



## Worldwide repairs carried out with PolymerMetal®

REP-# 015



Sealing of a steam pipe under pressure using MM-metal UW while the plant was still operating with a pressure of 87 psi at a temperature of 160 °C.

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REP-# 046



Sealing of a cooling water pipe made of steel without switching off the plant. Cause of the damage was material fatigue. The repair was carried out with MM-metal UW with Hardener UW3 and MM-Fabric tape (glass fibre).

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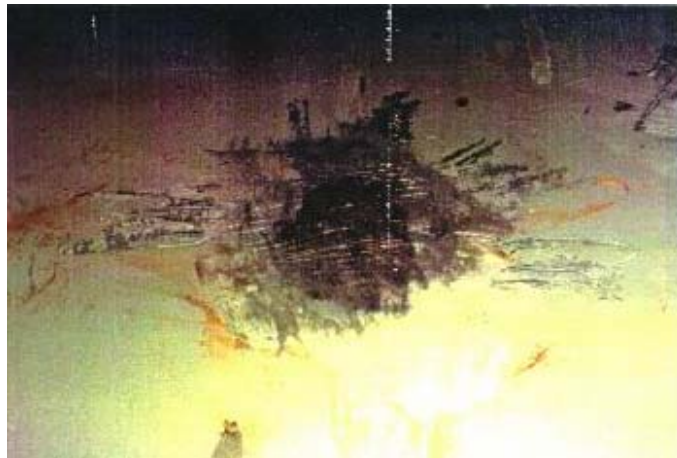
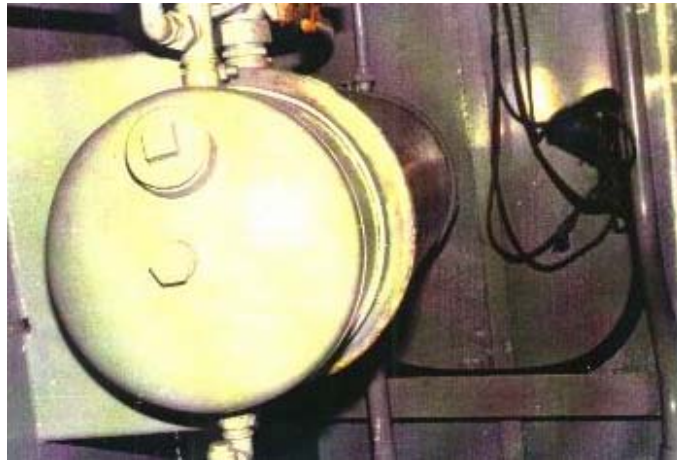
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**REP-# 050**



Sealing of an overrun container on board of a ship with MM-metal UW and Hardener UW3 respectively Hardener UW9.

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**REP-# 051**



Repair of a water piping which was under pressure by using MM-metal UW and Hardener UW3. The sealing has been carried out while water was still escaping.

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**REP-# 052**



Sealing of a warm water pipe in a heat station with MM-metal UW and Hardener UW9 together with MM-Fabric tape.

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**REP-# 053**



Leakage removal at a hydraulic pressure header tank with MM-metal UW and Hardener UW3.

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## Worldwide repairs carried out with PolymerMetal®

REP-# 054



A leakage in a cooling pipe was sealed without reducing the water pressure. The repair was carried out with MM-metal UW and Hardener UW9.

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## Worldwide repairs carried out with PolymerMetal®

REP-# 056



Sealing of a steam pipe under pressure by using MM-metal UW and Hardener UW3. Reason for the repair were cracks of welding seams caused by vibration at a working pressure of 2 bar and a temperature of 90 °C.

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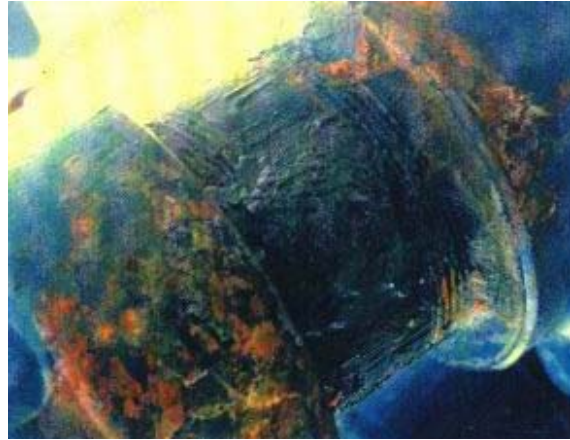


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REP-# 058



Repair of a valve at an installation pipe with MM-metal UW and Hardener UW3. The leakages have been caused by corrosion due to water and sand.

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REP-# 059



Sealing of a cooling water pipe in the high-hazard area of a high-pressure water installation without interrupting operation. The leakage was a 5 cm long crack at a water pressure of 2,5 bar. The sealing was carried out with MM-metal UW and Hardener UW3 without pressure reduction. Materials used were a pre-shaped metal sheeting and MM-Fabric tape (glass fibre).

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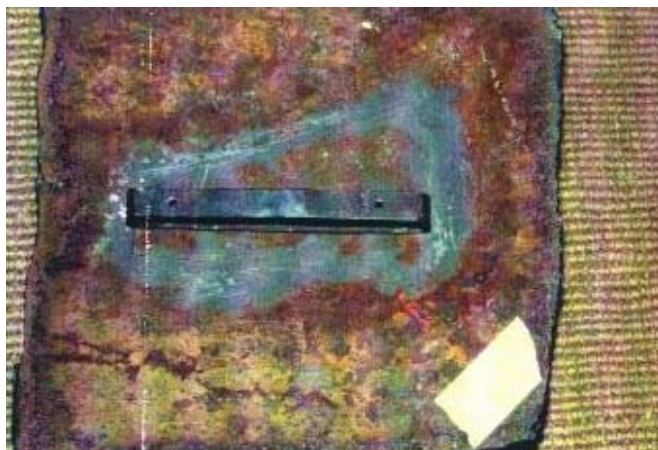
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REP-# 060



A tanker (size 15.000 GRT) loaded with petrol, touched ground. Damage was an extensive leakage with a size of 200 mm x 700 mm. The repair was carried out under water using MM-metal UW with Hardener UW9 and a metal plate.

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## Worldwide repairs carried out with PolymerMetal®

REP-# 061



A leakage at the stern of a barge was sealed under water using MM-metal UW with Hardener UW9. The repair was completed within 30 minutes time.

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## Worldwide repairs carried out with PolymerMetal®

REP-# 074



Repair of an oil / gas tank under arctic temperature. The repair was carried out with MM-metal UW and Hardener UW3 in Russia.

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**REP-# 078**



Repair of a water piping system which was under pressure using MM-metal UW and Hardener UW3.

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**REP-# 087**



Durable repair of a leakage in a piping system under water by using MM-metal UW and Hardener UW9.

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**REP-# 107**



A leaky welding seam of a sea water pump was sealed using MM-metal UW and Hardener UW9.

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REP-# 120



Sealing of a cracked pump casing at reduced water outlet using MM-metal UW and Hardener UW3.

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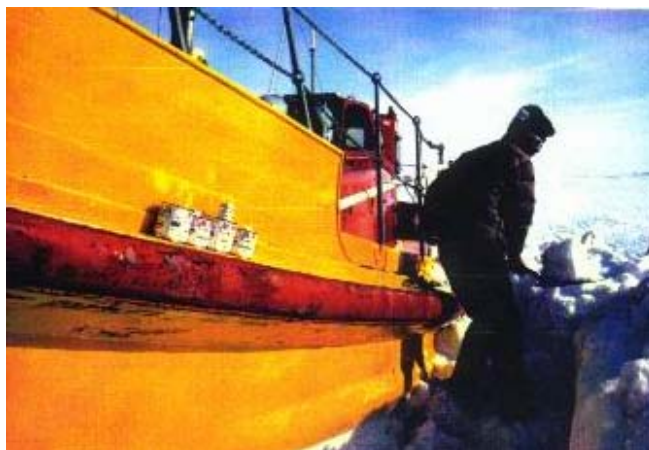
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## Worldwide repairs carried out with PolymerMetal<sup>®</sup>

REP-# 123



Repairs with MM-metal UW and Hardener UW3 are possible under arctic conditions at temperatures even down to minus 20 °C.

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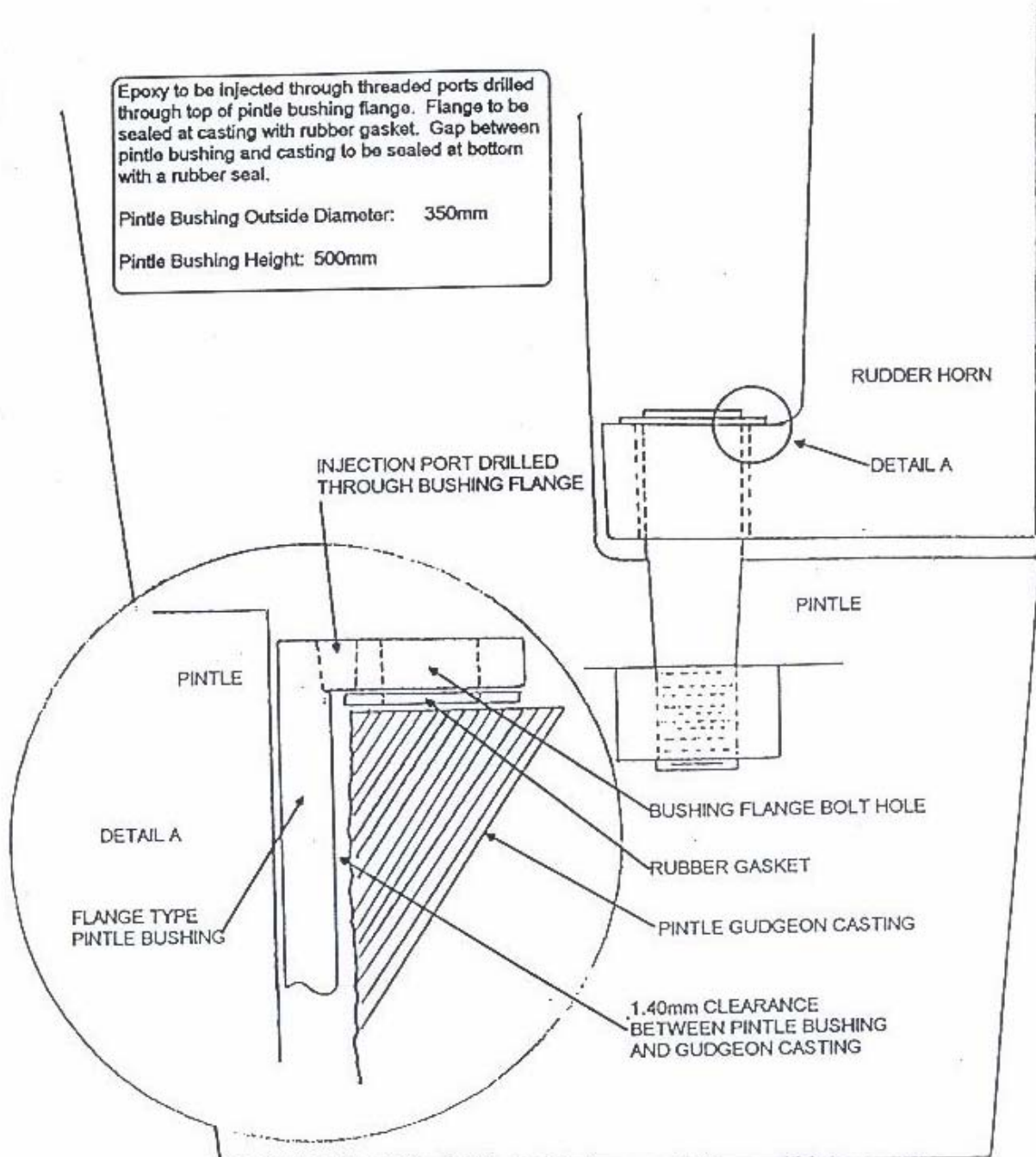


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## Worldwide repairs carried out with PolymerMetal®

REP-# 133



The seat of a vessel's pintle bushing has been restored. At first under water the pintle bushing was fixed at a temperature of 2-3 °C. Then MM-metal UW with Hardener UW9 was injected through several threaded ports drilled into the bushing flange. Here an appr. 1,4 mm clearance between pintle bushing and gudgeon casting filled. The repair was carried out by a Canadian diving company. Because of the quick total curing time of the PolymerMetal in spite of the low temperature the vessel was ready for action again within short time.

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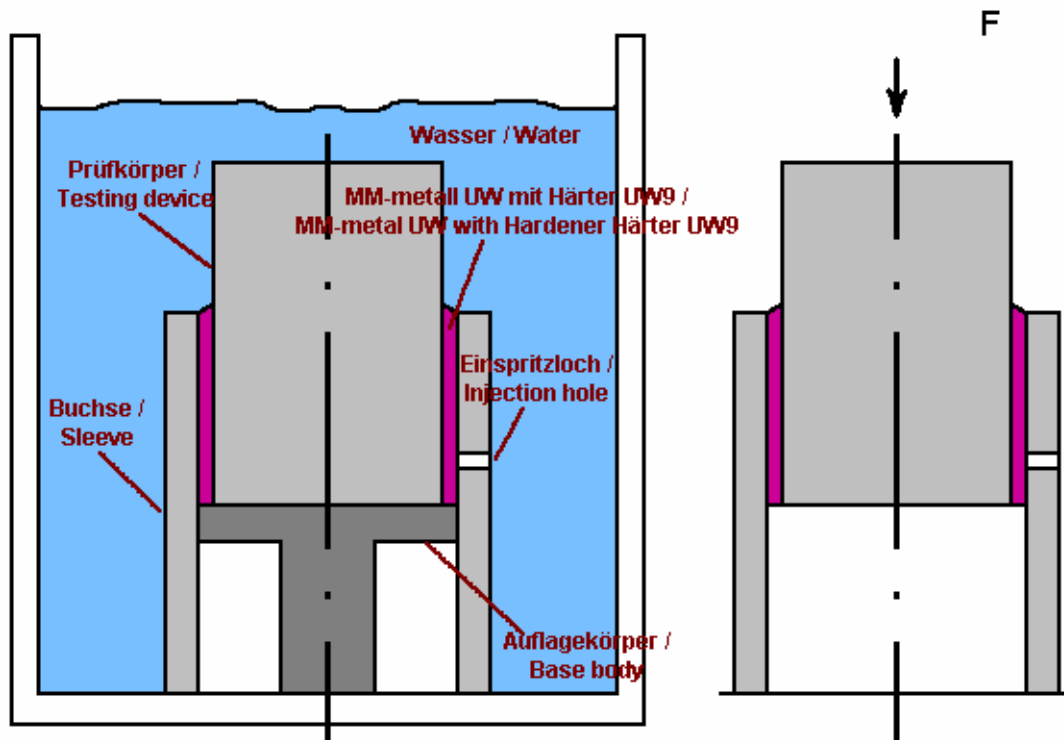
## Technical Report PolymerMetal®

### TEC-# 005

Test of the compression-shear-strength of MM-metal UW with Hardener UW9 after injection under water

### Used products

MM-metal UW with Hardener UW9



### Description

Normally MM-metal UW gets a pasty application consistency after mixing with Hardener. When a different mixing ratio (2 volumen parts MM-metal UW with 1,5 volumen parts Hardener UW) is chosen, you receive a liquid application consistency, so that the PolymerMetal can also be injected.

During the test the PolymerMetal was injected under water at a very low water temperature of 3 °C. From the changed mixing ratio and the low temperature results a pot life of appr. 65 min.

The test of the compression-shear-strength result in the following values

<b>Time of measuring</b>	<b>Compression-shear-strength</b>
6 h after injection	5,21 MPa
18 h after injection	7,80 MPa
48 h after injection	8,34 MPa

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## Technical Report PolymerMetal<sup>®</sup>

### TEC-# 007

The corrosion-chemical behaviour of PolymerMetals in combination with casting material (contact corrosion)

### Used products

MM-metal SS-steelceramic / MM-metal SQ / MM-metal SS-steel 382 / MM-metal SS-steel / MM-metal oL-steelceramic / MM-metal UW / Ceramium<sup>®</sup> / MM-metal S-steel

### Introduction

PolymerMetals are used for repairs of metallic constructions which were damaged by physical loads like tear, impact, erosion, abrasion, corrosion and cavitation or by chemical load.

Questions of customers concerning the contact corrosion of our PolymerMetals lead us to do tests.

The following report shows how the test has been carried out and what results have been obtained. Tests have been made with seven different PolymerMetals in artificial sea water (laboratory test) as well as in aggressive marshy soil. The PolymerMetals used were potentially equivalent or potentially superior to the base material (cast iron).

### Place of repair

Moorland in the North of Germany and laboratory

### Preparation of test samples

56 plates measuring 150 x 95 x 25 mm and 95 x 47 mm have been cut off cast iron. The surface of 23 plates has been treated mechanically. 2-3 bore holes of different diameters were installed in order to create different proportions between cast iron and PolymerMetals.

### General information

An ordinary salt spray test proved insufficient. As the tested PolymerMetals are non-electrical conductive products it was decided not to measure the current density potential curves. The contact resistance in the Meg-Ohm-sphere was too high.

### Test in moorland

Marshy soil is to be said very aggressive (DVGW rating no. -15 up to -19)

Reasons are:

- very low soil resistance (appr. 950-1200 Ohm x cm)
- very high salt content (chloride 800 - 1250 mg/kg / sulphate 4300 - 19000 mg/kg)
- very high moisture contents (appr. 55 - 85%)
- anaerobic conditions, proved by hydrogen-sulphide

The cast iron plates and PolymerMetals, machined and non-machined, were stored in a considerable depth of marshy soil for more than one year.

### Test in artificial see water (laboratory test)

The cast iron plates and PolymerMetals - machined and non-machined - were stored in a laboratory in considerable depth of artificial sea water (DIN 50 900) for more than one year.



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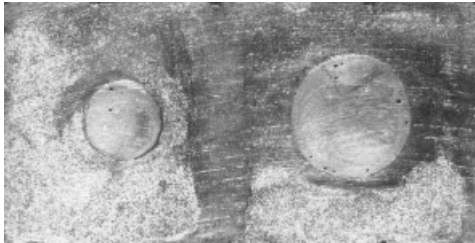
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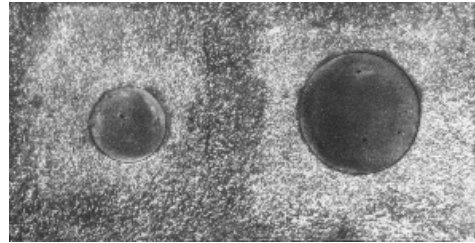
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## Samples

The following photographs show the different PolymerMetals applied to cast iron which have been partly machined after full curing. After they have been stored for 12 months in aggressive moorland or artificial sea water the samples have been examined. The following four photographs concern machined samples which have been exposed to artificial sea water:



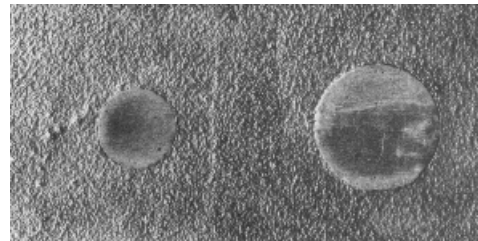
Sample MM-metal SS-steelceramic



Sample MM-metal SS-steel



Sample MM-metal oL-steelceramic



Sample MM-metal UW

## Result

The results of both tests were nearly the same. Due to the strong reaction caused by the aggressive soil or by the sea water the cast iron plates were coated with ferric hydroxide. While the surface of the cast iron plates were differently affected, the PolymerMetals still remained unchanged after storage of more than 12 months. They were only covered with rust deposit. Even peak-to-valley heights from previous treatments could clearly be recognised. There was no contact corrosion, not even at the transitional point of the PolymerMetal and the cast iron. It was proved that PolymerMetals are not electrically conductive and cannot constitute any local element with cast iron.

## Tested PolymerMetals

MM-metal SS-steelceramic  
 MM-metal SS-steel 382  
 MM-metal SS-steel  
 MM-metal SQ  
 MM-metal oL-steelceramic  
 MM-metal UW  
 Ceramium®  
 MM-metal S-steel

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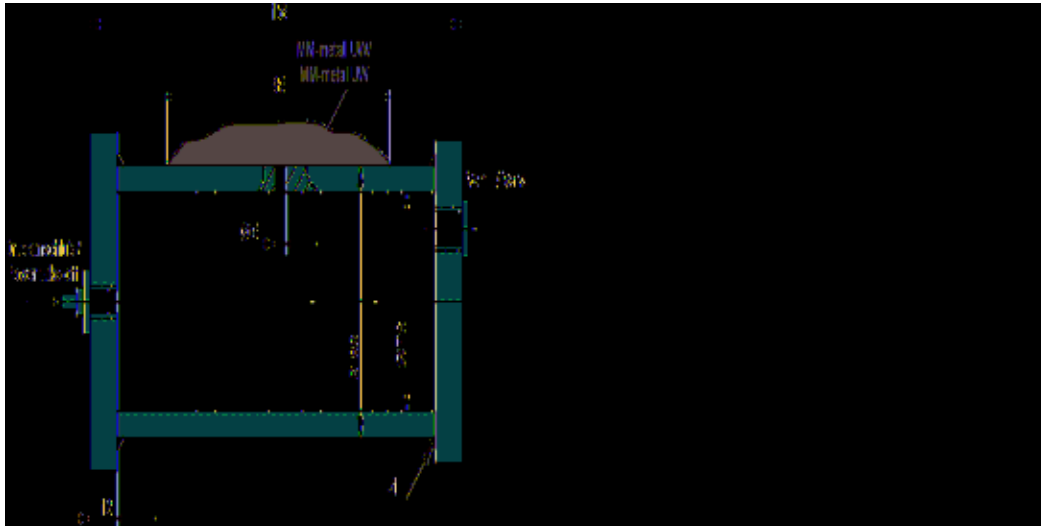
## Technical Report PolymerMetal®

### TEC-# 012

Pressure tightness test of MM-metal UW

### Used products

MM-metal UW



### Testing method:

The pressure tightness has been tested at repaired leakages at MAN-testing bodies with MM-metal UW. This test has been carried out according to the test reports of Lloyd's Register of Shipping.

### Results:

The following data are from a repair under water with MM-metal UW and Hardener UW9:

<u>Pressure</u>	<u>Data</u>
50 bar	pressure tight
100 bar	pressure tight
120 bar	after 10 min small leakage

The following data were achieved at a repair on a wet metal surface with a first layer of MM-metal UW with Hardener UW3 and a final coating with MM-metal UW and Hardener UW9:

<u>Pressure</u>	<u>Data</u>
100 bar	pressure tight
150 bar	pressure tight
200 bar	after 15 min small leakage

### Conclusion:

MM-metal UW can be used in many cases, where an application under water or on wet surfaces is required. The total curing time at 20 °C is between 10 - 60 minutes and a processing is possible up to an ambient temperature of 0 °C. Because of the a.m. technical data MM-metal UW can be used i.e. to seal leakages at water pipings, which need to resist strong pressure.

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