOLUTIONS FOR YOUR INSTALLATIONS

NEW APPLICATION
Deck reinforcement

DEFECTS TYPE	**External corrosion**
DETAILS	**Deck reinforcement – max. op. temp. 40°C**
LOCATION	**VIETNAM, Onboard FPSO Armada TGT1**
3X SOLUTION	**REINFORCEKiT® PATCH**

Fig. 1&2: Surface preparation on progress using Bristle Blaster

Fig. 3&4: F3X8 filler and R3X55 resin applications

Fig. 5&6: Impregnation of the 2nd patch and reference plate

Fig. 7: Deck overview with several patching repairs

Fig. 8: Anti-UV painting applied

OVERVIEW

The objective of the repairs, performed end of April 2021, by 3X ENGINEERING (3X) local distributor PETROENERTECH, was to **reinforce the main deck onboard FPSO Armada TGT1 suffering from external damages** ➔ metal loss due to the extreme offshore conditions.

SCOPE OF WORK

A total of 34 locations were reinforced on the main deck by applying 2 layers of tailor made **REINFORCEKiT® PATCH** as per ASME PCC-2 guidances.

Before starting the repairs, surface preparation was completed with Bristle Blaster® pneumatic machine (ATEX approved) to get a good surface roughness and ensure the bonding between the deck and the composite. Surface profile evaluation was performed to confirm the roughness was superior to 60µm.

Hygrometric conditions were checked and the whole prepared surface was cleaned with acetone.

REINFORCEKiT® PATCH installation was then performed as follows.

❶ **F3X8 filler** application on the defected areas.

❷ **R3X55 resin** application to ensure good wetting and impregnation of the 1st patch.

❸ Impregnation of the 2nd patch. Finalization of the repair with reference plate positioning for traceability purpose and validation of the repair using hardness measurements.

❹ Finally, some anti-UV painting was applied to protect the repairs.

➔ **Almost 50sqm of total surface repaired on the main deck using REINFORCEKiT® PATCH product.**

RESULTS

This project was a great challenge and almost 50sqm of damaged surface were reinforced on the main deck of this FPSO to ensure the safety of the personal onboard. It has been also successfully completed on time despite international COVID-19 pandemic and all the safety measures and constraints associated.

DEFECT TYPES	**Hole defect**
TANK DETAILS	**47" gas separator – max op. temperature 60°C – calculated pressure 10 bar**
LOCATION	**NORWAY**
3X SOLUTION	**REINFORCEKIT® PATCH**

Fig. 1-2: Tank overview – View of the defect

Fig. 3: Surface preparation using Bristle Blaster®

Fig. 4: Composite patching on progress

Fig. 5-6: Identification plate – Repair overview

OVERVIEW

The objective of the repair, performed in July 2020 by 3X ENGINEERING (3X) Specialists and FUGLESANGS (3X local distributor), was to **reinforce a tank suffering from severe external corrosion leading to through wall defect (hole characteristics: 15x15mm – max defect depth 5mm).**

SCOPE OF WORK

After analysis of the tank and defect characteristics, it was decided to repair the installation using **REINFORCEKIT® PATCH**, specially designed for tank long-term repair. According to ISO 24.817 and 3X repair calculations, it was determined to apply 6 Kevlar® patches covered with epoxy resin (size 300x300mm).

Before starting the repair, surface preparation was completed using Bristle Blaster® to get a good surface roughness (between 60 and 100µm) and thus ensure a good bonding between the steel tank and the composite system.

Hygrometric conditions were checked and the whole prepared surface was cleaned with acetone before starting the reinforcement.

The composite repair was then performed following the steps below:

❶ **F3XS1 filler** (epoxy filler with high mechanical properties and chemical resistance) was applied on the defect to plug it.

❷ **R3XHT+ resin** was applied on the whole surface prepared to protect the surface from corrosion and ensure the perfect impregnation of the first Kevlar® patch.

❸ Composite patch application was then performed using **Kevlar® patches impregnated with R3XHT+ resin.** Patches are centered on the defect and each patch is impregnated separately and superimposed one after each other to reach the 6 layers/patches needed for the repair.

❹ Finalization of the repair. A steel plate was then installed on the repair with ratchet belts to avoid patches sliding. After curing time, the steel plate was removed and **reference plate** was installed for traceability purpose.

Samples of filler and resin were taken during application for quality control.

RESULTS

The repair was successfully executed in this complicated period with Covid-19 pandemic. **The design lifetime for this composite reinforcement is 20 years.**

DEFECT TYPE	**Leaking defect**
TANK DETAILS	**Water tank - 18.9 x 8.1 1/2 OD - installation temperature 50°C**
LOCATION	**QUEBEC, MONTREAL**
3X SOLUTION	**TANKiT®**

OVERVIEW

The objective of the repair performed in March 2019 by 3X ENGINEERING (3X) distributor in Quebec - ATELIER AHR - was to **reinforce a water tank by sealing a leak of about 25mm diameter.**

Fig. 1: View of the defect

SCOPE OF WORK

After analysis of the tank and defect characteristics, it was decided to use the **TANKiT®**, **emergency composite patch repair system specifically designed to repair damaged tank**. This solution is suitable for tanks up to 20m Ø and defects (leaking or not) up to 100mm Ø, and is made of 5 Kevlar® patches 300x300mm impregnated with a bi-component epoxy resin.

Surface preparation was completed on the area to be fixed (previously delimited with adhesive tape), using Bristle Blaster® machine, to remove rust and foreign matters and get a good surface roughness (minimum of a Rz of 60 µm). This step is essential to ensure a good bonding between the tank surface and the patch composite.

Before composite patching, dew point, moisture and surface temperature were checked and the surface was cleaned and degreased.

Composite repair was then performed as per the following steps:

❶ **Filler & metallic plate application.** A thick layer of F3X8 filler was applied in the surrounding area of the hole. The metallic plate, initially prepared using Bristle Blaster®, was recovered with F3X8 filler and applied on the defected area using magnets.

❷ **Resin application.** After filler curing, the surface was then covered with 3X specific epoxy resin (R3X5) to ensure good wetting and impregnation of the Kevlar® tape.

❸ **Kevlar® patches application (5 layers).** First Kevlar® patch (previously impregnated with R3X5 on both side) was applied over the defect using paintbrush and making sure to remove all air bubbles. The next 4 Kevlar® patches were then applicated similarly and perfectly overlaid on each other.

❹ **Finalization of the repair.** Final layer of R3X5 resin was applied on the edges of the repair system for protection and identification plate was positioned on the tank for traceability. Rigid cover plate was finally applied using magnets to compress the patch and keep the position during the curing.

Fig. 2 & 3: Surface preparation in progress using Bristle Blaster® & roughness checking

Fig. 4: Metallic plate application over the defect using magnets

Fig. 5: Composite patching completed (5 layers)

RESULTS

The repair was successfully performed and the integrity of the water tank was restored using the **TANKiT®**. An anti-UV coating was applied over the patching by the client to ensure good ageing of the repair.

INNOVATIVE REPAIR SOLUTIONS FOR YOUR INSTALLATIONS

DEFECT TYPE	**Leaking defect**
TANK DETAILS	**Crude oil storage tank**
LOCATION	**Araguaney Station - CASANARE, COLOMBIA**
3X SOLUTION	**TANKiT®**

OVERVIEW

The objective of the job performed in 2019 by 3X ENGINEERING (3X) distributor in Colombia – CPS - was to **reinforce a crude oil storage tank by sealing a leak situated on the first ring of the tank (due to external corrosion).**

Fig. 1: View of the defect

Fig. 2: Surface preparation in progress using Bristle Blaster®
Fig. 3: Surface preparation of the defected area completed

Fig. 4 & 5: Metallic plate and fillers application

Fig. 6: Composite patching in progress
Fig. 7: Composite patching completed (5 layers)

SCOPE OF WORK

After analysis of the tank and defect characteristics, it was decided to temporarily repair the installation using the TANKiT®. This solution is perfect for emergency online repair required by the client.

The work team carried out the surface preparation, using Bristle Blaster® machine, to remove the coating and to get a good surface roughness (greater than 60 µm) to ensure the adherence between the tank and the composite solution. Hygrometric conditions were checked and the surface was cleaned and degreased with ethanol.

Composite repair was then performed as per the following steps:

❶ **F3XS1 filler** was first applied over the defect to stop the leak and level the surface.

❷ **F3X8 filler** was then applied to create a barrier against the corrosive environment and to facilitate the adhesion of the metallic plate.

❸ **Metallic plate** was applicated over the defected area using a thick layer of **F3X8 filler** to seal the leak.

❹ Once the curing time of the fillers was reached, the patches installation was started. **Kevlar® patches impregnated with R3X5** were applied to repair the tank. It was necessary to install 5 Kevlar® patches corresponding to 5 layers.

❺ Finally, anti-UV coating was applied to protect the repaired area and identification plate was installed for traceability.

RESULTS

The repair was successfully performed by our distributor in Colombia using our TANKiT® product and following 3X procedures. After 5 days, the repair was checked. No leak, drips or humidity were reported.

Composite Repair Specialist

DEFECT TYPE	**External corrosion**
TANK DETAILS	**Reboiler - 64'' OD - max. operating temp. 130°C - installation temp. 80°C - calculated pressure 20 barg – design lifetime: 20 years**
LOCATION	**VIET-NAM - FPSO**
3X SOLUTION	**REINFORCEKiT® PATCH**

Figure 1: Surface preparation using Bristle Blaster machine

Figure 2: F3XS1 filler application on patch area

Figure 3: Composite patching finalized

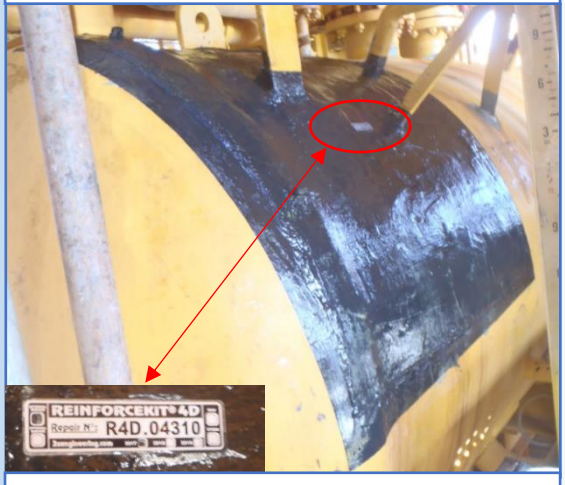


Figure 4: Final overview of the repair with ID plate

OVERVIEW

The objective of the repair performed in August 2017 by 3X ENGINEERING (3X) and its local distributor PETROENERTECH was to **reinforce a reboiler located on FPSO suffering from external corrosion.**

SCOPE OF WORK

After analysis of the corrosion extent, calculations according to ISO 24.817 were performed, concluding that 4 layers were needed to reinforce the reboiler. Because of the specific reboiler design, it was decided to use REINFORCEKiT® PATCH product, specially designed for tank & vessel repair ➔ i.e. 4 Kevlar®patches size 1032x1032mm for this case.

Surface preparation was completed, using Bristle Blaster machine, to remove coating and get a good surface roughness (between 60 µm and 100 µm anchor profile) to ensure a good bonding between the steel and the composite.

Before composite patching, dew point, moisture and surface temperature were checked and the surface was cleaned and degreased.

Composite repair was performed as per the following steps:

❶ F3XS1 filler was applied on the patch area (previously delimited) to fill metal loss and reshape the tank side.

❷ The surface was then covered with 3X specific epoxy resin (R3X1660) to ensure good wetting and impregnation of the Kevlar® tape.

❸ First Kevlar® patch was applied on the wet surface using paintbrush and making sure to remove all air bubbles. The Kevlar® patch was then impregnated with R3X1660 resin in order to create the wet surface for the next patch. This step was repeated until the good number of layers was reached (4 layers/patches).

❹ Final layer of epoxy resin was applied over the repair for protection.

Identification plate was positioned on the tank for traceability.

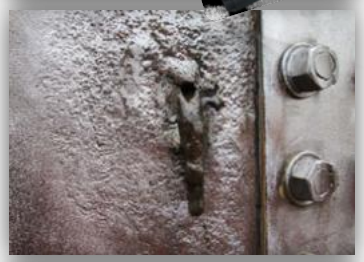
RESULTS

Thanks to the efficient collaboration between 3X and its local distributor the corroded area of the reboiler was successfully repaired. The reboiler integrity is now restored.

COMPOSITE REPAIR SPECIALIST

- **LOCATION:** **Tsiengui Panga (GABON)**
- **DATE OF PROJECT:** **May 2014**
- **INSTALLATION:** **Storage Oil Tank**
- **TYPE OF DEFECT:** **External corrosion with leak**
- **NOMINAL PRESSURE:** **1.5 bar**
- **TEMPERATURE:** **Ambient**
- **3X SOLUTION:** **Composite Solution (3X specific filler)**

REPAIR PERFORMED BY OUR LOCAL DISTRIBUTOR FRIEDLANDER GABON



OVERVIEW

The objective of the repair performed in may 2014 by 3X ENGINEERING and its local distributor FRIEDLANDER, was to stop a severe corrosion on the joint of the lower wall panel and to reinforce the tank integrity.

SCOPE OF WORK

- Design of the repair has been done by finite elements calculation.

- Surface preparation (ST3 Standard) was carried out using Bristle Blaster tools.

- F3X8 filler has been used to seal the leak, fill the corroded area and coat the nuts prior composite stratification.

- Layers of composite (resin-impregnated glass fiber) were applied to reinforce the damaged area as per 3X procedure.

- After curing time, the tank has been filled to its optimum level with crude oil.

RESULTS

This case has been managed by FRIEDLANDER, our local distributor in Gabon, with our technical support from Monaco. It proves once again the capabilities of our local partner and 3X solutions in such case.

For more information, please contact us at :
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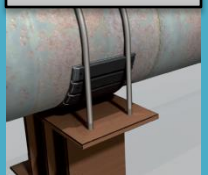
Phone : +377 92 05 79 81- Fax : +377 92 05 72 71
E-mail: info@3xeng.com - www.3xengineering.com

3X ENGINEERING Range of Products

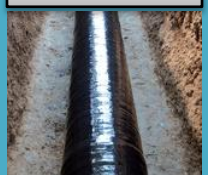
STOPKiT®

ROLLERKiT®



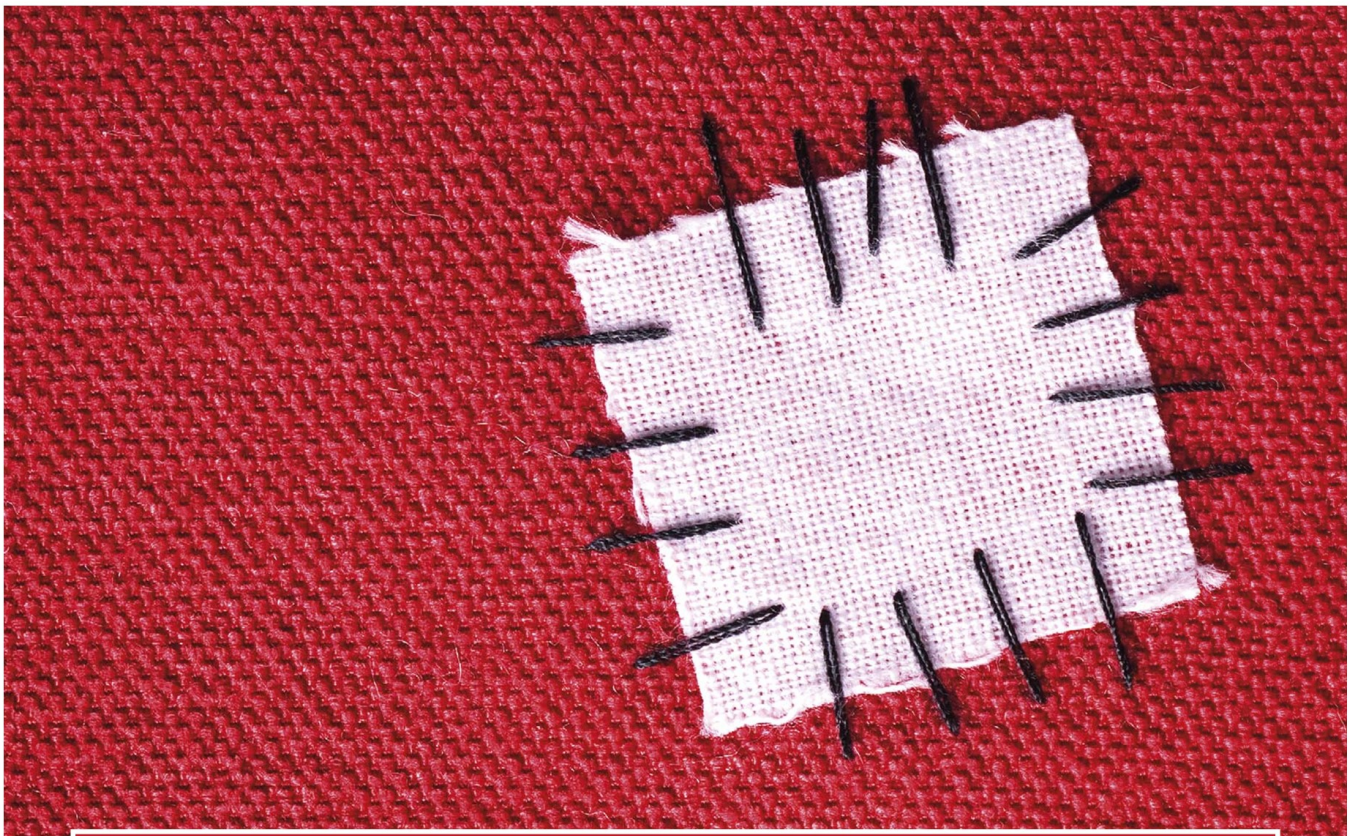
REFLANGEKiT® SF6

REINFORCEKiT® 4D



6. PRESS ARTICLES

3XENGINEERING
OIL & GAS
ONSHORE /OFFSHORE



PATCHING UP PROBLEMS

Laurette Sapin Cuiret and Olivier Marin, 3X ENGINEERING, Monaco, take a look at composite solutions for storage tank repair and reinforcement.

Storage tanks and terminals and their contents are extremely valuable assets that need to be repaired when damage occurs.

The most common cause of damage, whether it results in a leakage or not, is corrosion. Tank corrosion leads to an increased likelihood of tank leaks, safety hazards, environmental damage, and productivity loss due to shutdowns.

The traditional repair method is to weld a patch plate on the defected area, but welding means hot work and this is difficult and time-consuming. Hot work also increases risk in potentially flammable or explosive environments. As a result, weld repairs often require a costly shutdown, emptying, and clean-out of the tank, carrying with it lost productivity costs. Moreover, operating conditions, complex geometries, and the severity of the damage can prohibit welded repairs.

Therefore, the question remains how can the repair be completed differently, in a quick and efficient manner?

Repairing using composite solutions

3X ENGINEERING (3X) has developed two products based on composite technology, designed to repair and reinforce tanks and pressured vessels suffering from corrosion defects and mechanical damages.

TANKiT® and REINFORCEKiT® PATCH are two composite patch repair systems. Both products are cold welding systems which allow damages to be repaired without altering the operation. The first is designed for emergencies, whilst the latter is a sustainable solution with a repair lifetime of up to 20 years.

The main advantage in using these composite repair solutions is that no cutting or welding is required during installation so the repair can be applied while the tank is still online (i.e. low environmental risks and low safety risks for workers). Beyond a decrease in safety and environmental risks, in-service installation results in cost savings because there is no downtime for production.

So, how do they work and how were these products developed?

Long-term solution for tank repair and reinforcement

The standards ISO 24.817 and ASME PCC-2 are commonly used to provide guidance and requirements for the composite repair system of fluid system components.

Both standards cover the full process, from qualification, design, installation, testing to inspection. The repair of tanks is covered and designed with a variety of construction standards, such as AWWA D100, AWWA D103, API 620, API 650, BS EN 13121-2, and PD 5500.

REINFORCEKiT PATCH can be used as a long-term patch composite repair application.

The use of the patch is conceivable when it is impractical for the repair to encompass the full circumference. In the case of a large diameter tank, patch repairs are especially cost-efficient for localised damaged area vs full circumferential wrapping.

The original concept is a combination of Kevlar® tape patching and 3X bi-component epoxy resin. The dimensions and number of patches, the type and quantity of resin will depend on the defect and will be defined using the company's software.

Figure 1. General view of corroded water tank before REINFORCEKiT® PATCH installation.

Figure 2. Example of REINFORCEKiT PATCH installed on water tank.

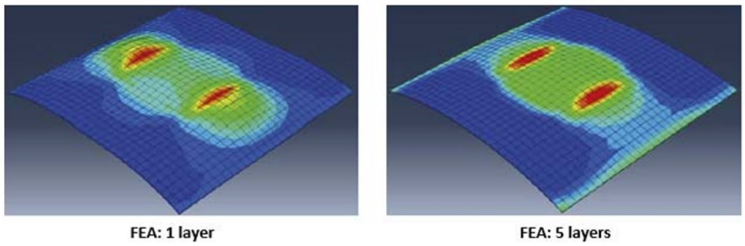


Figure 3. Stress evolution according to number of layers.

The product is tailor-made for each repair. The team first designs a specific solution according to the damage and then trained and certified applicators perform the repair in order to ensure the correct implementation and effectiveness of the product.

Being a customised solution, this product has no limits in terms of tank or defect size, no limitation in pressure, and the repair complies with international standards ISO 24.817 and ASME PCC-2.

This solution has been engineered to restore a tank's original integrity without hot work, and does not require a shutdown unless there is an active leakage (Figures 1 and 2).

Emergency solution for tank repair and reinforcement

Based on market research and customer feedback, it was established that end-users were looking for an alternative solution. In emergency scenarios, the need for engineering calculations and supply time can be an issue. To address this, 3X developed its own pre-engineered composite solution, called TANKiT, dedicated to emergency and temporary cases. This solution is suitable for tanks up to 20 m and defects (leaking or not) up to 100 mm.

The product is delivered, ready to be used, in a box containing all necessary materials and tools, and is made of five Kevlar patches impregnated with a bi-component epoxy resin.

The application can be done online, unless there is a loss of containment. To apply it, the surface must firstly be cleaned and prepared (surface roughness [Rz] › 60 µm and Swedish standard sandblasting [SA] 2.5). Next, a steel plate is installed over the defected area and cold welded with filler using magnets. Finally, the Kevlar patches (impregnated with the specific resin) are positioned over the area.

As the TANKiT does not follow the design guidances of standards, it was necessary to determine its performances and limitations, and it has undergone rigorous R&D tests:

- Surface preparation: a surface preparation is required to get a good bonding (Rz › 60 µm and SA 2.5).
- Containment: in case of loss of containment, it is preferable to use a first barrier. A steel plate is cold welded with F3X8 filler.
- Choice of reinforcement: Kevlar tape (plain weaving, 400 gsm) was selected due to its impressive performance.
- Choice of resin: as the composite may be in contact with harsh environment, it was decided to use the R3X5 resin to obtain excellent chemical resistance.
- Dimensions of the patch and number of layers:

Short-term testing/burst test

As it was not possible to test the product on each tank configuration, the goal was to establish a correlation between full scale testing with 100 mm hole and finite element analysis (FEA).

The size of the patches was chosen to be 300 mm x 300 mm. It was observed that larger patches did not significantly improve the pressure resistance, most of the stresses being concentrated in the surrounding area of the defect.

The number of layers was set to five plies for cost-effective reasons. As expected, the more plies that are present, the better pressure resistance is. However, increases in pressure resistance are not proportional to the number of additional layers applied beyond five plies (Figure 3).

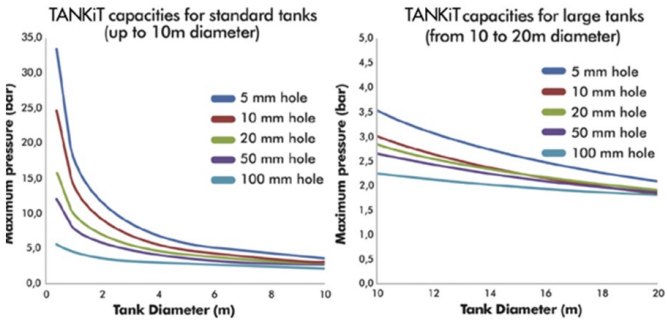


Figure 4. TANKiT® capacities.

Long-term

Short-term testing cannot analyse the risk of long-term failure and up to two-thirds of the performance could be lost, which is known as degradation factor. Thus, TANKiT was successfully tested considering long-term safety factors.

Gathering all the testing and FEA data, the company was able to determine the maximum capability of this solution as a function of tank and hole dia. (Figure 4).

Suitable solutions

Both solutions are suitable for use with various tank designs and sizes and can be used in a wide range of industries and applications.

Reboiler repair in Vietnam

The objective of the repair performed in August 2017 in Vietnam by 3X and its local distributor was to reinforce a reboiler located on a floating production storage and offloading (FPSO) vessel suffering from external corrosion. The technical details were as follows: 64 in. outer dia., maximum operating temperature of 130°C, installation temperature 80°C, calculated pressure 20 bars, design lifetime of 20 years.

After analysis of the corrosion extent, calculations according to ISO 24.817 were performed, concluding that four layers were needed to reinforce the reboiler. Due to

Figure 5. Final overview of the repair with ID plate.

the specific reboiler design, it was decided to use REINFORCEKiT PATCH, specially designed for tank and vessel repair, i.e. four Kevlar patches size 1032 mm x 1032 mm in this case.

Surface preparation was completed, using a Bristle Blaster® machine, to remove coating and get a good surface roughness (between 60 µm and 100 µm anchor profile) to ensure a strong bonding between the steel and the composite.

Before composite patching, dew point, moisture and surface temperature were checked and the surface was cleaned and degreased.

Composite repair was performed as per the following steps:

- F3XS1 filler was applied on the delimited patch area to fill metal loss and reshape the tank side.
- The surface was then covered with 3X specific epoxy resin (R3X1660) to ensure good wetting and impregnation of the Kevlar tape.
- The first patch was applied onto the wet surface using a paintbrush whilst making sure to remove all air bubbles. The patch was then impregnated with R3X1660 resin in order to create the wet surface for the next patch. This step was repeated until all four layers had been applied.
- The final layer of epoxy resin was applied over the repair for protection.
- Identification plate was positioned on the tank for traceability.

As a result, the corroded area of the reboiler was successfully repaired and reboiler integrity was completely restored (Figure 5).

Conclusion

Composite technology offers the best solutions to rehabilitate installations in a solid and durable manner, saving time and money. The integrity of storage tanks and terminals will be preserved as if they were new.

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TANK STORAGE

2021 STORAGE OUTLOOK
Eight terminal operators reflect on 2020 & share their predictions on the storage market for the year ahead

A SOLAR-POWERED PARTNERSHIP
Singapore LNG discusses its green strategy as well as the terminal's role in the energy transition

PRIO PRIORITISES THE PLANET
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INNOVATIVE AND EFFICIENT TANK MAINTENANCE

Despite the added complications of working in a pandemic, 3X Engineering successfully completed a tank repair earlier this year

IN JULY 2020 pipeline repair and protection specialist 3X Engineering was asked to reinforce a tank suffering from severe external corrosion leading to a through wall defect (a hole measuring 15x15 mm and depth 5 mm).

After analysis of the tank and defect characteristics, 3X Engineering decided to repair the installation using a REINFORCEKiT PATCH, specially designed for tank long-term repair. According to ISO 24.817 and 3X repair calculations, they applied 6 Kevlar patches covered with epoxy resin (size 300x300mm).

Before starting the repair, surface preparation was completed using Bristle Blaster to get a good surface roughness (between 60 and 100 µm) and thus ensure a good bonding between the steel tank and the composite system.

Hygrometric conditions were checked and the whole prepared surface was cleaned with acetone before starting the reinforcement.

The composite repair was then performed following the steps below:

1. F3XS1 filler (epoxy filler with high mechanical properties and chemical resistance) was applied on the defect to plug it.
2. R3XHT+ resin was applied on the whole surface prepared to protect the surface from corrosion and ensure the perfect impregnation of the first Kevlar patch.
3. Composite patch application was then performed using Kevlar patches impregnated with R3XHT+ resin. Patches are centered on the defect and each patch is impregnated separately and superimposed one after each other to reach the six layers/patches needed for the repair.
4. Finalisation of the repair. A steel plate was then installed on the repair with ratchet belts to avoid patches sliding. After curing time, the steel plate was removed and reference plate was installed for traceability purpose.

Samples of filler and resin were taken during application for quality control.

The design lifetime for this composite reinforcement is 20 years.

For more information:

This article was written by 3X Engineering.

Visit www.3xeng.com or contact info@3xeng.com

01 Tank overview – view of the defect
02 Tank overview – view of the defect
03 Surface preparation using Bristle Blaster
04 Composite patching in progress
05 Identification plate – repair overview
06 Identification plate – repair overview

7. REFERENCES LIST

References List

REINFORCEKiT® PATCH / TANKiT

Tank repair and reinforcement

This references list includes all the applications made by 3X ENGINEERING Monaco but not the exhaustive list of our Worldwide Distributors

LC - 12/2021

Dates	Countries	Clients	Application areas	Line & Tank References	Type of defects	Performed by 3X Monaco/ 3X Distributor
2021						
Jul-21	RUSSIA	**Salym Petroleum Development N.D.**	Onshore, oil mining	3400mm oil separator	Internal corrosion, 700x700mm, 60% metall loss	3X Distributor
July-2021	Ivory Coast	**CNR**	Pressurized vessel	Tank reinforcement	Internal corrosion	3X Distributor
2020						
October-20	RDC	**PERENCO**	Tank onshore	Tank reinforcement	Holes & external corrosion	3X Distributor
September-20	FRANCE	**CENTRE AQUATIQUE DU CLERMONTAIS**	Tank reinforcement - Onshore	Ø2000	External corrosion	3X Distributor
august-20	Russia	**Enisey**	Tank onshore	3400/internal repair/oil,water	applying anticorrosion coating	3X Distributor
July-20	Norway	**EQUINOR**	Tank reinforcement	Gas separator	Hole defect	3X Distributor/3X Monaco
July-20	Russia	**GASPROM Neft**	Tank buried	3200mm/internal repair/oil	4 through wall defects	3X Distributor
2019						
Dec-19	UAE	**ADNOC LNG**	Tank reinforcement	7meter Tank with 2 leaks	Leak reapir	3X Distributor
June-19	Colombia	**Ecopetrol**	Tank reinforcement (TANKiT)	Crude oil storage tank	Leaking defect	3X Distributor
August-19	Perú	**Terminales del Perú**	TDP-EL CALLAO	TANK LINES	EXTERNAL AND INTERNAL CORROSION	3X Distributor
March-19	Canada	**Indorama**	Tank reinforcement (TANKiT)	Water tank	Leaking defect	3X Distributor
2018						
Nov-18	Kazakhstan	**CPC**	Tank reinforcement	Tank 20 000m3	Leak	3X Distributor
Jul-18	Gabon	**ADDAX**	Tank reinforcement	Nozzle reinforcement from interior of tank	Internal corrosion	3X Distributor/3X Monaco
2016						
Nov-16	FRANCE	**EPPLN**	Tank reinforcement	HC Tank storage	External corrosion + Hole	3X Monaco
2017						
Aug-17	Viet-Nam	**FPSO Lewek Emas**	Tank reinforcement Offshore	Reboiler on FPSO	External corrosion	3X Monaco
2015						
Oct-15	Kazakhstan	**KPO**	Tank reinforcement	Tank 60-5620-VW-001 Nozzle's	Internal corrosion	3X Distributor
2014						
May-14	Gabon	**ADDAX**	Tank reinforcement	Tank 510-A	Leak	3X Distributor
2013						
	YEMEN	**Yemen LNG**	Tank	Seawater Tank	Leaks	3X Monaco
2012						
	Yemen	**Yemen LNG**	Tank	Seawater Tank	Leaks	3X Monaco