

GENERAL SPECIFICATION

PIPING VALVES VESSELS

GS EP PVV 711

Composite repairs for metallic pipeworks and pressure vessels

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1. Scope

Generalities

This General Specification is applicable for the design, material selection, qualification and installation of Nonmetallic Composite Repair systems as per ASME Post-Construction Standard [ASME PCC-2](#).

It applies for the repairs of metallic equipment and piping within the scope of ASME Codes and Standards after they have been placed in service.

These repairs are temporary but may be extended, subject to periodic inspection and re-assessment.

It is limited to above ground, non buried, non immersed pipework and pressure vessels used in the petroleum, petrochemical and natural gas industries.

This Specification is not applicable for the repair of GRP components.

The repair on toxic or sour service system is not recommended and shall be subject to Company Approval. The defect piping / pressure vessels need to be replaced as soon as possible.

This Specification is not applicable for arctic environment (below -40°C for ambient temperature) and for repair on cryogenic services (below -50°C metal temperature at external surface) unless specific derogation.

For such case when the pipe is exposed to permanent negative temperatures and insulated, the Repair System and wrapping technique shall be specifically assessed for those conditions.

This General Specification deals with the technical requirements only, administrative or policy requirements are outside the scope of this specification.

The specification does not intend to address all the safety concerns associated with its use.

It is the specification user responsibility to establish appropriate safety and health practices prior to use.

Where equipment repair is subject to jurisdictional regulation, jurisdictional approval may be required.

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Applicability

Inspection and flow evaluation shall be done carefully to assess the type and extend of defect.

This General Specification covers the repair of the defects listed in the Table 1 below:

Table 1 - Applicability of Nonmetallic Composite Repairs on metallic components

Type of defect	Applicability	Comments
General wall thinning	Y: External phenomenon only	Not allowed for internal phenomenon since there is no possibility to monitor the wall thickness evolution after repair
Local wall thinning	Y: External phenomenon only	
Pitting	Y: External phenomenon only	
Gouges / Dents	R: External phenomenon only	Not allowed for internal gouges / dents
Blisters	Y	
Laminations	Y	
Cracks	Not allowed	
Through-wall defect	Not allowed	

Y = Generally appropriate

R = May be used, but requires special cautions (see paragraph 1.2 below).

2. Reference documents

The reference documents listed below form an integral part of this General Specification.

Any conflicting requirements between this specification and any other relevant document shall be reported to the Company for decision. In any case, and notwithstanding the final decision of the Company, the most stringent requirements is always first meant to govern.

External Documents

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and addendums, is the latest revision published at the effective date of this document.

The basic code is the [ASME PCC-2](#).

Reference	Title
API 579-1 / ASME FFS-1	Fitness for Service
ASME BPVC Section VIII	Rules for Construction of Pressure Vessels
ASME B31.3	Process Piping
ASME PCC-2	Repairs of pressure equipment and piping - Part 4: Non Metallic and bonded repairs - Article 4.1: Non metallic Composite Repair Systems: High-Risk applications.
ISO 24817	Petroleum, petrochemical and natural gas industries - Composite repairs for pipework - Qualification and design, installation, testing and inspection

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Reference	Title
ISO 4624	Paints and Varnishes - Pull-off test for adhesion
ISO 8501-1	Preparation of steel substrates before application of paints and related products - Visual assessment of surface cleanliness - Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrate after removal of previous coatings
ISO 8503-4	Preparation of steel substrates before application of paints and related products - Surface roughness characteristics of blast-cleaned steel substrates - Part 4: Method for the calibration of ISO surface profile comparators and for the determination of surface profile - Stylus instrument procedure

Total General Specifications

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and addendums, is the latest revision published.

Reference	Title
GS EP COR 350	External protection of offshore and coastal structures and equipment by painting
GS EP SAF 337	Passive Fire Protection: basis of design

3. Terms and Definitions

The terms and acronyms used in this General Specification are defined in the [ASME PCC-2](#) Part 4 Article 4.1 Appendix A with the following amendments:

Owner: Organization that owns or operates the substrate to be repaired.

Company: The Group, Headquarter or the Affiliate.

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4. Amendments to ASME PCC-2

The rest of this General Specification is based on the [ASME PCC-2](#), Part 4 Article 4.1. Non Metallic Composite Repair systems: High Risk Applications

The paragraph and appendices numbering follows the [ASME PCC-2](#) Part 4 Article 4.1.

Additional paragraphs and appendices are provided to list additional Company requirements.

Any derogation to this General Specification shall be subject to the Managing Entity review and approval through formal derogation request.

1. Description

1.1 Scope

The paragraph 1.1 of the [ASME PCC-2](#) Part 4 Article 4.1 fully applies with the limitations defined in the previous Section A Scope.

1.2 Applicability

This paragraph is amended as follows:

- (a) This Article is applicable to a variety of straight components for piping or equipment:
 - (1) The repair of pipework originally designed in accordance with [ASME B31.3](#).
 - (2) The repair of cylindrical pressure vessels originally designed in accordance with [ASME BPV Section VIII](#) Code.

Other configuration such as pipe fittings (elbows, tees, reducers, etc.) or pressure vessel heads and components shall be subject to Company approval.
- (b) The Repair System qualification, design, installation, and operational requirements provided in this Article covers situations involving damage commonly encountered in fluid systems.
- (c) The following type of defect can be repaired (and are assessed in paragraph 3.3.3 including its amendment):
 - (1) External corrosion (general and local wall thinning, pitting) where structural integrity is compromised. In this case, the corrosion process shall be stopped first. Then the repair system and its application shall prevent any external ingress that could re-start the corrosion phenomenon or impair substrate / composite interface.
 - (2) External damage such as dents, gouges, fretting, or wear at supports subject to special cautions (i.e. assessment whether application of the repair will stop any possible future defect growth).
 - (3) Blisters and laminations.

The composite repair is not allowed for the following types of defect:

- Crack(s)
- Either internal corrosion or internal erosions

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- Leaks/through wall defect
- Defect during manufacturing or fabrication; this defect shall be repaired directly in the fabrication shop.

In addition, composite repairs are not allowed for any system subject to transient load, surge, slug, water hammer, pulsation, vibration, etc.

Repair on systems subject to cyclic loads are subject to derogation.

- (d) Internal fluids and external environments affect the compatibility of the composite. The pressure / temperature limits are dependent on the type of damage being repaired and the Repair System being used. These limits are determined by the testing and qualification requirements of this Article. A Lower temperature of -50°C can be assumed unless a lower temperature capability is through qualification testing.
- (e) This Article applies to repairs of metallic (substrate) materials only.
- (f) Wrapping composite repair shall encompass the full circumference of the component; repair by patch is not allowed.
- (g) The composite repair thickness is limited to $D/12$ (D being the original outside diameter of the component).
- (h) Composite repair is limited to 600 mm (24") diameter; for larger diameter specific derogation shall be established.

1.3 Risk Assessment

A comprehensive risk assessment shall be performed by the Owner before to implement any composite repair.

The paragraph 1.3 of the [ASME PCC-2](#) Part 4 Article 4.1 is fully applicable with the following additional requirement:

The design conditions for the component and contents shall be confirmed by the Owner.

The minimum and maximum operating permanent temperatures can be used instead of the design temperature at the Owner discretion.

The Owner shall evaluate the access limitation to the welds included in the repaired area (i.e. welds covered by the composite material) for future inspections.

1.4 Repair life

The paragraph 1.4 of the [ASME PCC-2](#) Part 4 Article 4.1 is fully applicable with the following additional requirements:

For repair life exceeding one (1) year, the Repair System shall be qualified with long term performance tests at the qualification temperature.

For repair life exceeding two (2) years, a comprehensive risk assessment, in accordance with the previous section 1.3, and supported by proven periodical inspections shall be performed by the Owner. The frequency of the risk assessment shall not exceed two (2) years.

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1.5 Defect Assessment

The paragraph 1.5 of the [ASME PCC-2](#) Part 4 Article 4.1 is amended as follows:

Defect assessment in the host component shall be performed with the [API 579-1 / ASME FFS-1](#). The assessment's methodology defined in Annex B1 [API 579-1 / ASME FFS-1](#) shall be subject to Company approval.

When the defect assessment methodology is beyond the limit of all these code/standard, the other proposed method shall be submitted to Company for review and approval.

2. Limitations

2.1 Additional requirements

Part 1 of the [ASME PCC-2](#) is applicable with the additional requirements and limitations defined in this General Specification.

2.2 Qualification

The paragraph 2.2 of the [ASME PCC-2](#) Part 4 Article 4.1 is fully applicable with the following additional requirements:

- (d) The Repair System supplier shall state the type of defects (as listed in the Table A Applicability of Nonmetallic Composite Repairs on metallic components) for which their Repair System has been qualified against.
- (e) Additional qualification tests as described in Appendix 2 shall be performed.

2.3 Installation

The paragraph 2.3 of the [ASME PCC-2](#) Part 4 Article 4.1 fully applies.

3. Design

3.1 Symbols

The paragraph 3.1 of the [ASME PCC-2](#) Part 4 Article 4.1 fully applies.

3.2 Repair System Qualification data

The paragraph 3.2 of the [ASME PCC-2](#) Part 4 Article 4.1 is amended as follow:

- (a) Qualification of the Repair system shall be completed in accordance with Table 1 "Repair System Required Material and Performance Properties", Mandatory Appendix II and Appendix 2.

In-plane shear modulus, impact performance, energy release rate tests are mandatory for Type B design case.

The optional long-term lap shear performance test and long-term strength test become mandatory depending on the repair life (see previous paragraph 1.4).

Chemical compatibility test is mandatory depending on the service environment defined by the Owner.

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Electrical conductivity test is mandatory where the substrate is insulating, e.g., glass FRP, and electrical conductivity requirements are specified by the Owner.

- (b) All components (e.g., primer, load transfer material and composite) of the Repair System shall be tested to define thermal performance.
- (c) Materials performance and test data shall be measured by a certified or internationally accredited test facility or certified by a registered Professional Engineer.
- (d) Repair system qualification data shall be measured for a representative member of each family of substrate materials (e.g. carbon steel, low and high alloy steel, stainless steel, duplex,) for which qualification for use of the Repair System is desired.

3.2.1 Basic Material Documentation

The paragraph 3.2.1 of the [ASME PCC-2](#) Part 4 Article 4.1 fully applies with the following additional requirement:

- (c) Carbon FRP laminates are not allowed for the composite repairs.

3.2.2 Surface Preparation

The paragraph 3.2.2 of the [ASME PCC-2](#) Part 4 Article 4.1 fully applies with the following additional requirement:

The grade of cleanliness ([ISO 8501-1](#)) of the surface preparation and its roughness ([ISO 8503-4](#)) shall be recorded.

3.2.3 Short Term Test Data

The paragraph 3.2.3 of the [ASME PCC-2](#) Part 4 Article 4.1 fully applies with the following additional requirement:

- (d) The energy release rate is mandatory for Type B design case.
- (e) Material and performance properties required by the previous paragraph 3.2 shall be provided.

3.2.4 Long-Term Test Data

The paragraph 3.2.4 of the [ASME PCC-2](#) Part 4 Article 4.1 fully applies with the following additional requirement:

- (a) (2) The long-term tensile strain of the repair laminate is mandatory.
- (c) Material and performance properties required by the previous paragraph 3.2 shall be provided.

3.3 Required Data

The paragraph 3.3 of the [ASME PCC-2](#) Part 4 Article 4.1 fully applies.

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3.3.1 Original Equipment Design Data

The paragraph 3.3.1 of the [ASME PCC-2](#) Part 4 Article 4.1 fully applies with the following additional requirements:

- The original equipment design data shall be cross checked and updated in consistency with those actually installed.
- The piping stress analysis shall be provided. The loading used for composite repairs design shall be checked with the output from piping stress analysis.

3.3.2 Maintenance and Operational History

The paragraph 3.3.2 of the [ASME PCC-2](#) Part 4 Article 4.1 fully applies.

3.3.3 Service Condition Data

The paragraph 3.3.3 of the [ASME PCC-2](#) Part 4 Article 4.1 fully applies with the following additional requirement:

- (d) MAWP/MAOP/MOP as stated by the Owner or as calculated according to the requirements of [API 579-1](#) / [ASME FFS-1](#). When the methodology is beyond the limit of all these code/standard, the other proposed method shall be submitted to Company for review and approval.

3.4 Design Methodology

3.4.1 Overview

The paragraph 3.4.1 of the [ASME PCC-2](#) Part 4 Article 4.1 is amended as follow:

The design of the repair laminate shall be carried out using the requirements in the following sections.

- (a) There are two design cases:
 - (1) Type A Design case. Components not leaking, requiring structural reinforcement only. The following three design methods shall be used:
 - (a) Include allowance for original component where underlying substrate does not yield (see paragraph 3.4.3.1 below)
 - (b) Exclude allowance for original component (see paragraph 3.4.4 below)
 - (c) Long-term performance test data (see paragraph 3.4.5 below) where required by the repair life (see paragraph 1.4).

Notes:

- The minimum repair thickness t_{min} shall be the maximum value of the minimum repair thickness determined from the three design methods (paragraphs 3.4.3.1, 3.4.4 and 3.4.5).
- Components with a remaining wall thickness less than 2.0 mm at the end of service life shall be designed also as Type B Design case, see sub-section 3.4.1.(a)(2)(b) below.