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PASSIVE FIRE PROTECTION NETWORK

PFPNet Conference 2024

PFPNet Project Report: Severity Level Guidelines for Aged and Damaged PFP Systems

22nd October 2024

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Introduction

Most voted for topic for PFPNet
Very detailed – but not today
Heat Bridging is an essential input
Requires some iterations and more input

Rules of the Guidelines

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- Not a risk assessment method
- Provide input to any assessment methodology
- Must be endorsed by the PFPNet membership
- A lowest common denominator?
- Best estimate screening
- Aimed at inspector/integrity manager
- Highlights manufacturer/3rd Party assistance
- Considers fire protection and substrate integrity

Considers

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Fireproofing/PFP Systems

- Proprietary PFP coatings
- Concrete fire protection
- Dry fit insulation systems
- Wet applied duplex systems
- Barrier systems
- Penetrations through barrier systems

Protected Items

- Structural Steelwork
- Equipment Supports
- Barriers
- Penetrations through barriers
- Critical Process Control Equipment (CPCEs)
- Process vessels and pipework

Data Sources

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- Published data collected in Phases I and II
- Published guidance already in public domain
- Interviews, asking questions on:
    - Damage
    - Age
    - Re-rating
    - Substrate Integrity
    - Repairs

Assigning a Severity Level to an installed fireproofing/PFP system

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1	Identify the fireproofing/PFP System
2	Determine Current Performance Standard or Specification
3	Undertake a basic suitability assessment of the fireproofing/PFP system
4	Undertake Inspection and record findings
5	Consider advisories for potential impact on fire resistance performance and protected item integrity which could affect severity
6	Assign a severity to the condition of the fireproofing/PFP system and the condition of the item it protects
7	Risk assess
8	Identify remedial action plan
9	Implement remedial actions

Severity Level	Description of Anomalies	Action
Level 3:	Anomalies present but will not affect the ***immediate*** fire and integrity performance.	Anomalies have the potential to become Severity Level 2 or 1 anomalies if not dealt with in a timely manner.
Level 2:	Anomalies will result in a level of fire protection that is below that of original state, but some fire protection will still be provided. Anomalies will lead to a significant and rapid deterioration of the PFP system, or the substrate, before next routine scheduled inspection.	Remedial action required if reduced performance or loss of integrity is unacceptable, or to prevent degradation to a Level 1 anomaly.
Level 1:	Presents immediate dropped object hazard to personnel. Anomalies directly invalidate the certified rating of a PFP system that is critical for emergency response or prevention of escalation Anomalies will cause gross failure of PFP during fire scenario leading to a significant portion of the protected item becoming exposed to the fire. Anomalies located on a region of the protected item which is critical to the fire resistance performance of the item in a fire CUI caused by PFP is severe and loss of substrate integrity is judged imminent.	Immediate remedial action required to remove immediate hazard, restore require fire protection resistance or remediate substrate loss of integrity.

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Basic Suitability Assessment

Assessing Basic Suitability

Why is it important?

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- No standard Jet Fire test before OTI 95 634 was introduced
- Some PFP products prior to 95 tested to jet fires (eg SOFIPP).
- Much older PFP systems are likely to be HC rated (H) only.
- Prior to HC rating – based on ratings from other industries (frequently - A)
- Now we have High Heat Flux Jet Fire (HHF), RWS curve, H_2 Jet Fires, battery fires as well
- Materials, details and thicknesses have evolved to mitigate the "new" fire threats (really our updated understanding).
- We relying on legacy systems now exposed to different fire scenarios for which they were developed and installed.

- Q1: What is "Legacy"? Pre-what?
- Q2: Do the old PFP systems still work?
- Q3: Why are we repairing them if they don't?

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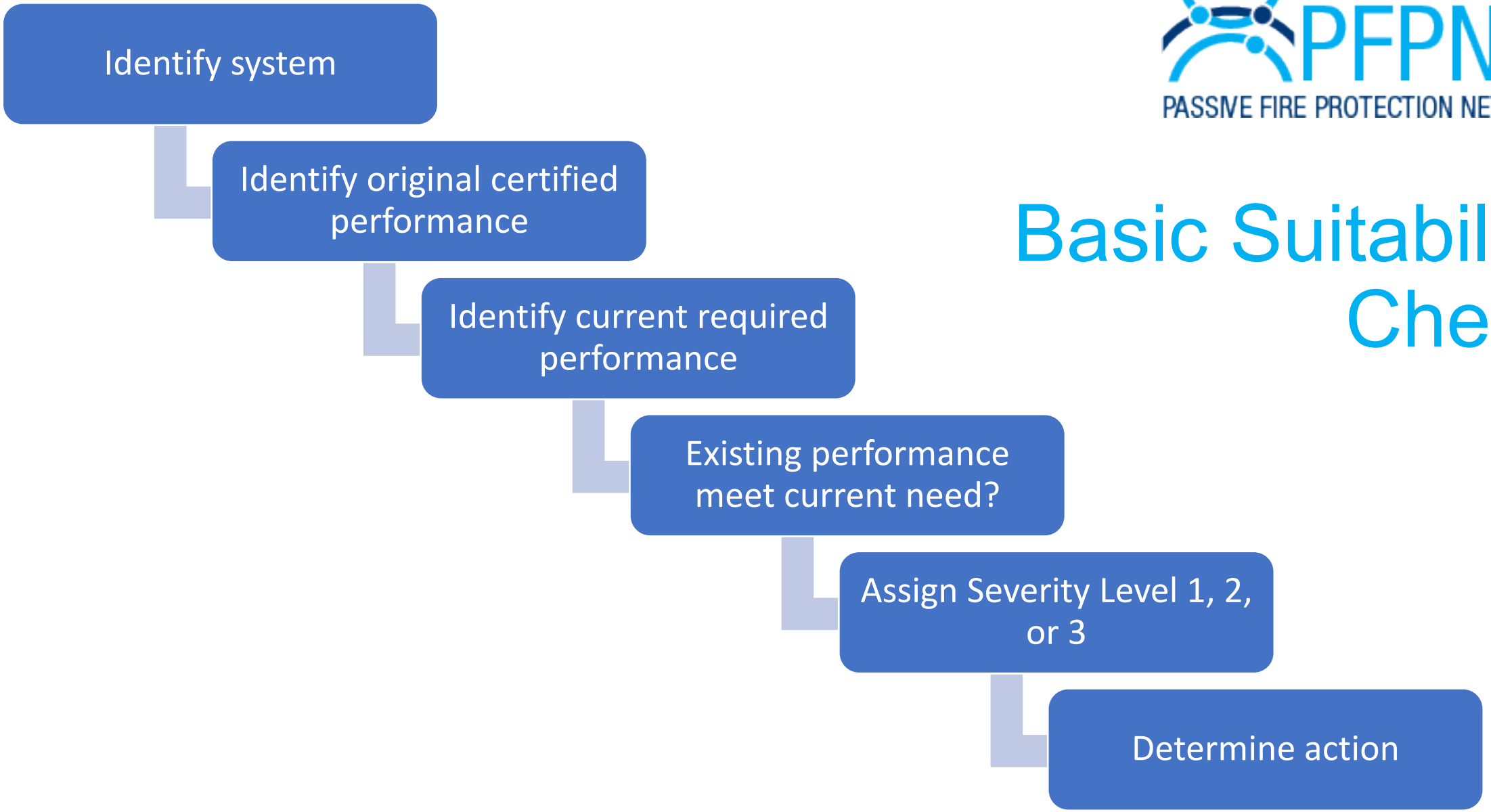
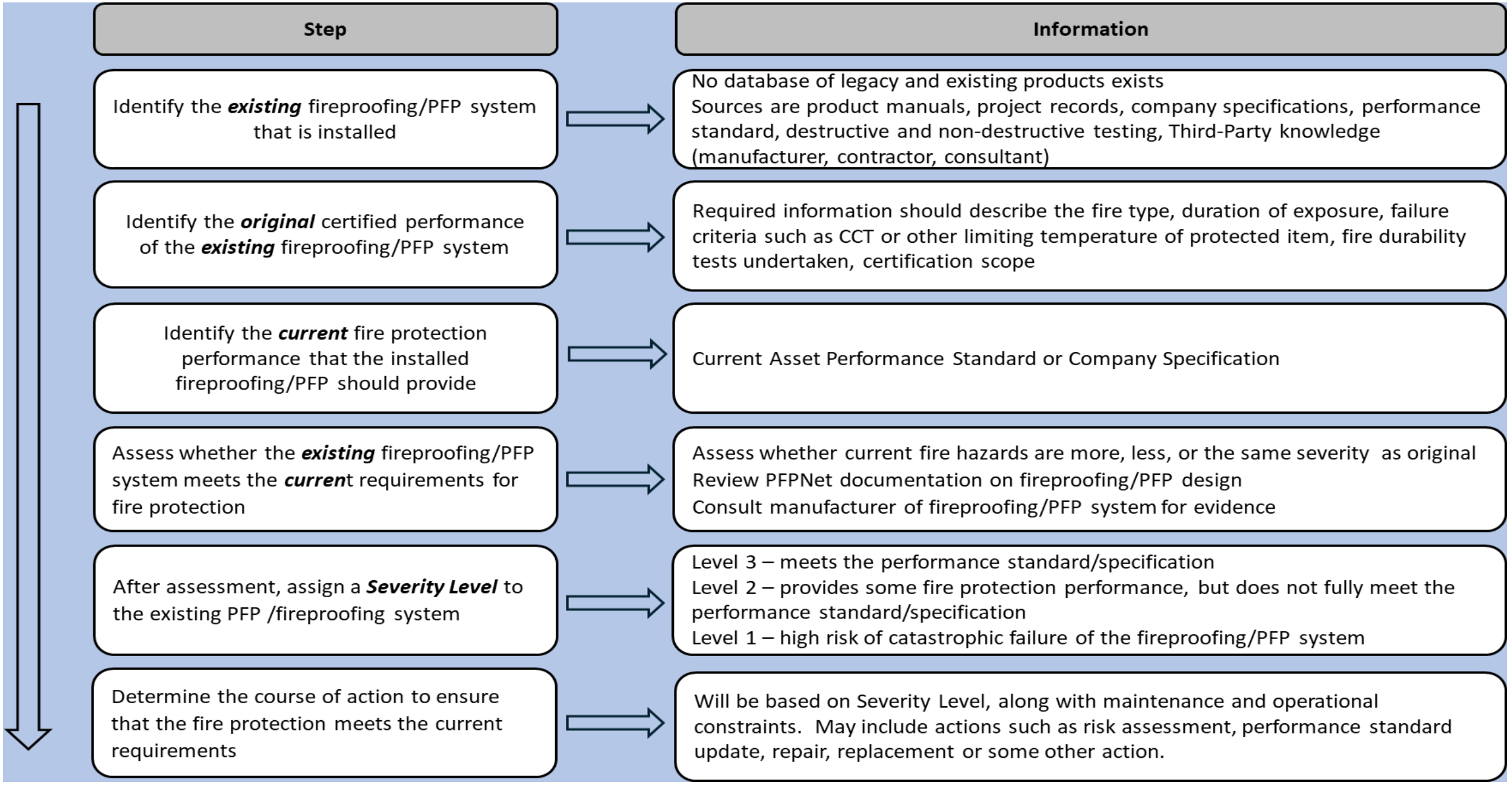
Basic Suitability Check




Step
Information
Identify the existing fireproofing/PFP system that is installed
No database of legacy and existing products exists
Sources are product manuals, project records, company specifications, performance standard, destructive and non-destructive testing, Third-Party knowledge (manufacturer, contractor, consultant)
Identify the original certified performance of the existing fireproofing/PFP system
Required information should describe the fire type, duration of exposure, failure criteria such as CCT or other limiting temperature of protected item, fire durability tests undertaken, certification scope
Identify the current fire protection performance that the installed fireproofing/PFP should provide
Current Asset Performance Standard or Company Specification
Assess whether the existing fireproofing/PFP system meets the current requirements for fire protection
Assess whether current fire hazards are more, less, or the same severity as original
Review PFPNet documentation on fireproofing/PFP design
Consult manufacturer of fireproofing/PFP system for evidence
After assessment, assign a Severity Level to the existing PFP /fireproofing system
Level 3 – meets the performance standard/specification
Level 2 – provides some fire protection performance, but does not fully meet the performance standard/specification
Level 1 – high risk of catastrophic failure of the fireproofing/PFP system
Determine the course of action to ensure that the fire protection meets the current requirements
Will be based on Severity Level, along with maintenance and operational constraints. May include actions such as risk assessment, performance standard update, repair, replacement or some other action.

Examples of “Re-Rating”

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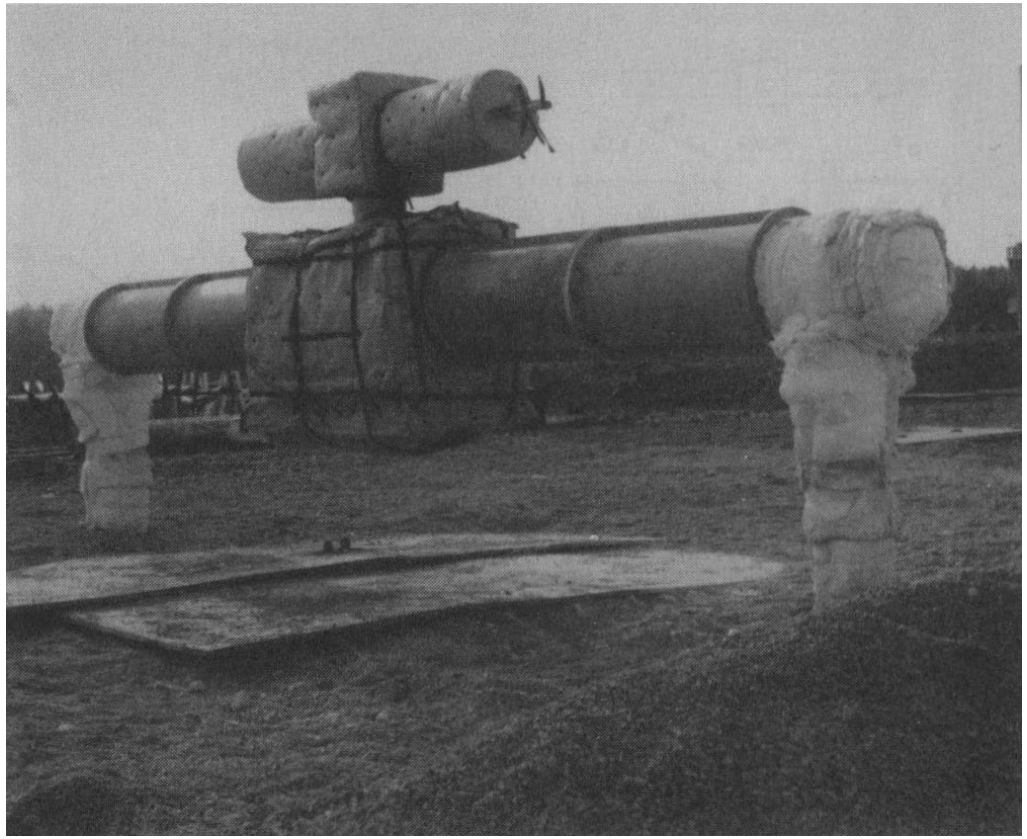

Examples of “Re-Rating”

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Examples of “Re-Rating”

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For Re-rating, Guidance Will Say:
Paraphrased

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- “Don’t do it”
- Ignore ad hoc rules (eg A60 = H30 = J15)
- Some fire resistance performance data available from tests
- The devil is in the detail
- Just because its half as thick, doesn’t mean it has half the performance
- Too many unknowns to be able to provide even a conservative assessment.
- Manufacturers of fireproofing/PFP won’t endorse a simple rule.
- If the PFP system is identifiable, seek advice from the original manufacturer or an experienced 3rd Party – they may have test data that can help

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Advisories

Advisories

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What are they?

- Observations and opinions on what causes damage – root causes.
- Advisories are an opportunity to capture and document this knowledge for future users

Uses?

- Highlights where there may or may not be an issue with PFP
- Help to guide how often and where to inspect, and what to look for

Does/should:

- Provide a repository for all the knowledge we have built up about how and why PFP systems are affected over time.
- Be an education tool and part of training
- Help to improve good detailing and design practice to improve long term integrity
- Assign a Severity Level that indicates the potential for an issue such as damage or ageing
- Consider integrity and fire resistance

Advisories – so far

Based on experience and interviews

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LWC and Concrete

- Hollow fill boxed details
- Corner beads
- Application over TSA

Epoxy Intumescents

- Site welded areas
- Heat bleeding through open insulation joints under epoxy intumescent
- Application over TSA

All Coatings

- Flange tips
- Poorly detailed terminations of coatings
- 3-sided protection of steelwork beams
- Coatbacks – corrosion, not size
- Cut-outs to fit supports
- Blockouts

All systems

- Interfaces between different PFP systems
- Repairs
- Workmanship and Quality Control
- Transportation and shipping damage
- Reinstatements after maintenance
- Terminations – corrosion and integrity
- Standing water
- Watersheds
- Maintenance and inspection
- Mastics and seals
- Incorrect primers and corrosion protection systems

Advisories – So Far

Based on experience and interviews

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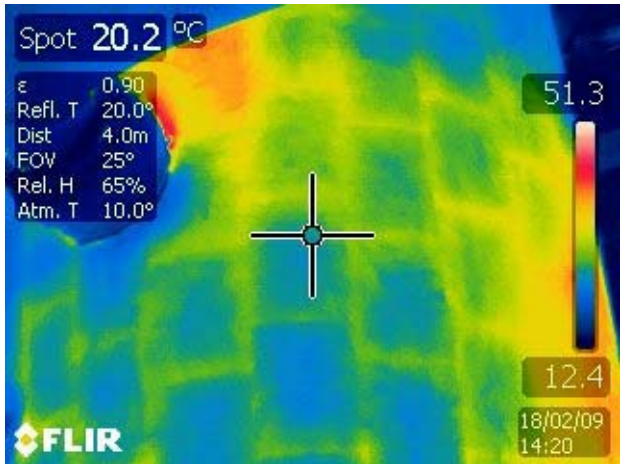
Locations

- Areas of high external or internal temperatures
- Plus moisture
- Water deluged areas
- Splash zone & immersed regions
- Proximity to elevated heat and moisture sources
- Equipment plinths and saddles
- Vessel skirts (eg top ring)
- Areas of high frequency vibration

Other Advisories

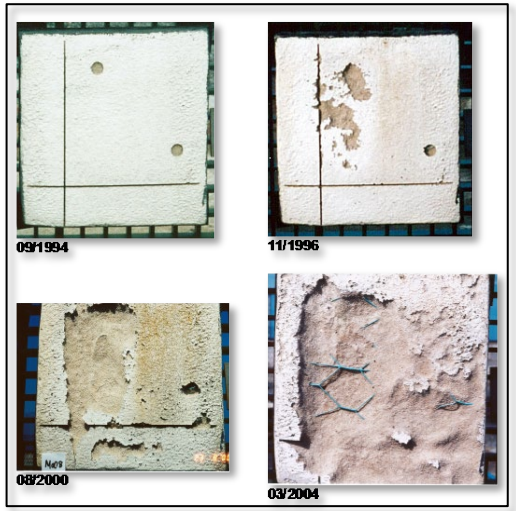
- Age
- Explosions
- Non-negotiables
- Others



Age - coatings

- Legacy PFP coatings tested to prevailing M501 and UL2431 at the time.
- Prior to this would be manufacturers own testing
- No testing of normal weight concrete fireproofing (but lots of experience)
- Long term weathering tests (unmaintained) show:
  - Good for epoxy PFP, not so good for LWC
- Allowable reductions in fire resistance performance after weathering:
  - Older version of UL2431 - 25% reduction
  - Most recent version of UL2431 - 15% reduction.
  - Norsok M501 - 10% reduction.
- Opinions vary as to whether the systems do, or do not, show a reduction (standards and in-house testing)

- 25% loss in fire resistance performance as a (very) conservative guideline for legacy systems, and 10-15% for newer?
- Or is specific advice from Manufacturers the guidance we provide? - TBD..



Age – not coatings

- No weathering/ageing testing reported on other systems
- Long term performance of dry-fit and component-based systems (enclosures, jackets, penetrations, etc) is affected by combinations of:
    - Removal and correct reinstatement
    - Repeated removal
    - Seals
    - Weather shielding
    - Corrosion protection systems

These are the major influence on the long-term fire resistance and integrity performance

- Issue with barriers is a combination of substrate and connection integrity (frequently steel),along with any installed fireproofing/insulation/PFP system

Age – Conclusions

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- Real fires: older PFP fireproofing/systems perform during fires (Proprietary/ anecdotal information)

- We can adopt the values used in the standards (TBD..) but not all systems are the same.

- More important than inherent age: Has the fireproofing/PFP system been correctly:
  - designed and detailed,
  - manufactured,
  - specified,
  - installed, and,
  - Maintained to manufacturers recommendations through life, or to rectify anomalies

Explosions

- Important for all forms of fireproofing and PFP – penetrations, dry-fit, coatings, etc
- If system is installed in a zone where an explosion occurs **and** it needs to function after the explosion, then it needs an assessment or demonstration that it will be able to do so.
- Or a risk assessment to assess the implications.
- Including as an “Advisory” highlights the risk

Non-Negotiables

Not permitted regardless of size or material

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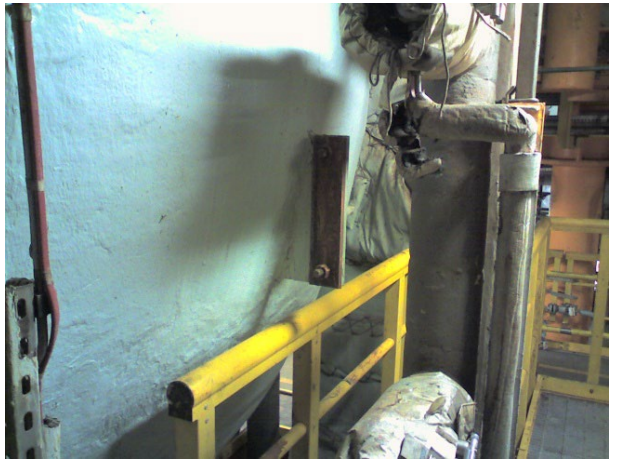
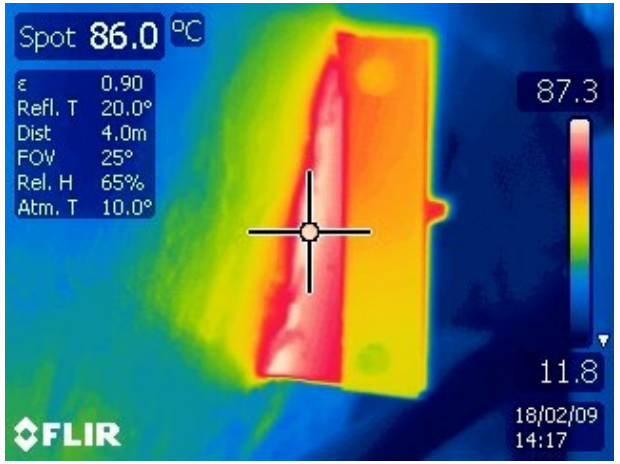
- Anomalies in pressure systems (pipework and vessels) containing flammable inventories
- Anomalies or breaches that invalidate the rating of boundaries where people shelter in an emergency
- Breaches through fire barriers which could initiate unwanted deluge on the unexposed side
- Heat bridges into vessels and CPCEs
- Others, to be agreed….





Advisory - Coatings - Workmanship

Level 1	Level 2	Level 3
Significant variation in thickness Reinforcement not encapsulated Soft material after curing Incomplete detailing Poor termination Reinforcement not installed	Obvious visual evidence of a lack of expertise Poor surface finish Variation in thickness Procedures not followed	Standard of installation is adequate but surface finish may lead to long term integrity issues. Thickness levels are met
 	 	 

Advisory - Coatings - Repairs		
Level 1	**Level 2**	**Level 3**
Mixed material repairs used without testing evidence of their long term integrity or fire resistance performance Incorrectly implemented manufacturers repairs. Poorly made repairs	Ad hoc “industry standard repairs” with no test evidence or validation.	Manufacturers recommended repair procedures used. Mixed system repairs with fire testing evidence to support use Ad hoc “industry standard repairs” with fire testing evidence or validation provided. Note: Level 3 - must be monitored
 	 	

Advisory - Watersheds

Level 1	Level 2	Level 3
Surface where ponding can occur with: • Vulnerable termination detail • Porous material • Open joint	Horizontal surface in area of high moisture content	Watershed detail used Note: Level 3 - must be monitored for integrity of seals and joints
 	 	

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Severity Levels for Damage

	Topcoat Anomaly in Fireproofing/PFP system - Damage Severity Level Assessment		
	Level 1	**Level 2**	**Level 3**
Topcoat Damage	**Loss of topcoat, hairline cracks, UV chalking, or discolouration** If a PFP system requires a topcoat (because tested for durability with a topcoat), then damage which exposes the PFP to environment may cause long term loss of performance of a PFP system.		
Damage to paint coatings on fireproofing and PFP coating systems	PFP requires a topcoat for long term durability and is correctly specified but extensive areas of damage over the whole surface. Topcoat is required but has been incorrectly specified	PFP requires a topcoat for long term durability and is correctly specified, and a small number of local areas of damage on the surface and number of areas visible are increasing.	PFP does not require a topcoat but topcoat is installed for aesthetic purposes Minor damage should be monitored.
			

	Cracks in Fireproofing/PFP system - Damage Severity Level Assessment		
	Level 1	**Level 2**	**Level 3**
Cracks	**Part thickness, through thickness, hairline, or wide cracks**		
General guidance for cracks in coatings	Single or multiple cracks that are: • of length greater than X, and; • with maximum width greater than Y mm, and; • part-thickness or through thickness, and; • coatings are **disbonded** from substrate.	Single or multiple cracks that are: • of length greater than X mm, and; • with maximum width less than Y mm, and; • part-thickness or through thickness, and; • Coatings still **fully bonded** to substrate.	Single or multiple cracks that are: • with maximum width less than Y mm, and; • part-thickness, and; • Coatings still **fully bonded** to substrate
			

	Cracks in Fireproofing/PFP system - Damage Severity Level Assessment		
	Level 1	**Level 2**	**Level 3**
Cracks	**Part thickness, through thickness, hairline, or wide cracks**		
Cracks in coatings on structural steelwork	As general cracking guidance but; Cracks of any width, length and depth not permitted on the edge (flange) or corner of a structural member.	As general cracking guidance but; Cracks on edge feature are Level 3	As general cracking guidance.
	   		

	Cracks in Fireproofing/PFP system - Damage Severity Level Assessment		
	Level 1	**Level 2**	**Level 3**
Cracks	**Part thickness, through thickness, hairline, or wide cracks**		
Cracks in components containing flammable inventories	Cracks of any width, length and depth not permitted in coatings of components containing flammable inventories	Cracks of any width, length and depth not permitted in coatings of components containing flammable inventories	As general cracking guidance
			

	Cracks in Fireproofing/PFP system - Damage Severity Level Assessment		
	Level 1	**Level 2**	**Level 3**
Cracks	**Part thickness, through thickness, hairline, or wide cracks**		
Cracks in vessel supports	As general cracking guidance	As general cracking guidance.	As general cracking guidance.
			

	Full Thickness Damage in Fireproofing/PFP system - Damage Severity Level Assessment		
	Level 1	**Level 2**	**Level 3**
	Full Thickness Damage - Chips, gouges, physical damage, blisters, material missing		
Structural steelwork	Total area of damage sites greater than Y% of component surface area/ X mm^2, or; Full thickness damage not permitted on the edge or corner of a structural member if area greater than X mm^2.	Total area of damage sites greater than X% of component surface area/ Ymm^2, or; Full thickness damage not permitted on the edge or corner of a structural member if area greater than X mm^2.	Any single area of damage less than X mm^2 At the moment X = 3000mm^2 or X = 1000mm^2
	 		

	Full Thickness Damage in Fireproofing/PFP system - Damage Severity Level Assessment		
	Level 1	**Level 2**	**Level 3**
	Full Thickness Damage - Chips, gouges, physical damage, blisters, material missing		
Component containing flammable materials	Always level 1 CUI risk and potential failure in fire risk	Always level 1 CUI risk and potential failure in fire risk	Always level 1 CUI risk and potential failure in fire risk
Fire divisions, partitions, etc.	Always level 1 if damage on a barrier making up an emergency shelter.	Level 2 if barrier is a fire barrier but has no insulation requirement or separates process areas	Always level 1 or Level 2 if barrier has a fire resistance requirement
Other component	Total area of damage sites greater than Y% of component surface area/ Z mm^2	Total area of individual or multiple damage sites greater than 3000mm^2 and less than Y% of component surface area	Any single area of damage less than X mm2 At the moment X = 3000mm^2 or X = 1000mm^2

Others for coatings

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- Disbondment from Substrate (With no visible signs of cracking)
- Part Thickness Damage - Chips, gouges, blisters, erosion, low material thickness
- Poor Material Condition that is effectively part thickness - Low material hardness, waterlogged (LWC), activated material (Epoxy)
- Leaching/Staining from Within Coating - Corrosion product, Coloured Liquid, Salts
- Retention/Reinforcement
- Missing, not at mid-point, not correctly overlapped, visible, mechanical fixings failed, damaged along edge feature,
- Incorrectly detailed termination, missing or damaged termination
- Sealing

And for other systems…

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Next Steps/Conclusions

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- Review Heat Bridging and populate with an **interim** X and Y
- Committee and others to review report and tables to date
- Seek further “advisories” and debate the Severity Levels
- More pictures to build nomographs
- Gain endorsement from Members
- Develop training options
- Revise X and Y after heat bridging JIP

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Discussion