3X ENGINEERING

REINFORCEKiT® 4D

HIGH-PERFORMANCE COMPOSITE REPAIR SOLUTION FOR PIPE REINFORCEMENT

According to ISO 24.817 & ASME PCC-2

OIL & GAS
ONSHORE /OFFSHORE

DOC MKT 029 – C2 – ENG – LC – 12/2022

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1. PRODUCT BROCHURE

3XENGINEERING
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REINFORCEKiT® 4D (R4D) is a wet lay-up repair system, wrapped around the pipe to reinforce the damaged area, restore original pipe integrity and prevent further deterioration.

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This composite technology, made of Kevlar® tape and bi-component epoxy 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.

REINFORCEKiT® 4D RANGE

REINFORCEKiT® 4D MAIN FEATURES & BENEFITS

- Emergency Pipeline Repair System (EPRS)
- Online repair (no loss of production)
- Long-term performance (up to 20-year lifetime)
- Designed according to the standards (ISO 24.817 and ASME PCC-2 compliant)
- Versatile product with a large range of applications (O&G assets, plants, refineries, platforms, FPSO ...)
- Suitable for transmission and distribution pipelines, piping, pipework ...
- Suitable for any pipe geometries (straight, elbow, tee) including irregularities (welds ...), without pipe size limitation
- User-friendly (no hot work, non conductive repair, light product)
- Premium installation by trained and certified applicators only
- Traceability using smart tag

REINFORCEKiT® 4D IMPLEMENTATION

DOC.MKT.019 - B - ENG - LC - 09.2021

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3X ENGINEERING

HIGH-PERFORMANCE COMPOSITE REPAIR SOLUTION FOR PIPE REINFORCEMENT

Any pipe diameters | Any pipe geometries | High pressure | -50°C to +150°C | Oil | Gas | Water

REINFORCEKiT® 4D

ISO 24.817 and ASME PCC-2 compliant

OIL & GAS
ONSHORE / OFFSHORE

INNOVATIVE REPAIR SOLUTIONS FOR YOUR INSTALLATIONS

2. TECHNICAL DATA SHEET

REINFORCEKiT® 4D

HIGH PERFORMANCE COMPOSITE REPAIR SOLUTION FOR PIPE REINFORCEMENT
Service temperature from-50°C (-58°F) up to +150°C (+302°F)

OIL & GAS
ONSHORE /OFFSHORE

TECHNICAL DATA SHEET

REINFORCEKiT® 4D DESCRIPTION

REINFORCEKiT® 4D (R4D) is an advanced permanent composite repair system for pipelines and piping suffering from corrosion defects and mechanical damage. R4D 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 by third-party laboratories, R4D 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 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.

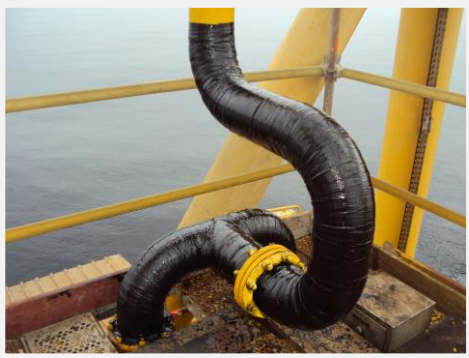
R4D is a wet lay-up system. It is wrapped helicoidally around the pipe in order to bring the mechanical resistance to the damaged pipe section. The number of layers, determined by calculation, is linked not only to the pipe pressure, temperature, diameter and thickness but also to the pit depth and length, 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.

REINFORCEKiT® 4D FEATURES

REINFORCEKiT® 4D (R4D) is recommended to repair and reinforce pipelines operating at temperature between -50°C (-58°F) up to +150°C (+302°F) subject to external/internal corrosion, leaks (dedicated procedure for live repair), dents and mechanical damages. The system restores the pipe integrity and prevents from further deterioration. This composite sleeve is made of 400 g/m² Kevlar® tape and highly-reinforced ceramic epoxy resin. This specific resin composition provides excellent anti-abrasion and chemical features. Even in case of through-wall defect, the fluid is kept inside the pipeline by the composite sleeve allowing restoring line integrity. As per standards, progressive internal corrosion defects repairs performed with R4D should be considered as temporary.

USES

- External/Internal Corrosion
- Pitting
- Weld defects
- Cracks
- Through-wall defect
- Dents
- Mechanical damages
- Severe abrasion and erosion
- Suitable for -50°C (-58°F) to +150°C (+302°F)



BENEFITS

- Online repair (no shutdown required except if leakage)
- Conform to any shape including welds, elbows and tees
- In accordance with standards
- No overload on corroded pipelines
- Fiber not hazardous for users

REINFORCEKiT® 4D

HIGH PERFORMANCE COMPOSITE REPAIR SOLUTION FOR PIPE 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
Resin consumption*	Kevlar tape 50m/50mm: 2.56kg / 2 parts A + 2 parts B Kevlar tape 50m/100mm: 5.12kg / 4 parts A + 4 parts B

FIBER SPECIFICATIONS	
Fiber nature	Aramid Kevlar® 49
Fiber directions towards pipe axis	Hoop/axial (0° / 90°)
Fiber type	Woven type
Tensile strength	2900 MPa (420.5 ksi)
Tensile modulus	110 GPa (15 950 ksi)
Weight per square meter	400 g/m2

COMPOSITE SPECIFICATIONS*		
Type of tape	**8020**	**6040**
Percentage of fiber in volume	Up to 30%	
Density	1.25 g/cm^3 (78.0 lb/cu.ft.)	
Laminate thickness	To be determined using calculations according to standards FYI, minimum laminate thickness is 2 plies and/or 2mm	
Nominal ply thickness	0.75 mm* (0.030 inch)	
Tensile strength in hoop direction (ISO 527 or ASTM D3039)	447 MPa (64 830 psi)	411 MPa (59 610 psi)
Tensile strength in axial direction (ISO 527 or ASTM D3039)	132 MPa (19 140 psi)	175 MPa (25 380 psi)
Tensile modulus in hoop direction (ISO 527 or ASTM D3039)	32.8 GPa (4 750 ksi)	24.25 GPa (3 520 ksi)
Tensile modulus in axial direction (ISO 527 or ASTM D3039)	8.8 GPa (1 276 ksi)	13.0 GPa (1 880 ksi)
Poisson's ratio (ISO 527 or ASTM D3039)	0.23	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	
Fatigue test on pipe spool (defect dependent)	>30 000 cycles (40-80% MAOP) with 70%WTL	
Application temperature	From +10°C (+50°F) up 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® 4D

HIGH PERFORMANCE COMPOSITE REPAIR SOLUTION FOR PIPE 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
Resin consumption*	Kevlar tape 50m/50mm: 2.6kg / 2 parts A + 2 parts B Kevlar tape 50m/100mm: 5.2kg / 4 parts A + 4 parts B

FIBER SPECIFICATIONS	
Fiber nature	Aramid Kevlar® 49
Fiber directions towards pipe axis	Hoop/axial (0° / 90°)
Fiber type	Woven type
Tensile strength	2900 MPa (420.5 ksi)
Tensile modulus	110 GPa (15 950 ksi)
Weight per square meter	400 g/m2

COMPOSITE SPECIFICATIONS*						
Type of tape		**8020**			**6040**	
Percentage of fiber in volume	Up to 30%					
Density	1.25 g/cm^3 (78.0 lb/cu.ft.)					
Laminate thickness	To be determined using calculations according to standards FYI, minimum laminate thickness is 2 plies and/or 2mm					
Nominal ply thickness	0.90 mm* (0.040 inch)					
Tensile strength in hoop direction (ISO 527 or ASTM D3039)	440 MPa (63 820 psi)				310 MPa (44 970 psi)	
Tensile strength in axial direction (ISO 527 or ASTM D3039)	149 MPa (21 610 psi)				157 MPa (22 770 psi)	
Tensile modulus in hoop direction (ISO 527 or ASTM D3039)	28.3 GPa (4 100 ksi)				21.6 GPa (3 130 ksi)	
Tensile modulus in axial direction (ISO 527 or ASTM D3039)	9.5 GPa (1 380 ksi)				13.1 GPa (1 900 ksi)	
Poisson's ratio (ISO 527 or ASTM D3039)	0.14				0.13	
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					
Fatigue test on pipe spool (defect dependent)	>30 000 cycles (40-80% MAOP) with 70%WTL					
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)	+115°C (+239°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® 4D

HIGH PERFORMANCE COMPOSITE REPAIR SOLUTION FOR PIPE 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
Resin consumption*	Kevlar tape 50m/50mm: 3.12kg / 3 parts A + 3 parts B Kevlar tape 50m/100mm: 5.20kg / 5 parts A + 5 parts B

FIBER SPECIFICATIONS	
Fiber nature	Aramid Kevlar® 49
Fiber directions towards pipe axis	Hoop/axial (0° / 90°)
Fiber type	Woven type
Tensile strength	2900 MPa (420.5 ksi)
Tensile modulus	110 GPa (15 950 ksi)
Weight per square meter	400 g/m2

COMPOSITE SPECIFICATIONS*		
Type of tape	**8020**	**6040**
Percentage of fiber in volume	Up to 30%	
Density	1.25 g/cm^3 (78.0 lb/cu.ft.)	
Laminate thickness	To be determined using calculations according to standards FYI, minimum laminate thickness is 2 plies and/or 2mm	
Nominal ply thickness	0.77 mm* (0.030 inch)	
Tensile strength in hoop direction (ISO 527 or ASTM D3039)	458 MPa (66 420 psi)	359 MPa (52 070 psi)
Tensile strength in axial direction (ISO 527 or ASTM D3039)	112 MPa (16 240 psi)	169 MPa (24 510 psi)
Tensile modulus in hoop direction (ISO 527 or ASTM D3039)	31.8 GPa (4 610 ksi)	22.5 GPa (3 260 ksi)
Tensile modulus in axial direction (ISO 527 or ASTM D3039)	7.9 GPa (1 145 ksi)	13.4 GPa (1 940 ksi)
Poisson's ratio (ISO 527 or ASTM D3039)	0.30	0.11
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)	15 MPa (2 170 psi)	
Cathodic disbondment (ASTM G8)	Passed	
Fatigue test on pipe spool (defect dependent)	>30 000 cycles (40-80% MAOP) with 70%WTL	
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*

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REINFORCEKiT® 4D

HIGH PERFORMANCE COMPOSITE REPAIR SOLUTION FOR PIPE 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
Resin consumption*	Kevlar tape 50m/50mm: 1.25kg / 1 part A + 1 part B Kevlar tape 50m/100mm: 2.50kg / 2 parts A + 2 parts B

FIBER SPECIFICATIONS	
Fiber nature	Aramid Kevlar® 49
Fiber directions towards pipe axis	Hoop/axial (0° / 90°)
Fiber type	Woven type
Tensile strength	2900 MPa (420.5 ksi)
Tensile modulus	110 GPa (15 950 ksi)
Weight per square meter	400 g/m2

COMPOSITE SPECIFICATIONS*		
Type of tape	**8020**	**6040**
Percentage of fiber in volume	Up to 30%	
Density	1.15g/cm^3 (71.8 lb/cu.ft.)	
Laminate thickness	To be determined using calculations according to standards FYI, minimum laminate thickness is 2 plies and/or 2mm	
Nominal ply thickness	0.76 mm* (0.030 inch)	
Tensile strength in hoop direction (ISO 527 or ASTM D3039)	432 MPa (62 650 psi)	365 MPa (52 940 psi)
Tensile strength in axial direction (ISO 527 or ASTM D3039)	90 MPa (13 050 psi)	183 MPa (26 540 psi)
Tensile modulus in hoop direction (ISO 527 or ASTM D3039)	32.9 GPa (4 770 ksi)	23 GPa (3 340 ksi)
Tensile modulus in axial direction (ISO 527 or ASTM D3039)	7.7 GPa (1 120 ksi)	14.4 GPa (2 090 ksi)
Poisson's ratio (ISO 527 or ASTM D3039)	0.39	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 (2 060 psi)	
Cathodic disbondment (ASTM G8)	Passed	
Fatigue test on pipe spool (defect dependent)	>30 000 cycles (40-80% MAOP) with 70%WTL	
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

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

REINFORCEKiT® 4D

HIGH PERFORMANCE COMPOSITE REPAIR SOLUTION FOR PIPE 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
Resin consumption*	Kevlar tape 50m/50mm: 3.84kg / 3 parts A + 3 parts B Kevlar tape 50m/100mm: 7.68kg / 6 parts A + 6 parts B

FIBER SPECIFICATIONS	
Fiber nature	Aramid Kevlar® 49
Fiber directions towards pipe axis	Hoop/axial (0° / 90°)
Fiber type	Woven type
Tensile strength	2900 MPa (420.5 ksi)
Tensile modulus	110 GPa (15 950 ksi)
Weight per square meter	400 g/m2

COMPOSITE SPECIFICATIONS*		
Type of tape	**8020**	**6040**
Percentage of fiber in volume	Up to 30%	
Density	1.52 g/cm^3 (94.9 lb/cu.ft.)	
Laminate thickness	To be determined using calculations according to standards FYI, minimum laminate thickness is 2 plies and/or 2mm	
Nominal ply thickness	1 mm* (0.041 inch)	
Tensile strength in hoop direction (ISO 527 or ASTM D3039)	420 MPa (61 700 psi)	310 MPa (45 550 psi)
Tensile strength in axial direction (ISO 527 or ASTM D3039)	106 MPa (15 500 psi)	147 MPa (21 600 psi)
Tensile modulus in hoop direction (ISO 527 or ASTM D3039)	29.6 GPa (4 300 ksi)	22.5 GPa (3 300 ksi)
Tensile modulus in axial direction (ISO 527 or ASTM D3039)	9 GPa (1 300 ksi)	14.4 GPa (2 110 ksi)
Poisson's ratio (ISO 527 or ASTM D3039)	0.41	0.14
Shear modulus (ASTM D5379)	1.65 GPa (242 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	
Fatigue test on pipe spool (defect dependent)	>30 000 cycles (40-80% MAOP) with 70%WTL	
Application temperature	From +10°C (+50°F) up 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*

REINFORCEKiT® 4D

HIGH PERFORMANCE COMPOSITE REPAIR SOLUTION FOR PIPE REINFORCEMENT

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
Resin consumption*	Kevlar tape 50m/50mm: 3kg / 2 parts A + 2 parts B Kevlar tape 50m/100mm: 6kg / 4 parts A + 4 parts B

FIBER SPECIFICATIONS	
Fiber nature	Aramid Kevlar® 49
Fiber directions towards pipe axis	Hoop/axial (0° / 90°)
Fiber type	Woven type
Tensile strength	2900 MPa (420.5 ksi)
Tensile modulus	110 GPa (15 950 ksi)
Weight per square meter	400 g/m2

COMPOSITE SPECIFICATIONS*		
Type of tape	**8020**	**6040**
Percentage of fiber in volume	Up to 30%	
Density	1.52 g/cm^3 (94.9 lb/cu.ft.)	
Laminate thickness	To be determined using calculations according to standards FYI, minimum laminate thickness is 2 plies and/or 2mm	
Nominal ply thickness	1 mm* (0.041 inch)	
Tensile strength in hoop direction (ISO 527 or ASTM D3039)	344 MPa (49 890 psi)	277 MPa (40 700 psi)
Tensile strength in axial direction (ISO 527 or ASTM D3039)	127 MPa (18 420 psi)	140 MPa (20 570 psi)
Tensile modulus in hoop direction (ISO 527 or ASTM D3039)	26.9 GPa (3 900 ksi)	19.6 GPa (2 880 ksi)
Tensile modulus in axial direction (ISO 527 or ASTM D3039)	8.3 GPa (1 200 ksi)	12.2 GPa (1 790 ksi)
Poisson's ratio (ISO 527 or ASTM D3039)	0.26	0.12
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	
Fatigue test on pipe spool (defect dependent)	>30 000 cycles (40-80% MAOP) with 70%WTL	
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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APPLICATION NOTES

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

Check atmospheric conditions before job start ($T_{Dew\ point}$ +3°C<$T_{Support}$; 85%RH). If the pipe presents some pitted or corroded areas, specific filler must be used to fill pits and reshape the pipe. Apply a uniform layer of resin on the whole surface. The Kevlar® tape is then impregnated and wrapped helicoidally over the pipe. Application instructions are provided to technicians during 3X training course. Apply a protective coating as per company standards and local pipe environment (UV, swamp, etc).

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. PIPE DEFECT REGISTER

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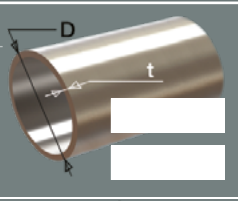
Pipe Defect Register (PDR)

Client		3X distributor	
Project		Contact details	
Defect ref.			

PIPE DIMENSION

mm ○ inch ○

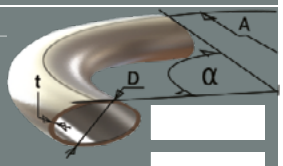
STRAIGHT



D: Original diameter

t: Wall thickness

BEND



D: Original diameter

t: Wall thickness

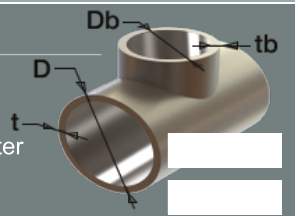
A: Medium radius of the bend

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

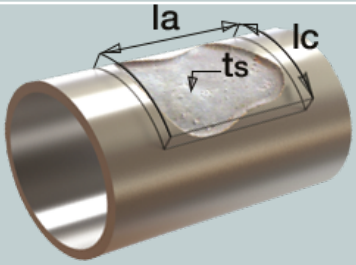
DEFECT TYPE

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 : / /

ERASE PRINT 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

4. PRODUCT APPLICATIONS

REINFORCEKiT® 4D

SUITABLE FOR VARIOUS PIPE GEOMETRIES AND DEFECTS

➲ ENVIRONMENT

ONSHORE – OFFSHORE TOPSIDE

➲ PIPE DIAMETER

NO LIMITATION

➲ SERVICE TEMPERATURE

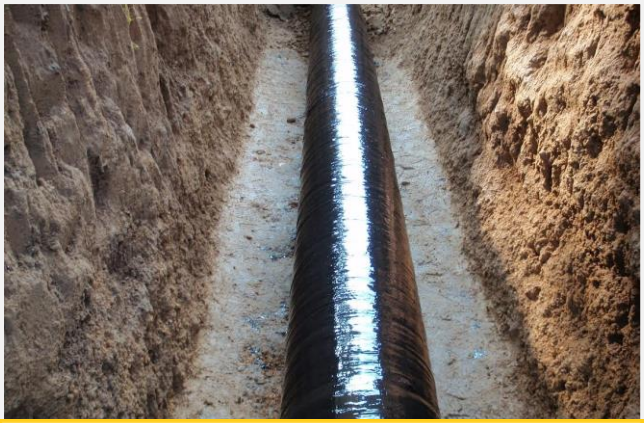
FROM -50°C TO +150°C (-58°F TO +302°F)

➲ FLUID

OIL – GAS – WATER

OIL & GAS
ONSHORE /OFFSHORE

➲ PIPE GEOMETRIES



STRAIGHT PIPE

ELBOW

TEE

RISER (TOPSIDE)

➲ PIPE DEFECTS

EXTERNAL CORROSION / PITTING

INTERNAL CORROSION / ABRASION / EROSION

➲ PIPE DEFECTS

HOLE / THROUGH-WALL DEFECT

CRACK

MECHANICAL DAMAGE / DENT

LEAK

5. CASE STUDIES

3X ENGINEERING

INNOVATIVE REPAIR SOLUTION FOR YOUR INSTALLATIONS

OIL & GAS
ONSHORE /OFFSHORE

HIGH-PERFORMANCE COMPOSITE REPAIR SOLUTION FOR PIPE REINFORCEMENT

DEFECT TYPES DETAILS	**Mechanical protection - 19 risers From 8" to 20" gas risers, straight line, max. operating temp. 70°C, calculated pressure 60 bars**
LOCATION	**Qatar, Offshore**
3X SOLUTION	**REINFORCEKiT® 4D**

Fig. 1: Risers to be protected - overview

OVERVIEW

The aim of the job, performed in October 2022 by **3X ENGINEERING (3X)** was to protect (mechanical protection + impact resistance) 19 risers (from 8" to 20" OD) on their splash zones and thus prevent further deterioration of the risers. To do that, it was decided to protect the risers areas using 3X composite solution **REINFORCEKiT® 4D.**

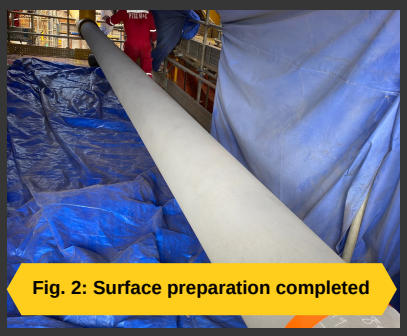


Fig. 2: Surface preparation completed

Fig. 3: R3X95 application (step 1)

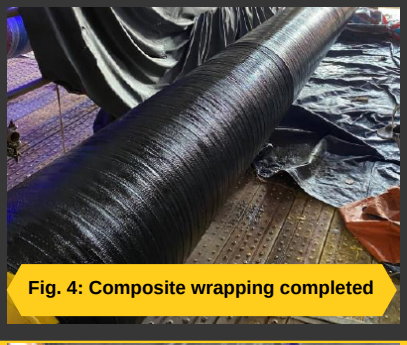


Fig. 4: Composite wrapping completed

SCOPE OF WORK

According to ISO 24.817 standard and 3X calculations, it was decided to apply 6 layers of **REINFORCEKiT® 4D (using R3X95 resin)** on each riser to protect them from impacts and corrosion issues.

Surface preparations were completed using sandblasting to remove coating and create a good surface roughness (superior to 60µm Rz) and ensure a good bonding between the steel pipes and the composite solution. Then hygrometric conditions were checked and the whole prepared surfaces were cleaned with air blower.

The composite applications were then completed following the main stages mentioned below (the procedure was the same for the 19 risers):

1/ One layer of **R3X95 resin** was firstly applied on the prepared surface to ensure the good impregnation of the first tape layer.

2/ **Composite wrapping** was then completed using **Kevlar® tape** impregnated with **R3X95 resin.** Six layers were applied on each riser with a repair length between 7220mm and 9200mm.

A total of over 175m repair length using REINFORCEKiT® 4D product was installed on the 19 risers.

3/ Last layer of **R3X95 resin** was applied all over the wrappings as finalization stage and **id plate** was installed for **traceability.**

4/ Eight hours after, coating was applied on the composite protection.

Fig. 5: Coating application

RESULTS

Samples of resin were taken during each tape impregnation for quality control and hardness measurements were performed and validated on site and in 3X offices.

The 19 risers are now protected with REINFORCEKiT® 4D from impacts and corrosion issues that could affect their mechanical resistance. The design life for each riser for this composite protection is 20 years.

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OIL & GAS
ONSHORE /OFFSHORE

HIGH-PERFORMANCE COMPOSITE REPAIR SOLUTION FOR PIPE REINFORCEMENT

DEFECT TYPES	**Internal corrosion**
DETAILS	**42" oil pipeline , buried, design pressure 14 bars, repair design temp. 20°C**
LOCATION	**France**
3X SOLUTION	**REINFORCEKiT® 4D**

Fig. 1: Overview of the buried pipe to be repaired

OVERVIEW

The objective of the repair, carried out in February 2022 by **3X ENGINEERING (3X)** and its local distributor **TSI** was to reinforce a buried 42" oil pipeline suffering from internal corrosion. To restore pipe integrity and prevent further deterioration, it was decided to repair the defected area using **REINFORCEKiT® 4D.**

Fig. 2: Isolated working area

SCOPE OF WORK

According to ISO 24.817 standard, 3X calculations and client requirements, it was decided to apply **REINFORCEKiT® 4D** using **R3X70+ resin.** 18 layers of composite were determined to reinforce the corroded area.

Because of the cold temperatures outside, the working area was isolated and equipped with a dehumidifier and heating system in order to keep the optimal conditions for the composite application.

Surface preparation was completed with grit blasting to get a good surface roughness (superior to 60µm Rz) and ensure a good bonding between the steel pipe and the composite repair. Hygrometric conditions were checked and the surface was cleaned with acetone.

The composite repair was then completed as below:

1/ **F3X8 filler** was applied on the defected area before metallic plate application to smooth the shape and facilitate metallic plate installation.

2/ **Metallic plate** (previously prepared and cleaned) was fixed on the defected area using **F3XS1** (specific filler with very good mechanical properties for sealing leaks) and rachet belts. Ratchet belts were removed after filler curing.

3/ One layer of **R3X70+ resin** was applied on the defected area to ensure a good wetting of the composite wrapping with the steel pipe.

4/ **Composite wrapping** was completed using **Kevlar® tape** impregnated with **R3X70+ resin** ==> *18 layers installed for a total repair length of 870mm.*

5/ Finishing stage ==> last layer of **R3X70+ resin** was applied all over the repair and **id plate was installed for traceability.**

Fig. 3: Metallic plate fixed with filler and ratchet belts

Fig. 4: Last layer of R3X70+ application over composite wrapping

Fig. 5: Composite wrapping repair completed + ID plate

RESULTS

Due to the low temperatures outside, the isolated working area remained in place 2 days after job completion to ensure the good resin polymerisation. Hardness measurements were then performed and concluded the good achievement of this repair using REINFORCEKiT® 4D product. As recommended by 3X specialists, the client should apply a coating to protect the repair before closing the excavation.
The design life for this composite reinforcement is planned for 10 years.

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HIGH-PERFORMANCE COMPOSITE REPAIR SOLUTION FOR PIPE REINFORCEMENT

DEFECT TYPES	**Internal corrosion on 3 valves**
DETAILS	**Onshore, Oil, design pressure from 105 to 180 psi, design temp. 76.7°C**
LOCATION	**Kingdom of Saudi Arabia**
3X SOLUTION	**REINFORCEKiT® 4D**

Fig. 1: Valve to be reinforced

OVERVIEW

The objective of the repair, carried out in October 2021 by **3X ENGINEERING (3X)** and its local distributor **WISKOTS** was to reinforce 3 valves with ball geometry suffering from internal corrosion. To restore valve integrity and prevent further deterioration, it was decided to repair the defected areas using **REINFORCEKiT® 4D.**

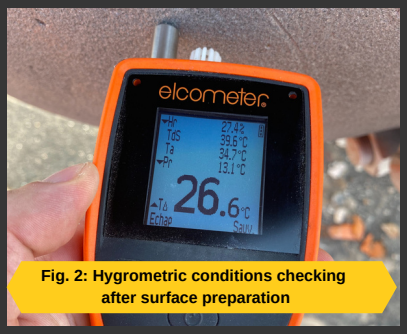

Fig. 2: Hygrometric conditions checking after surface preparation

Fig. 3: Filler application

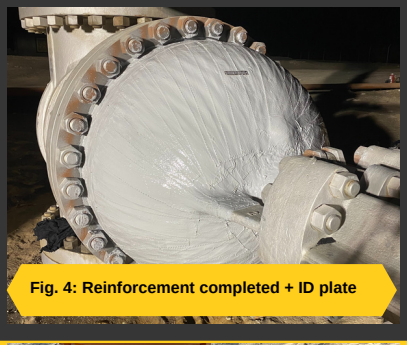

Fig. 4: Reinforcement completed + ID plate

SCOPE OF WORK

According to ASME PCC-2 standard and 3X calculations, it was decided to apply **REINFORCEKiT® 4D** using **R3X150+ resin (specifically dedicated to internal and external corrosion at high temperature).** From 6 to 8 layers of composite were determined to reinforce the valves.

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

The composite repairs were then completed following below stages (application procedure is the same for the 3 valves to be reinforced).

1/ **F3XCOMB filler** application on the defected areas to avoid sharp angles and reshape the valve before reinforcement.

2/ **F3XS1 filler** application to impregnate the surface and ensure good wetting and perfect impregnation of Kevlar® tape on the corroded areas.

3/ Composite covering using **300mm width Kevlar® tape impregnated with F3XS1 filler** (1 layer) on internal corrosion areas.

4/ Composite reinforcement using **100mm width Kevlar® tape impregnated with R3X150+ resin (for high temperature)**. The overlap is made by "L" patches on the complete circumference of the valves (depending on the valve and the level of corrosion, between 6 and 8 layers were applied).

5/ Finishing stage with **id plate installation for traceability.**

Fig. 5: Overview of final result

RESULTS

Hardness measurements validated the good curing of the applied products and concluded the good completion of the valve reinforcements.

The design life for these reinforcements is 20 years.

This job was quite complicated because of the specific valve geometry but was perfectly performed and will enable the sytem to operate efficiently and safely.

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ONSHORE /OFFSHORE

HIGH-PERFORMANCE COMPOSITE REPAIR SOLUTION FOR PIPE REINFORCEMENT

DEFECT TYPES	**Internal and external corrosion**
DETAILS	**6" WAG line , Offshore topside, design pressure 347 bars, max operating temp. 38°C**
LOCATION	**Angola, FPSO**
3X SOLUTION	**REINFORCEKiT® 4D**

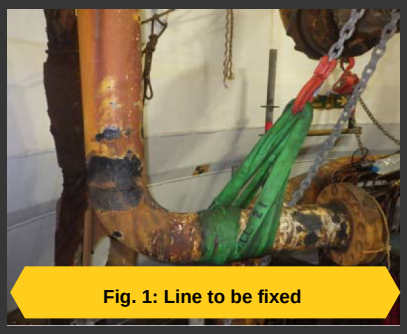

Fig. 1: Line to be fixed

OVERVIEW

The objective of the repair, carried out in August 2021 by **3X ENGINEERING (3X)** and its local distributor 3A SERVICES was to reinforce a 6" gas line suffering from internal and external corrosion. The defected area is located above the flange and the corrosion expanded circumferentially on approx. 1.8m. External corrosion is notified on 3 areas: on the straight line above the bend, on the bend and on the straight line between the bend and the flange. To restore pipe integrity and prevent further deterioration, it was decided to repair the defected areas using **REINFORCEKiT® 4D**, **approved by ABS**.

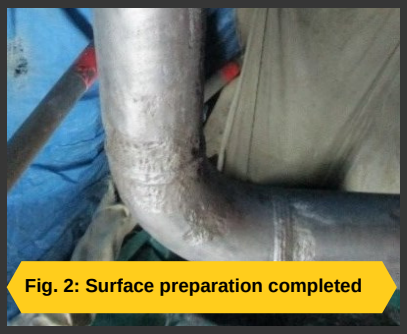

Fig. 2: Surface preparation completed

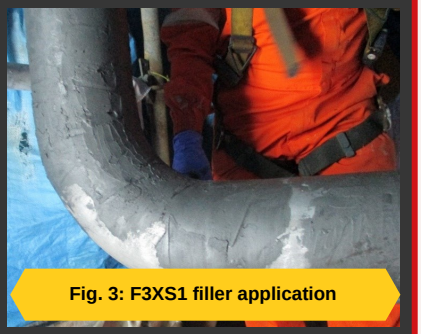

Fig. 3: F3XS1 filler application

Fig. 4: R3X70+ resin application

SCOPE OF WORK

According to ASME PCC-2 standard and 3X calculations, it was decided to apply **REINFORCEKiT® 4D** using **R3X70+ resin (specifically dedicated to internal and external corrosion at high temperature).** 30 layers of composite were determined to reinforce the straight line above the bend, 36 layers for the bend and 48 layers for the straight line near the flange.

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

The composite wrapping repairs were then completed following below stages (application procedure is the same for the 3 areas to be reinforced).

1/ **F3XS1 filler** application on the defected areas (straight lines and bend) to reshape the pipe.

2/ One layer of **R3X70+ resin** application on the defected areas (same as above) to protect the prepared surfaces from corrosion.

3/ **Composite wrapping** was completed using **Kevlar® tape** impregnated with **R3X70+ resin** ==> *30 layers completed for a total repair length of 815mm for the straight line above the bend / 36 layers for a total repair length of 874mm for the bend / 48 layers for a total repair length of 703mm for the straight line near the flange.*

4/ Finishing stage ==> last layer of **R3X70+ resin** applied all over the repair and **id plate installed for traceability.**

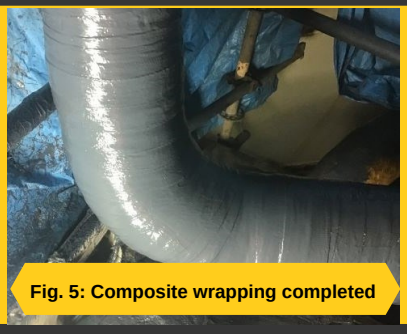

Fig. 5: Composite wrapping completed

RESULTS

Hardness measurements were performed and concluded the good achievement of the repairs. The job was quite complicated because of several criteria : high temperature + gas line + pipe geometry but was completed successfully by 3X specialists using REINFORCEKiT® 4D product.
The design life for this composite reinforcement is 10 years ==> ABS APPROVED.

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INNOVATIVE REPAIR SOLUTION FOR YOUR INSTALLATIONS

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HIGH-PERFORMANCE COMPOSITE REPAIR SOLUTION FOR PIPE REINFORCEMENT

DEFECT TYPES	**Internal acidic corrosion (3 defects)**
DETAILS	**42" gas pipeline, straight line, bend and tee, operating temp. 50°C, design pressure 20 bars**
LOCATION	**Kazakhstan, Onshore**
3X SOLUTION	**REINFORCEKiT® 4D**

Fig. 1: Pipeline to be repaired - overview

Fig. 2: Bend composite wrapping

Fig. 3: Tee composite wrapping

Fig. 4: Straight lines wrapping

OVERVIEW

The aim of the repair, performed in October 2019 by **3X ENGINEERING (3X)** local distributor **CASPIAN INTERINDUSTRIAL COMPANY** was to reinforce a 42" gas pipeline damaged by 3 internal acidic corrosion defects, leading to hazardous loss of containment in one location. To restore pipe integrity and prevent further deterioration, it was decided to repair the defected areas using 3X composite repair solution **REINFORCEKiT® 4D.**

SCOPE OF WORK

According to ISO 24.817 standard and 3X calculations, it was decided to apply **REINFORCEKiT® 4D** using **R3X70+ resin** recommended for internal corrosion**.** Three damaged areas were identified to be repaired: 2 defected areas on straight lines and 1 defected zone occuring on area made up of bend and tee.

Surface preparation was completed using Bristle Blaster machine to remove remaining coating and create a good surface roughness (superior to 60µm Rz) and ensure a good bonding between the pipe and the composite repair system. Then hygrometric conditions were checked and the surface was degreased and cleaned.

The composite repairs were then completed following the main stages mentioned below (the procedure was the same for the 3 defected areas):

1/ One layer of **R3X70+ resin** was applied on the whole prepared surfaces to ensure the good impregnation of the first tape layer.

2/ **Composite wrapping** was then completed using **Kevlar® tape** impregnated with **R3X70+ resin.** The repair design relies on the occurrence of maximum through-wall defect of 20mm x 20mm.

- Defect No. 1 - bend and tee ==> 6 layers were applied on the tee (2000mm) and 6 layers also applied on the bend (3000mm) with additional layers applied on the leak area (total of 18 layers for 600mm).
- Defect No. 2 - straight line ==> 6 layers were applied for a total length of 500mm.
- Defect No. 3 - straight line ==> 6 layers were applied for a total length of 2500mm.

3/ Last layer of **R3X70+ resin** was applied all over the repairs as finalization stage and **id plate was installed over each reinforcement for traceability.**

Fig. 5: Job completed - overview

RESULTS

Samples of resin were taken during each tape impregnation for quality control and hardness measurements were performed 72 hours after job completion and concluded this successful repair using REINFORCEKiT® 4D product.

Congratulations to our distributor for this excellent job mixing several geometries and big diameter.

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HIGH-PERFORMANCE COMPOSITE REPAIR SOLUTION FOR PIPE REINFORCEMENT

DEFECT TYPES	**External corrosion (3 defects)**
DETAILS	**- sweepolet: max op T° 35°C, design pressure 9 bars** **- 6" riser: max op T° 95°C, design pressure 220 bars** **- 12" bended pipe: max op T° 70°C, design pressure 19 bars**
LOCATION	**Qatar, Halul Island**
3X SOLUTION	**REINFORCEKiT® 4D**

Fig. 1: Sweepolet overview

Fig. 2: Sweepolet repair finalized

Fig. 3: Riser wrapping on progress

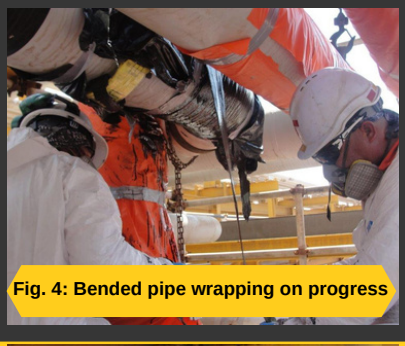

Fig. 4: Bended pipe wrapping on progress

OVERVIEW

The objective of the repair, carried out in June 2022 by **3X ENGINEERING (3X)** local distributor **POWER ENGINEERING CORPORATION (PEC)** was to reinforce 3 different lines transporting oil (located in Offshore platform) and suffering from external corrosion ==> sweepolet - 6" riser - 12" bended pipe.
To restore their integrity and prevent further deterioration, it was decided to repair the defected areas using 3X composite repair solution **REINFORCEKiT® 4D.**

SCOPE OF WORK

According to ASME PCC-2 standard and 3X calculations, it was decided to apply **REINFORCEKiT® 4D** using **R3X95 resin** (specially used for repairing pipe operating up to 95°C)**.** Four layers of composite were determined to reinforce each defected area.

For the riser, removal of existing wrapping was performed before surface preparation.

Surface preparation was completed using Bristle Blaster machine to get a good surface roughness (superior to 60µm Rz) and ensure a good bonding between the steel pipe and the composite repair system. Then hygrometric conditions were checked and the surface was degreased with acetone.

The composite repair was then completed following 4 main stages, as below :

1/ **F3X8 filler** was applied on the defected areas to smooth the shape (this step was not necessary for 6" riser reinforcement).

2/ One layer of **R3X95 resin** was then applied on the defected area to protect the surface from corrosion and ensure a good wetting of the composite wrapping with the steel pipe.

3/ **Composite wrapping** was completed using **Kevlar® tape** impregnated with **R3X95 resin** ==> *4 layers were installed for a total repair length of 120mm for sweepolet repair, 1300mm for riser repair and 402mm for bended pipe repair.*

4/ Last layer of **R3X95 resin** was applied all over the repairs as finishing stage and **id plate was installed over each reinforcement for traceability.**

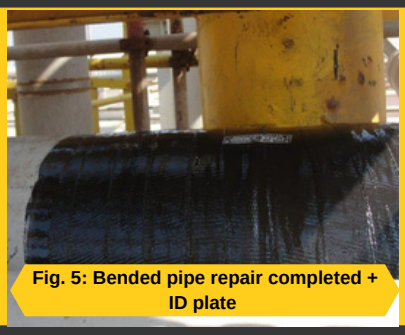

Fig. 5: Bended pipe repair completed + ID plate

RESULTS

Samples of resin were taken during each tape impregnation for quality control. Hardness measurements were performed 3 days after job completion and concluded the good achievement of these repairs using REINFORCEKiT® 4D product.

Lifetime design for sweepolet and 12" bended pipe is 10 years and 20 years for the 6" riser.

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3X ENGINEERING

INNOVATIVE REPAIR SOLUTION FOR YOUR INSTALLATIONS

OIL & GAS
ONSHORE /OFFSHORE

HIGH-PERFORMANCE COMPOSITE REPAIR SOLUTION FOR PIPE REINFORCEMENT

DEFECT TYPES	**External corrosion (4 defects)**
DETAILS	**20.9" gas pipeline, straight line, calculated pressure 39 bars, max. op. temp. 20°C**
LOCATION	**Czech Republic, Onshore**
3X SOLUTION	**REINFORCEKiT® 4D**

Fig. 1: Sandblasting in progress

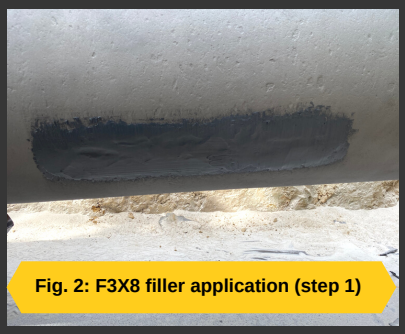

Fig. 2: F3X8 filler application (step 1)

Fig. 3: R3X55 resin layer application (step 2)

Fig. 4: Composite wrapping in progress (step 3)

Fig. 5: Composite wrapping completed + ID plate (step 4)

OVERVIEW

The objective of the repair, carried out in July 2022 by **3X ENGINEERING (3X)** and its local distributor **ORTODROMA** was to reinforce a 20.9" gas pipeline suffering from 4 external corrosion defects, situated in 4 different locations (Mnichov, Hory, Tridomi, Chodov). To restore pipe integrity and prevent further deterioration, it was decided to repair the defected areas using 3X composite repair solution **REINFORCEKiT® 4D.**

SCOPE OF WORK

According to ASME PCC-2 standard and 3X calculations, it was decided to apply **REINFORCEKiT® 4D** using **R3X55 resin.** Four layers of composite were determined to reinforce each defected area.

Surface preparation was completed using sandblasting to get a good surface roughness (superior to 60µm Rz) and ensure a good bonding between the steel pipe and the composite repair system. Then hygrometric conditions were checked and the surface was degreased with acetone.

The composite repair was then completed following 4 main stages, as below (the procedure was the same for the 4 defected areas):

1/ **F3X8 filler** was applied on the defected area to smooth the shape.

2/ One layer of **R3X55 resin** was then applied on the defected area (previously delimited) to protect the surface from corrosion and ensure a good wetting of the composite wrapping with the steel pipe.

3/ **Composite wrapping** was completed using **Kevlar® tape** impregnated with **R3X55 resin** ==> *4 layers were installed for a total repair length of 1040mm for Mnichov repair , 1900mm for Tridomi repair, 890mm for Hory repair and 3500mm for Chodov one.*

4/ Last layer of **R3X55 resin** was applied all over the repair as finishing stage and **id plate was installed over each reinforcement for traceability.**

RESULTS

Samples of resin were taken during each tape impregnation for quality control. Hardness measurements were performed 2 days after job completion and concluded the good achievement of this repair using REINFORCEKiT® 4D product.

This composite reinforcement is designed for lasting 20 years.

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INNOVATIVE REPAIR SOLUTIONS FOR YOUR INSTALLATIONS

DEFECT TYPE	**Pipe subjected to compressive stress**
PIPE DETAILS	**30" pipe – Operating temperature 45°C - Pressure 600 psi**
LOCATION	**COLOMBIA**
3X SOLUTION	**REINFORCEKIT® 4D – EC**

Figure 1: Pipe to be reinforced

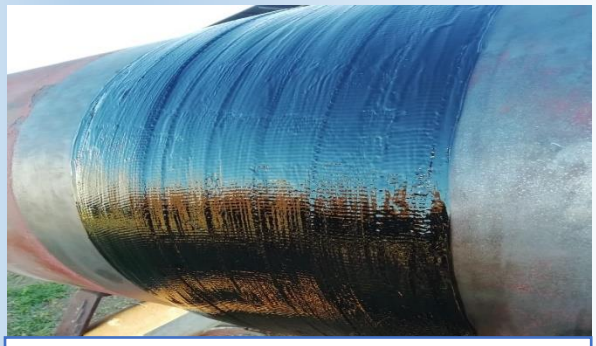
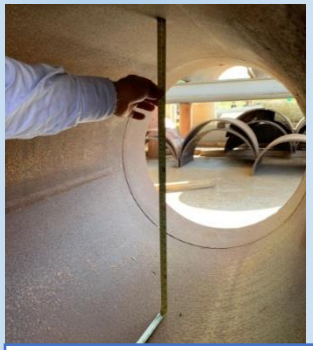


Figure 2: Wrapping completed



Figures 3-4: Measurement of inner diameter and initial loading

Figures 5-6: 3,5 tons of loads applied on reinforced pipe

OVERVIEW

The objective of the job, carried out in 2018 in Colombia by CPSERVICES (3X ENGINEERING (3X) distributor), was to **reinforce and protect a 30" pipe subjected to compressive stress** in order to verify if the pipe integrity remains preserved once loads are applied.

SCOPE OF WORK

Each reinforcement is designed specifically according to the characteristics of the pipe, the operating conditions and the size of the defect. In accordance with ASME PCC-2 standard and 3X repair calculations, 4 layers of **REINFORCEKIT® 4D-EC** were determined to reinforce the pipe.

1/ Before the repair, qualified staff of CPSERVICES inspected and delimited the area to be reinforced.

2/ Surface preparation was carried out by an external contractor using manual-mechanical tools to obtain a good surface roughness (between 60 and 100 µm) and thus guarantee the bonding between the steel pipe and the composite.

3/ The surface was cleaned with ethanol and the hygrometric conditions were checked before wrapping process.

4/ Wrapping composite reinforcement covering the delimited area was completed using **Kevlar® tape impregnated with R3X1060 resin** (4 layers with a specific repair length according to the characteristics of the loads to which the 30" pipe would be subjected).

5/ Once wrapping completed, the inner diameter was measured in order to detect any final deformation.

6/ Finally, two external loads (1.75 tons each one) were applied to check the resistance of the pipe.

RESULTS

The pipe reinforced with **REINFORCEKIT® 4D-EC** was subjected to 3.5 tons of external loads without presenting any type of damage or deformation. The lifetime of this composite reinforcement is 20 years.

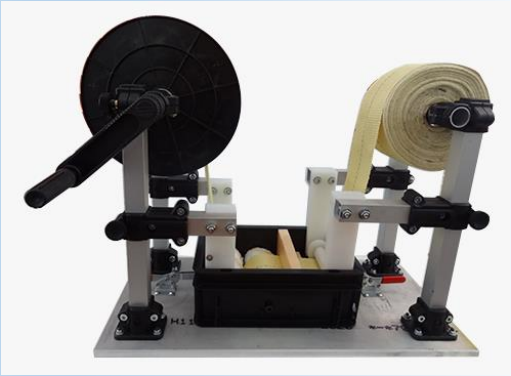
DEFECT TYPE	**Corrosion**	PIPE DETAILS	**16" water line**
LOCATION	**NIGERIA**		
3X SOLUTION	**REINFORCEKiT® 4D-EC using BOBiPREG®**		

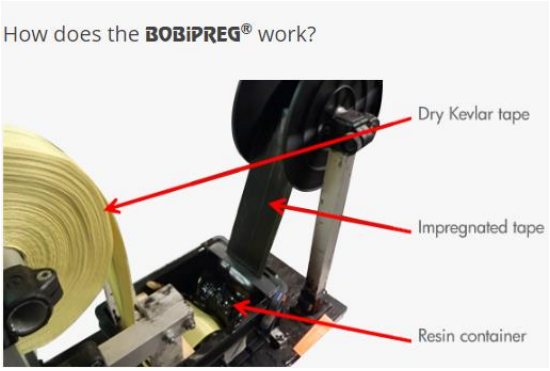
OVERVIEW

The objective of the job, performed in August 2018 by 3X ENGINEERING (3X) and its local distributor SAVIC, was to protect a **16" pipe from aggressive environment on several long sections (for a total of 70-meter length).**

SCOPE OF WORK

The reinforced protection was performed in a yard, prior on-site assembly, using **BOBiPREG®** machine. This specific machine, designed by 3X, allows a quick and regular impregnation of the Kevlar® tape with the resin before application.





Figures 1 & 2: BOPiPREG machine and how it operates

This pre-preg system was very convenient for this case because the **REINFORCEKiT® 4D-EC** application should be carried out as fast as possible. The reinforced protection was performed following 4 stages:

❶ Surface preparation of the pipe using sandblasting to get at least 60 µm roughness and thus ensure a good bonding between the pipe and the composite.

❷ Kevlar® tape impregnated with **R3X1060 resin** using **BOBIPREG®.**

❸ Wrapping around the pipe using **3X specific handles** to ensure proper tensile strength during application. This device will facilitate and speed-up the wrapping step. Four layers were applied to guarantee an optimal protection.

❹ Finalization of the protection with reference plate positioning for traceability purpose.

Figure 3: Kevlar tape impregnation with resin using BOBiPREG

Figure 4: Composite wrapping on progress using specific handles

Figure 5: Reinforced protection finalized with reference plate installation

RESULTS

Initially developed for subsea application, **BOBIPREG®** machine is proving to be also very efficient in this onshore configuration. This application method added to onsite conditions offer many benefits:

- easier logistic & safer environment (implementation environment performed in a yard rather than a platform).
- efficiency increased & cost effective (the wrapping was performed four times faster than with traditional method).

DEFECT TYPE	**External corrosion – 4 defects**
PIPE DETAILS	**10" and 12" – Oil lines – design temperature 70°C - design pressure 40 and 200 bar**
LOCATION	**THE NETHERLANDS – Platform (Offshore on air)**
3X SOLUTION	**REINFORCEKIT® 4D – High Temperature**

OVERVIEW

The objective of the repair, performed in October 2018 by 3X ENGINEERING (3X), was to **repair and reinforce 4 external corrosion defects on 2 straight lines (2 defects situated on the 10" line and 2 defects on the 12" line).** The pipes are located on the top of the bridge of the platform.

Fig. 1: Working conditions – View of scaffoldings

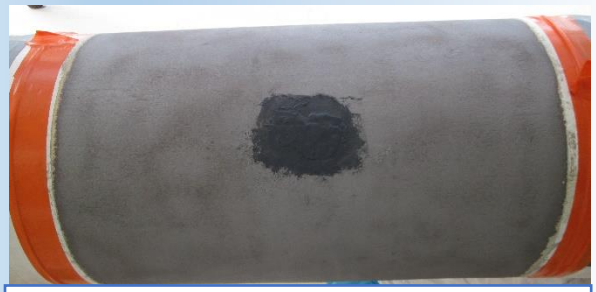


Fig. 2: View of the delimited repair area to be wrapped & Example of filler F3X8 application on 12" pipe defect

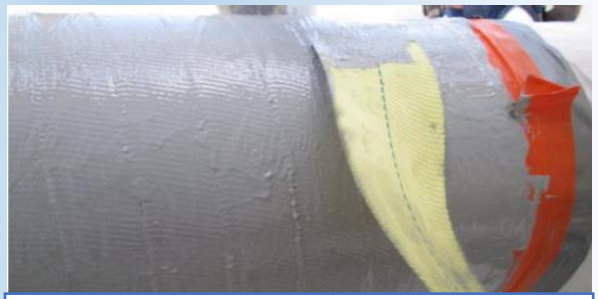


Fig. 3: Wrapping in progress

Fig. 4: Wrapping completed & Identity plate installed

SCOPE OF WORK

Each repair is designed specifically according to the pipe characteristics, the operating conditions and the size of the defect. According to ASME PCC-2 standard and 3X repair calculations, 4 layers of **REINFORCEKIT® 4D HT+, specifically dedicated to high temperature,** were determined to repair each of the 4 defects.

Because of the complex pipes situation, the client provided scaffoldings to perform the repair.

Before starting the composite reinforcement, 3X technicians first recognized and delimited the repair areas with adhesive tape. Surface preparation was completed with grit blasting to get a good surface roughness (between 60 and 100µm) and ensure the bonding between the steel pipes and the composite. The surface was then cleaned using acetone and hygrometric conditions were checked before wrapping procedure.

The composite repair for each defect was performed as follows:

❶ **F3X8 filler** application on each defect to give back the initial shape to the pipes.

❷ Wrapping process covering the delimited areas was completed using **Kevlar® tape impregnated with R3XHT+ resin** (4 layers for each defect but with a specific repair length in accordance to defect characteristics ➔ 260mm repair length for both 10" line defects, 457mm and 1060mm for the defects on 12" line).

❸ **Reference plate** for traceability purpose was positioned on each repair.

For each repair, samples of **filler F3X8** and **resin R3XHT+** were taken during installation for quality control. After 3X operation, anti-UV coating was applied by the client to protect the repair.

RESULTS

The lines suffering from external corrosion were successfully repaired using our **REINFORCEKIT® 4D HT+**. Hardness measurements were performed and concluded the success of the repair. The design life for this composite reinforcement is 10 years.

DEFECT TYPE	**External corrosion – 4 defects**
PIPE DETAILS	**24", 20" & 4.5" - Oil line – max. op. temp. 105°C - application temp. 60°C - design pressure 10 barg**
LOCATION	**VIET-NAM – FPSO**
3X SOLUTION	**REINFORCEKIT® 4D ECHT (R4D-ECHT) – High Temperature**

OVERVIEW

The objective of the repair, performed in October 2018 by 3X ENGINEERING (3X) and its local distributor PETROENERTECH, was to **repair 4 external corrosion defects on 2 different lines (1 flare scrubber and 1 heat exchanger).**

SCOPE OF WORK

According to ISO 24.817 and 3X repair calculations, 4 layers of **REINFORCEKIT® 4D ECHT, specifically dedicated to high temperature,** have been determined to repair each of the 4 defects.

Surface preparation was completed using Bristle Blaster® machine to get a good surface roughness (between 60 and 100µm) and ensure the bonding between the pipe and the composite. Hygrometric conditions were measured and the surface was cleaned using acetone.

The composite repair for the 2 points of the flare scrubber (4.5" & 24") was then performed following several stages:

❶ **F3X8 filler** application on fitting & vessel to get a smooth geometry.

❷ Surface covered with **R3X1080 resin** to ensure a good wetting and impregnation of the Kevlar® tape.

❸ Kevlar® strips application all around the surface (from the vessel to the straight line) to share the constraints.

❹ Wrapping process covering the straight line was completed using **Kevlar® tape impregnated with R3X1080 resin** (4 layers).

❺ Final protective layer of **R3X1080 resin** was applied all over the repair with reference plate positioning for traceability purpose.

The composite repair for the 2 defects (300x350mm & 5x5mm) situated on heat exchanger (24" – straight line) was performed following the same stages, except Step 3. The total repair length for these defects were respectively 850mm & 305mm.

RESULTS

The lines suffering from external corrosion were successfully repaired using our **REINFORCEKIT® 4D ECHT**. The challenge of these repairs was the specific geometries to be repaired added to high temperature application.

Figure 1: Kevlar® strips application (flare scrubber - part No. 1 of 4.5")

Figure 2: Composite wrapping finished (flare scrubber - part No. 2 of 24")

Figures 3 & 4: Composite wrappings finished on heat exchanger (2 defected areas)

DEFECT TYPES	**External corrosion, cracks and dents**
PIPE DETAILS	**20" buried oil pipeline – design temperature 30°C - design pressure of 78 bar**
LOCATION	**FRANCE**
3X SOLUTION	**REINFORCEKIT® 4D EC using BOBIPREG®**

OVERVIEW

The objective of the several repairs, carried out in 2019 by 3X ENGINEERING (3X) and its French distributor PLS CONTROLE, was to **reinforce a strategic oil pipeline (260 km long) in France suffering from various defects (external corrosion, cracks and dents)**

Fig. 1: Overview of the line to be repaired

Fig. 2-3: Filler application over the defect area

Fig. 4: Field-impregnation machine developed by 3X
Fig.5: Wrapping in progress using 3X handles

Fig. 6: Wrapping completed and measurement of the repair

SCOPE OF WORK

As per ISO 24.817 requirements and 3X repair calculations, between 4 and 32 composite layers of **REINFORCEKIT® 4D EC,** were needed to reinforce the various defects (external corrosion defects, cracks and dents) and restore the original design pressure.

A total of over 100 repairs were performed on the pipeline. This represents approx. 250m in terms of linear repair length.

The largest composite repair performed on this pipeline measured 9,4m (the longitudinal weld was damaged by external corrosion). Almost 2.3km of Kevlar® tape and 230kg of epoxy resin together with 16kg of filler have been used to reinforce the area.

Below are the different steps performed as part of this repair – the procedure was the same for all the repairs performed on the pipeline.

❶ **Surface preparation** was made according to 3X requirements to get a good surface roughness (60µm at least) and ensure a good bonding between the steel of the pipe and the composite of the repair. Hygrometric conditions were checked and the surface was cleaned using acetone.

❷ **F3X8 filler** was applied over the defect to restore a smooth shape.

❸ Composite wrapping was then applied using **Kevlar® tape impregnated with R3X1060 resin** ➔ 14 layers and 9400mm repair length for the largest repair. To save time and speed-up the wrapping process, the repair was performed using 2 specific tools developped by 3X.

➲ **BOBIPREG® machine**: field-impregnation system that allows a quick and regular Kevlar® tape impregnation with resin before wrapping.

➲ **3X handles:** device that ensures constant and controled tape tension during wrapping.

❹ **Reference plate** was installed for traceability purpose.

For each repair, samples of filler and resin were taken during application for quality control.

RESULTS

Hardness measurements performed after polymerization confirmed the good performance of the repairs. **Repair lifetime: 20 years for external corrosion defects and dents.**

INNOVATIVE REPAIR SOLUTIONS FOR YOUR INSTALLATIONS

DEFECT TYPE	**External corrosion at weld connection**
PIPE DETAILS	**12" gas line – Operating temperature: ambient (20°C) - Pressure 64 bars**
LOCATION	**AUSTRIA – Aerial pipeline**
3X SOLUTION	**REINFORCEKIT® 4D – EC**

Fig. 1: Surface Preparation using Bristle Blaster®

Fig. 2: F3X8 filler application

Fig. 3: Composite wrapping on progress

Fig. 4: Repair overview with ID plate

OVERVIEW

The objective of the job, carried out in June 2019 in Austria, was to **restore the pipe integrity of a 12" gas line suffering from external corrosion at weld connection**. The access to the defect was complicated due to the height of the line. The aerial line is situated on a bridge crossing the Danube river.

SCOPE OF WORK

Each repair is designed specifically according to the characteristics of the pipe, the operating conditions and the size of the defect. According to ISO 24.817 standard and 3X ENGINEERING (3X) repair calculations, 4 layers of **REINFORCEKIT® 4D-EC** were determined to reinforce the straight line.

The complicated pipe location (aerial) required Rope Access Work.

Before starting the reinforcement, the coating was removed each side of the weld to have enough length for composite application. Surface preparation was then completed using Bristle Blaster® machine to get a good surface state and surface profile. Finally, the whole prepared surface was cleaned with acetone and roughness test and hygrometric measures were performed to ensure that all the conditions were satisfying before composite application.

The composite repair was then performed following several steps:

1/ F3X8 filler application on weld and defect to reshape the pipe.

2/ R3X1060 resin application on the whole surface to protect it from corrosion.

3/ Wrapping process using **Kevlar® tape impregnated with R3X1060 resin ➔** 4 layers completed for a total repair length of 400mm.

4/ Finalization of the repair. **R3X1060 resin** application over the repair to ensure good wetting of the fibers and good visual aspect and identification plate application for traceability purpose.

Hardness measurements on resin and filler samples were performed 10 days after job completion to check the good curing and validate the repair.

RESULTS

The project was effectively planned and executed by 3X specialists. This job demonstrated the capacity and adaptability of 3X technicians to work on specific conditions such as aerial work with rope access. This composite repair will extend the lifetime of the pipe while awaiting its replacement (design lifetime: 1 year, as per client requirement).

DEFECT TYPES	**Internal corrosion & hole**
PIPE DETAILS	**8" Tee – Water line – operating temperature 60°C - operating pressure <1 bar**
LOCATION	**OMAN**
3X SOLUTION	**REINFORCEKIT® 4D – High Temperature**

Fig. 1: View of tee with through wall defect

Fig. 2-3: Leak sealed with metallic plate and F3XS1

Fig. 4-5: Wrapping in progress

Fig. 6: Wrapping completed (12 layers) & ID plate installed

OVERVIEW

The objective of the repair, performed in August 2019 by 3X ENGINEERING (3X) and its local distributor SYNERGY, was to **reinforce 2 tees of 8" suffering from internal corrosion and through wall defect.**

SCOPE OF WORK

Calculations using 3X software were performed to define the minimum thickness and length necessary to give back the full integrity of the pipe, (according to the design pressure and temperature). Following client's request, it was decided to design the repair according to no standard, to reduce the number of layers. In these conditions, 3X advised to apply a minimum of 12 layers of **REINFORCEKIT® 4D HT+ (specifically dedicated to high temperature)** to reinforce the tee with through wall defect and 8 layers for the one suffering from internal corrosion.

Due to through wall defect, the client shutdown and flushed the line in order to apply the composite on the leak.

Before starting the tee reinforcement, surface preparation was completed with grit blasting to get a good surface roughness and ensure the bonding between the steel pipe and the composite. Surface profile evaluation was performed to confirm the roughness was superior to 60µm. The surface was then cleaned using acetone and hygrometric conditions were checked before wrapping procedure (steps described below).

❶ **F3XS1 filler with metallic plate** was applied on through wall defect to seal the leak (this step was not necessary for internal defect).

❷ Wrapping process covering the delimited areas was completed using **Kevlar® tape impregnated with R3XHT+ resin** (12 layers for hole defect and 8 layers for internal defect ➔ both of them with 600mm repair length).

❸ **Reference plate** was installed on each repair for traceability purpose.

For each repair, samples of filler and resin were taken during application for quality control.

RESULTS

This job was a great challenge because of the several complicated data: tee geometry + hole defect + high temperature. Despite these difficulties the 2 lines were successfully repaired using our **REINFORCEKIT® 4D HT+**.

DEFECT TYPES	**External corrosion – 6 defects**
PIPE DETAILS	**2" & 6" straight line, elbow, pipe on support and flange – hydrocarbon gas – operating temperature 80°C - operating pressure <12 bar**
LOCATION	**MALAYSIA – Puteri Platform**
3X SOLUTION	**REINFORCEKiT® 4D – High Temperature**

Fig. 1-2: Straight line reinforcement (before/after)

Fig. 3-4: Elbow reinforcement (before/after)

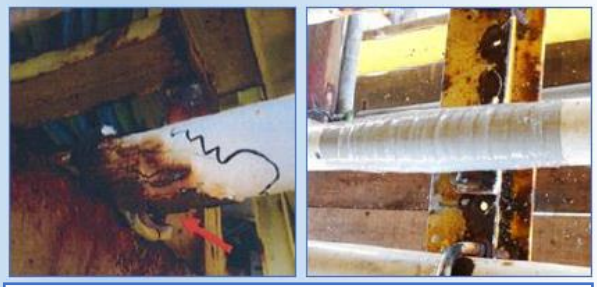


Fig. 5-6: Pipe on support reinforcement (before/after)

Fig. 7-8: Flange reinforcement (before/after)

OVERVIEW

The objective of the repair, performed in October 2019 by 3X ENGINEERING (3X) local distributor IN-SITU, was to **reinforce 6 areas suffering from existing external corrosion and prevent from any potential internal corrosion.**

SCOPE OF WORK

Calculations using 3X software were performed to define the minimum thickness and length necessary to give back the full integrity of the pipe, (according to the design pressure and temperature).

Following client's request, it was decided to design the repair according to ISO 24.817. In these conditions, 3X advised to apply a minimum of 2 layers of **REINFORCEKiT® 4D HT+ (specifically dedicated to high temperature)** to reinforce the straight line, elbow, pipe on support and flange suffering from external corrosion.

IN-SITU specialists applied the composite **online**.

Before starting the 6 reinforcements, surface preparation was completed with grit blasting to get a good surface roughness and ensure the bonding between the steel pipe and the composite. Surface profile evaluation was performed to confirm the roughness was superior to 60µm. The surface was then cleaned using acetone and hygrometric conditions were checked before wrapping procedure (steps described below – for each reinforcement).

❶ **F3X8 filler** was applied on the pipe.

❷ Wrapping process covering the delimited areas was completed using **Kevlar® tape impregnated with R3XHT+ resin** (2 layers for each defect ➔ from 188mm up to 1085mm repair length).

❸ **Reference plate** was installed on each repair for traceability purpose.

For each repair, samples of filler and resin were taken during application for quality control.

RESULTS

The 6 areas were successfully repaired using our **REINFORCEKiT® 4D HT+**. The challenge of these reinforcements was to repair online several geometries at high temperature.

DEFECT TYPES	**Cracks**
PIPE DETAILS	**MDEA Regenerator column - 264" – MDEA / Acid Gas – max op. temperature 90°C - design pressure 1 bar**
LOCATION	**LIBYA**
3X SOLUTION	**REINFORCEKIT® 4D – High Temperature**

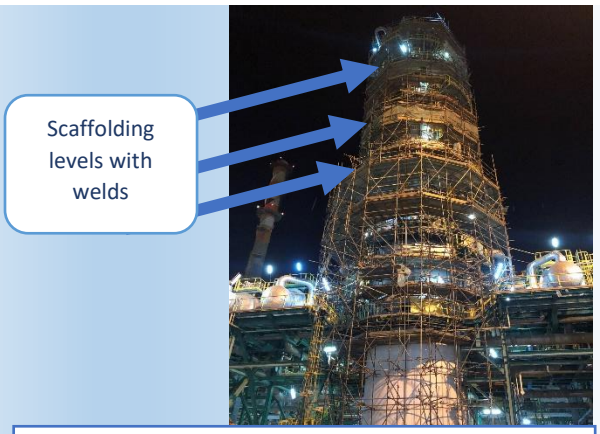


Fig. 1: Column overview with welds location

Fig. 2: F3XS1 application on weld

Fig. 3-4-5 : Wrapping in progress

Fig. 6: Wrapping completed (4 layers)

OVERVIEW

The objective of the repair, carried out end of December 2019 by 3X ENGINEERING (3X) and its local distributor AL MAIDA, was to **reinforce 3 circumferential welds suffering from cracks, situated on a huge column.**

SCOPE OF WORK

According to ISO 24.817 and 3X repair calculations, 4 composite layers of **REINFORCEKIT® 4D HT+ (specifically dedicated to high temperature)** were determined to reinforce the defects.

Scaffoldings and surface preparation were already managed before 3X team arrival. The surface preparation was made according to 3X requirements to get a good surface roughness and ensure a good bonding between the steel of the column and the composite of the repair. Upon arrival, 3X specialists checked the surface profile and the hygrometric conditions and cleaned the surface using acetone before starting the wrapping procedure (steps described below – the procedure is the same for the 3 welds to be reinforced).

❶ **F3XS1 filler** was applied on the weld to smooth the shape and improve the Kevlar® tape fitting on the column.

❷ **R3XHT+ resin** was applied on the surface to ensure the perfect impregnation of the Kevlar® tape.

❸ Composite wrapping was completed using **Kevlar® tape impregnated with R3XHT+ resin** ➔ 4 layers and 1270mm repair length for each defect. During the process, tape impregnation was checked on both sides to ensure the expected performance.

❹ Finalization of the repair. A layer of **R3XHT+** was applied all over the repair to ensure good wetting and improve the visual aspect. **Reference plate** was installed on each repair for traceability purpose.

For each repair, samples of filler and resin were taken during application for quality control.

RESULTS

Hardness measurements were performed 3 days after job completion and concluded the good achievement of the repairs. This project was challenging because of the large column diameter and the time frame for completing the job. The column was successfully reinforced on the weakest areas and is now protected from leaking issues.

DEFECT TYPES	**Leaks and welding defects**
PIPE DETAILS	**32'' column – Vapor with Glycol – max op. temperature 60°C - design pressure 42 bar**
LOCATION	**IRAQ**
3X SOLUTION	**REINFORCEKIT® 4D – High Temperature**

Fig. 1-2: Column overview – View of the defects

OVERVIEW

The objective of the repair, performed in January 2020 by 3X ENGINEERING (3X) local distributor GULFSTAR, was to **reinforce the line suffering from severe internal corrosion and leading to through wall defects (➔ 12 leaks).**

SCOPE OF WORK

According to ASME PCC-2 and 3X repair calculations, 6 composite layers of **REINFORCEKIT® 4D HT+ (specifically dedicated to high temperature)** were determined to reinforce the damaged area with leaks.

Before starting the repair, surface preparation was completed with grit blasting. A test was then conducted on different locations of the column to confirm the surface roughness was made according to 3X requirements (between 60 and 100µm).

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

The composite repair was then performed following the steps described below:

❶ **F3XS1 filler** (epoxy filler with high mechanical properties and chemical resistance) was applied on the leaks to plug them. **F3X8 filler** was preferred to be applied around the welded joint to smooth the shape and improve the Kevlar® tape fitting on the column.

❷ **R3XHT+ resin** was applied on the surface to ensure good wetting and the perfect impregnation of the Kevlar® tape.

❸ Composite wrapping was completed using **Kevlar® tape impregnated with R3XHT+ resin ➔** 6 layers and 3500mm total repair length.

❹ Finalization of the repair. A layer of **R3XHT+** was applied all over the repair to ensure good wetting and improve the visual aspect. **Reference plate** was installed for traceability purpose.

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

Fig. 3: Wrapping in progress

Fig. 4: Wrapping completed (6 layers) with ID plate

RESULTS

Hardness measurements were performed 2 days after job completion and concluded the good achievement of the reinforcement. This job was challenging because of the quantity of leaks to be plugged. The column was successfully repaired on the sensitive area and is now protected from leaking issues.

DEFECTS TYPE	**5 defects of internal corrosion**
PIPE DETAILS	**8" pipe spools -gas line – max. op. temp. 40°C – op. pressure 81 bars**
LOCATION	**QATAR, Ras Laffan treatment plant**
3X SOLUTION	**REINFORCEKiT® 4D (R4D)**

Figure 1: Pipe spool A overview

Figure 2: Surface preparation on progress using Bristle Blaster

Figure 3: R4D composite wrapping on progress

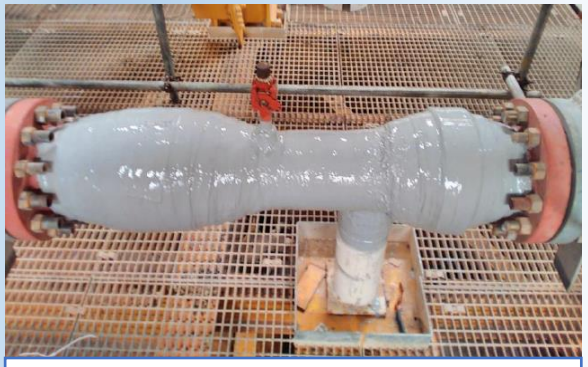


Figure 4: Repair overview (pipe spool A)

OVERVIEW

The objective of the repair, performed end of August, beginning of September 2020 by 3X ENGINEERING (3X) local distributor PEC, was to **reinforce two 8" pipe spools suffering from internal damages** ➔ pipe spool A damaged by 3 defects + pipe spool B with 2 defects.

SCOPE OF WORK

The job was carried out on 2 different pipe spools (both with same details) using **R4D**. Below is firstly described the repair of pipe spool A damaged in 3 locations (3.8mm, 5mm and 7mm metal loss).

Before starting the repair, surface preparation was completed with Bristle Blaster pneumatic machine (ATEX approved) to get a good surface roughness and ensure the bonding between the pipe spool 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.

The composite wrapping reinforcement was then performed as follows. These steps are the same ones for the 2 defects near the flanges (to reinforce the middle area defected, no metallic plate was necessary).

❶ **Metallic plate** (previously prepared to ensure a good bonding with the substrate) was installed using **F3XS1 filler** on the defected area and fastened with ratchet belts for good tightening.

❷ Impregnation of the surface with **R3XHT+ resin** to ensure good wetting and impregnation of the Kevlar® tape.

❸ Kevlar® tape impregnated with **R3XHT+ resin** and wrapped around the pipe. According to ISO 24.817 and 3X repair calculations, 86 layers of **R4D** have been determined to reinforce the 2 defects situated on the extremities of the pipe spool, near the flanges. Only 6 layers were needed to reinforce the middle area for a total repair length of 1433mm.

❹ Finalization of the repair with reference plate positioning for traceability purpose and validation of the repair using hardness measurements.

Process repair was the same to reinforce the pipe spool B damaged by 2 internal defects: 86 layers for defect 1 near the flange (5.82mm metal loss) and 6 layers for defect 2 (7.9mm metal loss) for a total repair length of 1350mm.

RESULTS

This project was a great challenge due to the pipe spools geometry (i.e. defects near to the flange area) but has been successfully completed on time despite international COVID-19 pandemic and all the safety measures and constraints associated.

COMPOSITE REPAIR FOR PIPE REINFORCEMENT

According to ISO 24.817 & ASME PCC-2

DEFECTS TYPE	**internal corrosion defect + 3 holes**
PIPE DETAILS	**10" spool – water line – max. op. temp. 40°C – op. pressure 9 bars – application temp. 130°C**
LOCATION	**QATAR**
3X SOLUTION	**REINFORCEKIT® 4D (R4D)**

OVERVIEW

The objective of the test, performed in November 2020, by 3X ENGINEERING (3X) local distributor PEC, was to **reinforce 10" spool suffering from internal corrosion defect and 3 holes**. This test was required by the client to qualify our **R4D** composite system before performing the physical wrapping on site.

Figure 1: 10" pipe spool overview

Figure 2: R4D composite wrapping in progress (step 3)

Figure 3: Repair overview with ID plate (step 4)

Figure 4: Hydrotest system overview

SCOPE OF WORK

Before starting the test, the spool was inspected, climatic conditions were checked, surface preparation was performed using sand blasting machine and surface profile was evaluated. Heating element process was then performed by a third party to preheat the specific area to be repaired at 130°C during minimum of 4 hours for application and 10 hours for full curing.

The repair length was measured, surface cleaning using acetone and hygrometric tests were performed before composite wrapping.

The reinforcement was then performed as follows. These steps are the same ones for the 3 holes. For internal corrosion defect, no metallic plate was necessary (step 1 not applicable).

❶ **Metallic plates** (previously prepared to ensure a good bonding with the substrate) were installed using **F3XS1 filler** on the defected areas and fastened with ratchet belts for good tightening. One metallic plate 100x95mm dimensions for 50mm hole and 2 metallic plates 31x24mm dimensions for 8mm pinholes. This step did not require any specific curing time.

❷ Impregnation of the surface with **3X specific resin** to ensure good wetting and impregnation of the Kevlar® tape.

❸ Kevlar® tape impregnated with **3X specific resin** and wrapped around the pipe. According to **ISO 24.817** and 3X repair calculations, 42 layers of **R4D** were determined to reinforce defected area for a total repair length of 703mm.

❹ Finalization of the repair with reference plate positioning for traceability purpose.

Twelve hours of curing load between 107°C and 135°C were necessary for the complete polymerisation of the composite wrapping system to provide full mechanical characteristics before hydrotest.

RESULTS

REINFORCEKIT® 4D composite system efficiently passed the hydrotest at 9 bars for 2h and 50mn. No leak was observed and concluded the successful mockup test. This mockup project was a great challenge due to the application at 130°C and the several internal and hole defects. **DNV GL inspection report certified our R4D composite system**.

DEFECT TYPES	**External corrosion and hole**
PIPES DETAILS	**18", 22", 24", 30" and 36" pipelines – oil and gas – temperature 70°C - design pressure from 3 to 17bars**
LOCATION	**Rajasthan, WEST INDIA**
3X SOLUTION	**REINFORCEKIT® 4D**

Total project of 850m repair length !!

Fig. 1: Example of straight line wrapped with R4D

Fig. 2: Section of straight line with irregularity perfectly wrapped with R4D

Fig. 3: Elbow reinforcement – R4D wrapping on progress

Fig. 4: Tee reinforcement – R4D wrapping on progress

OVERVIEW

The objective of the repairs, started in January 2021 by 3X INDIA, is to **reinforce several pipelines of various diameters (from 18" to 36") and geometries (straight line, elbow and tee) in Rajasthan region (west India) suffering from external corrosion or hole defects.**

SCOPE OF WORK

According to ASME PCC-2 requirements and 3X design repair calculations, between 4 and 12 composite layers of **REINFORCEKIT® 4D,** are needed to reinforce the various defects (external corrosion and hole) and restore the original pipelines integrity.

A total of around 850m repair length will be achieved to completely restore the client's assets. This represents approximately 150 km of Kevlar® tape and almost 17 tons of 3X bi-component epoxy resin.

In one month, 80 meters have been already wrapped on the 36" pipeline. For this particular project, up to 16 technicians are involved and will be deployed for the next 24 months.

To increase the productivity of this huge project, the application team was divided in 3 sub-teams. One team is dedicated to the pipe cleaning and coating removal, the second one conducts the surface preparation and the last one proceeds with composite wrapping.

Below are the different steps performed for the 36" pipeline reinforcement affected by external corrosion:

❶ **Surface preparation** was made according to 3X requirements to get a good surface roughness (60µm at least) and ensure a good bonding between the steel of the pipe and the composite of the repair. Hygrometric conditions were checked and the surface was cleaned using acetone.

❷ **3X filler** was applied over the defects to restore a smooth shape.

❸ Composite wrapping was then applied using **Kevlar® tape impregnated with R3X110 resin (dedicated for high temperature)** ➔ 4 layers (design pressure is 3bars) were applied for a total of 80m repair length.

❹ **Reference plate** was installed for traceability purpose.

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

RESULTS

This is just the beginning of this fantastic project. **Repair design lifetime: 10 years.** The quality of the first wrappings done and the good hardness measurements already performed predict a coming success.

DEFECT TYPES	**Internal corrosion pittings**
PIPE DETAILS	**¾ straight piping lines – oil – design temp. 74°C – design pressure 144 barg**
LOCATION	**QATAR - Offshore**
3X SOLUTION	**REINFORCEKIT® 4D – High Temperature**

Fig. 1: Piping area to be repaired

Fig. 2: Filler and bended plate applied on defected area

Fig. 3: Wrapping on progress

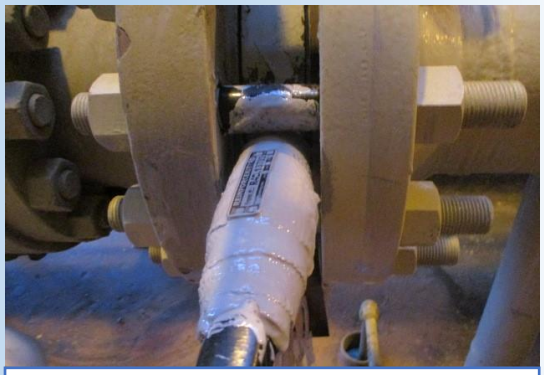


Fig. 4: Repair overview with ID plate

OVERVIEW

The objective of the repair, performed in February 2021 by 3X ENGINEERING (3X) local distributor POWER ENGINEERING CORPORATION (PEC), was to **reinforce 2 areas suffering from internal corrosion pitting defects.**

SCOPE OF WORK

Calculations using 3X software and according to ASME PCC-2 were performed to define the design of the repair. 3X and PEC advised to apply 14 layers of **REINFORCEKIT® 4D** to reinforce both piping lines suffering from internal corrosion defects (10mm defect length).

Before starting the composite reinforcements, surface preparation was completed with grit blasting to get a good surface roughness and ensure the bonding between the pipe and the composite. Surface profile evaluation was performed to confirm the roughness was superior to 60µm. The surface was then cleaned using acetone and hygrometric conditions were checked before wrapping procedure (steps described below are the same for each reinforcement).

❶ **Metallic plate** (previously sandblasted and bended to fit with the geometry of the damaged area) covered with **3X specific filler** was applied on the defected area and fixed using fastened belts. Excess of filler was used to further smooth the edges of the plate. Climatic conditions were checked before moving on composite wrapping.

❷ Wrapping process to reinforce the defected area (previously covered with epoxy resin to ensure good wetting and impregnation of the tape) was completed using **Kevlar® tape (specific size tape for small pipe diameter) impregnated with 3X high-temperature resin** ➔ a total of 14 layers was applied for 180mm repair length.

❸ **Last layer of epoxy resin was applied all over the repair and reference plate** was installed on each repair for traceability purpose.

For each repair, samples of filler and resin were taken during application for quality control.

RESULTS

The 2 piping lines were successfully repaired using **REINFORCEKIT® 4D.** composite solution (repair lifetime: 2 years). This project was quite complicated due to the ¾ spools geometry and difficult accessibility to perform the repair but was completed on time as per the schedule required by the client. All the COVID-19 safety measures were correctly respected.

DEFECT TYPES	**178 joint sections suffering from internal damages**
PIPE DETAILS	**2inch piping spools– Sour Water– design temp. 85°C – design pressure 30.5 barg**
LOCATION	**QATAR – Onshore Treatment Plant**
3X SOLUTION	**REINFORCEKIT® 4D**

Fig. 1: Filler applied on defected joint area
Fig. 2: Piping repaired with R4D

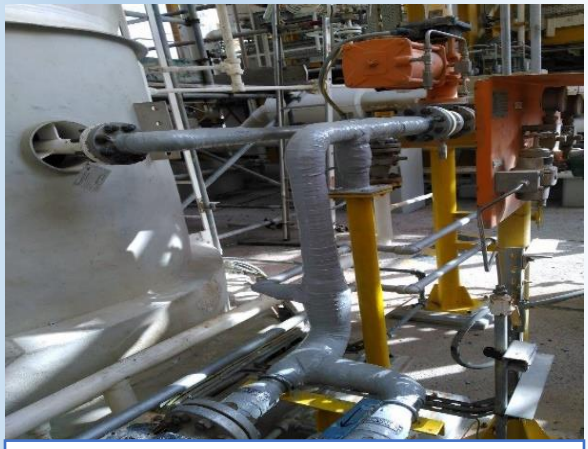


Fig. 3: Complex piping section repaired with R4D

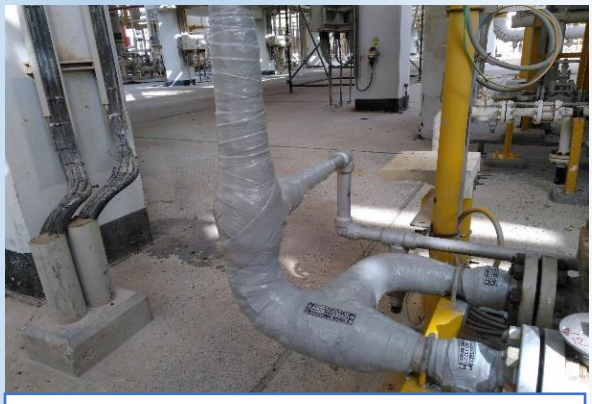


Fig. 4: Another complex piping repair overview completed with ID plate for traceability

OVERVIEW

The objective of the repair, carried out at the beginning of March 2021 by **PEC** team (**Power Engineering Corp. / Alqodara Alhandaseya Co**), **3X ENGINEERING (3X)** local distributor was to **reinforce piping spools areas suffering from internal damages.**

SCOPE OF WORK

Calculations using **3X** software and according to **ISO 24.817:2017** were performed to define the design of the repair. **PEC** advised to apply 6 layers for straight line, 8 layers for bend, 8 layers for flange, 8 layers for reducer & 12 layers for tee sections with **REINFORCEKIT® 4D (R4D).**

Surface preparation was completed by **PEC** team, using Bristle Blaster machine, in order to get a good surface roughness (superior to 60µm Rz) and ensure the bonding between the substrate and the composite system. Hygrometric conditions were checked and the surface was cleaned and degreased with acetone (steps described below – the procedure was the same for the second piping spool to be reinforced).

❶ **F3XS1 ceramic anti-abrasion filler were applied over the defected weld joint.** A minimum of 3mm thickness of ceramic filler F3XS1 was applied over each joint section. Climatic conditions were checked before moving on composite wrapping.

❷ Wrapping process to reinforce the defected area (previously covered with epoxy resin to ensure good wetting and impregnation of the tape) was completed using **Kevlar® tape** (i.e.: **specific size tape for small pipe diameter**) **impregnated with 3X specific epoxy resin**.

❸ Last layer of epoxy resin was applied all over each repair and reference plate was installed for traceability purpose.

For each repair, samples of filler and resin were taken during application for quality control.

➔ 178 joint sections were successfully completed using R4D composite system in 4 weeks by 1 composite specialist and 4 applicators. This job represents over 35m repair length.

RESULTS

The 3 piping lines were successfully repaired using **R4D** composite solution (i.e.: 2-year repair lifetime). This project was quite complicated due to the total numbers of spools to be wrapped and the difficult accessibility to perform the repair but was completed on time as per the schedule required by the client. All the COVID-19 safety measures were correctly respected.

COMPOSITE REPAIR SPECIALIST

- **TYPE OF DEFECT :** **Crack on elbow (GRE pipe)**
- **PIPE DETAILS :** **10" GRE water pipeline – design pressure 10 bars**
- **LOCATION :** **GABON**
- **3X PRODUCT :** **REINFORCEKiT® 4D (R4D)**

OVERVIEW

The objective of the repair performed in December 2016 by 3X local exclusive distributor FRIEDLANDER was to **repair a 10" GRE pipe damaged by a crack.**

SCOPE OF WORK

- After calculations using 3X software R.E.A, 16 layers have been determined to perform the repair.

- Prior wrapping, surface preparation was performed with sandpaper to allow the resin to adhere on the pipe surface.

- Climatic conditions have been checked using hygrometer and the surface has been cleaned and degreased with acetone.

- Composite repair has been performed following 2 main stages:

1/ F3X8 filler application on the whole surface to be treated in order to plug the defect and rebuild the surface.

2/ Wrapping process was then started using Kevlar® and R3X5 resin ➔ 16 layers of composite over 960mm were applicated.

- Identification plate has been positioned on the pipe for traceability process.

- Hardness measurements have been performed 72 hours after job completion and the values were superior to the minimal requirements ➔ composite is well polymerized and operational. Pressure can be applied.

RESULTS

This job has been successfully managed by our local distributor following 3X procedures. The pipe has been quickly repaired using our REINFORCEKiT® 4D, despite the pipe material (GRE).
This proves the capabilities of our partners all around the world, to use and implement 3X products even with specific characteristics.

View of the elbow and leak point prior repair

Climatic conditions measurements and surface preparation

Mastic application and wrapping process with Kevlar® tape and resin

View of the elbow after wrapping and id plate positioning

View of the repair completed and hardness measurements

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COMPOSITE REPAIR SPECIALIST

- **TYPE OF DEFECT :** **Internal corrosion**
- **PIPE DETAILS :** **44" ballast water line - max. operating temp. 25°C – design press. 6 barg**
- **LOCATION :** **EGYPT (Ain Sokhna)**
- **3X PRODUCT :** **REINFORCEKiT® 4D (R4D)**

OVERVIEW

The objective was to **reinforce a 44" ballast line and encapsulate 2 flanges of a vessel, damaged by internal corrosion (79% metal loss).**

SCOPE OF WORK

- After calculations and Finite Elements Analysis (FEA), 8 layers have been determined to perform the reinforcement.

- In consultation with the client, we have decided to extend the length of the repair from 310mm to 4000mm to cover all the pipe (from under the flange, below the deck, to the upper deck). Prior to 3X intervention, coating was removed on the section to be repaired.

- Surface preparation was then completed by 3X team, using Bristle Blaster machine, to get a good surface roughness (superior to 60µm) and ensure the bonding between the steel pipe and the composite. Climatic conditions have been checked and the surface has been cleaned and degreased with Acetone.

- The composite repair has been performed following 6 main stages:

1/ F3XS1 filler application on flanges and deck weld.

2/ R3X5 resin application (1 layer) on the whole pipe surface to protect it from corrosion.

3/ Reinforcement process was then started on the deck weld using Kevlar® strips impregnated with R3X5 resin ➔ 70 strips were necessary to make 1 pass all around the pipe (i.e. 2 layers). This step was repeated 4 times to reach the 8 layers.

4/ F3XCOMB filler application to encapsulate the 2 flanges and reshape their profile to facilitate composite application.

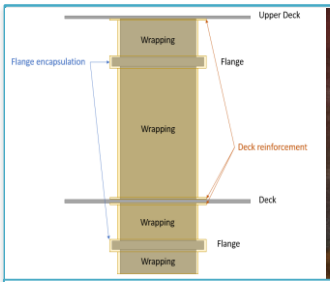
5/ Same reinforcement process was completed on flanges using Kevlar® strips and R3X5 resin ➔ 87 strips applied for 1 pass (i.e. 2 layers). This step was repeated 4 times to reach the 8 layers.

6/ Wrapping process covering the total surface (i.e. straight part of the pipe and flanges) was finally completed using Kevlar® tape and R3X5 resin.

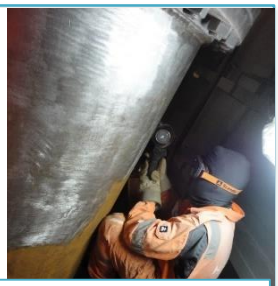
- Last layer of R3X5 resin was applied on the whole repair and identification plate for traceability has been positioned on the pipe. Hardness measurements have been performed 3 days after job completion.

RESULTS

The 44" ballast line suffering from internal corrosion was successfully repaired using REINFORCEKiT® 4D. The total length of the repair was 4m. A special thanks to client team who helped us to work in the best conditions.



Design of the repair



Surface preparation

Composite repair steps

Repair overview

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COMPOSITE REPAIR SPECIALIST

- **TYPE OF DEFECT :** **Crack on tee**
- **PIPE DETAILS :** **56” Gas pipeline - max. operating temp. 80°C – design pressure 90 barg**
- **LOCATION :** **IRAN**
- **3X PRODUCT :** **REINFORCEKiT® 4D (R4D)**

OVERVIEW

The objective of the repair performed in March 2017 by 3X ENGINEERING and its local exclusive distributor TAVANA PIPELINE ENGINEERING was to **reinforce a 56” pipe damaged by a longitudinal crack.**

SCOPE OF WORK

- After calculations and Finite Elements Analysis (FEA), 8 layers have been determined to perform the repair.

- Because of the specific geometry of the pipe, it has been decided in accordance with the client to extend the repair length from 1.17m to 2.4m to cover all the tee section. Prior to 3X intervention sandblasting was completed to get a good surface roughness (100-micron surface profile was measured).

- Before wrapping, climatic conditions have been checked and the surface has been cleaned and degreased.

- The wrapping repair has been performed following several stages:

1/ F3X8 filler application to shape the welding joint and the crack.

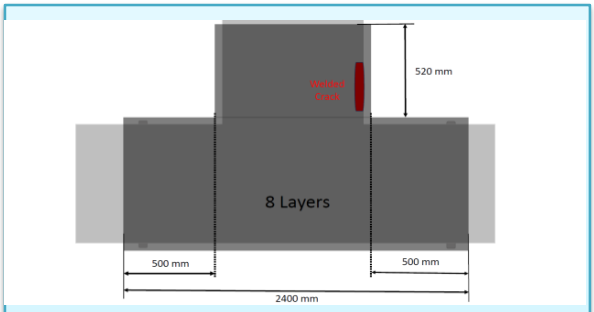
2/ Two first layers with R3X5 resin were applied on the tee in order to cover the 3 parts of the pipe**.**

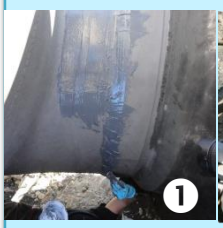
3/ Wrapping process was then started on the straight part using Kevlar® and R3X1060 resin ➔ 6 layers of composite over 2.4m were applicated. On the branch 8 layers were implemented to secure the defected area.

- Identification plate for traceability has been positioned on the pipe. Hardness measurements have been performed 3 days after job completion.

RESULTS

Thanks to the efficient collaboration between 3X and its local distributor, the pipe have been quickly and successfully repaired using our REINFORCEKiT® 4D, despite the geometry and pipe diameter complexity.





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COMPOSITE REPAIR SPECIALIST

- **TYPE OF DEFECT :** **Severe external corrosion spots & leaking defect**
- **PIPE DETAILS :** **20" Gas pipeline - max. operating temp. 60°C – design pressure 172 barg**
- **LOCATION :** **IRAN**
- **3X PRODUCT :** **REINFORCEKiT 4D (R4D)**

OVERVIEW

The objective of the repair performed in August 2015 by 3X ENGINEERING and its local exclusive distributor TAVANA PIPELINE ENGINEERING was to **reinforce and stop corrosion on localized area of the pipe (several external corrosion spots and one 1mm diameter hole).**

SCOPE OF WORK

- After calculations and Finite Elements Analysis (FEA), 68 layers have been determined to perform the repair.

- Because of the leaking defect the repair has been performed offline. An initial sandblasting has been made prior 3X intervention to get a good surface roughness (75-micron surface profile).

- Before wrapping, climatic conditions have been checked and the surface has been cleaned and degreased.

- The wrapping repair has been performed following several stages:

1/ Special filler (F3XS1) application to rebuild the surface.

2/ Metallic steel plate (with filler), fixed with straps during curing time, installed over the defected area.

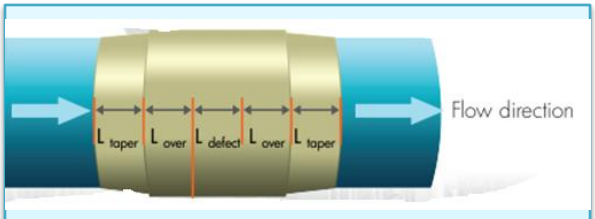
3/ Second filler application performed to ensure the proper impregnation of the first layer.

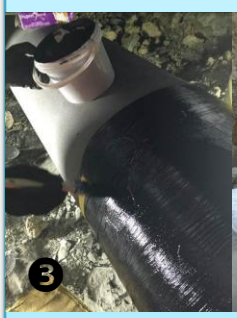
4/ Wrapping using Kevlar and R3X1080 resin. 68 layers of composite (over 88cm) were applicated to reinforce the pipe i.e. 34 passes (50% overlap).

- Identification plate for traceability has been positioned on the pipe. Curing time of the composite system required 50°C during 3 days. This curing process has been initiated with heating blanket during 72 hours.

RESULTS

Thanks to the efficient collaboration between 3X and its local distributor, the pitted areas have been repaired using our REINFORCEKiT 4D-ECHT and the pipeline is now protected from external corrosion. The pipe integrity has been restored and the pipeline has been pressurized successfully back up to 153 barg.





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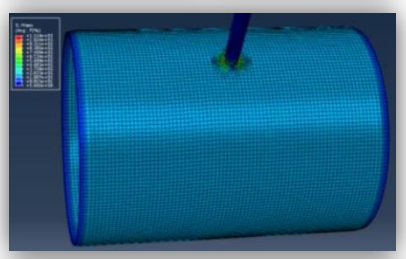
COMPOSITE REPAIR SPECIALIST

- **LOCATION:** **Meximieux (FRANCE)**
- **DATE OF PROJECT:** **July 2014**
- **PIPE:** **32" OD (X52, t=7.92mm)**
- **SWEEPOLET :** **1'' OD & 2''OD**
- **TYPE OF DEFECT:** **Sweepolet defected welding joints**
- **NOMINAL PRESSURE:** **50 bar**
- **TEMPERATURE:** **20°C**
- **3X SOLUTION:** **REINFORCEKIT 4D**

REPAIR PERFORMED BY OUR LOCAL DISTRIBUTOR



OVERVIEW

Two defects were found on sweepolet welding joints due to bad molten metal using ultrasonic gauge.

SCOPE OF WORK

The whole repair was done according to the proprietary 3X finite elements calculation software. Fifty six (56) layers of composite for the first sweepolet (96% wall thickness loss) and twenty (20) layers for the second sweepolet (67% wall thickness loss) were found necessary to reinforce the pipeline.
Surface preparation was made using sandblasting device. Pipeline was repressurized just after surface preparation up to operational pressure in order to minimize production loss.
F3X8 filler (3X) was applied at the sweepolet welding joints.
As this pipeline operates between ambient and 60°C temperatures, a combination of R4D-IC and R4D-EC kits were applied.
Aramide tape was impregnated with R3X5 resin, then with R3X1060, and helicoïdally wrapped with 50% tape overlap.
Curing time of 72 hours was necessary to get a fully functional repair.

RESULTS

On this special case 3X ENGINEERING has demonstrated once again its efficiency and competency in defected sweepolet and welding joints reinforcement (onshore & offshore).

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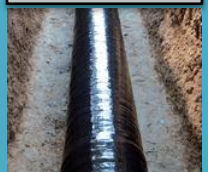
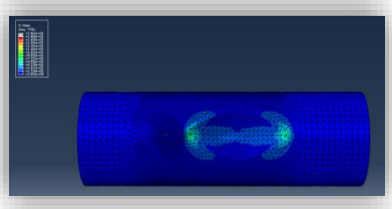


COMPOSITE REPAIR SPECIALIST

- **TYPE OF DEFECT :** **Dent, Gouges & Leak**
- **PIPE SIZE :** **24” OD (API 5L Grade B, t=8.1mm)**
- **NOMINAL PRESSURE :** **12.66 bar**
- **PIPE TEMPERATURE :** **60°C**
- **LOCATION :** **Martinique**
- **3X PRODUCT :** **REINFORCEKiT 4D (R4D)**
- **YEAR OF PROJECT :** **April 2014**



OVERVIEW

One onshore transfer 24’’ pipeline was damaged by an excavator which caused both one large dent and a leak. The pipeline reinforcement was performed in April 2014 by 3X ENGINEERING (3X) team.

SCOPE OF WORK

The whole repair was done according to the proprietary 3X finite elements calculation programme. Twenty (20) layers of composite were found necessary to reinforce the pipeline.

The pipe was fully flooded with water. The leak sealing was done by using arc welding.
F3X8 filler (3X) was applied at the welding area. The dent and its gouges were also filled in with this filler.

As this pipeline operates between ambient and 60°C temperature, the R4D-IC kits were used.
Aramide tape was impregnated with R3X5 resin (3X) and helically wrapped with 50% tape overlap.
Curing time of 72 hours was done prior to hydrotest at 10 bar pressure.

RESULTS

On this quite special case 3X ENGINEERING has demonstrated once again its efficiency and competency in damaged pipeline repairs and particularly in the particular case of very severe dents with gouges (onshore & offshore).
Our on-site pro-active support allowed a restarting of the pipeline without removing the damaged pipe.

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E-mail: info@3xeng.com - www.3xengineering.com

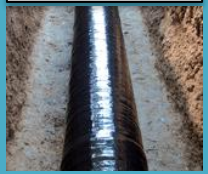
3X ENGINEERING Range of Products

STOPKiT®

ROLLERKiT®

REFLANGEKiT® SF6

REINFORCEKiT® 4D



6. PRESS ARTICLES

ON THE MEND

Laurette Cuiret, 3X ENGINEERING, Monaco, discusses pipeline repair using composite solutions.

Initially introduced in the aerospace industry, the efficiency of composites has been widely proved in various markets, especially in the oil and gas sector. Composite wrap for pipeline rehabilitation offers many advantages compared to pipeline replacement or steel sleeve installation. Because of their mechanical properties, composites are able to offer a solid solution with long-term guarantee (up to 20 years) and relative low cost compared to other methods. This repair technique is quick and can be installed without shutdown. Therefore, choosing to use a composite repair system is not only a fast and reliable solution, but also a cost-effective option for companies as it will minimise production loss.

For over 25 years, 3X ENGINEERING has developed a large range of composite products for pipeline rehabilitation and has performed many successful composite repairs all over the world. Not only does 3X manufacture and commercialise its own products, it also offers a complete integrated service, from the design of the repair to onsite installation. The company provides highly qualified engineers and technicians to perform and supervise repair operations. Today, represented by over 40 distributors all around the world, 3X is able to quickly operate onshore and offshore to reinforce and rehabilitate pipelines suffering from various defects, such as external and internal corrosion, dents, cracks, leaks, weld defects etc.

3X will propose the adapted solution to reinforce and extend the life of a damaged pipe, taking into account the defect characteristics and the environment. For this reason, the 3X research and development (R&D) team has developed a complete range of products dedicated to this application, called REINFORCEKiT® 4D (R4D). 3X products have been going through rigorous qualification and testing programmes to ensure they are in meeting performance objectives in accordance with international standards. All products' capabilities are certified by third party, such as ABS, Bureau Veritas, TUV, Lloyd's Register etc., and over 10 patents are pending or approved worldwide.

Composite repair solution for lasting pipe reinforcement

Designed according to ISO/TS 24.817 and ASME PCC-2 international standards, R4D is a wet lay-up system wrapped helicoidally around the pipe in order to bring the mechanical resistance to the damaged pipe section. Made of Kevlar® tape and specific epoxy resin, this solution will restore pipe original integrity and prevent from further deterioration.

This technology can be applied online, except if it is a through wall defect. This is one of the main benefits of this solution because it avoids costly shutdowns and production losses. In case of leakage, the production must be temporarily decreased or stopped.

R4D can be used for operating temperatures ranging from -50°C to 150°C (-58°F to 302°F). It can be installed on all kinds of pipe geometry (straight, oval, elbow, tee etc.), transporting most common fluids (oil and water) and gas on all pipe diameters and in all environments (onshore, offshore and subsea).

The repair is designed for a lifetime of 20 years. A good surface preparation prior to wrapping and a proper installation by trained and certified applicators are essential to guarantee the long-term of the repair.

Figure 1. R4D wrapping in progress.

Iran: pipeline repair with leaking defect

The objective of the repair, performed in August 2015 by 3X and its local exclusive distributor, was to reinforce and stop external corrosion on localised area of the pipe (several external corrosion spots plus one 1 mm dia. hole).

After analysis of the corrosion extent and geometry, calculations and finite elements analysis (FEA) were performed, concluding that 68 layers were needed to perform the repair and restore full operating pressure.

Because of the leak, the repair was performed after pipeline shutdown and depressurisation. An initial grit blasting was performed prior to the composite application, in order to get a good surface roughness (75 µm anchor profile).

Before composite wrapping, dew point and ambient temperature were checked and the surface was cleaned and degreased. The wrapping repair was performed as per the following steps:

- Special filler (F3XS1) application to rebuild the surface to its original shape.
- Metallic steel plate (with filler), fixed with straps during curing time, installed over the defective area.
- Second filler application performed to ensure the proper impregnation of the first layer.
- Wrapping using Kevlar and R3X1080 epoxy resin. 68 layers of composite (over 0.88 m in length) were applied to reinforce the pipe, i.e. 34 passes with 50% overlap.

Identification plate for traceability was positioned on the pipe. Curing time of the composite system required 50°C during three days. This curing process was initiated with heating blanket during 72 hrs.

Thanks to the efficient collaboration between 3X and its local distributor, the corroded area was repaired using R4D and the pipeline is now protected from external corrosion. The pipe's integrity was restored and the pipeline was successfully returned to service at 153 barg operating pressure.

Specific solution for subsea application

Loss of production due to subsea repair operations can cost millions of dollars per day in lost revenue. As a result, online composite pipeline repair is an attractive option for operators, and is often preferred since it yields considerable flexibility and is highly efficient. That is the reason why more and more requests coming in recent years concerns the rehabilitation of subsea pipes.

To satisfy this growing demand, the 3X R&D department has developed R4D Subsea (R4D-S). Based on R4D technology (as described above) and using Kevlar tape and ceramic reinforced subsea curing epoxy resin, R4D-S can repair and reinforce pipe operating at temperatures from 5 - 50°C (41 - 122°F). It applies to both external and internal corrosion, dents and leaks (provided it has completely stopped prior to composite application) in underwater environments.

Even if this technology is very attractive, it is technically challenging, as applying composite products in a subsea environment needs to be performed with highly qualified staff

and specially designed equipment. To this purpose, 3X technicians and engineers are trained and certified to work offshore. For subsea repair requiring divers to perform the composite wrapping, 3X provides subsea operation supervision and co-ordination of technical repair divers (including saturation divers). The company developed a range of subsea tools to apply the composite repair in controlled conditions. These specific tools (i.e. BOBiPREG®– a unit designed to perform a good, regular and quick impregnation of the Kevlar tape with the resin before immersion) will guarantee the performance of the repair.

Figure 2. View of the finalised composite repair in Iran.

Figure 3. R4D-S reinforcement.

Figure 4. BOBiWRAP – 3X subsea repair machine.

3X has performed several risers' repairs and reinforcements in various countries. In the last few years, their experience and know-how in subsea repair (including deepwater) has been steadily increasing with successful repairs performed in India, Vietnam, Colombia, UAE, Nigeria, Iran, Saudi Arabia etc.

Nigeria: subsea pipeline repair

In September 2016, an important subsea job was completed for a major oil and gas company in Nigeria. The objective of the repair job was to restore a damaged subsea pipe section over 2.5 m long due to dent defect, which was located in 16 m water depth with zero visibility.

After FEA, it was determined that 50 composite layers of R4D-S were needed to achieve the reinforcement, designed for five years life. Underwater, several preliminary operations (such as sediments excavation, removal of concrete and corrosion coating, identification of the surface to be wrapped etc.) were performed before grit blasting, which was needed to obtain the required surface roughness (60 µm minimum anchor profile). Wrapping reinforcement was then performed as follows:

- A print of the dent was taken in order to confirm calculations and design, as well as manufacture the appropriate composite rigid plate, acting as mold.
- Primer (P3X32) was applied on the defect using a dispensing gun, to restore the pipe shape and provide a good adhesion of the composite materials.
- Five rigid composite plates covered with F3XSS filler were positioned over the dent and strongly fixed with ratchet belts during the three hours curing time.
- Kevlar tape pre-impregnated with R3X1050-S resin (using BOBiPREG) was then wrapped around the pipe with 82 Kevlar rolls necessary to cover the dent with the composite thickness needed.
- Finally, a neoprene soft cover was applied to protect the repair from fouling.

Zero injury, schedule respected and repair according to design concluded this successful job.

Looking to the future

3X is now focusing its energy to develop high technical solutions for repairing pipes in extreme conditions of deep offshore.

This ambitious project is the result of a close partnership between 3X and big players in the petroleum industry. 3X had already developed a specific subsea machine called BOBiWRAP®, aimed at applying composite products with divers in an efficient and repeatable manner. The company is now working on adapting this machine to the deepwater environment.

The company keeps exploring new technologies to continuously improve the quality of its products and services, and to develop new repair solutions.

Composite wrap vaccine

Jean-François Ribet, 3X ENGINEERING, Monaco, shows how composite wrapping was used to repair a topside line experiencing damaging internal corrosion on a North Sea platform.

Ageing offshore platforms face numerous problems with their topside lines today. Due to the harsh offshore conditions, external and internal corrosion are common problems. In addition, due to normal (and sometimes inadvertent) operations, they are also subjected to dents and cracks, which are other types of defects identified in oil and gas operations. In the worst case scenario, these may lead to through wall defects and

Despite these issues – which can be critical – the platforms need to produce continuously, and shutdown is rarely an option; if it must happen it can only be for a very short time according to the pipes and to their functions.

Figure 1. *R4D composite repair wrapping in subsea environment.*

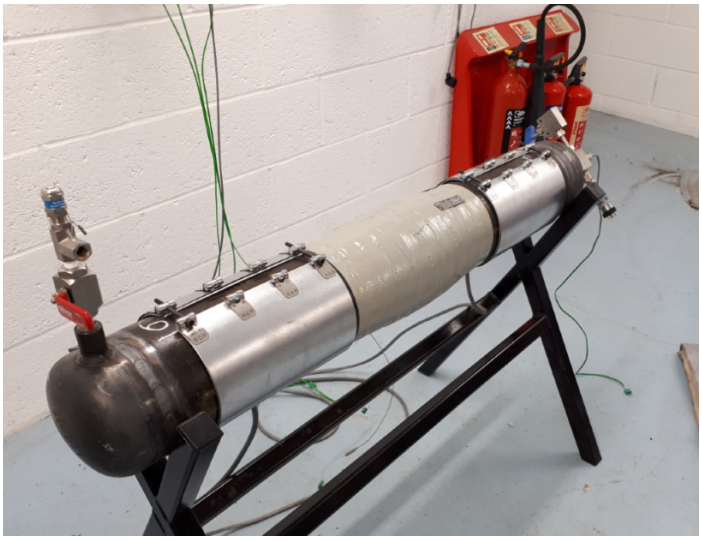


Figure 2. *Energy release rate – qualification of R4D system at high temperature.*

Figure 3. *Hole defect overview.*

3X ENGINEERING (3X) specialises in maintenance solutions for the oil and gas industry, including leak sealing systems, anti-corrosion products and composite repairs to restore pipe integrity and for structural matters.

REINFORCEKiT® 4D (R4D) is a permanent composite repair system for pipelines and piping experiencing corrosion-related defects and mechanical damage. Made of an epoxy resin and bi-directional woven high-strength Kevlar® aramid-fibre material, the system is a non-metallic technical alternative to metal clamps, welded sleeves and pipe replacement. Thoroughly tested by third-party laboratories, it can restore pipe integrity in compliance with applicable standards such as ISO 24.817 and ASME PCC-2.

R4D composite is applicable in environments ranging from onshore transmission pipelines and refinery piping to offshore piping, risers and even sealines. The company has over 30 years of experience in composite repair for pipe and pipework repairs, with a particular focus on subsea composite repair. Several R&D projects intended to expand the limits of composite repair are ongoing, such as online leak sealing, high-temperature solutions or deep subsea repair.

Case study

3X and its partner in the North Sea were asked to repair a pipe on an offshore platform that had a substantial hole due to internal corrosion. The damaged area was located on a 4 in. pipe near a flange.

The challenge was to implement a solution that took into consideration the harsh environment, the damaged state of the old pipe section and the considerable size of the hole. It was thus decided to install R4D to seal the leakage and reinforce the damaged area. A condition of the intervention was to install the composite repair at an ambient temperature (during shutdown of the line), which was more or less 20˚C; after the repair, the line would operate again at 70˚C.

A defect assessment was provided and calculations using the company's REA software program made it possible to propose a technical offer and a repair design that complied with the ISO 24.817 standard. Once the go-ahead was given by the client, the job could start.

A surface preparation was made in order to achieve a good surface state and surface profile. This preparation made it possible to remove rust and obtain a sufficient roughness to ensure good bonding between the steel and the composite. It was performed with a Bristle Blaster® machine.

A roughness test surface profile evaluation was carried out to check the quality of the blasting. A test was conducted across different locations of the pipe. Using a roughness comparator, it was established by 3X that the roughness was acceptable and superior to 60 µm.

Before applying the resin, it was important to make sure that the hygrometric conditions were satisfying. Tests were carried out using a calibrated hygrometer.

The company's requirements, in terms of climatic conditions, are:

- Dew point at least 3˚C below the pipe surface temperature (ΔT>3˚C).
- Moisture lower than 85% relative humidity (RH).
- Surface temperature superior to 10˚C.

The whole prepared surface was then cleaned with acetone and white rags in order to remove any residual

contaminants, such as dust or grease, from the carbon steel substrate.

The first step of the proper repair was to apply the filler with a plate to cover the hole for leak sealing purposes. The filler was selected according to its high mechanical properties and chemical resistance.

The second step was the application of the chemical-resistant epoxy resin on the prepared surface to transfer the loading from the piping to the composite sleeve.

The third step was the application of the Kevlar roll on the wet surface. It was wrapped helicoidally around the straight pipe with 50% covering with continuous tape impregnation. The wrapping on the straight part started from one edge with a turnaround for the first lap to prevent any sliding of the tape. After that, the tape was shifted to obtain a 50% overlap of the previous layer. The wrapping job was made by applying a regular tensile strength. When the pipe was fully covered by the impregnated tape, the first pass was achieved. The wrapping had to be continued to the other sides and so on and so forth.

Once the tape was positioned on the pipe, it was immediately impregnated with 3X resin and wrapping continued.

The final step was to apply a final layer of resin all over the repair to ensure good wetting of the fibres and give a good surface aspect. To finalise the repair, an identification plate was applied on the composite, enabling traceability of the repair. Eventually the curing was followed up by hardness (shore D) testing and a job report was issued to the end user for their records.

Figure 4. *Repair overview with ID plate installed for traceability.*

Conclusion

Despite the striking features of the defect, it was repaired successfully. The company can now also perform hole repair online through its FIXOKiT® engineering solution.

The way ahead for composite repair

VINCENT RIBOULEAU, Sales Manager Middle East at 3X ENGINEERING, speaks about pipeline repair using composite solutions.

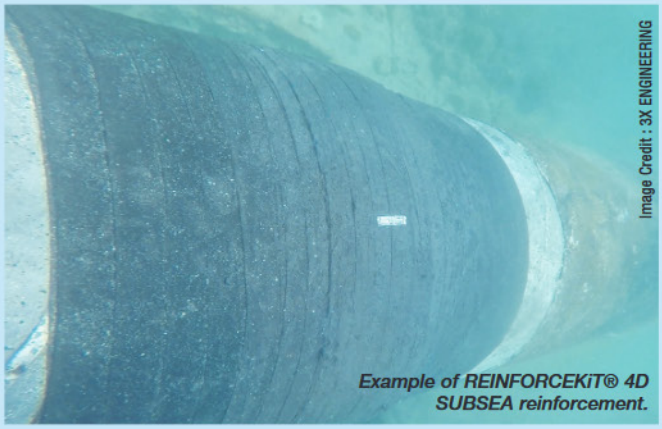


Image Credit : 3X ENGINEERING

Example of REINFORCEKiT® 4D SUBSEA reinforcement.

Composite repair is now established in the oil and gas industry. How can you simply describe the key features and benefits of this technology?
Indeed, our clients are using REINFORCEKiT® 4D, our composite wrapping solution, for three simple reasons. The first one is the wide type of defects which can be reinforced, such as external or internal corrosion, hole, crack but also dent or weld defect. The second reason is the advantage in terms of application, in different environments onshore, offshore or even subsea. The last one is for cost impact. Almost all our repairs are done online and under pressure. In case of shutdown for a hole reinforcement the shutdown is very limited, with in any case a simple logistics base.

What are the new challenges for a company like 3X ENGINEERING?
Each repair is a challenge in itself. As we are complying with ISO 24.817 or ASME PCC-2, we are considering each single repair as unique with its own specifications. However, 3X ENGINEERING considers that the most challenging activity remains subsea in harsh environment with limited time of application to reduce to the maximum the cost of implementation. We have given the priority in our technical development to Innovation. Today we have specific tools for subsea application, we have some partnerships with top ranking oil companies such as TOTAL and Equinor and EPCs such as Saipem for the development and the application of our composite solutions in deep sea and cold environments.

You are talking about innovation. How is it impacting your activity?
Innovation is the key word of our company. We have developed unique solutions to seal pipe leaks online with STOPKiT® or TANKiT® for tank repair. Then we have enlarged the application of composite subsea with severe defects like the repair we made in Middle East on a 32" pipe suffering from leaking cracks at 80 bar and 70-metre depth. Deep sea is our next step but we are going even further soon with an intelligent repair: a communicating tape with impressive features in the application and data collection during the life cycle of the repair.

Stand: 9338

References List

REINFORCEKiT® 4D

Pipe 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 - 12/2022

Dates	Countries	Clients	Application areas	Line & Tank References	Type of defects	Performed by 3X Monaco/ 3X Distributor
2022						
November-22	Poland	**PKN ORLEN Group**	Onshore	20" gas line	External corrosion	3X Distributor
November-22	VIETNAM	**North Oil Company**	Onshore	JA WHP: 12" Water Injection; 12" Wet Crude; 18" Wet Gas; 8" Gas Lift. Coating System.	External coating system	3X Distributor
November-22	VIETNAM	**North Oil Company**	Onshore	KA WHP: 10" Water Injection; 10" Wet Crude; 18" Wet Gas; 8" Gas Lift; 8" WAG. Coating System.	External coating system	3X Distributor
November-22	VIETNAM	**North Oil Company**	Onshore	GE-CPP: 12" Water Injection; 12" Wet Crude; 18" Wet Gas; 8" Gas Lift; 10" Water Injection; 10" Wet Crude; 18" Wet Gas; 8" Gas Lift; 8" WAG; 20" Wet Gas Pipeline. Coating System.	External coating system	3X Distributor
November-22	INDONESIA	**Pertamina Gas Negara**	Onshore	8" gas line	External corrosion	3X Distributor
November-22	MALAYSIA	**PCMSB**	Onshore	1 1/2" pipe	External Corrosion	3X Distributor
November-22	MALAYSIA	**PCMSB**	Onshore	2"pipe	External Corrosion	3X Distributor
October-22	Poland	**GAZ SYSTEM S.A.**	Onshore	8" gas line	External corrosion	3X Distributor
October-22	VIETNAM	**BSR**	Onshore	Total 75 defect including straight, bend, tee from 0.75" to 12" External corrosion, temperature from 50°C to 130°C, from 1 Barg to 230 Bargs.	External corrosion	3X Distributor
October-22	VIETNAM	**KNOC**	Offshore	18 inch Gas Export Riser	External corrosion	3X Distributor
October-22	UAE	**TABREED**	Onshore	48" Chilled Water Line	Through Wall Defect	3X Distributor
October-22	INDONESIA	**Pertamina Hulu Rokan Zone 4 Pendopo Field**	Onshore	28" gas line	Internal Corrosion (6 points)	3X Distributor
October-22	MALAYSIA	**PCMSB**	Onshore	1 1/2" pipe	External Corrosion	3X Distributor
October-22	MALAYSIA	**PCMSB**	Onshore	2"pipe	External Corrosion	3X Distributor
September-22	INDONESIA	**PHE OSES**	Subsea	18" gas line	External corrosion	3X Distributor
September-22	MALAYSIA	**ABF**	Onshore	1" pipe	External Corrosion	3X Distributor
September-22	Nigeria	**EXXON MOBIL**	Offshore topside	3"-HL-TO36-030-F03 S	External Corrosion/Leak	3X Distributor
September-22	Nigeria	**EXXON MOBIL**	Offshore topside	2"- ME-T075-102-JO1	External Corrosion/Leak	3X Distributor
September-22	Nigeria	**EXXON MOBIL**	Offshore topside	2" Separator Deadlegs (16# defect points)	Leak	3X Distributor
September-22	SAUDI ARABIA	**ARAMCO**	Onshore	6´´ elbow	Leak	3X Distributor
September-22	QATAR	**QPDJ**	Subsea	8" Subsea pipeline	Internal Corrosion	3X Monaco / 3X Distributor
September-22	UAE	**TABREED**	Onshore	48"	Leak	3X Distributor
September-22	KUWAIT	**KOC**	Onshore	30"	Internal Corrosion	3X Distributor
August-22	Poland	**PSG Sp. z o.o.**	Onshore	12" gas line	Weld leak	3X Distributor
August-22	VIETNAM	**PVEP Block 01 & 02**	Offshore	Vent line of gaslift header	External corrosion	3X Distributor
August-22	VIETNAM	**PVEP Block 01 & 03**	Offshore	Flowline of well 10PL	External corrosion	3X Distributor
August-22	VIETNAM	**PVEP Block 01 & 04**	Offshore	6" gaslift line before SDV-0610	External corrosion	3X Distributor
August-22	VIETNAM	**PVEP Block 01 & 05**	Offshore	Insulated FWS line after MPFM	External corrosion	3X Distributor
August-22	VIETNAM	**PVEP Block 01 & 06**	Offshore	6" gaslift line near SDV 0610	External corrosion	3X Distributor
August-22	VIETNAM	**PVEP Block 01 & 07**	Offshore	3" gaslift line before and after 80VC-0622	External corrosion	3X Distributor
August-22	VIETNAM	**PVEP Block 01 & 08**	Offshore	6" gaslift riser	External corrosion	3X Distributor
August-22	VIETNAM	**PVEP Block 01 & 09**	Offshore	2" gaslift injection line	External corrosion	3X Distributor
August-22	VIETNAM	**PVEP Block 01 & 10**	Offshore	2" gaslift injection line	External corrosion	3X Distributor
August-22	VIETNAM	**PVEP Block 01 & 11**	Offshore	2" gaslift injection line	External corrosion	3X Distributor
August-22	VIETNAM	**PVEP Block 01 & 12**	Offshore	Utility gas line	External corrosion	3X Distributor
August-22	VIETNAM	**PVEP Block 01 & 13**	Offshore	Utility gas line	External corrosion	3X Distributor
August-22	VIETNAM	**PVEP Block 01 & 14**	Offshore	10" FWS Riser	External corrosion	3X Distributor
August-22	VIETNAM	**PVEP Block 01 & 15**	Offshore	2" gaslift to vent header	External corrosion	3X Distributor
August-22	Nigeria	**EXXON MOBIL**	Offshore topside	1"-PW-HU27-001-B03	External Corrosion	3X Distributor
August-22	Nigeria	**EXXON MOBIL**	Offshore topside	3"-HL-TO36-086-D03	External Corrosion/Leak	3X Distributor
August-22	Nigeria	**EXXON MOBIL**	Offshore topside	3"-ME-TO75-145-J01	External Corrosion/Leak	3X Distributor
August-22	Nigeria	**EXXON MOBIL**	Offshore topside	2"-ME-TO75-026-J01	External Corrosion/Leak	3X Distributor
August-22	Nigeria	**EXXON MOBIL**	Offshore topside	2"-ME-TO75-031-J01	External Corrosion/Leak	3X Distributor
August-22	Nigeria	**EXXON MOBIL**	Offshore topside	2"-ME-TO75-162-J01	External Corrosion/Leak	3X Distributor
August-22	Nigeria	**EXXON MOBIL**	Offshore topside	2"-ME-TO75-144-J01	External Corrosion/Leak	3X Distributor
August-22	Nigeria	**EXXON MOBIL**	Offshore topside	6"-ME-TO75-145-J01	External Corrosion	3X Distributor
July-22	VIETNAM	**HLHV**	Offshore	8" gas lift riser FPSO	External corrosion	3X Distributor
July-22	VIETNAM	**HLHV**	Offshore	6" Gas lift riser H1	External corrosion	3X Distributor
July-22	VIETNAM	**HLHV**	Offshore	8" Water injection riser H1-H4, H1-HST	External corrosion	3X Distributor
July-22	VIETNAM	**HLHV**	Offshore	6" Gas lift riser No.1	External corrosion	3X Distributor
July-22	VIETNAM	**HLHV**	Offshore	8" water injection pipe riser No.2	External corrosion	3X Distributor
July-22	VIETNAM	**HLHV**	Offshore	16" production riser No.3	External corrosion	3X Distributor
July-22	VIETNAM	**HLHV**	Offshore	6" Gas lift riser No.1	External corrosion	3X Distributor
July-22	VIETNAM	**HLHV**	Offshore	8" Water injection riser No.2	External corrosion	3X Distributor
July-22	VIETNAM	**HLHV**	Offshore	12" Production riser No.3	External corrosion	3X Distributor
July-22	MALAYSIA	**MLNG**	Onshore	1 1/2" pipe	External Corrosion	3X Distributor
July-22	MALAYSIA	**OCIM**	Onshore	16" x 2" pipe	Leak	3X Distributor
July-22	Nigeria	**EXXON MOBIL**	Offshore topside	6"-DO-HU71-030-B49H	Crack	3X Distributor
July-22	Nigeria	**EXXON MOBIL**	Offshore topside	3"-HG-TO31-027-B03	Leak	3X Distributor
July-22	Nigeria	**EXXON MOBIL**	Offshore topside	C04C10"	Leak	3X Distributor
July-22	Nigeria	**EXXON MOBIL**	Offshore topside	2"-ME-TO75-030-J01	Leak	3X Distributor
July-22	Nigeria	**EXXON MOBIL**	Offshore topside	2"-ME-TO75-006-H01	Leak	3X Distributor
July-22	Nigeria	**EXXON MOBIL**	Offshore topside	3"-CD-TO28-014-B03	Leak	3X Distributor
July-22	Nigeria	**EXXON MOBIL**	Offshore topside	3"-HL-HU27-044-B03	Leak	3X Distributor
July-22	Nigeria	**EXXON MOBIL**	Offshore topside	24"-HL-TO20-035-B03	Leak	3X Distributor
July-22	Nigeria	**EXXON MOBIL**	Offshore topside	4"-ME-HU75-004-B01	Leak	3X Distributor
July-22	Venezuela	**CHEVRON-PDVSA**	Onshore	14´´ elbow	Internal Corrosion	3X Distributor
July-22	Venezuela	**CHEVRON-PDVSA**	Onshore	10´´	Leak (next to tee)	3X Distributor
July-22	Venezuela	**PDVSA**	Onshore	30´´	External Corrosion	3X Distributor
July-22	Venezuela	**PDVSA**	Onshore	30´´	External Corrosion	3X Distributor
July-22	Venezuela	**PDVSA**	Onshore	42´´	External Corrosion	3X Distributor
July-22	SAUDI ARABIA	**ARAMCO**	Onshore	6" and 30" Piping	Leak	3X Distributor
July-22	Kazakhstan	**KPO**	Onshore	10"-DH-05002-EJ 3-05000-DH-518/519/520/521-8"-EJ	Internal corrosion	3X Distributor
June-22	MALAYSIA	**MLNG**	Onshore	3/4" pipe	External Corrosion	3X Distributor
June-22	MALAYSIA	**MLNG**	Onshore	1/2" pipe	External Corrosion	3X Distributor
June-22	MALAYSIA	**MLNG**	Onshore	1/2" pipe	External Corrosion	3X Distributor
June-22	MALAYSIA	**OCIM**	Onshore	6" X 3/4" pipe	External Corrosion	3X Distributor
June-22	MALAYSIA	**MLNG**	Onshore	2" x 1" pipe	External Corrosion	3X Distributor
June-22	COLOMBIA	**CENIT**	Onshore	6"	External Corrosion	3X Distributor
June-22	COLOMBIA	**CENIT**	Onshore	8"	External Corrosion	3X Distributor
June-22	COLOMBIA	**CENIT**	Onshore	10"	Dent	3X Distributor

7. REFERENCES LIST

June-22	Vietnam	**HLHVJOC**	Offshore Topside	38inch Riser	External Corrosion	3X Distributor
June-22	Kazakhstan	**KPO**	Onshore	KATS-AT-5310-RW-206-0200-A21 -Terminal Atyrau	Internal corrosion	3X Distributor
June-22	QATAR	**TOTAL ENERGIES**	Offshore topside	6" Oil Riser	External corrosion	3X Distributor
June-22	QATAR	**TOTAL ENERGIES**	Offshore topside	12" oil line	External corrosion	3X Distributor
June-22	QATAR	**TOTAL ENERGIES**	Offshore topside	3/4" Oil pipe	External corrosion	3X Distributor
June-22	KUWAIT	**KOC**	Onshore	24" LP Separator Oil Line GC 30 (32 meters lenght)	Internal corrosion	3X Distributor
June-22	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 3 2"-SH-10311-B511	EXTERNAL CORROSION	3X Distributor
June-22	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 4 16"-SH-10311-B511	EXTERNAL CORROSION	3X Distributor
June-22	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 5 10-R-4010B	EXTERNAL CORROSION	3X Distributor
June-22	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 6 16 "AMP-ODP1 PIPELINE RISER	EXTERNAL CORROSION	3X Distributor
May-22	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 1 20"IG 2287B511	EXTERNAL CORROSION	3X Distributor
May-22	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 2 20"IG 2287B511	EXTERNAL CORROSION	3X Distributor
May-22	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 3 20"IG 2287B511	EXTERNAL CORROSION	3X Distributor
May-22	MALAYSIA	**PCSB**	Offshore	2" pipe	External Corrosion	3X Distributor
May-22	MALAYSIA	**PCSB**	Offshore	2" pipe	External Corrosion	3X Distributor
May-22	MALAYSIA	**MLNG**	Onshore	1" pipe	External Corrosion	3X Distributor
May-22	MALAYSIA	**OCIM**	Onshore	1 1/2" X 8" pipe	Leak	3X Distributor
May-22	MALAYSIA	**MLNG**	Onshore	6" x 3/4" pipe	External Corrosion	3X Distributor
May-22	Venezuela	**CHEVRON-PDVSA**	Onshore	42 straight pipeline	Leak	3X Distributor
May-22	COLOMBIA	**HOCOL**	Onshore	12"	External corrosion	3X Distributor
May-22	COLOMBIA	**CENIT**	Onshore	8"	External corrosion	3X Distributor
May-22	COLOMBIA	**CENIT**	Onshore	6"	External corrosion	3X Distributor
May-22	COLOMBIA	**CENIT**	Onshore	10"	External corrosion	3X Distributor
May-22	COLOMBIA	**ECOPETROL**	Onshore	8"	External corrosion	3X Distributor
May-22	COLOMBIA	**CENIT**	Onshore	6"	External corrosion	3X Distributor
May-22	COLOMBIA	**CENIT**	Onshore	10"	External corrosion	3X Distributor
May-22	KUWAIT	**KOC**	Onshore	30" Crude Oil Line CR-183 (30 meters lenght)	Internal corrosion	3X Distributor
April-22	MALAYSIA	**MLNG**	Onshore	1" pipe	External Corrosion	3X Distributor
April-22	MALAYSIA	**MLNG**	Onshore	1/2" pipe	External Corrosion	3X Distributor
April-22	MALAYSIA	**MLNG**	Onshore	1" pipe	External Corrosion	3X Distributor
April-22	Venezuela	**CHEVRON-PDVSA**	Onshore	48´´ pipe and 2´ TEE	Internal corrosion	3X Distributor
April-22	COLOMBIA	**CENIT**	Onshore	8"	External corrosion	3X Distributor
April-22	COLOMBIA	**CENIT**	Onshore	6"	External corrosion	3X Distributor
April-22	Kazakhstan	**KPO**	Onshore	30-4100-DH-5021-0600-EJ (6"-DH-5021-EJ)	Internal corrosion	3X Distributor
April-22	KUWAIT	**KOC**	Onshore	24" HP116 Gas Pipeline	Internal corrosion	3X Distributor
April-22	QATAR	**QATARGAS**	Onshore	28" Gas Pipe	External corrosion	3X Distributor
March-22	UAE	**DEWA**	Onshore	24" Gas Line	Weld Reinforcement	3X Distributor
March-22	MALAYSIA	**MLNG**	Onshore	1/2" pipe	External Corrosion	3X Distributor
March-22	Venezuela	**CHEVRON-PDVSA**	Onshore	14´´ elbow	Internal corrosion	3X Distributor
March-22	Bangladesh	**EXCELERATE ENERGY**	Subsea	3,5" Umbelical	Leak	3X Distributor
March-22	Kazakhstan	**KPO**	Onshore	4 " - Piping Process	Internal corrosion	3X Distributor
March-22	Kazakhstan	**KPO**	Onshore	18 " - Piping Process	Internal corrosion	3X Distributor
March-22	SAUDI ARABIA	**ARAMCO**	Onshore	6" 10" cooling water line	External corrosion	3X Distributor
March-22	IRAQ	**BGC (Shell)**	Onshore	20" oil line	Leak	3X Distributor
February-22	Indonesia	**Pertamina Gas CSA**	Onshore	8" gas line	External corrosion (35 points)	3X Distributor
February-22	MALAYSIA	**MLNG**	Onshore	2"pipe	External Corrosion	3X Distributor
February-22	MALAYSIA	**MLNG**	Onshore	6" pipe	External Corrosion	3X Distributor
February-22	MALAYSIA	**MLNG**	Onshore	1/2" pipe	External Corrosion	3X Distributor
February-22	MALAYSIA	**PCMSB**	Onshore	3/4" pipe	External Corrosion	3X Distributor
Feb-22	Peru	**PETROTAL**	Onshore	6" - (Elbow-90º)	Internal corrosion	3X Distributor
Feb-22	Venezuela	**CHEVRON-PDVSA**	Onshore	14´´ elbow	Internal corrosion	3X Distributor
Feb-22	Egypt	**AMAPETCO**	Onshore	16" Pipe	Internal corrosion / Leakage	3X Distributor
Feb-22	Kazakhstan	**KPO**	Onshore	10 " - Piping Process	Internal corrosion	3X Distributor
Feb-22	IRAQ	**BGC (Shell)**	Onshore	14" Oil Pipeline	Leak	3X Distributor
Feb-22	Taiwan	**CPC**	Onshore	16" Gas line	External corrosion	3X Distributor
January-22	MALAYSIA	**MLNG**	Onshore	1/2" pipe	External Corrosion	3X Distributor
January-22	MALAYSIA	**MLNG**	Onshore	1" pipe	External Corrosion	3X Distributor
January-22	MALAYSIA	**MLNG**	Onshore	1/2"pipe	External Corrosion	3X Distributor
01/01/2022	COLOMBIA	**ECOPETROL**	Onshore	10"	External corrosion	3X Distributor

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December-21	ALGERIA	**GRTG**	Onshore	10" gas line	External corrosion	3X Distributor
December-21	Angola	**TOTAL**	Offshore	Various lines / GIRASSOL	External corrosion	3X / 3A Services
Dec-20	Iraq	**BGC (Shell)**	Onshore	40" Pipe line	External corrosion	3X Distributor
December-21	Malaysia	**Petronas Dagangan Berhad**	Onshore	12" x 1" tee pipe	External corrosion	3X Distributor
December-21	Malaysia	**Malaysia LNG Sdn Bhd**	Onshore	1 " X 5 points & 1 1/2" x 2 points	External corrosion	3X Distributor
December-21	Malaysia	**Malaysia LNG Sdn Bhd**	Onshore	6" pipe	External corrosion	3X Distributor
December-21	Malaysia	**Malaysia LNG Sdn Bhd**	Onshore	2" elbow pipe	External corrosion	3X Distributor
December-21	Malaysia	**Asean Bintulu Fertilizer Sdn Bhd**	Onshore	10" pipe	External corrosion	3X Distributor
December-21	FRANCE	**TRAPIL**	Onshore	20" oil line	External corrosion	3X Distributor
December-21	FRANCE	**SPMR**	Onshore	16" oil line	External corrosion	3X Distributor
December-21	Vietnam	**Thang Long JOC**	Offshore - Hai Su Trang platform	10 inch production riser 80oC	External corrosion	3X Distributor
December-21	Vietnam	**Thang Long JOC**	Offshore - Hai Su Trang platform	10 inch production riser 30oC	External corrosion	3X Distributor
December-21	Egypt	**DAPETCO**	Onshore	10" / 12" ELBOW	Internal corrosion / Leakage	3X Distributor
November-21	COLOMBIA	**HOCOL**	Onshore	4"	External corrosion	3X Distributor
November-21	Malaysia	**Malaysia LNG Sdn Bhd**	Onshore	2" Elbow + Straight pipe	External corrosion	3X Distributor
November-21	Malaysia	**Malaysia LNG Sdn Bhd**	Onshore	1-1/2" pipe	External corrosion	3X Distributor
November-21	Malaysia	**Malaysia LNG Sdn Bhd**	Onshore	6" straight pipe	External corrosion	3X Distributor
November-21	Angola	**OPS/SBM**	Offshore topside	TEG Flash vessel	Internal corrosion / Leaks	3X / 3A Services
November-21	Egypt	**SUMED**	Onshore	12" Elbow WATER RUN OFF	Internal corrosion / Leakage	3X Distributor
November-21	Malaysia	**Malaysia LNG Sdn Bhd**	Onshore	1" Elbow pipe	External corrosion	3X Distributor
October-21	Angola	**TOTAL**	Offshore	Various lines / PAZFLOR	External corrosion	3X / 3A Services
October-21	Angola	**OPS/SBM**	Offshore	20-WP-F241208-01C25	External corrosion	3X / 3A Services
October-21	Malaysia	**Petronas Carigali Sdn Bhd**	Offshore	14" pipe	Weld Joint	3X Distributor
October-21	Malaysia	**Malaysia LNG Sdn Bhd**	Onshore	3/4" pipe	External corrosion	3X Distributor
October-21	Malaysia	**Malaysia LNG Sdn Bhd**	Onshore	2" x 3/4" reducer	External Corrosion	3X Distributor
October-21	Malaysia	**Malaysia LNG Sdn Bhd**	Onshore	2" pipe	External corrosion	3X Distributor
October-21	Malaysia	**Malaysia LNG Sdn Bhd**	Onshore	8" pipe	External corrosion	3X Distributor
September-21	SAUDI ARABIA	**ARAMCO**	Offshore	UA Corroded Valves	Internal Corrosion	3X Distributor
September-21	Malaysia	**Marin Sejagat Sdn Bhd**	Offshore	2",18" & 20" straight pipe	External corrosion	3X Distributor
September-21	Vietnam	**HLHV JOC**	Offshore	- 30" Conductor of wells, above from splash zone, 10m/Conductor, Total: 6 Conductors.	External corrosion	3X Distributor
September-21	Vietnam	**HLHV JOC**	Offshore	- 30" Conductor of wells, above from splash zone, 10m/Conductor, Total: 7 Conductors.	External corrosion	3X Distributor
September-21	Vietnam	**HLHV JOC**	Offshore	- H1-H4 gas lift riser, 1m length - H4-H1 Production Riser, 1m length - 30" Conductor of wells, above from splash zone, 10m/Conductor, Total: 5 Conductors.	External corrosion	3X Distributor
September-21	Angola	**OPS/SBM**	Offshore topside	8"-PL-T62028 & 8"-PL-T62029	Internal corrosion / Holes/ pinholes	3X / 3A Services
September-21	Angola	**OPS/SBM**	Offshore topside	12"-PL-T62025	Internal corrosion / Leaks	3X / 3A Services
September-21	Angola	**OPS/SBM**	Offshore topside	10-WI-T26034-25C02	Internal corrosion / Leak defect	3X / 3A Services
August-21	Vietnam	**PVEP POC**	Subsea	Dai Hung 02 Platform	Leak defect on casing 20inch	3X Distributor
August-21	Angola	**OPS/SBM**	Offshore topside	14-WI	Internal corrosion / Leaks	3X / 3A Services
August-21	Angola	**OPS/SBM**	Offshore topside	8"-CZ-T26537-01S01	Internal corrosion / Leak defect	3X / 3A Services
August-21	Angola	**OPS/SBM**	Offshore topside	10"-CZ-T26537-01S01	Internal corrosion / Leaks	3X / 3A Services
August-21	Angola	**OPS/SBM**	Offshore topside	6"-WI-M26004-25C02	External corrossion	3X / 3A Services
August-21	NIGERIA	**TOTAL**	Piping Reinforcement - Offshore	FSO UNITY OML 100	External and Internal Corrosion - 16 repair points	3X Distributor
August-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 1 12"IG 2287 B511	External Corrosion	3X Distributor
August-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 2 8"FS 1501 B511	Internal corrosion	3X Distributor
August-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 3 8"FS 1501 B511	Internal Corrosion	3X Distributor
August-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 7 8"FS 1501 B511	External Corrosion	3X Distributor
August-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 9 8"FS 1501 B511	External Corrosion	3X Distributor
August-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 11 8"FS 1501 B511	Internal Corrosion	3X Distributor
August-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 16 "IG2283 B511	Internal Corrosion	3X Distributor

August-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 34 12"IG 2223 B511	External Corrosion	3X Distributor
August-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 36 12"IG 2223 B511	External Corrosion	3X Distributor
August-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 37 16"IG 2261 B511	External Corrosion	3X Distributor
August-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 41 AREA 7 FSO	External Corrosion	3X Distributor
August-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 42 10"FS 2021 B51	External Corrosion	3X Distributor
August-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 43 12"IG 2222 B511	External Corrosion	3X Distributor
August-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 57 12"IG 2223 B511	External Corrosion	3X Distributor
August-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 58 12"IG 2222 B511	External Corrosion	3X Distributor
August-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 59 12"IG 2223 B511	External Corrosion	3X Distributor
July-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 1 16"IG2261 B511	External Corrosion	3X Distributor
July-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 2 16"IG2261 B511	External Corrosion	3X Distributor
July-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 3 16"IG2261 B511	External Corrosion	3X Distributor
July-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 7 16"IG2262 B511	External Corrosion	3X Distributor
July-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 9 16"IG2263 B511	External Corrosion	3X Distributor
July-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 11 16"IG2277 B511	Internal Corrosion	3X Distributor
July-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 16 16"IG2276 B511	Internal Corrosion	3X Distributor
July-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 34 12"IG2283 B511	External Corrosion	3X Distributor
July-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 36 12"IG 2283 B511	External Corrosion	3X Distributor
July-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 37 12"IG 2284 B511	External Corrosion	3X Distributor
July-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 41 12"IG 2287 B511	Internal Corrosion	3X Distributor
July-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 42 12"IG 2287 B511	Internal Corrosion	3X Distributor
July-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 43 12"IG 2287 B511	Internal Corrosion	3X Distributor
July-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 57 16"IG 2200 B511	External Corrosion	3X Distributor
July-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 58 12"IG 2222 B511	External Corrosion	3X Distributor
July-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 59 12"IG 2223 B511	External Corrosion	3X Distributor
July-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 124 8"FS 1505 B511	External Corrosion	3X Distributor
July-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 125 8"FS 1505 B511	External Corrosion	3X Distributor
July-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 137 8"FS 1501 B511	External Corrosion	3X Distributor
July-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 138 8"FS 1501 B511	External Corrosion	3X Distributor
July-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 139 8"FS 1501 B511	External Corrosion	3X Distributor
July-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 140 8"FS 1501 B511	External Corrosion	3X Distributor
July-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 141 8" FS 1501 B511	External Corrosion	3X Distributor
July-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 142 8"FS 1501 B511	Internal Corrosion	3X Distributor
July-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 143 8"FS 1501 B511	External Corrosion	3X Distributor
July-21	NIGERIA	**TOTAL**	OFFSHORE	REPAIR POINT 146 8"FS 1501 B511	Internal Corrosion	3X Distributor
July-21	NIGERIA	**TOTAL**	Piping Reinforcement - Offshore	FSO UNITY OML 100	External and Internal Corrosion - 26 repair points	3X Distributor
July-21	Egypt	**SUMED**	Onshore	12" Elbow WATER RUN OFF	Internal corrosion / Leakage	3X / 3X Distributor
Jul-21	Vietnam	**PVEP Block 01&02**	WHP Ruby A	-11 defects on 11 pipeline 2 inch - defect on 6inch pipeline - defect on flange 10inch	External corrosion	3X Distributor
Jul-21	KUWAIT	**KUWAIT OIL COMPANY (KOC)**	Pipe Reinforcement- Onshore	30" HP063 Gas Line (8 locations)	External Corrosion	3X Distributor
Jun-21	IRAQ	**BGC (Shell)**	Onshore	8"pipe	External Corrosion	3X Distributor
June-21	Malaysia	**Serba Dinamik Sdn Bhd**	Onshore	1" pipe	Thinning	3X Distributor
July-21	Malaysia	**Asean Bintulu Fertilizer Sdn Bhd**	Onshore	2" pipe	Thinning	3X Distributor
July-21	Malaysia	**Asean Bintulu Fertilizer Sdn Bhd**	Onshore	3" pipe	Thinning	3X Distributor
July-21	Malaysia	**Malaysia LNG Sdn Bhd**	Onshore	4" pipe	Pinhole	3X Distributor
June-21	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Elbow & Straight Pipe-Onshore	2 location of 6" sch 40 pipe (Loc 5 & 6) and 2 location of 8" sch 40 pipe (Loc 9 & 12) at V457	External corrosion	3X Distributor
June-21	Malaysia	**PRPC UTILITIES & FACILITIES SDN BHD**	Straight Pipe-Onshore	10 leak points of 10" ERW pipe water line at PRPC Plant	External corrosion	3X Distributor
Jun-21	Ivory Coast	**Petroci CI11**	Piping reinforcement - onshore	16 different points Rollerkit + Reinforce kit	Prevention	3X Distributor
Jun-21	Ivory Coast	**SIR**	Piping reinforcement - onshore	Through hole Repair 42'	Through Hole Repair	3X Distributor
Jun-21	Iraq	**Basra Gas Co.**	Kaz Plant	8" Gasoline condensate line-98bar	external defect due to corrosion	3X Distributor
May-21	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Reducer-Onshore	1-1/2" x 1" reducer (LOC 93A (1)) at V-470 to E-474	External corrosion	3X Distributor
May-21	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Straight Pipe-Onshore	2 units of 2" pipe at LOC L6X & LOC IN2BX V201, Inplot plant	External corrosion	3X Distributor
May-21	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Straight Pipe-Onshore	1 units of 1/2" pipe (LOC 93B) at V-470 to E-474	External corrosion	3X Distributor
May-21	Indonesia	**Pertagas**	Underground Pipeline	8" Gas Line	External corrosion	3X Distributor
April-21	Vietnam	**VietsovPetro**	Amanda FPSO- Offshore	34 defects on deck	External corrosion	3X Distributor
April-21	Malaysia	**Serba Dinamik Sdn Bhd**	Onshore	3/4" pipe	Pinhole and Thinning	3X Distributor
April-21	Malaysia	**BASF PETRONAS CHEMICALS SDN BHD**	Straight Pipe-Onshore	2" straight pipe at BDO plant	External corrosion	3X Distributor
April-21	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Straight Pipe-Onshore	9 units of 2" pipe at V-101, CD 1	External corrosion	3X Distributor
April-21	Malaysia	**PRPC UTILITIES & FACILITIES SDN BHD**	Straight Pipe-Onshore	2 locations of 3900-3A (10" 150#), PRPC Plant.	External corrosion	3X Distributor
April-21	Malaysia	**PRPC UTILITIES & FACILITIES SDN BHD**	Straight Pipe-Onshore	1 location of 3900-06C (10" 150#), PRPC Plant.	External corrosion	3X Distributor
Apr-21	Roumania	**STIZO NUCLEAR**	Onshore	42" pipe	Internal Corrosion	3X Monaco/ 3X Distributor
March-21	Malaysia	**PETRONAS GAS BERHAD**	Straight Pipe-Onshore	Plant/Location : GPP 5/6, Butane Product Tank, T 5/6-0710 A&B	External corrosion	3X Distributor
March-21	Malaysia	**PETRONAS CHEMICALS ETHYLENE SDN BHD**	Elbow Pipe-Onshore	1"elbow pipe at ET-0-V-401,PCESB	External corrosion	3X Distributor
March-21	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Elbow Pipe-Onshore	2 units of 1" elbow (LOC 2) & ¾" tee (LOC 5) E-7302, LRCC plant.	External corrosion	3X Distributor
Mar-21	FRANCE	**CCMP**	Pipe reinforcement - onshore	12'' oil line	External corrosion	3X Distributor
February-21	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Straight Pipe-Onshore	2 unit of 1/2" pipe at C-451 (Loc K2 & K5) Complex plant	External corrosion	3X Distributor
February-21	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Straight Pipe-Onshore	Tag 1: 1 unit of 2" pipe at J32 in LRCC plant. Tag 2: 1 unit of 1" pipe at Top Level	External corrosion	3X Distributor
February-21	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Tee Pipe-Onshore	1 unit of 4" x 2" TEE pipe at C-451 (Loc 45-LZA-012) Plat 2 plant.	External corrosion	3X Distributor
Feb-21	Ivory Coast	**Petroci CI11**	Piping reinforcement - onshore	35 different points Rollerkit + Reinforce kit	External corrosion (Electrolisis)	3X Distributor
Feb-21	Iraq	**Basra Gas Co.**	NGL Plant- de Sulfurization	4and 6 inch Nozzles on NRNGL 4100-V22	through wall structural inforcement	3X Distributor
January-21	Malaysia	**PETRONAS GAS BERHAD**	Tee Pipe-Onshore	3/4" tee pipe leak at GPP4/LTSU/400, LTSU-1901L(BB), PGB-GPK.	External corrosion	3X Distributor
January-21	Malaysia	**PETRONAS GAS BERHAD**	Tee Pipe-Onshore	Plant/Area/Unit : GPP1 / UTILITY / 100	External corrosion	3X Distributor
January 21	IRAQ	**BGC (Shell)**	Onshore	Two nozzles N3&N5 6''	External Corrosion + hole	3X Distributor
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Dec-20	Indonesia	**Pertamina Hulu Mahakam**	Underground Pipeline	Various Line	External	3X Distributor
Dec-20	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Straight, Reducer & Elbow Pipe-Onshore	Tag 1: 1 unit of 2" straight pipe at C-650 (65HY02) at HRC PD plant. Tag 2: 1 unit of 2" x 1" reducer at E-652	External corrosion	3X Distributor
Dec-20	Malaysia	**PETRONAS CHEMICALS ETHYLENE SDN BHD**	Tee, Elbow & Straight Pipe-Onshore	Tag 1: 1" elbow,straight & tee pipe leak at V-501, IBL area 4	External corrosion	3X Distributor
Dec-20	UAE	**DEWA**	Pipe reinforcement - Onshore	24'' oil line	External and Internal corrosion	3X Distributor
Dec-20	France	**TOTAL**	Onshore	Buried Oil Pipeline	several repairs (cracks, dents, ext corrosion)	3X Distributor
Dec-20	France	**VEOLIA**	Hot water line- treatment plant	3"-4" hot water	online leak repair & external corrosion	3X Monaco
Dec-20	NORWAY	**ARCHER**	TOPSITE PIPES+TANKS	Reparation of external corrosion on degasser tank	Holes+ external corrosion	3X Distributor
Dec-20	Kazakhstan	**KPO**	Pipe reinforcement	50-3390-AM-044-12-A18	Internal corrosion	3X Distributor
Dec-20	Kazakhstan	**KPO**	Pipe reinforcement	50-210A-PO-040-3"-B11	Internal corrosion	3X Distributor
Dec-20	Kazakhstan	**KPO**	Pipe reinforcement	50-210A-PO-041-3"-B11	Internal corrosion	3X Distributor
Nov-20	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Tee Pipe-Onshore	1 unit of 8" x 2" Tee pipe at CD 2 near C-156 (8" P1124-31010X)	External corrosion	3X Distributor
Nov-20	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Straight & Tee Pipe-Onshore	2 unit of 8" straight pipe and 1 unit 8" x 8" Tee pipe at E-107 L/E-107H at HRC PD plant	External corrosion	3X Distributor
Nov-20	Malaysia	**PETRONAS CHEMICALS ETHYLENE SDN BHD**	Tee, Elbow & Straight Pipe-Onshore	2" pipe at ET-0-C-201 PARETO A1 (Phase 9) at PCESB	External corrosion	3X Distributor
Nov-20	Kazakhstan	**KPO**	Pipe reinforcement	50-210C-PO-040-3"-B11	Internal corrosion	3X Distributor
Nov-20	Kazakhstan	**KPO**	Pipe reinforcement	300.30N.040.09.00	Internal corrosion	3X Distributor
Nov-20	Kazakhstan	**KPO**	Pipe reinforcement	60-5620-WW-510-6-A11	Internal corrosion	3X Distributor
Nov-20	France	**GEOSTOCK**	Pipeline reinforcement- onshore	20" chemical product	External corrosion	3X Monaco
Nov-20	Qatar	**QATAR SHELL GTL LTD**	Pipe reinforcement - onshore	10'' oil line	Internal corrosion + holes	3X Distributor
Oct-20	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Elbow Pipe-Onshore	2 unit of 4" elbow at E-107 A-J location 3 & 5, CD 1 HRC PD Plant.	External corrosion	3X Distributor
Oct-20	Malaysia	**PETRONAS CHEMICALS ETHYLENE SDN BHD**	Straight & Tee Pipe-Onshore	Tag 1: 1" tee pipe & elbow pipe leak at IBL area 2 Tag 2: 1" Tee pipe & elbow pipe leak at IBL area 1 Tag 3: 1" elbow & straight pipe at IBL area 1	External corrosion	3X Distributor

Oct-20	Malaysia	**PETRONAS CHEMICALS POLYETHYLENE SDN BHD**	Elbow & Straight Pipe-Onshore	Tag 1: 1" valve leak at PE-1-R-400,Train level 7 Tag 2: 3/4" valve leak at E-0-P-634AB, Area SRU Tag 3: 2" elbow leak at PE-0-V-006, Area 1 SRU Tag 4: 2"elbow & tee pipe leak at PE-0-V-004, Area 1 RSU Tag 5: 1" elbow pipe leak at PE-1-V-131, Area 2 PPU1 Tag 6: 1" Straight pipe leak at E-1-R-400, SRU level 6	External corrosion	3X Distributor
Oct-20	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Straight Pipe-Onshore	1 unit of 2" pipe line at F456 north header for location 2X/2Y, 3BX, 4AX/4AY, 5AY, 6X & 7X.	External corrosion	3X Distributor
Oct-20	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Straight Pipe-Onshore	1 unit of 3" straight pipe at V-3512 location 4 at HRC PD Plant.	External corrosion	3X Distributor
Oct-20	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Nozzle Pipe-Onshore	2" & ¾" - 63008-3136 outlet from nozzle N4, C-630 HRC PD Plant.	External corrosion	3X Distributor
Oct-20	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Elbow Pipe-Onshore	2" burner line at F456 for location DTN2, D3S, D7-S, D1-S & D2-N	External corrosion	3X Distributor
Oct-20	Malaysia	**PETRONAS CHEMICALS POLYETHYLENE SDN BHD**	Elbow & Straight Pipe-Onshore	Tag 1: 3/4" straight pipe at PE-0-S-062,CPO/Area 1	External corrosion	3X Distributor
Oct-20	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Straight Pipe-Onshore	1 unit of 2" straight pipe and 1 unit of 2" elbow at C-650, HRC PD Plant	External corrosion	3X Distributor
Oct-20	Kazakhstan	**KPO**	Pipe reinforcement	50-210B-HA-001B	Internal corrosion	3X Distributor
Oct-20	Kazakhstan	**KPO**	Pipe reinforcement	50-210C-HA-001A	Internal corrosion	3X Distributor
Oct-20	Kazakhstan	**KPO**	Pipe reinforcement	50-210C-HA-001B	Internal corrosion	3X Distributor
Oct-20	NORWAY	**KCA DEUTAG**	Offshore	6" piping bend	leak	3X Distributor
Oct-20	France	**TOTAL**	Onshore	Buried Oil Pipeline	several repairs (cracks, dents, ext corrosion)	3X Distributor
Oct-20	RDC	**PERENCO**	Onshore	Tank reinforcement	Holes & external corrosion	3X Distributor
Oct-20	UAE	**DOLPHIN ENERGY LIMITED**	Piping reinforcement - onshore	30" Gas Line	External corrosion	3X Distributor
sept-2020	Malaysia	**PETRONAS CHEMICALS MTBE SDN BHD**	Tee Pipe-Onshore	Plant : PDH Plant Area/Location : FV-2761 V-2519 CUI 2" Hydrogen Line	External corrosion	3X Distributor
sept-2020	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Elbow Pipe-Onshore	2 unit of 3" elbow at 4"-P1081-1108 (LPG) - CDU 2 HRC PD Plant	External corrosion	3X Distributor
sept-2020	Malaysia	**PETRONAS GAS BERHAD**	Straight Pipe-Onshore	Plant / Unit : GPP-1 / Unit 2 Equipment : Air Dust To Preheater Drawing AS-0202	External corrosion	3X Distributor
sept-2020	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Elbow Pipe-Onshore	1 unit of 3" elbow and 1 unit of 4" elbow at V-354 to flare, HRC PD Plant	External corrosion	3X Distributor
sept-2020	Kazakhstan	**KPO**	Pipe reinforcement	50-214B-FL-002-8-A11	Internal corrosion	3X Distributor
sept-2020	Kazakhstan	**KPO**	Pipe reinforcement	50-210B-HA-001A	Internal corrosion	3X Distributor
sept-2020	Qatar	**DOLPHIN ENERGY**	Piping reinforcement - onshore	8" gas line	Internal corrosion (3 defects)	3X Distributor
sept-2020	Indonesia	**Perusahaan Gas Negara**	Underground Pipeline	8" Gas Line	External	3X Distributor
sept-2020	Ivory Coast	**FOXTROT**	Offshore	3" piping	Hole	3X Distributor
sept-2020	CROATIA	**IMP Promont d.o.o.**	Pipe reinforcement - onshore	DN100 gas line	Dent	3X Distributor
sept-2020	Russia	**SIBUR**	pipe/onshore	219mm/ straight line/ GAS	Internal corrosion	3X Distributor
sept-2020	Russia	**SIBUR**	pipe/onshore	377/straight line/ GAS	Internal corrosion	3X Distributor
August-20	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Elbow Pipe-Onshore	5 unit of 2" elbow at sour water / sour oil line at MVU, HRC PD Plant.	External corrosion	3X Distributor
August-20	Malaysia	**PETRONAS CHEMICALS ETHYLENE SDN BHD**	Elbow, Straight & Tee-Onshore	Tag 1: 2" elbow at C-201T-202, IBL Area 3 Tag 2: 3/4" Straight pipe at ET-O-E-404 A/B,IBL Area 4	External corrosion	3X Distributor
August-20	Malaysia	**PETRONAS CHEMICALS MTBE SDN BHD**	Elbow & Tee Pipe-Onshore	PDH plant,PCMTBE Tag 1: 2" weldolet Tag 2: 2" elbow	External corrosion	3X Distributor
August-20	Malaysia	**PETRONAS GAS BERHAD**	Manual Band	1 locations at PGB-GPK. Area/Plant/Equipment : Utility/GPP-1, DPCU-2901E(BB)	External corrosion	3X Distributor
August-20	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Straight & Tee Pipe-Onshore	2 unit of 2" pipe and 1 unit of 2" x 4" Tee pipe at F-456, Plot 2 HRC PD Plant	External corrosion	3X Distributor
august-20	France	**NAVAL GROUP / Marine Nationale**	Subsea line	confidential	protection	3X Monaco
august-20	Ivory Coast	**PETROCI**	Offshore	8" gas riser	Leak & external corrosion	3X Distributor/3X Monaco
august-20	Russia	**Enisey**	Tank onshore	3400/internal repair/oil,water	applying anticorrosion coating	3X Distributor
august-20	Russia	**AGMK Polymetall**	Cooling tower	internal repair/water, acid	applying anticorrosion coating	3X Distributor
July-20	Malaysia	**PETRONAS CHEMICALS POLYETHYLENE SDN BHD**	Elbow & Straight Pipe-Onshore	Tag 1: 1" elbow & 3" Dome end at PE-1-R-400 Tag 2: 1" straight pipe at PE-0-C-630	External corrosion	3X Distributor
July-20	Malaysia	**PETRONAS GAS BERHAD**	Manual Band	1 locations at PGB-GPK. Area/Plant/Equipment : Utility/GPP-1, DPCU-2901E(BB) Nearest Equipment : Q-101A Pipe : Manual Band Defect : External Corrosion Max Operating Temperature: 150ºC	External corrosion	3X Distributor
July-20	Malaysia	**PETRONAS PENAPISAN (TERENGGANU) SDN BHD**	Elbow & Straight Pipe-Onshore	Area/Location/Plant : BT-2	Internal corrosion	3X Distributor
July-20	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Nozzle-Onshore	1 unit of vessel V-630 body patching (area 1: 238mm x 494mm; area 2: 644mm x 494mm	Internal corrosion	3X Distributor
July-20	Malaysia	**PETRONAS CHEMICALS POLYETHYLENE SDN BHD**	Tee Pipe-Onshore	1" tee pipe & 3" dome end at PE-1-R-400 , PCPSB	External corrosion	3X Distributor
July-20	Malaysia	**PETRONAS CHEMICALS POLYETHYLENE SDN BHD**	Straight & Tee Pipe-Onshore	Tag 1: 3/4" tee pipe at PE-1-S-4771 Tag 2: 1/2" straight pipe at area 1	External corrosion	3X Distributor
July-20	Malaysia	**PETRONAS GAS BERHAD**	Straight Pipe-Onshore	4" straight pipe at Tank B	External corrosion	3X Distributor
July-20	Kazakhstan	**KPO**	Pipe reinforcement	150.OFC.040.01.06	Internal corrosion	3X Distributor
July-20	Kazakhstan	**KPO**	Pipe reinforcement	50.IP.040.01.00	Internal corrosion	3X Distributor
July-20	Kazakhstan	**KPO**	Pipe reinforcement	10"-FH-7005-B01 & 2"-DR-3637-0F	Internal corrosion	3X Distributor
July-20	Kazakhstan	**KPO**	Pipe reinforcement	2" DEG line (E-309)	Internal corrosion	3X Distributor
July-20	CROATIA	**IMP Promont d.o.o.**	Pipe reinforcement - onshore	DN100 gas line	External corrosion	3X Distributor
July-20	France	**TOTAL**	Onshore	Buried Oil Pipeline	several repairs (cracks, dents, ext corrosion)	3X Distributor
July-20	France	**NAVAL GROUP / Marine Nationale**	Subsea line	confidential	protection	3X Monaco
July-20	Russia	**GASPROM Neft**	Tank buried	3200mm/internal repair/oil	4 through wall defects	3X Distributor
July-20	SAUDI ARABIA	**ARAMCO**	Onshore	16" Oil Pipeline	External corrosion	3X Distributor
July-20	SAUDI ARABIA	**ARAMCO**	Subsea	48" Subsea Oil Pipeline	Leak and External Defects	3X Distributor
July-20	COLOMBIA	**ECOPETROL S.A**	Piping reinforcement - onshore	12" polyduct line	External corrosion	3X Distributor
July-20	NIGERIA	**EXXON MOBIL**	Subsea	36" Subsea Line	Crack and plastic deformation	3X Distributor
July-20	NORWAY	**EQUINOR (Statoil)**	Piping reinforcement- offshore	topside platform- pipe	several defects- holes and external corrosion	3X Distributor / Monaco
July-20	NORWAY	**EQUINOR (Statoil)**	Piping reinforcement- offshore	topside platform- tank	external corrosion	3X Distributor / Monaco
July-20	NORWAY	**EQUINOR (Statoil)**	Subsea	38" Casing Subsea	Holes	3X Distributor/3X Monaco
July-20	INDIA	**HPCL**	Offshore Subsea	36" Oil Pipeline	External corrosion	3X Distributor
July-20	VIETNAM	**PVGAS**	Offshore Subsea	16" Gas Pipeline	Dent	3X Distributor
July-20	ANGOLA	**OPS**	FPSO SAXI	24" & 28" piping	Leak	3X Distributor
June-20	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Reducer-Onshore	1 unit of 3" x 2" reducer to Tee pipe at F-102 location 8.	Internal corrosion	3X Distributor
June-20	Malaysia	**PETRONAS CHEMICALS DERIVATIVES SDN BHD**	Tee Pipe-Onshore	Tag 1: R40-HT-F 50/100 as per below information.	Hole (Crack)	3X Distributor
June-20	Malaysia	**PETRONAS CHEMICALS POLYETHYLENE SDN BHD**	Straight & Tee Pipe-Onshore	Tag 1: 1" Straight,elbow & tee pipe at PE-1-V-340 Tag 2: 3/4" Straight elbow & tee pipe at PE-0-E-805	External corrosion	3X Distributor
Jun-20	NORWAY	**KCA DEUTAG**	TOPSITE PIPES+TANKS	Reparation of holes on 3 topsite pipes+separation tank	Holes+ external corrosion	3X Distributor
June-20	Kazakhstan	**KPO**	Pipe reinforcement	50-210A-RG-039-6"-A10	Internal corrosion	3X Distributor
June-20	Kazakhstan	**KPO**	Pipe reinforcement	30-2200-005-FN-4"-B04	Internal corrosion	3X Distributor
June-20	Kazakhstan	**KPO**	Pipe reinforcement	1"-PW-0009-A04	Internal corrosion	3X Distributor
June-20	Kazakhstan	**KPO**	Pipe reinforcement	60-562-VW-01	Internal corrosion	3X Distributor
June-20	Kazakhstan	**KPO**	Pipe reinforcement	50-341A-RG-021-2"-C11	Internal corrosion	3X Distributor
June-20	FRANCE	**TOTAL / GEOSEL**	Pipe reinforcement- onshore	20" oil line	Internal / External corrosion	3X Monaco
June-20	France	**TOTAL**	Onshore	Buried Oil Pipeline	several repairs (cracks, dents, ext corrosion)	3X Distributor
June-20	Indonesia	**Transportasi Gas Indonesia**	Underground Pipeline	28" Gas Line	External	3X Distributor
June-20	Vietnam	**PV GAS**	Subsea - Reinforcement of 16" pipeline	Subsea dent KP 39.970	Subsea dent	3X Distributor
June-20	CROATIA	**Feromihind.o.o./Crodux plin d.o.o.**	Pipe reinforcement - onshore	DN400 gas line	External corrosion	3X Distributor
June-20	Brazil	**Naturgy (Gas Fenosa)**	Pipe reinforcement - ONSHORE	4 repairs in 6" gas line	External corrosion	3X Distributor
June-20	COLOMBIA	**HOCOL S.A**	Piping reinforcement - onshore	10" pipeline	External corrosion	3X Distributor

June-20	COLOMBIA	**ECOPETROL S.A**	Piping reinforcement - onshore	16" hydrocarbon line	External corrosion	3X Distributor
June-20	IRAQ	**SHELL BGC**	Onshore	Nozzle	Leak	3X Distributor
May-20	Malaysia	**PETRONAS CHEMICALS POLYETHYLENE SDN BHD**	Elbow & Straight Pipe-Onshore	1" Elbow,1" Straight pipe & 3" Dome end at PCPSB plant.	External corrosion	3X Distributor
May-20	Malaysia	**PETRONAS CHEMICALS MTBE SDN BHD**	Elbow-Onshore	3/4" Elbow at PCMTBE.	External corrosion	3X Distributor
May-20	Malaysia	**PETRONAS CHEMICALS POLYETHYLENE SDN BHD**	Elbow & Straight Pipe-Onshore	2" Straight & Elbow pipe at IBL Area 4, PCESB.	External corrosion	3X Distributor
May-20	Malaysia	**PETRONAS CHEMICALS ETHYLENE SDN BHD**	Elbow & Straight Pipe-Onshore	2" & 4" Pipe for PARETO A1 (Phase 4) at PCESB.	External corrosion	3X Distributor
May-20	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Nozzle Pipe-Onshore	Location: C-156, Location Z1U (remaining wall thickness 2.10mm)	Internal corrosion	3X Distributor
May-20	Malaysia	**PETRONAS CHEMICALS ETHYLENE SDN BHD**	Elbow, Straight & Tee-Onshore	Tag 1: 3/4" Straight pipe at SILENCER. Tag 2: 4" to 4mm at C-A01	External corrosion	3X Distributor
May-20	Kazakhstan	**KPO**	Pipe reinforcement	50-364A-FL-011-3/4"-A11	Weld defect	3X Distributor
May-20	Kazakhstan	**KPO**	Pipe reinforcement	50-364B-RG-016-20"-C11 (1" branch)	Internal corrosion	3X Distributor
May-20	Kazakhstan	**KPO**	Pipe reinforcement	6" DH-5021-EJ	Internal corrosion	3X Distributor
May-20	Kazakhstan	**KPO**	Pipe reinforcement	60-0000-GY-034-8"-A13	Internal corrosion	3X Distributor
May-20	Kazakhstan	**KPO**	Pipe reinforcement	50-210D-RG-011-8"-A11	Internal corrosion	3X Distributor
May-20	COLOMBIA	**ECOPETROL S.A**	Piping reinforcement - onshore	10" polyduct line	External corrosion	3X Distributor
May-20	COLOMBIA	**ECOPETROL S.A**	Piping reinforcement - onshore	10" polyduct line	Internal corrosion	3X Distributor
May-20	COLOMBIA	**ECOPETROL S.A**	Piping reinforcement - onshore	20" water suction line	External corrosion	3X Distributor
May-20	France	**TOTAL**	Onshore	Buried Oil Pipeline	several repairs (cracks, dents, ext corrosion)	3X Distributor
May-20	COLOMBIA	**PERENCO OIL AND GAS**	Piping reinforcement - onshore	3,5" blast Joint	Internal corrosion	3X Distributor
April-20	Malaysia	**PETRONAS CHEMICALS POLYETHYLENE (M) SDN BHD**	Elbow, Straight & Tee-Onshore	1" , 2", 3/4" pipe at PCPSB plant	Internal corrosion	3X Distributor
April-20	Malaysia	**PETRONAS CHEMICALS ETHYLENE SDN BHD**	Elbow, Straight & Tee-Onshore	1",1/2"3/4" & 4" pipe at PCESB plant.	Internal corrosion	3X Distributor
April-20	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Elbow-Onshore	4 unit 4" elbow at V-7101, LRCC Plant.	External corrosion	3X Distributor
April-20	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Nozzle-Onshore & Tee-Onshore	C-104 at CD 1, HRC PD Plant	Internal corrosion	3X Distributor
April-20	Malaysia	**PETRONAS CARIGALI SDN BHD**	Straight Pipe-Onshore	2" Straight pipe at PCSB, Bekok C Platform.	External corrosion	3X Distributor
April-20	Malaysia	**PETRONAS CHEMICALS ETHYLENE SDN BHD**	Elbow & Straight Pipe-Onshore	2",1",3/4" Straight & Elbow pipe at PCESB plant.	External corrosion	3X Distributor
April-20	Kazakhstan	**KPO**	Pipe reinforcement	50-364A/B/C-FL-010-3/4"-C11	Weld defect	3X Distributor
April-20	France	**ELENGY**	Tank leak sealing	24" online leak sealing and reinforcement	leak	3X Monaco
April-20	France	**ELENGY**	Tank leak sealing	6" online leak selaing and reinforcement	leak	3X Monaco
Apr-20	Vietnam	**HLHV**	Offshore - Flange reinforcement	Riser No1 to no 12 (12 flange)	External corrosion	3X Distributor
Apr-20	Vietnam	**HLHV**	Offshore - Clamp reinforcement	Riser No1 to no 12 (12 clamp)	External corrosion	3X Distributor
Apr-20	Vietnam	**HLHV**	Offshore - Conductor coating	No 3 to No 6 (6 conductor, 2 part)	External corrosion	3X Distributor
April-20	COLOMBIA	**OCENSA. Central Pipeline S.A**	Piping reinforcement - onshore	36" pipeline	External loads	3X Distributor
April-20	QATAR	**QP**	SUBSEA	48" Subsea Oil Pipeline	Double Dent	3X Distributor/3X Monaco
March-20	Malaysia	**PETRONAS CHEMICALS FERTILISER (KEDAH) SDN BHD**	Straight Pipe-Onshore	3-AL-34004-31070 (V-34-03), NOZZLE N4 3" Straight Pipe.	Internal corrosion	3X Distributor
March-20	Malaysia	**PETRONAS CHEMICALS ETHYLENE SDN BHD**	Straight & Elbow Pipe-Onshore	Tag 1: 1/2" Tee Pipe at UT-0-T-603,OBL Area 4 Tag 2: 1" Elbow at ET-0-P-401, IBL Area 4	External corrosion	3X Distributor
March-20	Malaysia	**MALAYSIAN REFINING COMPANY SDN BHD**	Tee-Onshore	2 locations, >2in tee pipe c/w surface preparation at LL-35-MPG35B	External corrosion	3X Distributor
March-20	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Elbow-Onshore	4 unit 4" elbow at E-311 (P/3014307 31010K-H40), LRCC Plant.	Internal corrosion	3X Distributor
March-20	Kazakhstan	**KPO**	Pipe reinforcement	5-362A/B/C-RG-002-16"-B11	Internal corrosion	3X Distributor
March-20	Indonesia	**Perusahaan Gas Negara**	Underground Pipeline	24" Gas Line	External	3X Distributor
March-20	Switzerland	**HYDRO EXPLOITATION**	Piping reinforcement- onshore	14" Water line	Internal corrosion	3X Monaco
March-20	COLOMBIA	**PERENCO OIL AND GAS**	Piping reinforcement - onshore	6" pipeline	External corrosion	3X Distributor
March-20	COLOMBIA	**PERENCO COLOMBIA LIMITED**	Piping reinforcement - onshore	4" pipeline - 4 defects	External corrosion	3X Distributor
March-20	COLOMBIA	**PERENCO COLOMBIA LIMITED**	Piping reinforcement - onshore	8 y 4" pipeline - 2 defects	External corrosion	3X Distributor
March-20	COLOMBIA	**PERENCO COLOMBIA LIMITED**	Piping reinforcement - onshore	8" pipeline - 3 defects	External corrosion	3X Distributor
March-20	COLOMBIA	**PERENCO COLOMBIA LIMITED**	Piping reinforcement - onshore	4" pipeline - 2 defects	External corrosion	3X Distributor
March-20	COLOMBIA	**PERENCO COLOMBIA LIMITED**	Piping reinforcement - onshore	6 y 3" pipeline	External corrosion	3X Distributor
March-20	COLOMBIA	**OCENSA. Central Pipeline S.A**	Piping reinforcement - onshore	36" pipeline	External loads	3X Distributor
March-20	COLOMBIA	**OCENSA. Central Pipeline S.A**	Piping reinforcement - onshore	30" pipeline	External loads	3X Distributor
March-20	COLOMBIA	**ECOPETROL**	Elbow Piping reinforcement - onshore	16" line	External corrosion	3X Distributor
March-20	COLOMBIA	**PERENCO COLOMBIA LIMITED**	Piping reinforcement - onshore	6" pipeline - 3 defects	External corrosion	3X Distributor
March-20	France	**TOTAL**	Onshore	Buried Oil Pipeline	several repairs (cracks, dents, ext corrosion)	3X Distributor
March-20	COLOMBIA	**PERENCO COLOMBIA LIMITED**	Piping reinforcement - onshore	8 y 6" pipeline	External corrosion	3X Distributor
Feb-20	Malaysia	**PETRONAS CARIGALI SDN BHD**	Tee Pipe-Onshore	1. 80-P-G1-6A 4" Tee Pipe (P2Y) WELL A-28 Internal Corrosion	Internal corrosion	3X Distributor
Feb-20	Malaysia	**PETRONAS CHEMICALS MTBE SDN BHD**	Straight Pipe-Onshore	1. P-1-AOA-60-60421-ET-Loc 1 1" Straight 2. FH-1-AOA-64-60424-ET-Loc 1 4" Straight	Internal corrosion	3X Distributor
Feb-20	Kazakhstan	**KPO**	Pipe reinforcement	50-210 AB-PO-067/063-10"-A13	Internal corrosion	3X Distributor
Feb-20	Kazakhstan	**KPO**	Pipe reinforcement	60-0000-DW-084-2"-A37	Internal corrosion	3X Distributor
Feb-20	France	**CFT GAZ**	Emergency online leak sealing	Emergency gas online leak sealing in hazardous conditions	several Leaks	3X Monaco
Feb-20	COLOMBIA	**GROUP STORK - MASA STORK**	rnal weld buildup piping reinforcement - ons	8" polyduct line	External corrosion	3X Distributor
Feb-20	COLOMBIA	**PERENCO OIL AND GAS**	Piping reinforcement - onshore	12 " Pipeline	External corrosion	3X Distributor
Feb-20	COLOMBIA	**PERENCO OIL AND GAS**	Piping reinforcement - onshore	10 " aqueduct	External corrosion	3X Distributor
Feb-20	COLOMBIA	**PERENCO COLOMBIA LIMITED**	Piping reinforcement - onshore	6" pipeline	External corrosion - 3 defects	3X Distributor
Feb-20	COLOMBIA	**PERENCO COLOMBIA LIMITED**	Piping reinforcement - onshore	4" pipeline	External corrosion - 2 defects	3X Distributor
Feb-20	France	**TOTAL**	Onshore	20" Buried Oil Pipeline	100 repairs (cracks, dents, ext corrosion)	3X Distributor
Feb-20	MALAYSIA	**PETRONAS OFFSHORE**	Offshore Topside	Piping Repair	External corrosion	3X Distributor
Jan-20	COLOMBIA	**GROUP STORK - MASA STORK**	Bend Piping reinforcement - onshore	6" polyduct line	External corrosion	3X Distributor
Jan-20	COLOMBIA	**PERENCO OIL AND GAS**	Piping reinforcement - onshore	12 " aqueduct	External corrosion	3X Distributor
Jan-20	COLOMBIA	**PERENCO COLOMBIA LIMITED**	Piping reinforcement - onshore	6" pipeline	External corrosion	3X Distributor
Jan-20	COLOMBIA	**OCENSA. Central Pipeline S.A**	Piping reinforcement - onshore	36" pipeline	External loads	3X Distributor
Jan-20	ANGOLA	**OPS**	FPSO SAXI	6" piping	Leak	3X Distributor
Jan-20	IRAQ	**SHELL BGC**	Basra Plant	30" Colum	Several Leaks	3X Distributor

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December-19	NIGERIA	**TOTAL**	Offshore Topside	2" OFD 1 Depressurization Line (2"-FS-21204-B51)	Internal corrosion & Leak	3X Distributor
December-19	NIGERIA	**TOTAL**	Offshore Topside	3/4"-FS-21204-B51	Internal corrosion & Leak	3X Distributor
December-19	NIGERIA	**TOTAL**	Offshore Topside	16" ODP-AMQ RISER LINE IPN-SH-103-15-D511	External corrosion	3X Distributor
December-19	NIGERIA	**TOTAL**	Offshore Topside	24"ODP FSO EXPORT LINE IPN-SH-103-10-B511	External corrosion	3X Distributor
December-19	Indonesia	**Perusahaan Gas Negara**	Above ground pipeline	16" Gas Line	External	3X Distributor
December-19	Brazil	**Naturgy (Gas Fenosa)**	Pipe reinforcement - ONSHORE	6" gas line	Several external corrosion on straight pipe and bend pipe sections (76% external thickness loss)	3X Distributor
Dec-19	UAE	**ADNOC LNG**	Tank reinforcement	7meyter Tank with 2 leaks	Leak reapir	3X Distributor
Dec-19	UAE	**ADNOC LNG**	Nozzle	2" Nozzle 20 location Das Island	External corrosion	3X Distributor
Dec-19	UAE	**ADNOC ONSHORE**	Straight Pipe-Onshore	20" Ellipsoidal Dished Head	Hole	3X Distributor
Dec-19	Kazakhstan	**KPO**	Pipe reinforcement	50-210 AB-PO-067/063-10"-A13	Internal corrosion	3X Distributor
November-19	Russia	**GASPROM Neft**	pipe/onshore	426mm/ tee/ OIL	through wall defect	3X Distributor
October-19	Kazakhstan	**KPO**	Pipe reinforcement	50-362A-RG-002-16-B11	Internal corrosion	3X Distributor
October-19	Kazakhstan	**KPO**	Pipe reinforcement	50-362C-RG-002-16-B12	Internal corrosion	3X Distributor
October-19	Kazakhstan	**KPO**	Pipe reinforcement	60-5620-WW- 047-6"-A11	Internal corrosion	3X Distributor
October-19	Kazakhstan	**KPO**	Pipe reinforcement	70-2300-FL-001-042-A11	Internal corrosion	3X Distributor
October-19	Indonesia	**Perusahaan Gas Negara**	Above ground pipeline	16" Gas Line	External	3X Distributor
October-19	Brazil	**Petrobras**	Leakage repair - OFFSHORE	10" flair gas line	5mm hole, 3mm hole and severe external corrosion	3X Distributor
October-19	Brazil	**Naturgy (Gas Fenosa)**	Pipe reinforcement - ONSHORE	8" gas line	External corrosion and 70% external thickness loss	3X Distributor

September-19	Kazakhstan	**KPO**	Pipe reinforcement	50-210 AB-PO-067/067-10"-A13	Internal corrosion	3X Distributor
September-19	Kazakhstan	**KPO**	Pipe reinforcement	3"-DR-6301-E01	Internal corrosion	3X Distributor
September-19	Brazil	**CENPES Petrobras & UERJ**	Tests repair - ONSHORE	16 Pipe spools for certifications tests (6 of 12" water line and 10 of 6" water line)	16 Repairs over Repair over 50mm hole (6 with Clamp and 10 with PU reinforcement)	3X Distributor
September 19	SAUDI ARABIA	**ARAMCO**	Abqaiq Plant	8" Straight Line	External Defect Hole Scenario	3X Distributor
September 19	SAUDI ARABIA	**ARAMCO**	Abqaiq Plant	36" Straight Line	External Defect Hole Scenario	3X Distributor
September 19	SAUDI ARABIA	**ARAMCO**	Abqaiq Plant	42" Straight Line	External Defect Hole Scenario	3X Distributor
September 19	SAUDI ARABIA	**ARAMCO**	Abqaiq Plant	1,5" Straight Line	External Defect Hole Scenario	3X Distributor
September 19	SAUDI ARABIA	**ARAMCO**	Abqaiq Plant	8" Straight Line	External Defect Hole Scenario	3X Distributor
Aug-19	Kazakhstan	**KPO**	Pipe reinforcement	50-210 A/B-PO-067-10"-A13	Internal corrosion	3X Distributor
Aug-19	Kazakhstan	**KPO**	Pipe reinforcement	3-12000-HG-509-4"- B15	Internal corrosion	3X Distributor
Aug-19	Indonesia	**PT Pertamina Gas**	Underground Pipeline	24" Gas Line	Dent	3X Distributor
Aug-19	Indonesia	**Perusahaan Gas Negara**	Above ground pipeline	6" Gas Line	External	3X Distributor
August-19	FRANCE	**TOTAL**	Onshore buried	12" ligne essence / gasoil - 13 réparations	External corrosion	3X Distributor
August-19	Perú	**Terminales del Perú**	TDP-EL CALLAO	TANK LINES	EXTERNAL AND INTERNAL CORROSION	3X Distributor
August-19	Perú	**Terminales del Perú**	TDP-CHICLAYO	DOCK	EXTERNAL AND INTERNAL CORROSION	3X Distributor
August-19	FRANCE	**TOTAL**	Straight Line Buried - onshore	12" Line Benzine / gasoil - 13 repairs	External corrosion	3X Monaco/3X Distributor
Jul-19	Indonesia	**Perusahaan Gas Negara**	Underground Pipeline	16" Gas Line	External	3X Distributor
July 19	OMAN	**CCED**	Onshore	8" Water Line Tee - 2 repairs	Internal corrosion & Leak	3X Distributor
July-19	COLOMBIA	**PERENCO /CASANARE**	Refuerzo sobre tubería - onshore	4" Línea de crudo / aguas asociadas	Corrosión externa	3X Distributor
July-19	COLOMBIA	**PERENCO /CASANARE**	Refuerzo sobre tubería - onshore	4" Línea de crudo	Corrosión externa	3X Distributor
July-19	COLOMBIA	**PERENCO /CASANARE**	Refuerzo sobre tubería - onshore	2" Línea de gas	Corrosión externa	3X Distributor
July-19	COLOMBIA	**ECOPETROL**	Refuerzo en Tee - onshore	16" Línea de crudo	Pérdida de material por daño mecánico	3X Distributor
July-19	COLOMBIA	**ECOPETROL**	Refuerzo sobre tubería - onshore	36" Línea de crudo	Corrosión externa	3X Distributor
July-19	COLOMBIA	**PERENCO /GUANDO**	Refuerzo sobre casing- onshore	9" Casing	Corrosión externa	3X Distributor
July-19	COLOMBIA	**OCENSA**	Refuerzo sobre tubería - onshore	30" Línea de crudo	Corrosión externa	3X Distributor
July-19	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Elbow-Onshore	2" elbow at Loc B, P455A	Internal corrosion	3X Distributor
July-19	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Elbow-Onshore	3/4" elbow at Loc C, P455A	Internal corrosion	3X Distributor
July-19	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Elbow-Onshore	2" elbow at Loc A, P455A	Internal corrosion	3X Distributor
July-19	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Straight Pipe-Onshore	1-1/2" pipe at bypass line 01-F-122 LOC 3, CD 1	Internal corrosion	3X Distributor
July-19	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Straight Pipe-Onshore	Tag 1:3" nozzle (Loc 1&3) and 1 unit of 2" nozzle (Loc 2) at C-104 Tapping Header, CD1 Tag 2 : 4" x 2" reducer at C-104, CD 1	Internal corrosion	3X Distributor
June-19	Ukraine	**Ukrnafta**	Straight Pipe-Onshore	8" pipeline - Fluid: Oil	Internal corrosion+Leak	3X Distributor
June-19	Perú	**Terminales del Perú**	TDP-SALAVERRY	TERMINAL ADJACENT TO PUMP PATIO	EXTERNAL AND INTERNAL CORROSION	3X Distributor
June-19	COLOMBIA	**PERENCO /CASANARE**	Refuerzo sobre tubería - onshore	6" Línea de crudo	Corrosión externa	3X Distributor
June-19	COLOMBIA	**PERENCO /CASANARE**	Refuerzo sobre tubería - onshore	6" Línea de crudo	Corrosión externa	3X Distributor
June-19	COLOMBIA	**PERENCO /CASANARE**	Refuerzo sobre tubería - onshore	6" Línea de crudo	Corrosión externa	3X Distributor
June-19	COLOMBIA	**PERENCO /CASANARE**	Refuerzo sobre tubería - onshore	2" Línea de gas	Corrosión externa	3X Distributor
June-19	COLOMBIA	**PERENCO /CASANARE**	Refuerzo sobre tubería - onshore	4" Línea de crudo	Corrosión externa	3X Distributor
June-19	COLOMBIA	**OCENSA**	Refuerzo sobre tubería - onshore	30" Línea de crudo	Abolladura	3X Distributor
June-19	Kazakhstan	**KPO**	Pipe reinforcement	60-5620-WW-112-4-A11	Internal corrosion	3X Distributor
June-19	Kazakhstan	**KPO**	Pipe reinforcement	70-2300-FL-001-042"-A11 (Bent)	Internal corrosion+Leak	3X Distributor
June-19	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Straight Pipe-Onshore	4" pipe lines at K-261B, CD2 plant (location A-V268A)	Internal corrosion	3X Distributor
June-19	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Straight Pipe-Onshore	1/2" pipe at nozzle K1, V-151	Internal corrosion	3X Distributor
June-19	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Straight Pipe-Onshore	2" joint to 4" level bridle (15LRC015-T01), V-151	Internal corrosion	3X Distributor
June-19	PERÚ	**Terminales de Perú (TDP)**	Piping reinforcement - onshore	6" Oil Line (10). 8" Oil Line (1). 16" Oil Line (2). 6" Oil Line (1), 3 " Code (1). 4" Code (1)	External / Internal Corrosion	3X Distributor
June-19	QATAR	**TOTAL**	Elbow Offshore Topside	2 X 2" Elbow	Internal corrosion	3X Distributor
June-19	NIGERIA	**TOTAL**	Offshore Topside	8" AFD -ODD EXPORT RISER	External corrosion	3X Distributor
June-19	NIGERIA	**TOTAL**	Offshore Topside	2" IMD CLOSE DRAIN LINE	External corrosion	3X Distributor
May-19	Indonesia	**Perusahaan Gas Negara (PGN)**	External pipe, pitting corrosion. Onshore	16" Gas Pipe Line	External corrosion	3X Distributor
May-19	Viet-Nam	**HOANG LONG JOC**	Riser reinforcement - offshore on air	6" gas line (H1-WHP/Riser No.1)	External corrosion	3X Distributor
May-19	Viet-Nam	**HOANG LONG JOC**	Riser reinforcement - offshore on air	8" water line (H1-WHP/Riser No.2)	External corrosion	3X Distributor
May-19	Viet-Nam	**HOANG LONG JOC**	Riser reinforcement - offshore on air	16" Oil line (H1-WHP/Riser No.3)	External corrosion	3X Distributor
May-19	Viet-Nam	**HOANG LONG JOC**	Riser reinforcement - offshore on air	8" gas line (H1-WHP/Riser No.4)	External corrosion	3X Distributor
May-19	Viet-Nam	**HOANG LONG JOC**	Pipeline reinforcement - offshore on air	8" gas line (H1-WHP/Riser No.4)	External corrosion	3X Distributor
May-19	Viet-Nam	**HOANG LONG JOC**	Riser reinforcement - offshore on air	10" water line (H1-WHP/Riser No.5)	External corrosion	3X Distributor
May-19	Viet-Nam	**HOANG LONG JOC**	Riser reinforcement - offshore on air	10" Oil line (H1-WHP/Riser No.6)	External corrosion	3X Distributor
May-19	Viet-Nam	**HOANG LONG JOC**	Riser reinforcement - offshore on air	10" Oil line (H1-WHP/Riser No.7)	External corrosion	3X Distributor
May-19	Viet-Nam	**HOANG LONG JOC**	Riser reinforcement - offshore on air	10" Oil line (H1-WHP/Riser No.8)	External corrosion	3X Distributor
May-19	Viet-Nam	**HOANG LONG JOC**	Riser reinforcement - offshore on air	10" Oil line (H1-WHP/Riser No.9)	External corrosion	3X Distributor
May-19	Viet-Nam	**HOANG LONG JOC**	Riser reinforcement - offshore on air	16" Oil line (H1-WHP/Riser No.10)	External corrosion	3X Distributor
May-19	Viet-Nam	**HOANG LONG JOC**	Riser reinforcement - offshore on air	8" water line (H1-WHP/Riser No.11)	External corrosion	3X Distributor
May-19	Viet-Nam	**HOANG LONG JOC**	Riser reinforcement - offshore on air	6" gas line (H1-WHP/Riser No.12)	External corrosion	3X Distributor
May-19	Viet-Nam	**HOANG LONG JOC**	Riser reinforcement - offshore on air	16" Oil line (H4-WHP/Riser No.3)	External corrosion	3X Distributor
May-19	Viet-Nam	**HOANG LONG JOC**	Riser reinforcement - offshore on air	16" Oil line (H4-WHP/Riser No.3)	External corrosion	3X Distributor
May-19	COLOMBIA	**OCENSA**	Refuerzo sobre tubería - onshore	30" Línea de crudo	Refuerzo sobre carga externa	3X Distributor
May-19	COLOMBIA	**OCENSA**	Refuerzo sobre tubería - onshore	36" Línea de crudo	Abolladura	3X Distributor
May-19	COLOMBIA	**PERENCO /CASANARE**	Refuerzo sobre tubería - onshore	3" Línea de crudo	Corrosión externa	3X Distributor
May-19	COLOMBIA	**OCENSA**	Refuerzo sobre tubería - onshore	30" Línea de crudo	Refuerzo sobre carga externa	3X Distributor
April-19	Kazakhstan	**KPO**	Pipe reinforcement	60-562-VV-01 (22 nozzles)	Internal corrosion	3X Distributor
April-19	Kazakhstan	**KPO**	Pipe reinforcement	60-562-VW-01 (25 nozzles)	Internal corrosion	3X Distributor
April-19	Kazakhstan	**KPO**	Pipe reinforcement	50-214C-FL-013-3"-A11	Internal corrosion	3X Distributor
Apr-19	COLOMBIA	**PERENCO /CASANARE**	Refuerzo sobre tubería - onshore	8" Línea de crudo	Corrosión externa	3X Distributor
Apr-19	COLOMBIA	**PERENCO /GUANDO**	Refuerzo sobre tubería - onshore	3" Línea de gas	Corrosión externa	3X Distributor
Apr-19	COLOMBIA	**HOCOL**	Refuerzo sobre tubería - onshore	8" Línea de crudo	Corrosión externa	3X Distributor
Apr-19	COLOMBIA	**HOCOL**	Refuerzo sobre tubería - onshore	8" Línea de crudo	Corrosión externa	3X Distributor
Apr-19	COLOMBIA	**HOCOL**	Refuerzo sobre tubería - onshore	8" Línea de crudo	Corrosión externa	3X Distributor
Apr-19	COLOMBIA	**PERENCO /CASANARE**	Refuerzo sobre tubería - onshore	4" Línea de gas	Corrosión externa	3X Distributor
Apr-19	COLOMBIA	**PERENCO /CASANARE**	Refuerzo sobre tubería - onshore	4" Línea de gas	Corrosión externa	3X Distributor
Apr-19	COLOMBIA	**OCENSA**	Refuerzo sobre tubería - onshore	36" Línea de crudo	Abolladura	3X Distributor
Apr-19	NIGERIA	**TOTAL**	Piping Reinforcement - Offshore	16" ODP-AMQ RISER LINE IPN-SH-103-15-D511	External corrosion	3X Distributor
Apr-19	NIGERIA	**TOTAL**	Piping Reinforcement - Offshore	24"ODP FSO EXPORT LINE IPN-SH-103-10-B511	External corrosion	3X Distributor
April-19	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Elbow-Onshore	1 unit of 3" Sch 40 elbow at T-7503 drain line, LRCC plant	Internal corrosion	3X Distributor
April-19	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Elbow-Onshore	2" elbow at Plat 2, P-3261B (Location 14)	Internal corrosion	3X Distributor
March-19	NIGERIA	**TOTAL**	Offshore Topside	2" OFD 1 Depressurization Line (2"-FS-21204-B51)	Internal corrosion & Leak	3X Distributor
March-19	NIGERIA	**TOTAL**	Offshore Topside	3/4"-FS-21204-B51	Internal corrosion & Leak	3X Distributor
March-19	COLOMBIA	**PERENCO /CASANARE**	Refuerzo sobre tubería - onshore	2" Línea de aguas asociadas	Corrosión externa	3X Distributor
March-19	COLOMBIA	**PERENCO /CASANARE**	Refuerzo sobre tubería - onshore	4" Línea de crudo	Corrosión externa	3X Distributor
March-19	COLOMBIA	**PERENCO /CASANARE**	Refuerzo sobre tubería - onshore	3" Línea de crudo / aguas asociadas	Corrosión externa	3X Distributor
March-19	COLOMBIA	**PERENCO /CASANARE**	Refuerzo sobre tubería - onshore	8" Línea de crudo	Corrosión interna	3X Distributor
March-19	COLOMBIA	**PERENCO /CASANARE**	Refuerzo sobre tubería - onshore	4" Línea de crudo / aguas asociadas	Corrosión externa	3X Distributor
March-19	COLOMBIA	**PERENCO /CASANARE**	Refuerzo sobre tubería - onshore	8" Línea de crudo	Corrosión interna	3X Distributor
March-19	COLOMBIA	**PERENCO /CASANARE**	Refuerzo sobre tubería - onshore	4" Línea de crudo	Corrosión externa	3X Distributor
March-19	COLOMBIA	**PERENCO /CASANARE**	Refuerzo sobre tubería - onshore	8" Línea de crudo	Corrosión externa	3X Distributor
March-19	COLOMBIA	**ECOPETROL**	Refuerzo en soldadura - onshore	36" Línea de crudo	Refuerzo en soldadura	3X Distributor
March-19	COLOMBIA	**PERENCO /CASANARE**	Refuerzo sobre tubería - onshore	3" Línea de crudo	Corrosión externa	3X Distributor
March-19	COLOMBIA	**PERENCO /CASANARE**	Refuerzo sobre tubería - onshore	3" Línea de aguas asociadas	Corrosión externa	3X Distributor
March-19	COLOMBIA	**PERENCO /CASANARE**	Refuerzo sobre tubería - onshore	2" Línea de gas	Corrosión externa	3X Distributor

March-19	COLOMBIA	**PERENCO /CASANARE**	Refuerzo sobre tubería - onshore	6" Línea de crudo	Corrosión externa	3X Distributor
March-19	COLOMBIA	**PERENCO /CASANARE**	Refuerzo sobre tubería - onshore	4" Línea de aguas asociadas	Corrosión externa	3X Distributor
March-19	Kazakhstan	**KPO**	Pipe reinforcement	70-2300-FL-001-042"-A11	Internal corrosion	3X Distributor
Mar-19	Indonesia	**Pertamina Hulu Energy Offshore Sout East Sumatra (Prev. CNOOC)**	External corrosion pipe, Offshore Platform	6", 12" and 18" gas line	External corrosion	3X Distributor
Mar-19	Russia	**SIBUR**	pipe/onshore	520mm/tee/GAS	Internal corrosion	3X Distributor
Mar-19	Russia	**SIBUR**	pipe/onshore	520mm/straight line/GAS	Internal corrosion	3X Distributor
Mar-19	Russia	**SIBUR**	pipe/onshore	57mm/bend/GAS	Internal corrosion	3X Distributor
Mar-19	Russia	**SIBUR**	pipe/onshore	159mm/ straight line/ GAS	Internal corrosion	3X Distributor
Mar-19	Russia	**SIBUR**	pipe/onshore	159mm/ straight line/ GAS	Internal corrosion	3X Distributor
Mar-19	Russia	**SIBUR**	pipe/onshore	219mm/ straight line/ GAS	Internal corrosion	3X Distributor
Mar-19	Russia	**SIBUR**	pipe/onshore	219mm/ straight line/ GAS	Internal corrosion	3X Distributor
Mar-19	Russia	**SIBUR**	pipe/onshore	219mm/ straight line/ GAS	Internal corrosion	3X Distributor
Mar-19	Russia	**SIBUR**	pipe/onshore	325mm/ tee/ GAS	Internal corrosion	3X Distributor
Mar-19	NIGERIA	**TOTAL**	Piping Reinforcement - Offshore	2" OFD 1 Depressurization Line (2"-FS-21204-B51)	Internal corrosion & Leak	3X Distributor
Mar-19	NIGERIA	**TOTAL**	Piping Reinforcement - Offshore	3/4"-FS-21204-B51	Internal corrosion & Leak	3X Distributor
Feb-19	Kazakhstan	**KPO**	Pipe reinforcement	60-5620-WW-110-6"-A12	Internal corrosion	3X Distributor
Feb-19	Kazakhstan	**KPO**	Pipe reinforcement	60-562-VV-01 (31 nozzle)	Internal corrosion+Leak	3X Distributor
Feb-19	PERU	**Terminales de Perú (TDP)**	Piping reinforcement - onshore	10" Oil Line (5).	External / Internal Corrosion	3X Distributor
February-19	Perú	**Terminales del Perú**	TDP-EL CALLAO	DOCK 4	EXTERNAL AND INTERNAL CORROSION	3X Distributor
Feb-19	COLOMBIA	**PERENCO /CASANARE**	Refuerzo sobre tubería y codo - onshore	6" Línea de crudo	Corrosión externa	3X Distributor
Feb-19	COLOMBIA	**PERENCO /CASANARE**	Refuerzo sobre tubería - onshore	6" Línea de crudo	Corrosión externa	3X Distributor
Feb-19	COLOMBIA	**PERENCO /CASANARE**	Refuerzo sobre tubería - onshore	6" Línea de crudo	Corrosión externa	3X Distributor
Feb-19	COLOMBIA	**PERENCO /CASANARE**	Refuerzo sobre tubería - onshore	4" Línea de gas	Corrosión externa	3X Distributor
Feb-19	COLOMBIA	**PERENCO /GUANDO**	Refuerzo sobre tubería - onshore	6" Línea de crudo	Corrosión externa	3X Distributor
Feb-19	COLOMBIA	**PERENCO /CASANARE**	Refuerzo sobre tubería - onshore	4" Línea de gas	Corrosión externa	3X Distributor
Feb-19	COLOMBIA	**PERENCO /CASANARE**	Refuerzo sobre tubería - onshore	6" Línea de aguas asociadas	Corrosión externa	3X Distributor
Feb-19	COLOMBIA	**PERENCO /CASANARE**	Refuerzo sobre Tee - onshore	6" Línea de aguas asociadas	Corrosión externa	3X Distributor
Feb-19	COLOMBIA	**PERENCO /CASANARE**	Refuerzo sobre tubería - onshore	4" Línea de gas	Corrosión externa	3X Distributor
Feb-19	COLOMBIA	**OCENSA**	Refuerzo sobre tubería - onshore	30" Línea de crudo	Refuerzo sobre carga externa	3X Distributor
Feb-19	COLOMBIA	**PERENCO /CASANARE**	Refuerzo sobre tubería - onshore	4" Línea de crudo / aguas asociadas	Corrosión externa	3X Distributor
Feb-19	COLOMBIA	**PERENCO /GUANDO**	Refuerzo sobre blast joint- onshore	3,5" Blast joint	Pérdida de material por abrasión	3X Distributor
Feb-19	COLOMBIA	**PERENCO /CASANARE**	Refuerzo sobre tubería - onshore	8" Líena de aguas asociadas	Corrosión externa	3X Distributor
Feb-19	COLOMBIA	**PERENCO /CASANARE**	Refuerzo sobre tubería - onshore	3" Línea de gas	Corrosión externa	3X Distributor
January-19	Kazakhstan	**KPO**	Pipe reinforcement	30-3413-C-102A	Internal corrosion	3X Distributor
January-19	Kazakhstan	**KPO**	Pipe reinforcement	3-12000-HG-509-4"- B15	Internal corrosion	3X Distributor
January-19	COLOMBIA	**ECOPETROL**	Refuerzo en soldadura - onshore	36" Línea de crudo	Refuerzo en soldadura	3X Distributor
January-19	COLOMBIA	**PERENCO /CASANARE**	Refuerzo sobre tubería - onshore	6" Línea de aguas asociadas	Corrosión externa	3X Distributor
January-19	COLOMBIA	**OCENSA**	Pipe reinforcement - Onshore	30" pipeline - Fluid: Oil	Protection against external loads	3X Distributor
January-19	COLOMBIA	**OCENSA**	Pipe reinforcement - Onshore	36" pipeline - Fluid: Oil	Protection against external loads	3X Distributor
January-19	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Straight Pipe-Onshore	3/4" Pipe, 1" pipe & 2" pipe at V-152 at Complex	Internal corrosion	3X Distributor
January-19	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Straight Pipe-Onshore	2" pipe with 47.5mm anchor wrapping at both end for L2 & L5 nozzle	Internal corrosion	3X Distributor
January-19	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Reducer-Onshore	2" x 1" reducer (K1/K2) at C-156, HRC Plant	Internal corrosion	3X Distributor

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Dec-18	COLOMBIA	**PERENCO**	Pipe reinforcement-Onshore	3,5" coiled tubing	Protection	3X Distributor
Dec-18	COLOMBIA	**OCENSA**	Pipe reinforcement - Onshore	30" pipeline - Fluid: Oil	Protection against external loads	3X Distributor
Dec-18	NIGERIA	**TOTAL**	Piping Reinforcement - Offshore	16" Stabilized Oil from AMP1 to Export Line at ODP	External corrosion	3X Distributor
Dec-18	NIGERIA	**TOTAL**	Piping Reinforcement - Offshore	36" Offloading manifold at AKPO FPSO	External corrosion	3X Distributor
Dec-18	NIGERIA	**TOTAL**	Piping Reinforcement - Offshore	16" Gas Riser at AKPO FPSO	External corrosion	3X Distributor
Dec-18	NIGERIA	**TOTAL**	Piping Reinforcement - Offshore	in line on 32" FSO Export Metering Piping(2"-DF-0969	Internal corrosion & Leak	3X Distributor
Dec-18	UKRAINE	**KRISTAL-8**	Onshore	4" water line	External corrosion	3X Distributor
Dec-18	Kazakhstan	**KPO**	Pipe reinforcement	30-3413-C-302A	Internal corrosion	3X Distributor
Nov-18	Kazakhstan	**KPO**	Pipe reinforcement	20-310E-WO-073	Internal corrosion	3X Distributor
Nov-18	Kazakhstan	**KPO**	Pipe reinforcement	50-210 ABC-PO-067-10"-A13	Internal corrosion	3X Distributor
Nov-18	Kazakhstan	**CPC**	Pipe reinforcement	Tank 20 000m3	Leak	3X Distributor
Nov-18	Kazakhstan	**KPO**	Pipe reinforcement	60-5900-WW-021-4"-A11	Internal corrosion	3X Distributor
Nov-18	NIGERIA	**TOTAL**	Piping Reinforcement - Offshore	2" OFD 1 Depressing Line	Internal corrosion & Leak	3X Distributor
Nov-18	France	**CIM**	Onshore - Pipe 42" reinforcement	42"	External corrosion	3X Monaco
Nov-18	The Netherlands	**TOTAL**	Offshore - 12" pipe reinforcement	12"	External corrosion	3X Monaco
Oct-18	Kazakhstan	**KPO**	Pipe reinforcement	20-310E-WO-073	Internal corrosion	3X Distributor
Oct-18	Indonesia	**Perusahaan Gas Negara (PGN)**	External pipe damage, cause by road construction, Onshore Buried	16" Gas Pipe Line	External corrosion	3X Distributor
Oct-18	The Netherlands	**TOTAL**	Offshore - 10" and 12" pipe reinforcement	10" and 12"	External corrosion	3X Monaco
Oct-18	Angola	**TOTAL**	Piping reinforcement - offshore	20" oil line	External Hole	3X Distributor
Oct-18	Angola	**TOTAL**	Piping reinforcement - offshore	2" oil line	External Hole	3X Distributor
Oct-18	Vietnam	**Cuu Long JOC**	Offshore- Pipe reinforcement at HP flare scubber	24"oil/gas line	External corrosion	3X Distributor
Oct-18	Vietnam	**Cuu Long JOC**	Offshore- Pipe reinforcement at nozzle of HP flare scubber	4" oil/gas line	External corrosion	3X Distributor
Oct-18	Vietnam	**Cuu Long JOC**	Offshore- 2 defect Pipe reinforcement at heat exchanger	20" gas/ glycol line	External corrosion	3X Distributor
Oct-18	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Straight Pipe-Onshore	8" propylene line at Neat Jetty, Section5	Internal corrosion	3X Distributor
Oct-18	Malaysia	**PETRONAS CHEMICALS MTBE SDN BHD**	Straight Pipe-Onshore	1" & 2" (6 locations) pipe at PCMTBE , PDH Plant	External corrosion	3X Distributor
August-18	COLOMBIA	**ECOPETROL**	Pipe reinforcement-Onshore	36" pipeline - Fluid: Oil	Derivation from 18 "to 14" in pipeline	3X Distributor
Aug-18	Angola	**OPS**	Piping reinforcement - offshore	20" oil line	External Hole	3X Distributor
Aug-18	Angola	**OPS**	Piping reinforcement - offshore	20" oil line	External Hole	3X Distributor
Aug-18	Angola	**OPS**	Piping reinforcement - offshore	4" oil line	External Hole	3X Distributor
Sep-18	France	**TOTAL**	Pipe reinforcement - ONSHORE	6" gaz	External corrosion	3X Distributor
Sep-18	Malaysia	**PETRONAS CHEMICALS MTBE SDN BHD**	Straight Pipe-Onshore	1" & 2" pipe at PCMTBE , PDH Plant	External corrosion	3X Distributor
Sep-18	Malaysia	**SANKYU (M) SDN BHD**	Elbow-Onshore	1" elbow (line #: 1" F6071037-1330YY) at Flare Area, LRCC plant	Internal corrosion	3X Distributor
Sep-18	France	**GEOSTOCK**	Pipe reinforcement / onshore	20" tee pipe reinforcement	Leaking defect & external corrosion	3X Monaco
Sep-18	NIGERIA	**TOTAL**	Piping Reinforcement - Offshore	16 "Crude Oil Riser Location A	Severe External corrosion	3X Distributor
Sep-18	NIGERIA	**TOTAL**	Piping Reinforcement - Offshore	16 "Crude Oil Riser Location B	Severe External corrosion	3X Distributor
Sep-18	Kazakhstan	**CPC**	Pipe reinforcement	2" line	Weld defect	3X Distributor
August-18	Kazakhstan	**KPO**	Pipe reinforcement	50-210D-PW-501-3-B28	Internal corrosion	3X Distributor
August-18	Kazakhstan	**KPO**	Pipe reinforcement	20-5610-VA-01 J1A Nozzle	Internal corrosion	3X Distributor
Aug-18	Angola	**OPS**	Piping reinforcement - offshore	20" water line	External Hole	3X Distributor
Aug-18	Angola	**OPS**	Piping reinforcement - offshore	20" water line	External Hole	3X Distributor
Aug-18	Angola	**OPS**	Piping reinforcement - onshore	10" water line	External Hole	3X Distributor
Aug-18	France	**TOTAL**	Pipe reinforcement - ONSHORE	20" essence	External corrosion	3X Distributor
Aug-18	Norway	**EQUINOR (Statoil)**	SUBSEA	OSE - 3 Caissons	Hole - Internal corrosion - 4 defects	3X Distributor/3X Monaco
Aug-18	Norway	**EQUINOR (Statoil)**	SUBSEA	OSS - 3 Caissons	Hole - Internal corrosion - 12 defects	3X Distributor/3X Monaco
Aug-18	NIGERIA	**EXXON**	Piping Protection - Onshore	16" piping	Preventive repair	3X Distributor/3X Monaco
Jul-18	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Elbow-Onshore	3/4" elbow at E-251E, CD 2	Internal corrosion	3X Distributor
Jul-18	Gabon	**ADDAX**	Tank reinforcement	Nozzle reinforcement from interior of tank	Internal corrosion	3X Distributor/3X Monaco
Jul-18	Russia	**GASPROM**	scrubber/offshore	520 / SEA WATER	Internal corrosion	3X Distributor

June-18	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Straight Pipe-Onshore	1" pipe at V-7609 (back side near C-7601), LRCC Plant	Internal corrosion	3X Distributor
May-18	Angola	**TOTAL**	Piping reinforcement - offshore	16" oil line	External Hole	3X Distributor
May-18	Angola	**TOTAL**	Piping reinforcement - offshore	6" oil line	External Hole	3X Distributor
May-18	Angola	**OPS**	Piping reinforcement - offshore	14" oil line	External Hole	3X Distributor
May-18	Angola	**OPS**	Piping reinforcement - offshore	14" oil line	External Hole	3X Distributor
May-18	Angola	**OPS**	Piping reinforcement - offshore	14" oil line	External Hole	3X Distributor
May-18	NIGERIA	**TOTAL**	Piping Reinforcement - Offshore	3/4" Weldolet on 12"SH-3021-C51 (location A)	External corrosion	3X Distributor
May-18	NIGERIA	**TOTAL**	Piping Reinforcement - Offshore	3/4" Weldolet on 12"SH-3021-C51 (location B)	External corrosion	3X Distributor
May-18	NIGERIA	**TOTAL**	Piping Reinforcement - Offshore	1 1/2" Nozzle on blind flange (Location C)	External corrosion	3X Distributor
May-18	NIGERIA	**TOTAL**	Piping Reinforcement - Offshore	3/4" Weldolet on (Location D)	External corrosion	3X Distributor
May-18	NIGERIA	**TOTAL**	Piping Reinforcement - Offshore	3/4" Weldolet on (Location E)	External corrosion	3X Distributor
May-18	NIGERIA	**TOTAL**	Piping Reinforcement - Offshore	3/4" Weldolet on (Location F)	External corrosion	3X Distributor
May-18	NIGERIA	**TOTAL**	Piping Reinforcement - Offshore	3/4" Weldolet on (Location G)	External corrosion	3X Distributor
May-18	NIGERIA	**TOTAL**	Piping Reinforcement - Offshore	6" Pipe on Location F	External corrosion	3X Distributor
May-18	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Reducer-Onshore	2" to 1/2" reducer at V-7609 (76 LG 1043), LRCC Plant	Internal corrosion	3X Distributor
May-18	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Straight Pipe-Onshore	1/2" pipe at C-7601, LRCC plant	Internal corrosion	3X Distributor
May-18	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Straight Pipe-Onshore	3" pipe at C-7601, LRCC Plant	Internal corrosion	3X Distributor
May-18	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Straight Pipe-Onshore	2" to ¾" reducer at V-7609 (76 LG 1009), LRCC Plant	Internal corrosion	3X Distributor
May-18	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Straight Pipe-Onshore	1" pipe at V-7609 (back side near C-7601), LRCC Plant	Internal corrosion	3X Distributor
May-18	Viet-Nam	**CLJOC**	Riser reinforcement - offshore	14" Oil riser	External corrosion	3X Monaco
May-18	Viet-Nam	**CLJOC**	Riser reinforcement - offshore	14" Gas riser	External corrosion	3X Monaco
May-18	Viet-Nam	**PV Gas**	Pipe line Subsea	16" Gas pipeline	Internal corrosion	3X Monaco
Apr-18	Angola	**TOTAL**	Piping reinforcement - offshore	18" line	External Corrosion	3X Distributor
Apr-18	Angola	**TOTAL**	Piping reinforcement - offshore	2" line	External Corrosion	3X Distributor
Apr-18	Angola	**TOTAL**	Piping reinforcement - offshore	2" line	External Corrosion	3X Distributor
Apr-18	Angola	**TOTAL**	Piping reinforcement - offshore	12" line	External Corrosion	3X Distributor
Apr-18	Angola	**TOTAL**	Piping reinforcement - offshore	3/4" line	External Corrosion	3X Distributor
Apr-18	Angola	**TOTAL**	Piping reinforcement - offshore	3" cold water line	External Corrosion	3X Distributor
Apr-18	Angola	**TOTAL**	Piping reinforcement - offshore	3" cold water line	External Corrosion	3X Distributor
Apr-18	Angola	**TOTAL**	Piping reinforcement - offshore	10" line	External Corrosion	3X Distributor
Apr-18	Angola	**TOTAL**	Piping reinforcement - offshore	4" pipe	External Corrosion	3X Distributor
Apr-18	Angola	**TOTAL**	Piping reinforcement - offshore	18" pipe	External Corrosion	3X Distributor
Apr-18	Angola	**TOTAL**	Piping reinforcement - offshore	18" pipe	External Corrosion	3X Distributor
Apr-18	Angola	**TOTAL**	Piping reinforcement - offshore	1" flare system line	External Corrosion	3X Distributor
April-18	Russia	**SIBUR**	pipe/onshore	159mm /bend/ GAS	Internal corrosion	3X Distributor
April-18	Russia	**SIBUR**	pipe/onshore	159mm/ straight line/ GAS	Internal corrosion	3X Distributor
April-18	Russia	**SIBUR**	pipe/onshore	159mm /bend/ GAS	Internal corrosion	3X Distributor
April-18	Russia	**LUKOIL**	pipe/onshore	325mm/ bend/ Oil	Internal corrosion	3X Distributor
April-18	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Straight Pipe-Onshore	2" to 1/2" reducer at V-7609 (76 LG 1043), LRCC Plant	Internal corrosion	3X Distributor
Mar-18	Angola	**CHEVRON**	Piping reinforcement - offshore	4" water line	External Hole	3X Distributor
Feb-18	Angola	**CHEVRON**	Piping reinforcement - offshore	4" gas line	External Hole	3X Distributor
Mar-18	France	**TOTAL**	Pipe reinforcement - ONSHORE	8" naphta	External corrosion	3X Distributor
Mar-18	FRANCE	**TOTAL**	Pipe reinforcement - ONSHORE	12" gazol	External corrosion	3X Distributor
Mar-18	France	**TOTAL**	Pipe reinforcement - ONSHORE	8" réseau EH	external corrosion + trou	3X Distributor
Mar-18	Russia	**SIBUR**	pipe/onshore	219mm /bend/ GAS	Internal corrosion	3X Distributor
Mar-18	Viet-Nam	**HLHV**	Riser reinforcement / offshore	CNV 3P well flow line 6 inch	External corrosion	3X Monaco
Mar-18	Viet-Nam	**HLHV**	Riser reinforcement / offshore	H4 gas lift riser 6 inch	External corrosion	3X Monaco
Mar-18	Viet-Nam	**HLHV**	Riser reinforcement / offshore	8" oil piping	External corrosion	3X Monaco
Feb-18	Russia	**SIBUR**	pipe/onshore	273-377mm/reducer/ GAS	Internal corrosion	3X Distributor
Feb-18	France	**GEOSTOCK**	Pipe reinforcement / onshore	20" pipe reinforcement	Internal & external corrosion - 5 defects	3X Monaco
Feb-18	Iran	**NIGC**	Pipe reinforcement / onshore	8" pipe reinforcement	External corrosion - 3 defects	3X Distributor
Feb-18	Angola	**CHEVRON**	Piping reinforcement - offshore	2" Diesel line	External Hole	3X Distributor
Feb-18	Angola	**CHEVRON**	Piping reinforcement - offshore	2" Diesel line	External Hole	3X Distributor
Feb-18	Angola	**CHEVRON**	Piping reinforcement - offshore	4" water line	External Hole	3X Distributor
January-18	Angola	**CHEVRON**	Piping reinforcement - offshore	2" water line	External Hole	3X Distributor

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Dec-17	Russia	**SIBUR**	pipe/onshore	219/bend/GAS	Internal corrosion	3X Distributor
Dec-17	COLOMBIA	**MORELCO**	Pipe reinforcement - Onshore	8" pipeline - Fluid: Gas	External corrosion and dent repair	3X Distributor
Dec-17	COLOMBIA	**OCENSA**	Pipe reinforcement - Onshore	30" pipeline - Fluid: Oil	External corrosion	3X Distributor
Dec-17	COLOMBIA	**OCENSA**	Pipe reinforcement - Onshore	36" pipeline - Fluid: Oil	External corrosion	3X Distributor
Dec-17	Qatar	**QPD - Japan**	Pipe reinforcement -offshore	8" Riser - splash zone	External corrosion	3X Monaco
Dec-17	Kazakhstan	**KPO**	Pipe reinforcement	60-5620-WW-114-6"-A11	Internal corrosion	3X Distributor
Dec-17	Kazakhstan	**KPO**	Pipe reinforcement	60-5620-WW-111-4"-A11	Internal corrosion	3X Distributor
Dec-17	Kazakhstan	**KPO**	Pipe reinforcement	60-5620-WW-112-4"-A11	Internal corrosion	3X Distributor
Dec-17	Kazakhstan	**KPO**	Pipe reinforcement	0-5620-WW-113-4"-A11	Internal corrosion	3X Distributor
Dec-17	Kazakhstan	**KPO**	Pipe reinforcement	60-5620-WW-060-6"-A11	Internal corrosion	3X Distributor
Nov-17	Kazakhstan	**KPO**	Pipe reinforcement	9-5310-RW-206-2"-A21	Internal corrosion	3X Distributor
Nov-17	Malaysia	**PETRONAS GAS BERHAD**	Straight Pipe-Onshore	2" pipe at Area 600, line No : P-2"-6435-D3102-C (N31A), GPP-3, Kerteh plant	External corrosion	3X Distributor
Nov-17	Malaysia	**PETRONAS GAS BERHAD**	Straight Pipe-Onshore	1" pipe at Area DHU 300, Line No : PR-1"-7022-D1101-C (N31A)(BL), GPP-3, Kerteh plant.	External corrosion	3X Distributor
Nov-17	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Elbow-Onshore	6" elbow at E-107 In-plot CD 1 plant	Internal corrosion	3X Distributor
Nov-17	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Straight Pipe-Onshore	6" straight pipe at E-107 In-plot CD 1 plant	Internal corrosion	3X Distributor
Nov-17	Russia	**SIBUR**	pipe/onshore	89/straight line/GAS	External corrosion	3X Distributor
Nov-17	Kazakhstan	**KPO**	Pipe reinforcement	2" pipeline	Internal corrosion + leak	3X Distributor
Nov-17	Nigeria	**ADDAX**	Piping reinforcement - offshore	6" gas line	Axial Crack	3X Distributor
Nov-17	Nigeria	**SEPLAT**	Pipe Re-coating	6" oil line	External Abrasion	3X Distributor
Nov-17	COLOMBIA	**PERENCO**	Pipe reinforcement - Onshore	3,5" coiled tubing	Protection	3X Distributor
October-17	COLOMBIA	**ECOPETROL**	Pipe reinforcement - Onshore	20" pipeline - Fluid: oily water	Incomplete fusion, overlap, undercut	3X Distributor
October-17	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Straight Pipe-Onshore	16" fuel oil pipeline at OffPlot Plant	Internal corrosion	3X Distributor
Sep-17	France	**NOVAPEX**	Pipe reinforcement	8" gas line	Hole et external corrosion	3X Distributor
Sep-17	France	**TOTAL ARKEMA**	Pipe reinforcement	8" gas line	External corrosion	3X Distributor
Sep-17	Martinique	**LA SARA**	Refinery - onshore	Line 4"	External corrosion	3X Monaco
Sep-17	Angola	**CHEVRON**	Piping reinforcement - offshore	P-8400 water line	External corrosion	3X Distributor
Sep-17	Angola	**SOMOIL**	Piping reinforcement - onshore	6" water injection grp line	Crack	3X Distributor
Sep-17	Angola	**CHEVRON**	Piping reinforcement - offshore	P-8401 water line	External Hole	3X Distributor
Sep-17	Angola	**CHEVRON**	Piping reinforcement - offshore	1" water line	External Hole	3X Distributor
Sep-17	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Straight Pipe-Onshore	4" slop line at PM165	Internal corrosion	3X Distributor
Aug-17	Italy	**Esso italiana S.r.l.**	Pipe reinforcement	12" Oil Line	Pipe crack	3X Distributor
Aug-17	COLOMBIA	**OCENSA**	Pipe reinforcement - Onshore	16" pipeline - Fluid: Oil	Mechanical damage	3X Distributor
Aug-18	COLOMBIA	**MORELCO**	Pipe reinforcement - Onshore	24" pipeline - Fluid: Oil	Lack of fusion in welds	3X Distributor
Aug-17	Angola	**CHEVRON**	Piping reinforcement - offshore	P-8470 water line	External Hole	3X Distributor

Aug-17	Angola	**CHEVRON**	Piping reinforcement - offshore	P-8075 water line	External Hole	3X Distributor
Aug-17	Angola	**CHEVRON**	Piping reinforcement - offshore	2" water line	External Hole	3X Distributor
Aug-17	Nigeria	**TOTAL**	Piping - Offshore	9A	External corrosion	3X Distributor
Aug-17	Nigeria	**TOTAL**	Piping - Offshore	2" By-Pass Line For 10" NG-46628-H21A (Item 27)	External corrosion	3X Distributor
Aug-17	Nigeria	**TOTAL**	Piping - Offshore	2" NC-46612-G21 Condensates to the Closed Drains Vessel (Item 17)	External corrosion	3X Distributor
Aug-17	Nigeria	**TOTAL**	Piping - Offshore	2" NC-46618-H21A Condensates to the Closed Drains Vessel (Item20A	External corrosion	3X Distributor
Aug-17	Nigeria	**TOTAL**	Piping - Offshore	3" NG-46630-H21A Gas Discharge to PSV-6526 (Item 25)	External corrosion	3X Distributor
Aug-17	Nigeria	**TOTAL**	Piping - Offshore	2" NG-46602-F01 Gas Discharge to PSV- 5740	External corrosion	3X Distributor
Aug-17	Nigeria	**TOTAL**	Piping - Offshore	3/4" piping on 16"NG-46617-G21 (item 1)	External corrosion	3X Distributor
Aug-17	Nigeria	**TOTAL**	Piping - Offshore	3/4" piping on 16"NG-46617-G21 (item 2)	External corrosion	3X Distributor
Aug-17	Nigeria	**TOTAL**	Piping - Offshore	3/4" piping on 16"NG-46617-G21 (item 3)	External corrosion	3X Distributor
Aug-17	Nigeria	**TOTAL**	Piping - Offshore	2" Nozzle on 10-DS-301B HIPPS VESSEL LOCATION A	External corrosion	3X Distributor
Aug-17	Nigeria	**TOTAL**	Piping - Offshore	2" Nozzle on 10-DS-301B HIPPS VESSEL LOCATION B	External corrosion	3X Distributor
Aug-17	Nigeria	**TOTAL**	Piping - Offshore	2" Nozzle on 10-DS-203	External corrosion	3X Distributor
Aug-17	Nigeria	**TOTAL**	Piping - Offshore	2" Nozzle on 10-DS-301A	External corrosion	3X Distributor
Aug-17	Russia	**GAZPROM**	scrubber/onshore	530mm/sea water	weld defect	3X Distributor
Aug-17	CONGO	**TOTAL**	OFFSHORE	NKP	External corosion / hole - 3 defects	3X Distributor
Aug-17	CONGO	**TOTAL**	OFFSHORE	NKP	External corosion - 5 defects	3X Distributor
Aug-17	CONGO	**TOTAL**	OFFSHORE	YAFP	Internal corrosion / hole - 2 defects	3X Distributor
Aug-17	CONGO	**TOTAL**	OFFSHORE	SEFP	Internal corrosion / hole	3X Distributor
Aug-17	Myanmar	**TOTAL EP Myanmar**	Piping reinforcement - offshore	Yadana: 3" glycol (PP pf) + 3" flare (PP pf) + 18" flare (MCP pf) + 30" flare (MCP pf)	Various localised external corrosion defects	3X Distributor
August-17	VIET NAM	**PREMIER OIL**	Piping reinforcement - offshore	2" - HC - 616 - 3A3 (2.875 Inch, Hydrocarbon condensate)	Leak @ elbow	3X Distributor
August-17	VIET NAM	**PREMIER OIL**	Piping reinforcement - offshore	MP PW Discharge line (8.625 Inch, Produced water)	Leak @ elbow	3X Distributor
August-17	VIET NAM	**PREMIER OIL**	Piping reinforcement - offshore	MP PW suction line (8.625 Inch, Produced water)	Seep	3X Distributor
August-17	VIET NAM	**PREMIER OIL**	Piping reinforcement - offshore	3" - HC - 24 - 616 - 3A3T (3.5 Inch, Hydrocarbon condensate)	Weld defect at elbow	3X Distributor
August-17	VIET NAM	**PREMIER OIL**	Piping reinforcement - offshore	3" - HC - 24 - 610 - 3A3T (3.5 Inch, Hydrocarbon condensate)	Weld defect at T connection	3X Distributor
August-17	VIET NAM	**PREMIER OIL**	Full wrapping - offshore	Cylinder #3 (Approx 1750mm, NGL Hydrocarbon)	Thining	3X Distributor
August-17	VIET NAM	**PREMIER OIL**	Full wrapping - offshore	Cylinder #5 (Approx 1750mm, NGL Hydrocarbon)	Thining	3X Distributor
August-17	VIET NAM	**PREMIER OIL**	Piping reinforcement - offshore	K1 Nozzle (2.75 Inch, NGL Hydrocarbon)	Thining	3X Distributor
August-17	VIET NAM	**PREMIER OIL**	Piping reinforcement - offshore	2" Drain Line (2.75 Inch, Crude oil)	Thining	3X Distributor
August-17	VIET NAM	**PREMIER OIL**	Reinforcekit Patch - offshore	NGL Reboiler E34 (Approx 1535mm, Hydrocarbon condensaten)	Thining	3X Distributor
August-17	ITALY	**EXXON MOBIL**	Piping reinforcement - Refinery	12" gasoline waste line	Internal corrosion	3X Monaco
July-17	Angola	**CHEVRON**	Piping reinforcement - offshore	2" water line	External Hole	3X Distributor
July-17	Angola	**CHEVRON**	Piping reinforcement - offshore	2" gas line	External Hole	3X Distributor
July-17	Angola	**CHEVRON**	Piping reinforcement - offshore	6" oil line	External corrosion	3X Distributor
July-17	Angola	**CHEVRON**	Piping reinforcement - offshore	2" gas line	External Hole	3X Distributor
July-17	Angola	**CHEVRON**	Piping reinforcement - offshore	3" oil line	External Hole	3X Distributor
July-17	Congo	**TOTAL**	Piping reinforcement - offshore	4" - Djeno	Hole	3X Distributor
July-17	Congo	**TOTAL**	Piping reinforcement - offshore	line 4" - compressor KX831B - SEFP	Hole	3X Distributor
July-17	Congo	**TOTAL**	Piping reinforcement - offshore	collecteur décompression gares racleur et manifolds 2-AV-1564-B52 - SEFP	Hole	3X Distributor
July-17	Congo	**TOTAL**	Piping reinforcement - offshore	Nozzle 2" on line 8" SW 2041 B97 - YAQ	Hole	3X Distributor
July-17	Qatar	**TOTAL**	Piping reinforcement - offshore	6" & 8" bend - gas line	Internal corrosion	3X Monaco
July-17	Qatar	**TOTAL**	Piping reinforcement - offshore	2" injection water line (2 defects)	Internal corrosion	3X Monaco
July-17	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Elbow Suction Line-Onshore	6" Elbow Suction Oil line & 6" Straight Pipe Oil line at V107	Internal corrosion	3X Distributor
July-17	Malaysia	**PETRONAS GAS BERHAD**	Elbow -Onshore	8" Elbow Water Line, Line No 8"-1006-D1101-(N-404)	External corrosion	3X Distributor
June-17	France	**NOVAPEX**	Pipe reinforcement	8"	External corrosion	3X Distributor
June-17	Angola	**CHEVRON**	Piping reinforcement - offshore	1" water line	External Hole	3X Distributor
June-17	Angola	**CHEVRON**	Piping reinforcement - offshore	16" line	External Hole	3X Distributor
June-17	Congo	**TOTAL**	Piping reinforcement - offshore	2" - Nkossa	External corrosion	3X Distributor
June-17	Congo	**TOTAL**	Piping reinforcement - offshore	3" - Nkossa	External corrosion	3X Distributor
June-17	Congo	**TOTAL**	Piping reinforcement - offshore	1" 1/2 sur 52" - Nkossa	External corrosion	3X Distributor
June-17	Congo	**TOTAL**	Piping reinforcement - offshore	3 1" 1/2 sur 12" - Nkossa	External corrosion	3X Distributor
May-17	France	**SPAC**	Pipe reinforcement	16"	Internal corrosion	3X Distributor
May-17	Angola	**CHEVRON**	Piping reinforcement - offshore	8" oil line	External Hole	3X Distributor
May-17	Angola	**CHEVRON**	Piping reinforcement - onshore	3" oil line	External Hole	3X Distributor
May-17	Angola	**CHEVRON**	Piping reinforcement - offshore	2" gas line	External Hole	3X Distributor
May-17	Angola	**CHEVRON**	Piping reinforcement - offshore	2" oil line	External Hole	3X Distributor
May-17	COLOMBIA	**PERENCO**	Pipe reinforcement - Onshore	2" pipeline - Fluid: Water	Material lost	3X Distributor
April-17	Kazakhstan	**KPO**	Pipe reinforcement	60-5620-OW-011-2-A11	Internal corrosion	3X Distributor
April-17	Kazakhstan	**KPO**	Pipe reinforcement	60-5620-SL-103-3-A11	Internal corrosion	3X Distributor
April-17	Kazakhstan	**KPO**	Pipe reinforcement	60-5620-SL-104-3-A11	Internal corrosion	3X Distributor
April-17	Kazakhstan	**KPO**	Pipe reinforcement	60-5620-SL-105-3-A11	Internal corrosion	3X Distributor
April-17	COLOMBIA	**PERENCO**	Pipe reinforcement - Onshore	3,5" coiled tubing	Protection	3X Distributor
April 2017	France	**SPAC**	Pipe reinforcement	16"	External corrosion	3X Distributor
April 2017	France	**SPAC**	Pipe reinforcement	16"	External corrosion	3X Distributor
April 2017	France	**SPAC**	Pipe reinforcement	16"	External corrosion	3X Distributor
April 2017	France	**SPAC**	Pipe reinforcement	16"	Pipe reinforcement	3X Distributor
April 2017	France	**SPAC**	Pipe reinforcement	16"	External corrosion	3X Distributor
April 2017	France	**SPAC**	Pipe reinforcement	16"	Axial crack	3X Distributor
April 2017	France	**GEOSEL**	Pipe reinforcement	2"	External corrosion	3X Distributor
Apr-17	Angola	**CHEVRON**	Piping reinforcement - offshore	2" water line	External Hole	3X Distributor
Apr-17	Angola	**CHEVRON**	Piping reinforcement - offshore	2" water line	External Hole	3X Distributor
Apr-17	Angola	**CHEVRON**	Piping reinforcement - offshore	6" oil line	External Hole	3X Distributor
Apr-17	Angola	**CHEVRON**	Piping reinforcement - offshore	8" water line	External Hole	3X Distributor
April-17	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Straight Pipe-Onshore	8" pipe feed line at V107	External corrosion	3X Distributor
Apr-17	UAE	**GASCO**	Pipe reinforcement	16" Manifold pipe line	External corrosion	3X Distributor
Apr-17	OMAN	**DALEEL**	Nozzle reinforcement	3" Nozzle	Internal corrosion	3X Distributor
March 2017	France	**NOVAPEX**	Pipe reinforcement	8"	External corrosion	3X Distributor
March 2017	France	**TRAPIL**	Pipe reinforcement	16"	transversal crack	3X Distributor
March-17	France	**TRAPIL**	Pipe reinforcement	16"	External corrosion	3X Distributor
March-17	Angola	**CHEVRON**	Piping reinforcement - offshore	4" water line	External Hole - 2 defects	3X Distributor
March-17	Angola	**CHEVRON**	Piping reinforcement - onshore	3" water line	External Hole	3X Distributor
March-17	Angola	**CHEVRON**	Piping reinforcement - offshore	6" oil line	External Hole	3X Distributor
March-17	Angola	**CHEVRON**	Piping reinforcement - offshore	6" oil line	External Hole	3X Distributor
March-17	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Straight Pipe-Onshore	1" & 2" pipe vacuum line at P-198A/B to V-198	External corrosion	3X Distributor
March-17	Malaysia	**HENGYUAN REFINING COMPANY BERHAD**	Nozzle-Onshore	1-1/2" & 3/4" nozzle gas line at near E-466 to V-261	External corrosion	3X Distributor
Mar-17	Kazakhstan	**KPO**	Pipe reinforcement	2-4" pipeline	Internal corrosion	3X Distributor
Mar-17	QATAR	**TOTAL**	Piping reinforcement - offshore	3" drain line	Internal corrosion (5 defects)	3X Distributor
Mar-17	QATAR	**TOTAL**	Piping reinforcement - offshore	6" gas line	External corrosion	3X Distributor
Mar-17	QATAR	**TOTAL**	Piping reinforcement - offshore	2" gas line	External corrosion	3X Distributor
Mar-17	SOUDAN	**PDOC**	Pipe line reinforcement	32" oil pipe line	External corrosion (100+ defects)	3X Monaco
Mar-17	IRAN	**NIGTC**	Pipe reinforcement	56" Tee gas line	Crack	3X Monaco
Mar-17	FRANCE	**TRAPIL**	Pipe reinforcement	12" oil line	Axial crack	3X Distributor
Mar-17	Russia	**RUSSNEFT**	Pipe reinforcement/onshore	820mm oil line	Weld crack	3X Distributor

Feb-17	France	**TRAPIL**	Pipe reinforcement	10"	External corrosion	3X Distributor
Feb-17	France	**GDH BP**	Pipe reinforcement	28"	External corrosion	3X Distributor
Feb-17	Angola	**CHEVRON**	Piping reinforcement - offshore	2" water line	External Hole	3X Distributor
Feb-17	Angola	**CHEVRON**	Piping reinforcement - offshore	1" water line	External corrosion	3X Distributor
Feb-17	Angola	**CHEVRON**	Piping reinforcement - offshore	2" oil line	External Hole - 5 defects	3X Distributor
Feb-17	Angola	**CHEVRON**	Piping reinforcement - offshore	4" water line	External Hole	3X Distributor
Feb-17	Malaysia	**PETRONAS GAS BERHAD**	Straight Pipe-Onshore	2" pipe water line, Line No L-101 a/b/c/d	External corrosion	3X Distributor
Feb-17	Malaysia	**BASF PETRONAS CHEMICALS SDN BHD**	Elbow Bend-Onshore	4" elbow water line at D-2801	External corrosion	3X Distributor
Feb-17	Kazakhstan	**KPO**	Pipe reinforcement	60-562-VV-01 (24 nozzles)	Internal corrosion	3X Distributor
Mar-17	Kazakhstan	**KPO**	Pipe reinforcement	60-562-VW-01 (25 nozzles)	Internal corrosion	3X Distributor
Feb-17	RUSSIA	**SIBUR**	Pipe reinforcement/onshore	108mm gas line	External corrosion	3X Distributor
				159mm gas line	External corrosion	3X Distributor
				426mm gas line	External corrosion	3X Distributor
Jan-17	Angola	**CHEVRON**	Piping reinforcement - offshore	2" oil line	External Hole	3X Distributor
Jan-17	Angola	**CHEVRON**	Piping reinforcement - offshore	4" gas line	External Hole	3X Distributor
Jan-17	Angola	**CHEVRON**	Piping reinforcement - offshore	14" gas line	External Hole	3X Distributor
Jan-17	NIGERIA	**TOTAL**	Piping Reinforcement - Offshore	32"B511	External corrosion	3X Distributor

2016

Dec-16	Myanmar	**TOTAL EP Myanmar**	Riser hang-off flange - offshore	Yadana: 20" (PP pf)	To ensure no sea water ingress inside the flange (repair of 3Xeno repair done in 2012)	3X Distributor
Dec-16	NIGERIA	**TOTAL**	Piping reinforcement	32" oil piping	Hole	3X Monaco
Dec-16	SOUDAN	**PDOC**	Pipe line reinforcement	32" oil pipe line	External corrosion (100+ defects)	3X Monaco
Dec-16	QATAR	**TOTAL**	Pipe line reinforcement	12" pipeline	External corrosion	3X Monaco
Dec-16	QATAR	**TOTAL**	Piping reinforcement	2" injection water line	Internal corrosion (4 defects)	3X Monaco
Dec-16	Kazakhstan	**KPO**	Pipe reinforcement	60-5620-OW-011-2"-A11	Internal corrosion	3X Distributor
Dec-16	Kazakhstan	**KPO**	Pipe reinforcement	60-5620-SL-101-3-A11	Internal corrosion	3X Distributor
Dec-16	Kazakhstan	**KPO**	Pipe reinforcement	60-5620-SL-102-3-A11	Internal corrosion	3X Distributor
Nov-16	FRANCE	**EPPLN**	Tank reinforcement	HC Tank storage	External corrosion + Hole	3X Monaco
Oct-16	OMAN	**OOCEP**	Trunk line rehabilitation	6" & 8" Gas piping	Internal corrosion (4 defects)	3X Monaco
Oct-16	NEDERLAND	**TOTAL**	Flare line reinforcement	8" Gas pipeline (K5PK platform)	External corrosion (4 defects)	3X Monaco
Oct-16	VIETNAM	**VIETSOVPETRO**	Flange protection	23" flange (HLHV platform)	External corrosion	3X Monaco
Sep-16	TUNISIA	**MARETAP**	Pipe reinforcement	4" Gas pipeline	External corrosion defects (3 defects)	3X Monaco
Sep-16	NIGERIA	**EXXON MOBIL**	Pipe line Subsea	36" pipeline	Dent	3X Monaco
Aug-16	SAUDI ARABIA	**ARAMCO**	Pipe line Subsea	48" oil pipeline	Leak	3X Monaco
Aug-16	SAUDI ARABIA	**ARAMCO**	Pipe line Subsea	48" oil pipeline	External corrosion defect (3 defects)	3X Monaco
Jul-16	VIETNAM	**PREMIER OIL**	Reboiler nozzle reinforcement	22" reboiler nozzle	External corrosion	3X Monaco
Jun-16	VIETNAM	**PVGAS**	Pipe line Subsea	16" Gas pipeline	Dent	3X Monaco
Jun-16	VIETNAM	**PVGAS**	Pipe line Subsea	18" Gas pipeline	Dent	3X Monaco
April-16	Kazakhstan	**KPO**	Pipe reinforcement	20-2300-FL-011-12"-A11	Internal corrosion	3X Distributor
April-16	Kazakhstan	**KPO**	Pipe reinforcement	310E-FL-16-4"-A11	Internal corrosion	3X Distributor
April-16	Kazakhstan	**KPO**	Pipe reinforcement	50-214D-VT-015-3-A18	Internal corrosion	3X Distributor
April-16	Kazakhstan	**KPO**	Pipe reinforcement	7-0000-FL-008-16"-A11	Internal corrosion+Leak	3X Distributor
March-16	Kazakhstan	**KPO**	Pipe reinforcement	20-4110-LT-002	Internal corrosion+Leak	3X Distributor
March-16	Kazakhstan	**KPO**	Pipe reinforcement	20-4110-FL-001-6" A11	Internal corrosion	3X Distributor
March-16	Kazakhstan	**KPO**	Pipe reinforcement	20-4110-LT-002		3X Distributor
Feb-16	Kazakhstan	**KPO**	Pipe reinforcement	7-0000-FL-008-16"-A11	Internal corrosion	3X Distributor
Feb-16	Kazakhstan	**KPO**	Pipe reinforcement	20-2300-FL-023-10"-A11	Internal corrosion	3X Distributor
Feb-16	COLOMBIA	**ECOPETROL**	Pipe line Subsea	24" pipeline	Dent	3X Monaco

2015

Dec-15	France	**EXXON**	Pipeline reinforcement	Pipeline 4"_C3 to LPP	Multiple dents	3X Monaco
Dec-15	Kazakhstan	**KPO**	Pipe reinforcement	60-5620-FL-105-2-A11	Internal corrosion	3X Distributor
Dec-15	Kazakhstan	**KPO**	Pipe reinforcement	60-5620-FL-106-2-A11	Internal corrosion	3X Distributor
Dec-15	Kazakhstan	**KPO**	Pipe reinforcement	60-5620-FL-107-2-A11	Internal corrosion	3X Distributor
Dec-15	Kazakhstan	**KPO**	Pipe reinforcement	60-5620-FL-108-1-A11	Internal corrosion	3X Distributor
Dec-15	Kazakhstan	**KPO**	Pipe reinforcement	60-5620-FL-109-1-A11	Internal corrosion	3X Distributor
Dec-15	Kazakhstan	**KPO**	Pipe reinforcement	60-5620-FL-049-1-A11	Internal corrosion	3X Distributor
Dec-15	Kazakhstan	**KPO**	Pipe reinforcement	60-5620-FL-050-1-A11	Internal corrosion	3X Distributor
Dec-15	Kazakhstan	**KPO**	Pipe reinforcement	60-5620-FL-051-1-A11	Internal corrosion	3X Distributor
Dec-15	Kazakhstan	**KPO**	Pipe reinforcement	60-5620-FL-052-1"-A11	Internal corrosion	3X Distributor
Dec-15	Kazakhstan	**KPO**	Pipe reinforcement	70-2300-VA-02-VT-001K-3	Internal corrosion	3X Distributor
Dec-15	Kazakhstan	**KPO**	Pipe reinforcement	60-5620-WW-510-6"-A11	Internal corrosion	3X Distributor
Dec-15	Kazakhstan	**KPO**	Pipe reinforcement	60-5620-BD-121-1-A11	Internal corrosion	3X Distributor
Dec-15	Kazakhstan	**KPO**	Pipe reinforcement	60-5500-WW-048-6-A21	Internal corrosion	3X Distributor
Dec-15	Kazakhstan	**KPO**	Pipe reinforcement	60-5500-WW-049-6-A21	Internal corrosion	3X Distributor
Nov-15	Kazakhstan	**KPO**	Pipe reinforcement	60-5620-WW-505-6"-A11	Internal corrosion	3X Distributor
Nov-15	Kazakhstan	**KPO**	Pipe reinforcement	50-214C-CS-041-6"-A18	Internal corrosion	3X Distributor
Nov-15	MYANMAR	**TOTAL E&P MYANMAR**	Riser protection	24" Riser	External corrosion	3X Monaco
Oct-15	VIETNAM	**HLJOC**	Piping reinforcement	2" piping	Internal corrosion	3X Monaco
Oct-15	VIETNAM	**PVGAS**	Pipe line Subsea	16" Gas pipeline	2 Dents	3X Monaco
Oct-15	Kazakhstan	**KPO**	Pipe reinforcement	Tank 60-5620-VW-001 Nozzle's	Internal corrosion	3X Distributor
Oct-15	Kazakhstan	**KPO**	Pipe reinforcement	50-214D-GL-014-3-A18	Internal corrosion	3X Distributor
Oct-15	Kazakhstan	**KPO**	Pipe reinforcement	50-214D-GL-015-8-A18	Internal corrosion+Leak	3X Distributor
Oct-15	Kazakhstan	**KPO**	Pipe reinforcement	50-214D-GL-030-8-A18	Internal corrosion	3X Distributor
Oct-15	Kazakhstan	**KPO**	Pipe reinforcement	60-5900-WW-032-3-A11	Internal corrosion	3X Distributor
Oct-15	Kazakhstan	**KPO**	Pipe reinforcement	50-3390-VA-03-VT-020E-2-A18	Internal corrosion	3X Distributor
Oct-15	Kazakhstan	**KPO**	Pipe reinforcement	50-3390-VA-03-VT-020F-2-A18	Internal corrosion	3X Distributor
Oct-15	Kazakhstan	**KPO**	Pipe reinforcement	50-3390-VA-03-VT-020-2-A18	Internal corrosion	3X Distributor
Oct-15	Kazakhstan	**KPO**	Pipe reinforcement	60-5500-WW-052&WW-053-1 1/2"-A21	Internal corrosion	3X Distributor
Oct-15	Kazakhstan	**KPO**	Pipe reinforcement	60-5620-WW-504-8-A11	Internal corrosion	3X Distributor
Oct-15	Kazakhstan	**KPO**	Pipe reinforcement	A4100-24110-VT-007E	Internal corrosion	3X Distributor
Oct-15	KAZAKHSTAN	**KPO**	Piping reinforcement	1" Flare line piping	Internal corrosion	3X Monaco
				2" Flare line piping	Internal corrosion	3X Monaco
Sep-15	ALGERIA	**SONATRACH**	Piping reinforcement	20" Gas Piping	Leaking cracks / Welding defect	3X Monaco
Aug-15	IRAN	**NISOC**	Pipe line reinforcement	20" Gas Pipeline	Leak	3X Monaco
Aug-15	VIETNAM	**PVGAS**	Pipe line Subsea	16" Gas pipeline	3 Dents	3X Monaco
Aug-15	Martinique	**LA SARA**	Process piping reinforcement	Tee 1"	External corrosion	3X Monaco
Jun-15	FRANCE	**CCMP**	Pipeline reinforcement	12" Oil pipeline	External corrosion	3X Monaco
				10" Gas lift riser	External corrosion	3X Monaco

Jun-15	VIETNAM	**CLJOC**	Riser reinforcement	12" Oil riser	External corrosion	3X Monaco
				16" Injection riser	External corrosion	3X Monaco
				24"Oil riser	External corrosion	3X Monaco
Jan-15	France	**TOTAL Raffinerie Normandie**	Pipe reinforcement	Transfer Line 16 "	External corrosion	3X Monaco
					External corrosion	3X Monaco
2014						
Dec-14	INDIA	**ONGC**	Pipe line Subsea	10" HR - HRG (WF)	Leaks	3X Monaco
Nov-14	YEMEN	**TOTAL E&P YEMEN**	Pipe reinforcement	8" Water Nunk Line from W3 to W2	Internal corrosion	3X Monaco
	France	**VERMILLION**	Pipe reinforcement	10" Transport huile	External corrosion	3X Monaco
Oct-14	France	**AIR LIQUIDE**	Pipe reinforcement	8" Gaz	External corrosion	3X Monaco
Sep-14	BRUNEI	**TOTAL E&P BORNEO**	Process piping reinforcement	MLJ-2 Sump caisson	External corrosion	3X Monaco
Aug-14	France	**TOTAL GARGANVILLE**	Pipe reinforcement	PLIF 20''	Internal corrosion	3X Monaco
	VIETNAM	**CLJOC**	Process piping reinforcement	28''	22 Welding defect	3X Monaco
				30''	Welding defect	3X Monaco
				10"	Welding defect	3X Monaco
Jul-14	France	**VERMILLION**	Pipe reinforcement	10" Oil Transport	8 Enternal corrosion	3X Monaco
	France	**TOTAL GARGANVILLE**	Pipe reinforcement	PLIF 20''	Internal corrosion	3X Monaco
Jun-14	VIETNAM	**JAPAN VIETNAM PETROLEUM COMPANY**	Pipe line Subsea	6" Gaz lift line	Buckling defect	3X Monaco
May-14	France (DOM-TOM)	**LA SARA**	Process piping reinforcement	4" Gaz lift	Leak	3X Monaco
April-14 to May-14	GABON	**TOTAL GABON**	Process piping reinforcement	Riser 8'' huile GRM-2	External corrosion	3X Monaco
				4-GH-227-D51	External corrosion	3X Monaco
		PRENCO GABON		Riser 10'' oil Export	External corrosion	3X Monaco
				8'' Riser BATANGA	External corrosion	3X Monaco
Apr-14	RDC	**PERENCO RDC**	Process piping reinforcement	MIBALE Aux	External corrosion	3X Monaco
				MIBALE Aux - coude	External corrosion	3X Monaco
				MIBALE PP	External corrosion	3X Monaco
				MIBALE 11 Gaz	External corrosion	3X Monaco
				MIBALE 11 Huile	External corrosion	3X Monaco
	France (DOM-TOM)	**LA SARA**	Pipe reinforcement	24'' Ligne de transfert SARA	Leak	3X Monaco
Mar-14	GABON	**TOTAL GABON**	Process piping reinforcement	10'' Riser	External corrosion	3X Monaco
Feb-14			Weld reinforcement	Heavy Oil 12'' CB1 UHL-COLLECTOR	11 Weld defect (external corrosion)	3X Monaco
			Flange rienforcement	Gas 10'' pipe	Leak	3X Monaco
	France	**AIR LIQUIDE**	Pipe reinforcement	DN100 (Saint Avold)	External corrosion	3X Monaco
2013						
Dec-13	GABON	**TOTAL GABON**	Process piping reinforcement	Riser 8'' AGM06	Leak	3X Monaco
Nov-13				6''FS 303 B51		
Oct-13				2'' Gaz DS700 →DS201		
Sep-13	France	**TOTAL PETROCHEMICALS**	Pipe reinforcement	16" DN400 OBERHOFFEN	9 External corrosion	3X Monaco
					1 peeling	3X Monaco
Sep-13	France	**SIP Corse**	Pipe line Subsea	line 4" subsea	Coating defect	3X Monaco
Sep-13	NIGERIA	**BUMIARMADA**	Process piping	20" BALLAST LINE SEPARATOR INLET & OUTLET	Leak	3X Monaco
				12" DISCHARGE OF THE BALLAST PUMP		
				18" T- PIECE DISCHARGE SIDE OF V/V 40		
				18" WELD SEAM AT V/V 36		
July to December-13	Abu Dhabi	**ADGAS**	Ø Piping from : 2" to 30" Temperature from: +10°C to +110°C - Fluid : Gas	Not listed due to a long exhaustive list	Cracked girth weld (H2S SCC)	3X Monaco
Jul-13	France	**SRPP**	Pipe line	16"	6 External corrosion	3X Monaco
	France	**Geostock Perthuis**	Pipe line	24'' defect on seam PK39	External corrosion	3X Monaco
	YEMEN	**Total E&P Yemen**	Process piping reinforcement	6"-WI-6E-8E	Internal corrosion	3X Monaco
	NIGERIA	**TOTAL NIGERIA**	Process piping reinforcement	2" by-pass line	3 External corrosion	3X Monaco
Jun-13	GABON	**TOTAL GABON**	Process piping reinforcement	Critical line 1" & 2" of KY600 under : DS601 ,DS602 ,DS603 ,DS604 , DS701	Internal corrosion	3X Monaco
				Line 3'' oil (Walkway)	External corrosion	3X Monaco
	NIGERIA	**ADDAX**	Pipe subsea	4" gas lift ADRP-1 to ADNA line	kink	3X Monaco
	YEMEN	**Yemen LNG**	Tank	Seawater Tank	Leaks	3X Monaco
May-13	UAE	**TOTAL ABK**	Pipe sub-sea reinforcement	10" Export line from ABK field to Das island	External corrosion	3X Monaco
Apr-13	BIRMANIE	**TOTAL MYANMAR**	Process piping reinforcement	36" EXPORT GAS PIPELINE RISER	External corrosion	3X Monaco
				20" UNUSED RISER AT PP	External corrosion	3X Monaco
	ANGOLA	**TOTAL ANGOLA**	Process piping reinforcement	3" GT-1101-F511 (43014071) / P10L	External corrosion	3X Monaco
				3" GT-1201-F511 (43013900) / P20R	External corrosion	3X Monaco
				3" GT-1201-F511 (43013900) / P20R	External corrosion	3X Monaco
				3" GT-1301-F511 (43014050) / P30R	External corrosion	3X Monaco
				3" GT-1302-F511 (43013661) / P30L	External corrosion	3X Monaco
				3" GT-1401-F511 (43013997) / P40R	External corrosion	3X Monaco
				3.5" Straight pipe xn 92007 (43014051)	External corrosion	3X Monaco
				12" NH-0095-B511 (43014123)	External corrosion	3X Monaco
				3" GT-1202-F511 (43014220) / P20L	External corrosion	3X Monaco
				3" GT-1601-F511 (43014221) / P60R	External corrosion	3X Monaco
				3" GT-1502-F511 (43014221) /50R	External corrosion	3X Monaco
				6" NH-160-B511 (43014092)	External corrosion	3X Monaco
				14" NH-0027-B511 (43014143)	External corrosion	3X Monaco
				18" NH-0068-B511	External corrosion	3X Monaco
				3" GT-1101-F511	External corrosion	3X Monaco
				3" GT-1501-F511	External corrosion	3X Monaco
				10" NH-5-61079-B511 bend 3	Internal corrosion	3X Monaco
				10" NH-5-61079-B511 straight 3	Internal corrosion	3X Monaco
				10" NH-5-61079-B511 bend 4	Internal corrosion	3X Monaco
				10" NH-5-61079-B511 straight 4	Internal corrosion	3X Monaco
				18" NH-5-61003-B511 TEE0130	Internal corrosion	3X Monaco
				18" NH-5-61003-B511 TEE0160	Internal corrosion	3X Monaco
				18" NH-5-61003-B511 TEE0190	Internal corrosion	3X Monaco
				18" NH-5-61003-B511 TEE0150	Leak due to internal corrosion	3X Monaco
				30" NH-6-83021-B513	Leak due to internal corrosion	3X Monaco
				14"/6" NW-5-33201-C513	Leak due to internal corrosion	3X Monaco
	France	**Arkema**	Pipe line	10'' TE PK 18581	Seam defect	3X Monaco
Mar-13	France	**SPAC**	Pipe line	20'' hydrocarbures Tranche 2A	Internal corrosion	3X Monaco
	France	**EDF Corse**	Pipe line	10'' SEA LINE def n°11	External corrosion	3X Monaco
					Internal corrosion	3X Monaco

January to March - 13	ANGOLA Cabinda	**SBM / CHEVRON**	Ø Piping from : 2" to 36" Temperature from: ambiant to 110°C Fluid : Oil, gas Water process & regulation	Not listed due to a long exhaustive list	External corrosion	3X Monaco
					Girth weld	3X Monaco
					Cracks	3X Monaco
					Leaks	3X Monaco
2012						
Dec-12	France	**CIM Le Havre**	Pipe Line	16'' Manifold 1 Collecteur 5	Leak	3X Monaco
Nov-12	France	**EDF Corse**	Pipe line	4" OLEODUC DU DPM déf N°6	External corrosion	3X Monaco
				déf N°18	External corrosion	3X Monaco
				déf N°25	External corrosion	3X Monaco
	GABON	**TOTAL GABON**	Process piping reinforcement	14'' NG-228-B51	Internal corrosion	3X Monaco
				14'' NG-228-B51	Leak due to internal corrosion	3X Monaco
				14'' NG-228-B51	Internal corrosion	3X Monaco
Oct-12	France	**EDF Corse**	Pipe line	4" OLEODUC DU DPM déf N°163	External corrosion	3X Monaco
				déf N°164	External corrosion	3X Monaco
				déf N°166	External corrosion	3X Monaco
	France	**TSI**	Pipe line	12'' at T62	External corrosion	3X Monaco
	Yemen	**Yemen LNG**	Tank	Seawater Tank	Leaks	3X Monaco
	France	**Andros**	Nozzels	3'' sur tronçons a ANDROS	Leak	3X Monaco
Jul-12	France	**CIM Le Havre**	Pipe Line	42'' Ecluse François 1er : PK22733.416	External corrosion	3X Monaco
				PK22733.416	External corrosion	3X Monaco
				PK22735.207	External corrosion	3X Monaco
				PK22768.762	External corrosion	3X Monaco
				PK22770.485	External corrosion	3X Monaco
				PK22793.274	External corrosion	3X Monaco
				PK22876.742	External corrosion	3X Monaco
				PK22877.089	External corrosion	3X Monaco
				PK22881.779	External corrosion	3X Monaco
	France	**Geostock Manosque**	Pipe line	4'' Conduite transfert gasoil liaisons puits	External corrosion	3X Monaco
	France	**Geostock Manosque**	Pipe line	24'' DN 600 Lupiac / Lussan	External corrosion	3X Monaco
Jun-12	ANGOLA	**TOTAL ANGOLA**	Process piping reinforcement	4"-FS-4-2102-B511	Leak	3X Monaco
				6"-NH-4-1111-F511	External corrosion	3X Monaco
				6"-NH-4-1111-F511 bend	External corrosion	3X Monaco
				16"-NH-4-0047-B511	External corrosion	3X Monaco
				8"-NH-R-230-B511	External corrosion	3X Monaco
				18"-NH-0072-B511	External corrosion	3X Monaco
				8"-NH-1216-F720	Saw damage	3X Monaco
				8"-NH-1216-F720 Tee	External corrosion	3X Monaco
				2"-IA-4-8507-B571 CUS 81	External corrosion	3X Monaco
				2"-IA-4-8507-B571 CUS 89	External corrosion	3X Monaco
				2"-IA-4-8507-B571 CUS 92	External corrosion	3X Monaco
				2"-IA-4-8507-B571 STRAIGHT TBR (4)	External corrosion	3X Monaco
				2"-IA-4-8507-B571 TEE TBR (3)	External corrosion	3X Monaco
				2"-IA-4-8507-B571 TEE TBR (1)	External corrosion	3X Monaco
				2"-IA-4-8507-B571 TEE TBR (2)	External corrosion	3X Monaco
Jun-12	France	**EDF Corse**	Pipe line	4" OLEODUC DU DPM déf N°78	External corrosion	3X Monaco
				déf N°69	External corrosion	3X Monaco
				déf N°81	External corrosion	3X Monaco
				déf N°12	External corrosion	3X Monaco
	YEMEN	**Yemen LNG**	Pipe line	line 38'' gas	Dent	3X Monaco
	France	**Geostock Manosque**	Pipe line	20'' sur site de GEOSEL Manosque	External corrosion	3X Monaco
May-12	GABON	**TOTAL GABON**	Process piping reinforcement	2'' NG-462-D70	External corrosion	3X Monaco
Apr-12	GABON	**TOTAL GABON**	Process piping reinforcement	1 MW 42311 B51	External corrosion	3X Monaco
				2 HD 517 B51	External corrosion	3X Monaco
				2 IA 688 B57	External corrosion	3X Monaco
				3 1 IA 621 B57	External corrosion	3X Monaco
				3 PW 41214 B53	External corrosion	3X Monaco
				3 SA 601 B51	2 External corrosion	3X Monaco
				3 SG 588 C51	External corrosion	3X Monaco
				3 WD 4151 B51	Leak	3X Monaco
				3 XH 634 B51	External corrosion	3X Monaco
				4 FS 440 B51	External corrosion	3X Monaco
				4 NG 424 D70	External corrosion	3X Monaco
				6 SD 660 B51	External corrosion	3X Monaco
				6 SD 661 B51	External corrosion	3X Monaco
				8 FS 433 B51	External corrosion	3X Monaco
				8 TW 550 F51	External corrosion	3X Monaco
				10 NG 42101 B51	External corrosion	3X Monaco
				10 TW 540 F51	External corrosion	3X Monaco
				14 FS 437 B51	External corrosion	3X Monaco
				2 SD 869 B55	External corrosion	3X Monaco
				4 NG 408 B51	External corrosion	3X Monaco
				14 NG 401 B51	External corrosion	3X Monaco
				8 FS 2102 B51	External corrosion	3X Monaco
Mar-12	FRANCE	**TSI**	Pipe reinforcement	8'' sur ligne de transport TE1	External corrosion	3X Monaco
	YEMEN	**Yemen LNG**	Flange	32-FT-46032	External corrosion	3X Monaco
	France	**SPAC**	Pipe line	42'' Fluxel à Fos-sur-Mer	External corrosion	3X Monaco
Feb-12	France	**Geostock Eguilles**	Pipe line	Tube 20'' sur ligne GSM 1 Nord – Point n°8	External corrosion	3X Monaco
Jan-12	ANGOLA	**TOTAL ANGOLA**	Process piping reinforcement	IPN-NH-0630-17-F710 (ADH 10-016 VIE/SCD)	External corrosion	3X Monaco
				3" GT-1502 F511 (CUS 312)	External corrosion	3X Monaco
				3" GT-1502 F511 (CUS 308)	External corrosion	3X Monaco
				3" GT-1501 F511 (CUS 317)	External corrosion	3X Monaco
				3" GT-1501 F511 (CUS 318)	External corrosion	3X Monaco
				3" GT-1302 F511 (CUS 330)	External corrosion	3X Monaco
				3" GT-1302 F511(CUS 328)	External corrosion	3X Monaco
				3" GT-1301 F511 (CUS 300)	External corrosion	3X Monaco
	France	**Geostock Istres**	Pipe line	20'' sur ligne 2 Engrenier – Rognac	External corrosion	3X Monaco
2011						
Dec-11	GABON	**TOTAL GABON**	Pipe reinforcement	18'' line	Leak	3X Monaco
			Process piping reinforcement	8-NG-411-C51	External corrosion	3X Monaco
				3-FG-7101-B51	External corrosion	3X Monaco
				16-NG-403-B51	External corrosion	3X Monaco
				3-SG-4-C51	External corrosion	3X Monaco
				8-FS-436-B51	External corrosion	3X Monaco
				1-IA-677-B57	External corrosion	3X Monaco

				2-NG-410-C51	External corrosion	3X Monaco
				4-FS-3-B51	External corrosion	3X Monaco
	ANGOLA	**TOTAL ANGOLA**	Process piping reinforcement	2-DF-4-6003-B511	External corrosion	3X Monaco
				8-GT-4-1002-F511	External corrosion	3X Monaco
				2-NG-4-5101-C511	External corrosion	3X Monaco
				24-NH-4-3213-B511	External corrosion	3X Monaco
				IPN-NH-0630-17-F710	External corrosion	3X Monaco
Nov-11	Gabon	**TOTAL Gabon**	Pipe line	ligne 18'' RABI :PK 1824	Internal corrosion	3X Monaco
				PK 2138.4	External corrosion	3X Monaco
				PK 4771.88	External corrosion	3X Monaco
				PK 5332.36	External corrosion	3X Monaco
				PK 5463.13	External corrosion	3X Monaco
				PK 6031.613	External corrosion	3X Monaco
				PK 6031.903	External corrosion	3X Monaco
				PK 18139.17	External corrosion	3X Monaco
	France	**SPSE**	Pipe line	34'' L111 (line)	External corrosion	3X Monaco
				34'' L111 (bend)	External corrosion	3X Monaco
Oct-11	France	**EDF Corse**	Pipe line	4'' OLEODUC DU DPM déf N°2	External corrosion	3X Monaco
				déf N°76	External corrosion	3X Monaco
	GABON	**TOTAL Gabon**	Pipe line	12'' Coucal ô pipe 18'' jonction Rabi	External corrosion	3X Monaco
Sep-11	France	**CIM Le Havre - Antifer**	Pipe line	24''	External corrosion	3X Monaco
				42''	External corrosion	3X Monaco
					External corrosion	3X Monaco
Aug-11	France	**CIM Le Havre**	Pipe line	24'' de la couronne de refoulement du bac 80	Leak	3X Monaco
					Leak	3X Monaco
					Leak	3X Monaco
Jun-11	France	**EDF Corse**	Pipe line	4'' OLEODUC DU DPM déf N°33	External corrosion	3X Monaco
				déf N°42	External corrosion	3X Monaco
				déf N°79	External corrosion	3X Monaco
	ANGOLA	**TOTAL ANGOLA**	Process piping reinforcement	36''-FS-2001-B661	External corrosion	3X Monaco
				36''-FS-2001-B661	External corrosion	3X Monaco
				36''-FS-2001-B661	External corrosion	3X Monaco
				36''-NH-3202-B511	External corrosion	3X Monaco
				36''-NH-3202	External corrosion	3X Monaco
				18''-NH-0084-B511	External corrosion	3X Monaco
				14''-NH-1103-F511	External corrosion	3X Monaco
				16''-F2015-B661	External corrosion	3X Monaco
				16''-0059-B511/12''-NH-0059	External corrosion	3X Monaco
				10''-FS-9501-B511	External corrosion	3X Monaco
				10''-FS-9501-B511	External corrosion	3X Monaco
				6''-CF-9503-C531	External corrosion	3X Monaco
May-11	France	**SPSE**	Pipe line	34'' L105 MERLON	External corrosion	3X Monaco
				L105 5R1	External corrosion	3X Monaco
				L106 6R2	External corrosion	3X Monaco
				L106 Descente	External corrosion	3X Monaco
				L112 Descente	External corrosion	3X Monaco
				L106 MERLON	External corrosion	3X Monaco
				L112 12R1	External corrosion	3X Monaco
				L108 8R2	External corrosion	3X Monaco
				L109 9R1	External corrosion	3X Monaco
				L108 MERLON	External corrosion	3X Monaco
				L102 MERLON	Internal corrosion	3X Monaco
				L110 10R2	Internal corrosion	3X Monaco
				L104 4R1	Internal corrosion	3X Monaco
				L101	Internal corrosion	3X Monaco
Apr-11	France	**Geostock Manosque**	Pipe line	20'' sur site de GEOSEL Manosque	External corrosion	3X Monaco
				18'' line	External corrosion	3X Monaco
Jan-11	ANGOLA	**TOTAL ANGOLA**	Process piping reinforcement	36''-NH-3202-B511/232-NH-3202-1	External corrosion	3X Monaco
				36''-NH-3202-B511/41-NH-3202-3	External corrosion	3X Monaco
				18''-NH-0068-B511 (01-NH-0068-1)	External corrosion	3X Monaco

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Nov-10	France	**Geostock Perthuis**	Pipe line	20'' GSM2	Internal corrosion	3X Monaco
Oct-10	YEMEN	**Yemen LNG**	Pipe line	line 38'' gas	Dent	3X Monaco
Sep-10	ANGOLA	**TOTAL ANGOLA**	Process piping reinforcement	6''-NH-1404-D511	External corrosion	3X Monaco
				8''-NH-1210	Internal corrosion	3X Monaco
				8''-NH-1409	Internal corrosion	3X Monaco
				8''-NH-1410	Internal corrosion	3X Monaco
				10''-NH-4-0137-B511	5 External corrosion	3X Monaco
				14''-NH-1103-F511	3 External corrosion	3X Monaco
				14''-NH-1503-F511	External corrosion	3X Monaco
				16''-NH-0048-B511	External corrosion	3X Monaco
				18''-NH-0062-B511	External corrosion	3X Monaco
				18''-NH-0138-B511	External corrosion	3X Monaco
	GABON	**Perenco Gabon**		riser 6'' on Tchatamba West	Internal corrosion	3X Monaco
Aug-10	France	**CIM Le Havre**	Pipe line	42'' Ecluse François 1er : PR15	External corrosion	3X Monaco
				PR14	External corrosion	3X Monaco
May-10				PK 22773.198	External corrosion	3X Monaco

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Dec-09	GABON	**Perenco Gabon**	Pipe line	10'' Gas Pipe : Diga-Batanga au pk 29	Internal corrosion	3X Monaco
Nov-09	ANGOLA	**TOTAL Angola**	Process piping reinforcement	03-GT-1201	External corrosion	3X Monaco
				04-GH-3302	External corrosion	3X Monaco
				04-NH-3422	External corrosion	3X Monaco
				08-NH-0024	External corrosion	3X Monaco
				10-FS-9401	External corrosion	3X Monaco
				12-CD-0079	External corrosion	3X Monaco
				12-FS-8004	External corrosion	3X Monaco
				12-NH-0056	External corrosion	3X Monaco
				16-NH-051	External corrosion	3X Monaco
				16-NH-0153	External corrosion	3X Monaco
				18-NH-0082	External corrosion	3X Monaco
				32-CW-9405	External corrosion	3X Monaco
				03-GT-1201	External corrosion	3X Monaco
				16 NH 0121 B511	External corrosion	3X Monaco
				36 NH 0028 B511	External corrosion	3X Monaco

Aug-09	ANGOLA	**TOTAL**	Process piping reinforcement	12 CD 0084 B511	External corrosion	3X Monaco
				18 NH 0072 B511	External corrosion	3X Monaco
				36 NH 0028 B511	External corrosion	3X Monaco
Nov-09	CONGO	**Perenco**	Pipe line	sea line 16'' Est Mibale	External corrosion	3X Monaco
Apr-09	RDC	**Perenco RDC**	Process piping reinforcement	Line 08" oil to Antonio	External corrosion	3X Monaco
				Line 08" oil to Mibale	External corrosion	3X Monaco
				Line 10" Water Injection	External corrosion	3X Monaco
				Line 08" Gas Lift	External corrosion	3X Monaco
				Line 08" Water Injection	External corrosion	3X Monaco
				Line 06" Gas Lift	External corrosion	3X Monaco
				Line 12" Oil	External corrosion	3X Monaco