



**AkzoNobel**



# Maintenance and Repair Solutions for Damaged or Aged PFP

Chris Fyfe & Dave Wickham, AkzoNobel  
Institute of Corrosion, Aberdeen, 30/05/2023



## Ageing Infrastructure & PFP Deterioration

- Many facilities are operating close to, or beyond, their design life
- Written schemes of examination and ICP focus on SCEs (PFP being the last line of defence)
- Is the PFP system suitable and in good repair?
  - Degradation due to weathering (aged PFP)
  - Mechanical or process damage
  - Change of use or re-classification of the fire hazard (changes in inventory, operating pressures etc)
- Damage may be extensive – need to identify affected areas/plant most critical
- Damaged PFP may be associated with corrosion (CUF)
- M&R budgets may not be finite but do need to be economically managed
- Inspection, assessment & repair of PFP or SCE, is a legislative requirement

[PFP = passive fire protection, ICP = independent competent person, SCE = safety critical element, CUF = corrosion under fireproofing, RBI = risk-based inspections]



## Anomalies and Defects Management

- RBI inspections, and defect categorization
- Effective risk ranking, identify and rank the most critical defects for repair
- Consider any mitigation measures (active fire protection, depressurisation, fire fighting & control etc)
- Implement repair solutions that:-
  - Have demonstrable fire resistance performance (third party verified)
  - Offer the most economical advantages, material costs but probably more importantly, installation costs
  - Provide assurance of reliability



## PFP M&R Manual

1. Introduction
2. Systems Overview
3. Surface Condition
4. Priming the Surface
5. Corrosion under Fireproofing
6. PFP Systems used in Downstream Facilities
7. Typical PFP Defects
8. Akzo Nobel Repair Solutions
9. PFP over Thermal Insulation
10. Upgrading of 3-sided Beams
11. Solutions for Existing Paint Schemes

PFP Maintenance & Repair Manual – 5th draft – May 2022



# Passive Fire Protection Maintenance & Repair Manual

The on-going maintenance of in-situ fire protection systems is a critical requirement to maintain the safety and operability of process plant. Akzo Nobel has developed a number of fire protection designs to facilitate system selection and correct installation to maintain required fire resistance on existing plant and, as with newly applied PFP systems, performance is critically dependent on the correct application of the system. These guidance notes are intended to assist plant owners, process safety, engineering and applicators and are for guidance only; AkzoNobel accepts no liability for the acts or omissions of any applicators of Chartek or other PFP systems.

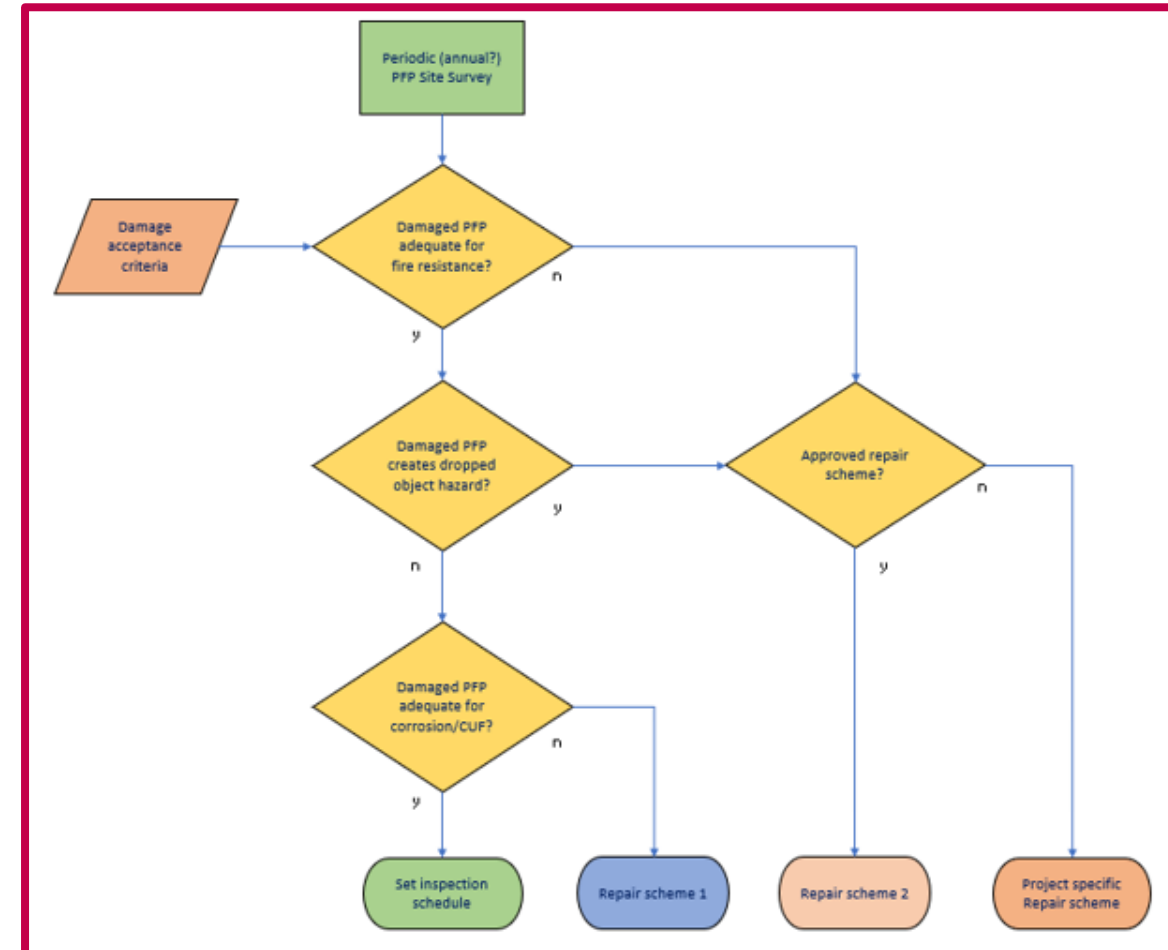
This document offers advice and guidance to ensure correct procedures are followed in M&R situations supported by Akzo Nobel and it is important that any proposed use of Chartek products should meet all requirements detailed in the relevant Chartek application manuals, which should be followed in FULL.



# Repair Solutions

Need for a repair:-


- Scheme 1 – PFP adequate for the fire case – repair solution to arrest rate of corrosion
- Scheme 2 a) – risk of dropped object hazard – repair required to remove the hazard and ensure repair is PFP functional
- Scheme 2 b) – loss of PFP functionality and corrosion concern – tested repair solution that reinstates the PFP & stops advancement of corrosion
- Scheme 3 – ‘special case’? – repair acceptable based on other criteria or requiring specific fire testing





## Repair Solutions (example solutions)

Disbonded, missing and cracked PFP – concrete / LWC:-

- **Interkote SFR** – jet and pool fire tested for over 180 mins
- Cracks up to 50mm wide
- Voids up to 900cm<sup>2</sup>
- Lloyds/UL verified

AkzoNobel 

PFP Maintenance & Repair Manual – 5th draft – May 2022

Repair System	Installation	Photos / Drawings	Limitations / Notes
Interkote FR	<p>a) Remove any adjacent loose or disbonded material back to sound fully adhered material.</p> <p>b) Prepare surface to receive Interkote FR according to section 3.2 above. The edges of the concrete/cementitious to which Interkote FR will bond to should be checked for any surface contamination - wire brushing may be required to remove more stubborn contaminants.</p> <p>c) Prime steel with approved surface tolerant primer per section 4 above. Interseal 670HS is the preferred primer.</p> <p>d) Once the primer has cured mix and apply Interkote FR in accordance with technical data sheet. Where the existing material is concrete, the exposed edges should first be wetted with clean warm water, for cementitious materials application of a PVA sealer will promote a better adhesive bond. prior. Application by hand wearing suitable gloves and should be fully compacted onto the surface building up layers of approximately 10mm. The Interkote should be brought level with the concrete/cementitious. No mesh reinforcement is required.</p>	 <p>Hand application of Interkote FR</p>  <p>Finished Interkote FR repair</p>	<p>Repair does not cover prevention of dropped object hazard. Refer to Item F</p> <p>Additional corrosion protection can be provided by inserting a vapour deposition corrosion inhibitor pellet before installation of Interkote FR.</p>


Page 18 of 38




## Repair Solutions (example solutions)

Disbonded, missing and cracked PFP – concrete / LWC:-

- **Interkote MP** – jet and pool fire tested for up to 120 mins
- Cracks up to 50mm wide
- Voids up to 800cm<sup>2</sup>
- Lloyds/UL verified

AkzoNobel 



PFP Maintenance & Repair Manual – 5th draft – May 2022

Repair System	Installation	Photos / Drawings	Limitations / Notes
Interkote MP	<p>a) Remove any adjacent loose or disbonded material back to sound fully adhered material.</p> <p>b) Prepare surface to receive Interkote MP according to section 3.2 above. The edges of the concrete/cementitious to which Interkote MP will bond to should be checked for any surface contamination - wire brushing may be required to remove more stubborn contaminants.</p> <p>c) Prime surface with approved surface tolerant primer per section 4 above. Interseal 670HS is the preferred primer</p> <p>d) Once the primer has cured apply Interkote MP in accordance with technical data sheet. Application by hand wearing suitable gloves should ensure the material is firmly pressed onto the surface and onto the concrete/cementitious edges. The required depth is achieved in 1 application only.</p>	 <p>Finished Interkote MP crack repair</p>	<p>Repair does not cover prevention of dropped object hazard. Refer to Item F</p> <p>Where mechanical surface preparation is not possible corrosion protection can be provided by inserting a vapour deposition corrosion inhibitor pellet before installation of Interkote MP.</p>

## Repair Solutions (example solutions)

### Dropped Object Hazard:-

- GRP wrap + Chartek 7E @2mm
- Chartek/Benarx Encasement system (pipe shell, epoxy box)

Item F	EXISTING PFP / SUBSTRATE	DEFECT / ANOMALY TYPE	
	Dense concrete or cementitious PFP / carbon steel	Dropped Object Hazard	
Repair System	Installation	Photos / Drawings	Limitations / Notes
Chartek 7E & GRP Overwrap	<p>a) Damaged/loose concrete/cementitious should be left in place.</p> <p>b) Cut the GRP material so that there is a minimum 50mm overlap around the perimeter of the section being wrapped</p> <p>c) The GRP should be pulled tight around the damaged PFP and then left to cure. Cure time is dependent on good light levels which should be between 1-2 hours. Any top protective layer should be removed to leave a matt surface finish</p> <p>d) Once the GRP is fully cured, apply Chartek 7E at minimum 2mm directly to the matt surface of the GRP. No primer is required</p>	 <p>Damaged &amp; loose concrete @ L, wrapped section, GRP &amp; Chartek 7E @ R</p>	Refer to the GRP manufacturers manual for application instructions
Benarx Boxes & Pipe Shells	<p>a) Damaged/loose concrete/cementitious should be left in place.</p> <p>b) The Benarx box/pipe shell can be fitted around the loose PFP and held in place using integral toggle &amp; latch fasteners or stainless steel bands</p>	 <p>Benarx F Chartek epoxy box with SS banding</p> <p>Benarx F Chartek pipe shell with integral locks</p>	Installation of Benarx solutions will require accurate measurements to ensure correct fit

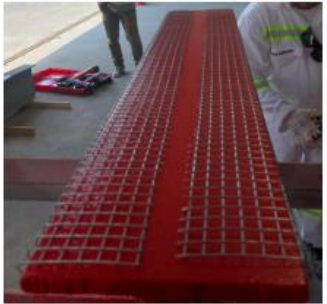
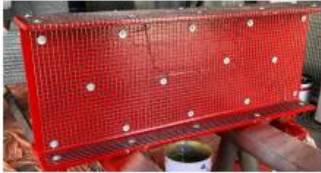




## Repair Solutions (example solutions)

Upgrading PFP on existing structure:-

- Chartek 7 over pinned metal mesh system
- Chartek 2218 over flange fitted Charloks

Item H	EXISTING PFP / SUBSTRATE	DEFECT / ANOMALY TYPE	
	None / carbon steel	Omission/Upgrading of PFP	
Repair System	Installation	Photos / Drawings	Limitations / Notes
Chartek 2218	<p>a) Visual inspection of system topcoat should reveal no breakdown of existing topcoat</p> <p>b) The topcoat surface should be lightly manually abraded</p> <p>c) For application over I sections, Charloks should be placed over the flanges, for hollow sections wire mesh should be wrapped around and tied with lacing wire</p> <p>d) Apply Chartek 2218 with HK1 or HK2 mesh (as required by certification) to the required dft</p> <p>e) Any coating breakdown exposing the substrate that exceeds 0.5% (Ri2) will require surface preparation &amp; priming in accordance with sections 3.2 &amp; 4.1 above</p>	 <p>Application of Charloks over flange outstands</p>	See TN/F/CT/357_Rev0 & TN/F/CT/547_Rev0
Chartek 7	<p>a) Visual inspection of system topcoat should reveal no breakdown of existing topcoat</p> <p>b) The topcoat surface should be lightly manually abraded</p> <p>c) Full 100% pinned metal mesh coverage is required for I sections, for hollow sections wire mesh should be wrapped around and tied with lacing wire</p> <p>d) Apply Chartek 7 with HK1 mesh (as required by certification) to the required dft</p> <p>e) Any coating breakdown exposing the substrate that exceeds 0.5% (Ri2) will require surface preparation &amp; priming in accordance with sections 3.2 &amp; 4.1 above</p>	 <p>Application of pinned metal mesh</p>	See TN/F/CT/357_Rev0 & TN/F/CT/547_Rev0





## Repair Solutions (example solutions)

Upgrading 3-sided beams:-

- Chartek 2218 (mesh free)
- Interkote SFR

*Testing of 2218 & Interkote SFR includes aged concrete beams*


Item G	EXISTING PFP / SUBSTRATE	DEFECT / ANOMALY TYPE	
	Dense concrete, cementitious or EPFP / carbon steel	Beams with no PFP on top flange	
Repair System	Installation	Photos / Drawings	Limitations / Notes
Chartek 2218	<p>a) Steel surface to be prepared to minimum SP11.</p> <p>b) Prime the exposed steel surface with approved surface tolerant primer. Interseal 670HS is the preferred primer</p> <p>c) Apply Chartek 2218 at minimum 6mm. The Chartek should overlap the exposed concrete edges either side of the beam. Apply topcoat if required</p>	 <p>Surface before priming (SP11) @ L, with Charetk 2218 at 8mm</p>	<p>Dft and use of HK2 mesh will depend on the required fire resistance duration.</p> <p>See TN/F/CT/524_Rev1 &amp; TN/F/CT/556_Rev0</p>
Interkote SFR	<p>a) Steel surface to be prepared to minimum SP11.</p> <p>b) Prime the exposed steel surface with approved Interkote primer. Intercrete 4840 is the preferred primer</p> <p>c) Apply Interkote SFR to a thickness 30mm minimum. No reinforcing mesh is required</p> <p>d) A suitable topcoat is required to protect the Interkote from environmental conditions exceeding C3</p>	 <p>Test beam with Intercrete 4840 primer</p> <p>Test beam with 30mm Interkote SFR</p>	<p>Not suitable for exposures greater than C3 without an approved topcoat</p> <p>See TN/F/CT/524_Rev1</p>



## Repair Solutions (example solutions)

Upgrading 3-sided beams:-

- Interkote MP (solution for grated walkways - under development)

Item G	EXISTING PFP / SUBSTRATE	DEFECT / ANOMALY TYPE	
	Dense concrete, cementitious or EPFP / carbon steel	Beams with no PFP on top flange	
Repair System	Installation	Photos / Drawings	Limitations / Notes
Interkote MP	<p>a) Steel surface to be prepared to minimum SP11.</p> <p>b) Prime the exposed steel surface with surface tolerant primer. Interseal 670HS is the preferred primer</p> <p>c) Roll the Interkote MP over the exposed flange. End lengths should be butted tightly together (the material will adhere tightly when ends are pushed together).</p>	 <p>Grated beam with Interkote MP</p>	<p>Interkote MP is supplied in a 30mm thick roll and to suit the flange width.</p> <p>Interkote MP applied to the top flange of beams is not suitable for foot traffic unless a walkway grating is applied over the putty or used in areas like pipe racks</p>



## Repair Solutions – Real World Site Trials

Interkote SFR repairs to failed LWC – Site in Belgium



Failed LWC on vessel skirt



Simple hand application of Interkote SFR



Interkote SFR finished repair

## Repair Solutions – Real World Site Trials

Interkote MP repairs to cracked LWC – site in Belgium



Prepared crack in LWC on vessel skirt



Finished IK MP repair

# Fire Testing

Application & Testing systems all 3<sup>rd</sup> party verified



Factual statement - Fire Test

Office: **Dubai**

Date: **16 September 2019**

This Statement is issued to the client, AkzoNobel Middle East-Protective Coatings, to verify that at their request, the undersigned surveyor to Lloyd's Register EMEA attended their works at Thomas Bell-Wright International Consultants on 16 September 2019 to witness a Fire Test in accordance with BS 476 parts 20 Annex D Hydrocarbon Curve. The dry film thickness was verified by Lloyd's Register at the time of application referenced in the reports prepared by the client dated 18 August 2019 and 24 August 2019.

### Scope of Survey

The following is in relation to a fire test conducted on total 2 steel sections to BS 476 parts 20 following a high rise hydrocarbon heating regime.

All equipment was calibrated as covered by International's ISO 9001 procedures.

The scope covers:

1. Verification of the sections' DFT thickness and panel reference number (stated in the table below)
2. Verification of the sections' references
3. Verification that all sections were in the same furnace test
4. Verification that the furnace temperature matched BS 476: 20 Annex D hydrocarbon curve.

Section reference	Detail	DFT for Chartek 2218 coating system (tested over 3 coat system) verified by International Protective Coatings (mm)	Temperature°C when control reached 400°C	Temperature°C when control reached 538°C
<b>05_SR_HFT</b>	Control	9.643	400	538
<b>06_SR_HFT</b>	Test	9.524	385	520

Type approvals pending....

Project No: 4788948154



Page 1

Project number: 4788948154  
11/12/19



WITNESSED CEMENTITIOUS MATERIALS A AND B REPORT, UTILISING THE FIRE CURVE SPECIFIED IN UL1709

For:  
**International Paint Ltd**  
Stoneygate Lane  
Felling  
Gateshead  
NE10 0JY  
UK

Copyright © 2019 UL LLC.

UL International (UK) Ltd.  
220 Cygnet Court, Centre Park, Warrington, WA1 1PP.

UL International (UK) Ltd authorizes the above-named company to reproduce this Report provided it is reproduced in its entirety.



Fire Test Witness Statement

Office: **Newcastle upon Tyne**

Date: **25 May 2022**

This Statement is issued to International Paint Ltd, to certify that the undersigned surveyor to Lloyd's Register EMEA did at their request remotely supervise a fire test at International Paint Ltd Felling site on 26 January 2021 carried out in accordance with the UL1709 heating curve.

### Scope of Survey

The following is in relation to a fire test conducted on a concrete-encased structural steel column section, with a putty material filling a 50x1000mm defect area in the concrete covering near the edge of the column flange. The test was carried out on 28<sup>th</sup> January 2021. The test was conducted in the AkzoNobel's UKAS accredited furnace facility in Felling, UK. The thermocouple positioning on the structural steel section was confined to areas of interest in and adjacent to the defect area and on the opposite flange. The temperature-time heating curve of the test was in accordance with UL1709-4.

The scope covers:

1. Verification of the specimen.
2. Verification of the nominal coating thickness and specimen reference number.
3. The thermocouple positioning on opposite flanges.
4. The heating was in accordance with UL1709-4.
5. Verification of the progression of the temperature of the steel with time during the test. Temperature stated is average temperature recorded by thermocouples fitted to flange.

Fire test no. FF481SB5, on 28<sup>th</sup> January 2021.

Specimen reference number	Section serial size	Nominal Thickness of concrete cover over flanges	Defect infill repair material	Time/min	Average temperature of repair area/°C	Average temperature of corresponding opposite flange/°C
PCFP8750/C1	254x254x73	50 mm	Interkote MP repair putty	0	9	10
				60	184	248
				120	356	454
				180	489	585



Jet Fire Test

Office: **Newcastle**

Date: **30-11-2022**

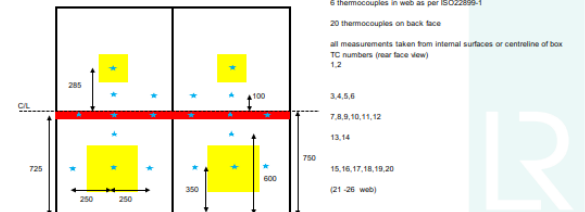
This certificate is issued to International Paint Ltd, to certify that at their request, the undersigned Surveyor to Lloyd's Register EMEA attended Spadeadam Test Site on 8<sup>th</sup> March 2022 to witness a jet fire test, generally in accordance with ISO 22899-1.

### Scope of Survey

The following is in relation to a jetfire test conducted on a structural steel jet fire box, one half of which was coated in nominally 50mm concrete, the other half (including the central web) in nominally 28mm of Pyrocrete 241. Three uncoated areas on each side of the rear face of the box were filled with Interkote MP repair material, to simulate repairs to damaged/missing fire protection. The three defect areas on each side measured 170x170mm, 740x50mm and 300x300mm. The repair material was filled to the same thickness as the surrounding PFP material. The specimen was prepared by International Paint Ltd to assess the jetfire resistance of the repair material. The test was conducted by DNV GL personnel at Spadeadam test site, with the jetfire test generally conforming to the requirements of ISO 22899-1. The thermocouple arrangement on the rear face was modified to accommodate extra data from the defect areas, as per attached diagram. A total of 20 type K thermocouples were fitted to the rear face of the box. The six thermocouples fitted into the web were as per ISO22899-1.

The scope covers:

1. Verification of the coating thicknesses and specimen reference number (stated in the table below)
2. The test setup was generally in accordance with ISO22899-1.
3. Verification of the progression of the temperature of the steel with time



## Fire Testing – Pool Fire

Concrete / LWC repair solutions – Interkote SFR & Interkote MP



Interkote MP@25mm  
Concrete repair



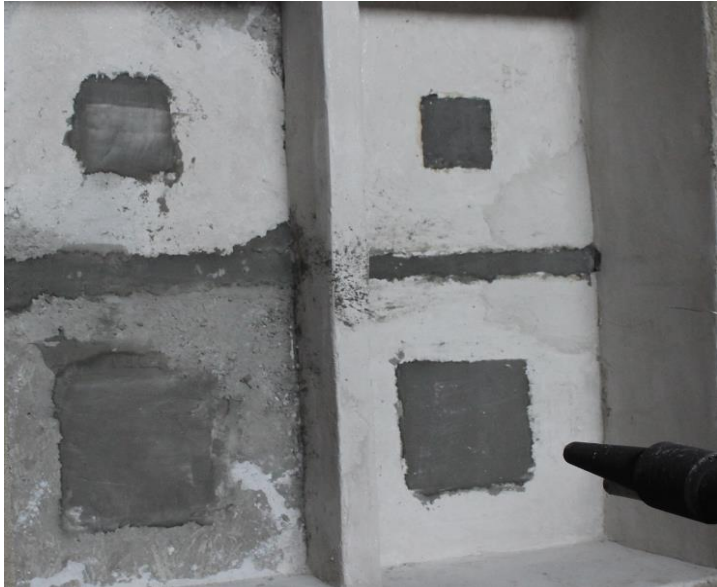
Concrete / LWC Columns  
post test



Interkote SFR@28mm  
LWC repair

## Fire Testing – Jet Fire

Concrete / LWC repair solutions – Interkote SFR & Interkote MP



Interkote SFR @50/28mm  
Concrete/LWC repair – jet fire  
box



Interkote MP @50/28mm  
Concrete/LWC repair – jet  
fire box



Interkote SFR – post jet fire



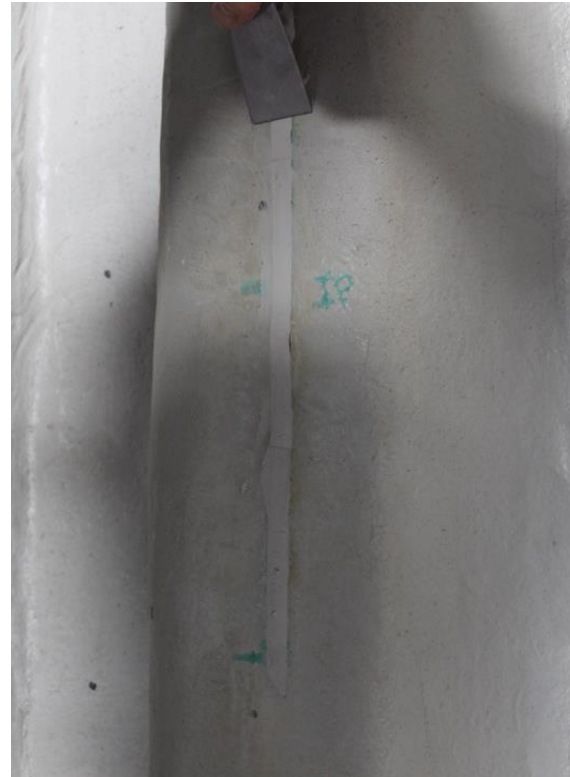
## Fire Testing – Jet Fire (new data 12/05/23)

Epoxy PFP repair solutions – Interkote MP (Lloyds Register witnessed at DNV)

3x3m corrugated blastwall



20mm wide 'crack' to steel surface



10mm IK MP flush with Chartek



Post-burn examination

Interkote MP@10mm, EPFP repair – 10 and 20mm cracks (steel temp @ 3hrs: no defects = 196C at 3hrs, under IK MP 204C & 220C)

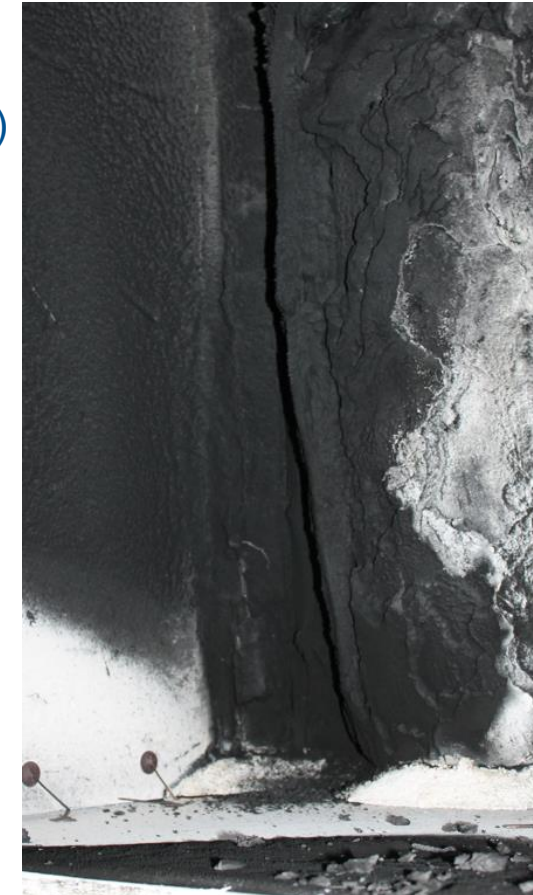
## Fire Testing – Jet Fire (new data 12/05/23)

Epoxy PFP repair solutions – Interkote MP (Lloyds Register witnessed at DNV)

3x3m corrugated blastwall



60mm perimeter gap



Post test – no integrity failure

Interkote MP @ 25-50mm, Sealer – gap widths up to 60mm (no temp measurements, integrity evaluation only)

## Product Testing

*Fire performance* - Both Interkote MP & SFR have shown excellent fire performance (in some cases better) than the in-situ LWC or concrete. IK MP verified in EPFP testing (TN to update)

Use technical note F\_021 to select best repair solution to meet fire protection requirements

### Interkote PFP Repair – Product Selector

#### Introduction

Akzo Nobel has developed solutions for repairing/reinstating damaged or missing concrete or cementitious PFP. This technical note (TN) contains the fire test data for both pool and jet fire tests pertaining to Interkote Mouldable Putty (IK MP) and Interkote Structural Fire Resistance (IK SFR). Details of application requirements and procedures are detailed in the Akzo Nobel PFP M&R manual. This purpose of this TN is to facilitate the selection of the right product depending on the fire resistance requirements and environmental exposures applicable to any particular site or asset. Where damage is excessive, beyond the scope of test validation or specified by the client, full removal and replacement with Chartek would be required. This TN comprises 3 parts, this document and parts A&B, the latter which contain details of both fire and other product performance tests undertaken.

#### Interkote Selection Tables

PFP	Defect	Fire duration (mins)	Type (pool/jet fire)	CCT 400/538	IK MP*	IK SFR <sup>§</sup>
<b>50mm concrete</b>	Crack ≤50mm wide	≤180	Pool only	538°C	✓	✓
		≤60	Pool & jet	538°C	✓	✓
		≤120	Pool only	400°C	✓	✓
		≤120	Pool & jet	400°C	✓	✗
	Void ≤290cm <sup>2</sup>	≤120	Pool & jet	400°C	✓	✓
	Void ≤800cm <sup>2</sup>	≤210	Pool only	538°C	✓	✓
		≤120		400°C	✓	✓
Void ≤900cm <sup>2</sup>	≤30	Pool & jet	400°C	✓	✗	

note\* depth of putty, 50mm for jet fire, 25mm for pool fire

note<sup>§</sup> depth of Interkote SFR to be level with concrete

PFP	Defect	Fire duration (mins)	Type (pool/jet fire)	CCT 400/538	IK MP*	IK SFR <sup>§</sup>
<b>28mm Cementitious</b>	Crack ≤50mm wide	≤180	Pool & jet	400°C	✗	✓
		≤120			✓	✓
	Void ≤290cm <sup>2</sup>	≤180			✗	✓
		≤120			✓	✓
	Void ≤800cm <sup>2</sup>	≤120	Pool only	400°C	✓	✓
		≤210		538°C	✓	✓
Void ≤900cm <sup>2</sup>	≤180	Pool & jet	400°C	✗	✓	

note\* depth of putty to be level with cementitious

note<sup>§</sup> depth of Interkote SFR to be level with cementitious



# Product Testing

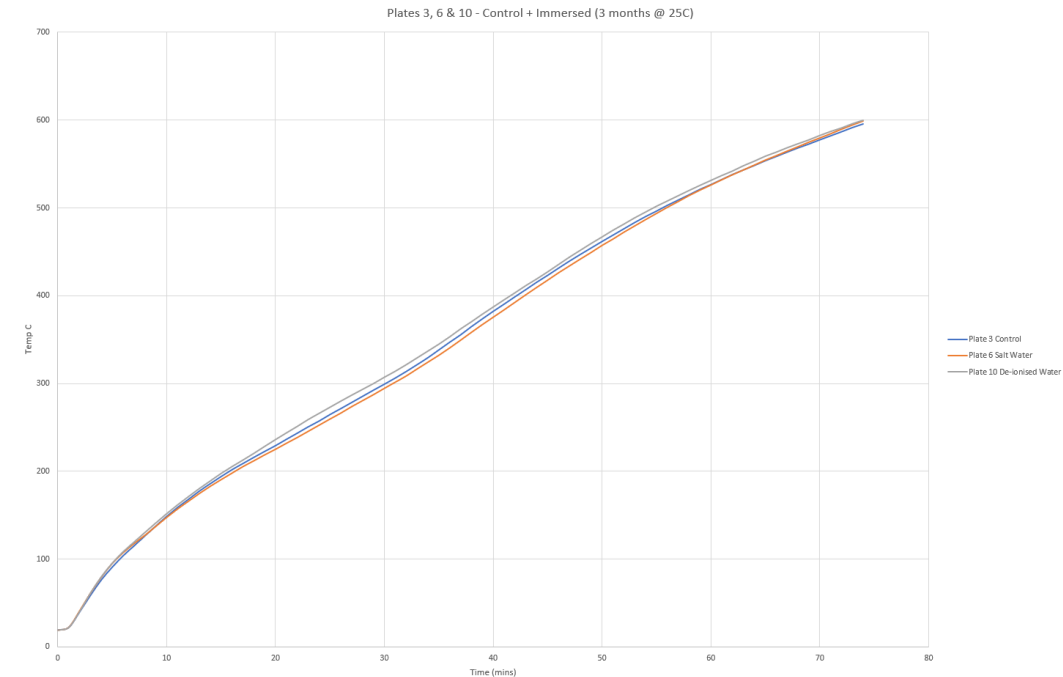
*Durability:-*

**Interkote MP** tested under immersion conditions, 3 months in salt water (5% solution @25C) & de-ionised water (@25C) – no loss of fire performance against a control, zero water uptake

Not affected by extreme cold temperatures (-60C tested to date)

**Interkote SFR** complies with EN13687, parts 1, 2 & 4 (freeze/thaw and salt water immersion/thermal shock/dry thermal cycling)

Currently under test to ISO12944-9, ASTM D5984 and ISO2812-2



Graph comparing fire test results of immersed plates compared to control



## Application Simplicity

### Interkote MP:-

- 1 component mouldable putty compound
- Completely non-hazardous
- Requires no PPE
- No tools required - can be applied direct from the pail by hand
- Repairs can be complete without any hot work permits

### Interkote SFR: –

- 1 component structural grade mesh-free repair mortar
- Completely non-hazardous
- Requires no PPE
- Only mixing with water required – and can be applied direct by hand
- Repairs can be complete without any hot work permits



## Summary

- Interkote PFP repair solutions extend AkzoNobel's proven Chartek solutions for maintaining damaged or failing PFP
- Focus on simple repairs to damaged LWC and concrete PFP (EPFP to be added for IK MP)
- Focus on application simplicity – most 'bang for the buck'!
- Confidence that repair solutions will provide the required fire resistance and repair integrity
- Repair solutions backed up by third party approvals

Further information and enquiries, please contact:-

Chris Fyfe: [chris.fyfe@akzonobel.com](mailto:chris.fyfe@akzonobel.com)

Dave Wickham: [david.wickham@akzonobel.com](mailto:david.wickham@akzonobel.com)

