

BSP-72-STANDARD-005

**Standard For Permanent and
Temporary Repairs of
Pipeline/Pipework**

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1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this document is to establish the use of various repair methods (pressure containment), apart from the conventional like-for-like repair, for pipe work and pipelines within BSP caused by **external corrosion/damage**. It also provides guidance on the proper use of the various repair techniques by referring to the associated guidelines/references.

For external corrosion damage it is the responsibility of the Technical Authority to determine the validity period of these types of repairs.

The repair methods SHALL only be applied to pipework and pipeline anomalies where the corrosion or defect is external.

1.2 SCOPE

Various methods, apart from the conventional like-for-like repair, are being employed to repair pipework and pipelines on a regular basis. To date, there are no clear definitions to differentiate temporary from permanent repairs. Growing concerns from the field have led to the need to define them properly.

In case of conflict, The Technical Authority in OPM/12 for pipeline and SEN/63 for pipework are to be consulted for a ruling.

1.3 TERMINOLOGY

Frequently used abbreviations and terms used in this document are defined in the Management System Glossary.

1.4 DEFINITIONS

Permanent Repair

A **Permanent** repair is intended to denote those situations where repair is required to reinstate the pipe work or pipeline to *its intended service lifetime for a specific assessed period* or to *extend its fitness for purpose for a specific assessed period* after which *it shall be replaced*.

This method holds long-term pressure containment throughout the design life requirement. However, periodic visual inspection during topside On-Stream Inspection (OSI) is still essential to ensure that it has not deteriorated from its original condition.

This type of repair usually applies onto sub sea pipeline repairs where mitigations of future deterioration of the anomalies and repair method material are fully defined and implemented. The remaining wall thickness should be **more than 25%** of the original wall thickness.

Temporary Repair

A **Temporary** repair is intended to denote those situations where repair is required to *technically survive for an agreed limited period* until *next earliest committed scheduled shut down* after which *it shall be replaced*.

This type of repair usually applies onto above water and onshore pipe work and pipeline. The remaining wall thickness is **less than 25%** of the original wall thickness.

This method does not hold or guarantee long-term pressure containment.

Any repair methods that do not restore the system to 'fit for purpose' state are not acceptable and therefore they are not considered to be either a temporary or permanent repair for the purpose of this guideline.

2.0 REPAIR METHODS

The repair method is dependent on the location, service, pressure system, temperature and installation limitation.

This standard covers the following methods:

- a) Mechanical Connector Repair (PYPLOK)
- b) Composite Repair
- c) PII Epoxy Sleeve Repair
- d) Smart Flanges
- e) Clamp Repairs using *Plidco Clamp*, "*Home-made*" Clamps and *Straud-Plast-Grip* and *Straud-Combi-Grip*

2.1 MECHANICAL CONNECTOR REPAIR (PYPLOK)

This repair is defined as a permanent repair. Mechanical Connector fittings are available in small bores only i.e. DN15 to DN50. Stainless steel Mechanical connector are recommended for repair/replacement work of existing corroded small bore piping and new installations of small bore piping (if economically justified). Carbon steel Mechanical connector can be used for "emergency repair work" of existing Carbon Steel small-bore pipes.

The stainless steel Mechanical connector is currently considered satisfactory for class 150# and 300# piping up to DN50.

The carbon steel Mechanical connector is currently considered satisfactory for class 150# and 600# piping up to DN50 and only used for "emergency repair work" of the existing carbon steel pipes.

Mechanical connector shall not be used in high-pressure fluid service which includes class 600# and above, high temperature system, high corrosion rate, lethal service and systems with significant cyclic behaviour such as vibration, pulsation and temperature variation. For any requirement on higher-pressure services, OPM/12 and SEN/63 need to be consulted.

Notes: -

1) **Stainless steel Mechanical connector** should be utilised for repair/replacement of **existing stainless steel** small bore piping.

2) **Carbon steel Mechanical connector** should be utilised for repair/replacement of **existing carbon steel** small bore piping.

2.2 COMPOSITE REPAIR

The following composite repair technique, type has been considered Shell Global Solution. This is as per their document [Composite repair for piping and pipeline, Qualification test program. Joint Shell OU sponsored project GS.06.51357 RISTRICATED – ECCN EAR 99.](#)

NOTE: Where all composite repair below only apply at temperature of 65 degree Celcius.

2.2.1 TDW (Black Diamond)

The TDW system (so-called Black diamond) has been developed by T.D.Williamson and consists of carbon fibre (weave) reinforced with epoxy, and providing high strength in both the hoop and axial direction. More details about the TDW system are given in Table below: -

Details of TDW system, as given by the manufacturer

Description	Property
Steel surface - primer	Epoxy resin
Filler material (external defects)	Epoxy putty
Reinforcement fibres	Carbon fibre (weave)
Matrix material - resin	Epoxy
Thickness over-wrap	
- through-the-wall defect	- 3.5mm
- external defect	- 5mm
Hoop tensile strength	758MPa
Axial tensile strength	191MPa
Hoop tensile modulus	67GPa
Axial tensile modulus	14.7GPa

Note:

- Where appropriate TA consultation and reference to anomaly report will be required.
- Specific request for the Higher Pressure class 1500# system, from the relevant Technical Authority in **OPM/12 (Piping/pipeline) or SENI/62/63 (Piping/pipeline)** which will be dealt with on a case by case basis.

2.2.2 Synthoglass

The Synthoglass system consists of glass-fibre (woven tape) reinforced with "water-activated" urethane resin. More details about the Synthoglass system are given in table below: -

Details of Synthoglass system, as given by the manufacturer

Description	Property
Steel surface - primer	Epoxy, aliphatic amine cured
Filler material (external defects)	Kevlar filled epoxy putty, aliphatic amine cured
Reinforcement fibres	E-glass (woven tape)
Matrix material	Aliphatic amine cured epoxy
Thickness over-wrap	
- through-the-wall defect	- 9mm
- external defect	- 9mm
Tensile strength	250MPa

Note:

- Where appropriate TA consultation and reference to anomaly report will be required.
- Specific request for the Higher Pressure class 1500# system, from the relevant Technical Authority in **OPM/12 (Piping/pipeline) or SENI/62/63 (Piping/pipeline)** which will be dealt with on a case by case basis.

2.2.3 Strongback

The Strongback system consists of glass-fibre reinforced tape, impregnated with a proprietary water-activated urethane resin. For proper bonding on a wet surface, an aliphatic polyamine curing epoxy, filled with Kevlar fibres, is used. More details about the Strongback system are given in table below: -

Details of Strongback system, as given by the manufacturer

Description	Property
Steel surface - primer	Polyamine cured epoxy
Filler material (external defects)	Kevlar fibre filled polyamine cured epoxy
Reinforcement fibres	E-glass woven tape
Matrix material	Water activated urethane
Thickness over-wrap - external defect	- 13mm
Tensile strength	420MPa
Tensile modulus	25.8GPa

Note:

- Where appropriate TA consultation and reference to anomaly report will be required.
- Specific request for the Higher Pressure class 1500# system, from the relevant Technical Authority in **OPM/12 (Piping/pipeline) or SENI/62/63 (Piping/pipeline)** which will be dealt with on a case by case basis.

2.2.4 Clock spring

The Clock Spring system is a pre-manufactured, standard 12" wide glass fibre reinforcement polyester coil, and fibres oriented in the hoop direction. The Clock Spring system is not designed for the repair of potentially leaking defects. Curved components, e.g. bends, may be repaired using Clock Spring, but only when radius is greater than 3 times the diameter. More details about Clock Spring system are given in table below: -

Details of Clock Spring system, as given by the manufacturer

Description	Property
Steel surface - primer	No
Filler material (external defects)	Epoxy putty
Reinforcement fibres	E-Glass (rovings)
Matrix material - resin	Ispophthalic polyester
Primer - adhesive	Toughened methacrylate
Thickness over-wrap	15mm
Hoop tensile strength	517MPa
Hoop tensile modulus	34GPa
Axial tensile modulus	9.1GPa

Note:

- Where appropriate TA consultation and reference to anomaly report will be required.
- Specific request for the Higher Pressure class 1500# system, from the relevant Technical Authority in **OPM/12 (Piping/pipeline) or SENI/62/63 (Piping/pipeline)** which will be dealt with on a case by case basis.

The following composite repair technique, type has **NOT** been considered Shell Global Solution. This is as per their document [Composite repair for piping and pipeline, Qualification test program. Joint Shell OU sponsored project GS.06.51357 RISTRICED – ECCN EAR 99.](#)

2.2.5 Armor Plate

The Armor plate system consists of continuous glass fibre (fabric) reinforced epoxy resin. More details about the system are given in Table below: -

Details of Armor Plate system, as given by the manufacturer

Description	Property
Steel surface - primer	Polyamide cured epoxy
Filler material (external defects)	Epoxy putty
Reinforcement	E-glass (fabric)
Matrix material – resin	Polyamide cured epoxy
Thickness over-wrap	
- through the-wall defect	- 12.5mm
- external defect	- 5.5mm
Tensile strength	177MPa
Tensile modulus	10GPa

Note:

Where appropriate TA consultation and reference to anomaly report will be required.

2.2.6 Diamant

The Diamant system has been designed for the repair of “through-the-wall” defects in pipelines and piping systems, and consists of wire-mesh reinforced putty material (UltraMetal 1250). More details about the Diamant system are given in table below: -

Details of Diamant system, as given by the manufacturer

Description	Property
Steel surface - primer	No
Filler material (external defects)	UltraMetal 1250
Reinforcement	Steel wire mesh
	- serie 1: one layer wire mesh.
	- Serie 2: three layer wire mesh.
Matrix material	UltraMetal 1250
Thickness	5 to 11mm
(*) Hoop tensile strength	48MPa (one wire-mesh layer)
(*) Hoop tensile modulus	5.5GPa (one wire-mesh layer)

(*) The tensile properties of Diamant material reinforced with one layer of wire-mesh where not given by the Manufacturer. Therefore a tensile test was performed in-house.

Application of a composite for the repair of a piping system with a “through-the-wall” defect should therefore be considered as a temporary repair option. Only when long-term regression tests have been performed, design lift may be extended.

Note:

Where appropriate TA consultation and reference to anomaly report will be required.

2.3 PII EPOXY SLEEVE REPAIR

This repair is defined as a permanent repair. The sleeve repair method involves clamping a split sleeve around the damage section. By this method a leak can be contained. When the pipeline is dented or buckled to the extent that it does not allow passage of pig, the method obviously cannot be used.

2.4 SMART FLANGES PLUS CONNECTORS

A better mechanical joint is the Smart Flanges marketed by Oceaneering/Hydratight. For underwater repair, the use of smart flanges would be the chosen methods. This can be considered as permanent repair mainly for pipeline. Please refer to the respective Technical Authority for specific use and suitability.

2.5 CLAMP REPAIRS

There are three types of clamps which are currently used in BSP. They are:

- Plidco clamp repair
- ‘home-made’ clamp repair
- Straud-Plast-Grip and Straud-Combi-Grip Repair

This repair method shall be applied to pipeline and piping leakages or anomalies where:

- The rest of the pipeline/piping section is in good condition.
- The repair is on the straight section of pipeline and piping whereby clamp installation is adequate.
- Local external corrossions are arrested.

This repair method is not allowed to be used to repair leakages or anomalies or defects on fittings such as flanges, equal tees, bends, etc.

2.5.1 PLIDCO CLAMP REPAIRS

Repairs to be performed with fully rated Plidco clamps are defined as temporary repair: See Appendix 1 for details.

This repair method shall be applied to pipeline and piping leakages or anomalies where:

- The rest of the pipeline/piping section is in good condition.
- The repair is on the straight section of pipeline and piping whereby clamp installation is adequate.
- Local external corrossions are arrested.

This repair method is not allowed to be used to repair leakages or anomalies or defects on fittings such as flanges, equal tees, bends, etc.

2.5.2 'HOME-MADE' CLAMPS REPAIR

This is a temporary repair method. Application shall only be made to low pressure liquid systems operating less than 2500 kPa. A variance shall be raised in FSR (Facility Station Report).

2.5.3 STRAUD-PLAST-GRIP AND STRAUD-COMBI-GRIP REPAIR

This is a permanent repair, but is only limited to potable and fire water system. The maximum operating pressure shall be less than 2000 kPa for all system. Produced water service is not allowed. Please refer to the respective Technical Authority for specific use and suitability.

3.0 DATA MANAGEMENT & STORAGE

The repair application will be recorded in CIRRAS II. Periodic maintenance and planned replacement will be based on the CIRRAS II data.

4.0 REFERENCES

When referring to the following publications, the latest issues only shall be used.

BSP Documents

- BSP-72-PR-010-03 : Control of Temporary Repairs .
BSP-72-P-011 : Emergency Pipeline Repair System.
BSP-12.G.101 : Guideline to Pipeline Engineering .
BSP-71-P-001 : Variation Control Procedure .
EDE12/STDVAR/99/02 : Use of Lokring Fittings - dated 12/4/99

Design and Engineering Practice (DEPs)

DEP 31.40.60.12-Gen Pipeline Repairs (Supplement to ANSI/ASME B31.4 and B31.8)

SIEP Reports

SIEP 99-5808 Composite Over-Wrap Repairs Part 2: Design Guideline Nov 1999

APPENDIX 1

A. PLIDCO CLAMP REPAIRS

Repair Type	Service	Status of Repair	Restriction/ Time Period	Maintenance Philosophy	Remarks
Plidco Clamp (Above Water /Above Ground)	Hydrocarbon	Temporary	Not to be used on Flanges, Equal Tees, Bends etc	1)Registered in CIRRAS. 2)On stream Inspection (OSI) /External Visual for every 2 years during or campaign period. 3) Conventional replacement to be made within 4 years.	Mainly use for External Defect or Corrosion. Up to class 1500#, Hydrocarbon services. Requires External Painting for above ground Installations.
Plidco Clamp (Above Water /Above Ground)	Non-Hydrocarbon (e.g water)	Temporary	Not to be used on Flanges, Equal Tees, Bends etc	1)Registered in CIRRAS. 2)On stream Inspection (OSI) /External Visual for every 2 years during or campaign period. 3) Conventional replacement to be made within 4 years.	Mainly use for External Defect or Corrosion. Up to class 1500#, Non-Hydrocarbon services. Requires External Painting for above ground Installations.

Repair Type	Service	Status of Repair	Restriction/ Time Period	Maintenance Philosophy	Remarks
Plidco Clamp (Under Ground)	Hydrocarbon & Non-hydrocarbon	Temporary	Not to be used on Flanges, Equal Tees, Bends etc	1)Registered in CIRRAS. 2) 2 yearly Visual Inspections or campaign period. 3) Conventional replacement to be made within 4 years.	Mainly use for External Defect or Corrosion. Up to class 1500#, Hydrocarbon & Non-Hydrocarbon services. Requires CP systems for buried Installations

Repair Type	Service	Status of Repair	Restriction/ Time Period	Maintenance Philosophy	Remarks
Plidco Clamp (Under Water)	Hydrocarbon & Non-hydrocarbon	Permanent	Not to be used on Flanges, Equal Tees, Bends etc	Registered in CIRRAS. Not expect to deteriorate due to CP application (Cathodic Protection)	Mainly use for External Defect or Corrosion. Up to class 1500#, Hydrocarbon & Non-Hydrocarbon services. Requires Sacrificial Anodes for Underwater.

Note:

- Specific request for the Higher Pressure class 1500# system, from the relevant Technical Authority in **OPM/12 (Piping/pipeline) or SENI/62/63 (Piping/pipeline)** which will be dealt with on a case by case basis.
- Number of clamps installed on the same line or system, this to be advised by the relevant Technical Authority.

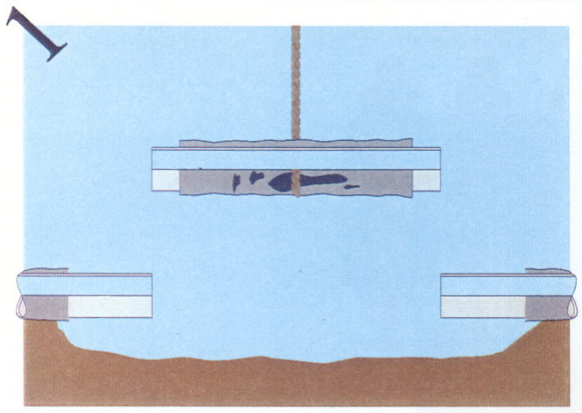
Above water/Above Ground –The Risk to People, Environment and Asset are HIGH due to leak/failure through the seal. Seal on the PLIDCO will deteriorate with time especially exposed to surface environment.

Under water/Under Ground – The Risk to People and Asset are LOW for under water and under ground line/services. If the seal on the PLIDCO fail or leak, potential exposure to environment can be rectified quickly.

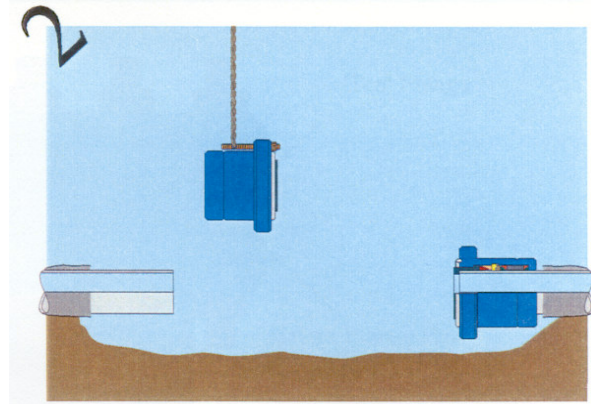
APPENDIX 2

A. REPAIRS OF PIPELINE SECTION USING MECHANICAL

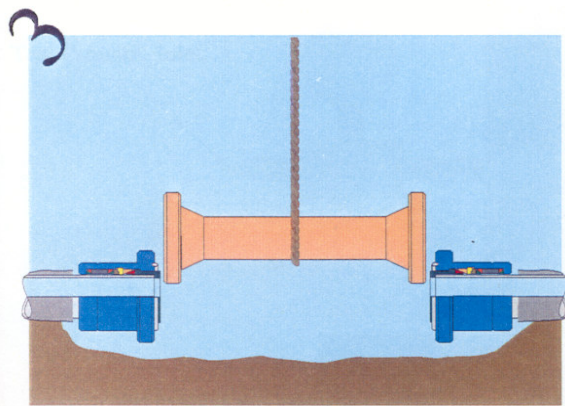
REPAIR OF PIPELINE SECTION USING MECHANICAL CONNECTOR



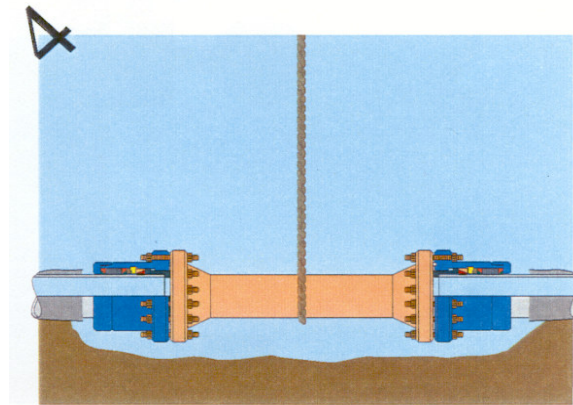
The concrete protective coating has been removed. The pipeline has been cut in two places and the deteriorated section is being hoisted away.



The ends of the pipeline have been cleaned more than the length of the Smart Flange Plus.



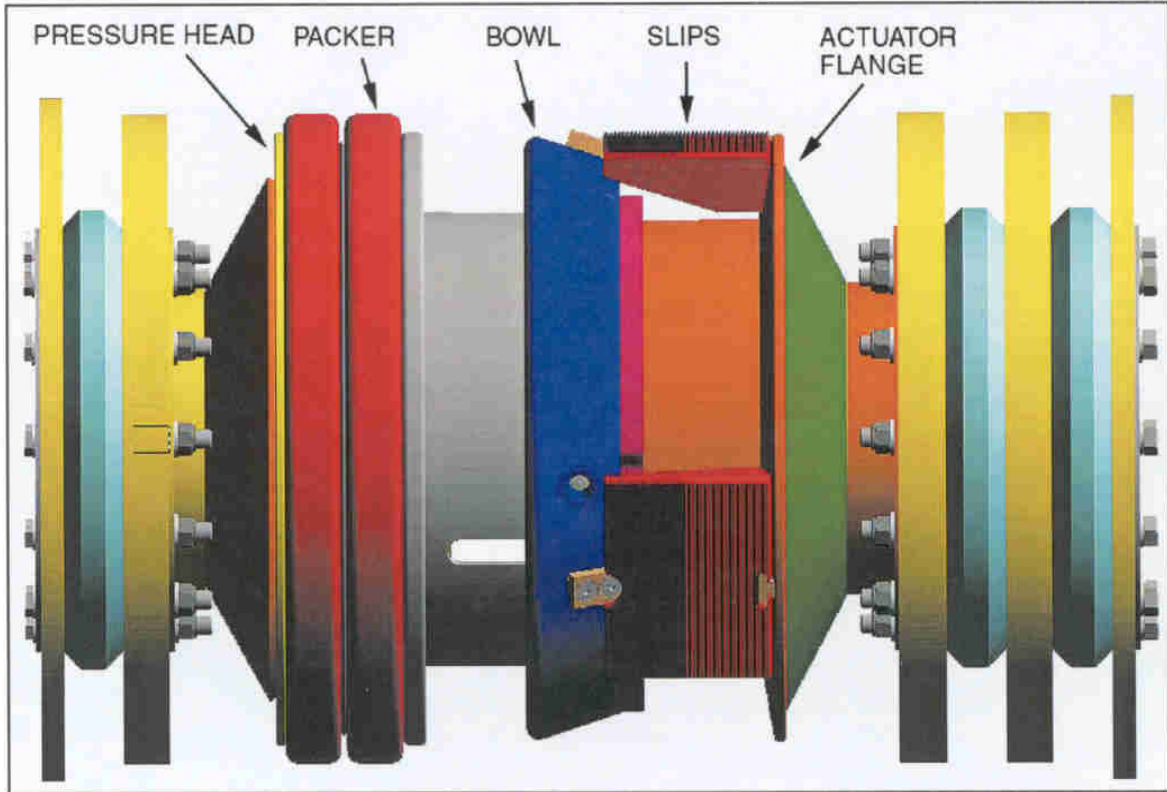
With both Smart Flange Plus's placed the spoolpiece (flanged section) replacement is descending.



The Smart Flange Plus on the left has been set. The Smart Flange Plus on the right was pulled to the replacement section by the tightening of the nuts on the replacement flange.

B. SMART PLUG FOR ISOLATION OF

SMART PLUG FOR ISOLATION OF PIPELINE



C. PLIDCO CLAMP FOR PERMANENT REPAIR OF

PLIDCO CLAMP FOR Permanent REPAIR of subsea lines



D. SMART FLANGE PLUS WITH MAF

Smart Flange Plus With MAF

