Aged & Damaged PFP

What have we learnt and how do we manage the problem?

Richard Holliday

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Introduction – Richard Holliday

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- Richard Holliday joined PPG in April 2015 in the role of their Global Director – Hydrocarbon PFP, focusing on PPG's product offer to the oil, gas and petrochemical industry for hydrocarbon hazards mitigation.
- He is an industry recognized expert on fires, explosions and cryogenic spill testing standards and is a member of industry standards bodies with ISO, ANSI, BSI and UL for hydrocarbon fires, jet fires, explosions and cryogenic spill protection. He represents the PFP manufactures on PFP Net's Steering Committee and was part of the Energy Instituter team that developed PFP Inspection and Maintenance procedures.
- Prior to joining PPG he was 7 years with a technical safety consultancy, MMI Engineering, specializing in major accident hazards and design and assessment of safety barriers to withstand and protect assets from their effect.
- Before that he worked in technical and business development roles for leading hydrocarbon PFP manufacturers in epoxy intumescent, syntactic phenolic, enclosures, jackets and composites.
- Originally a graduate in Mechanical and Offshore Engineering from Robert Gordon's University, Aberdeen, he has held technical and project management positions with contracting and engineering companies in the nuclear, aerospace, and power generation industries as well as the oil gas and petrochemicals industries.

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Some key questions for consideration

- **Who**
  - Who should inspect the PFP?
- **What**
  - What PFP do I need?
- **Why**
  - Why has the PFP failed?
- **Where**
  - Where do I need concentrate my repairs
- **When**
  - When do repairs need to be completed

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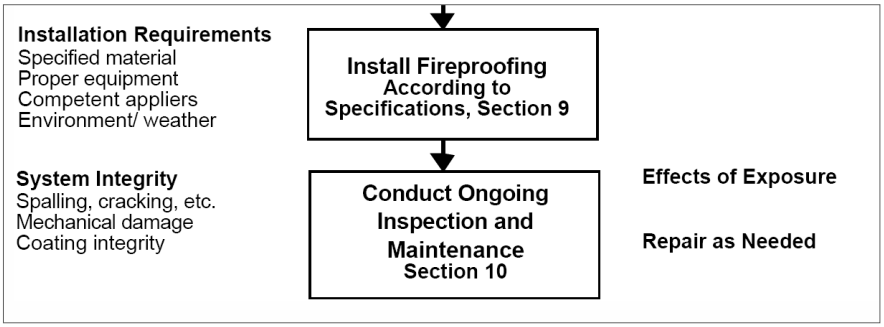
Clear Industry Guidance & Regulations

a) appropriate measures to mitigate fire and explosion are in place
b) and ensure, as far as is reasonably practicable, that they remain capable of fulfilling their function

Source: PFEER Regulations – HSE Guidelines



Source: Fireproofing Practices in Petroleum and Petrochemical Processing Plants API Publication 2218

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The Reality!

Not a pretty picture

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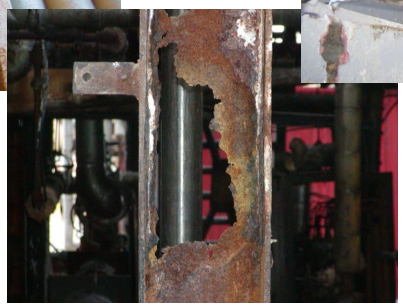
The reality is often not pretty!



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Dense Concrete





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Light Weight Cementitious





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Epoxy Intumescent




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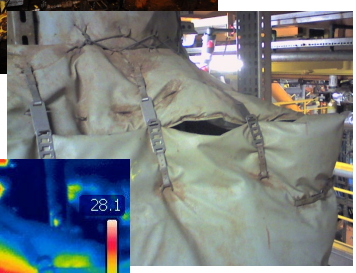
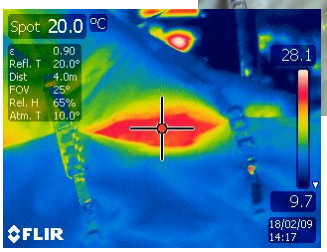
Fire Blankets and Wraps

Penetration & Fire Stopping



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Often materials were not suitable for the environment

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Poor understanding of the performance requirement

- Inspector thought the insulation inside the building was the fire protection – the steel on the outside had completely loss gas tightness and fire integrity,

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Inspection of PFP

Ensuring Performance Standards are Maintained

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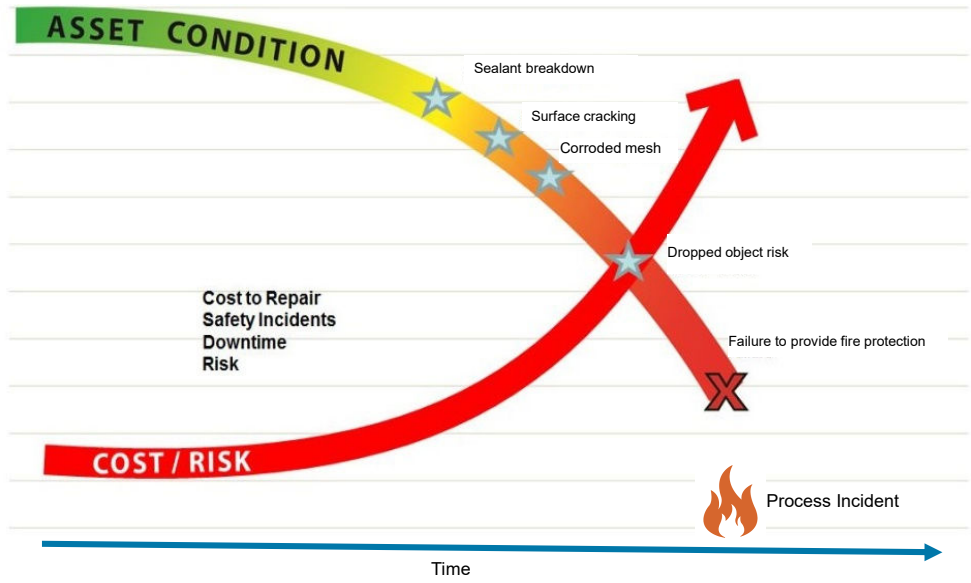
Degradation in Performance



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Industry Guidance Does Exist

- Energy Institute published guidelines in 2021
- *"Guidelines for in-service management of passive fire protection coating systems"*
- Mainly focused on coating systems
  - Cement based PFP
  - Epoxy Intumescent PFP
  - Some commentary on other PFP types
- Mainly offshore focused

- www.energyinst.org

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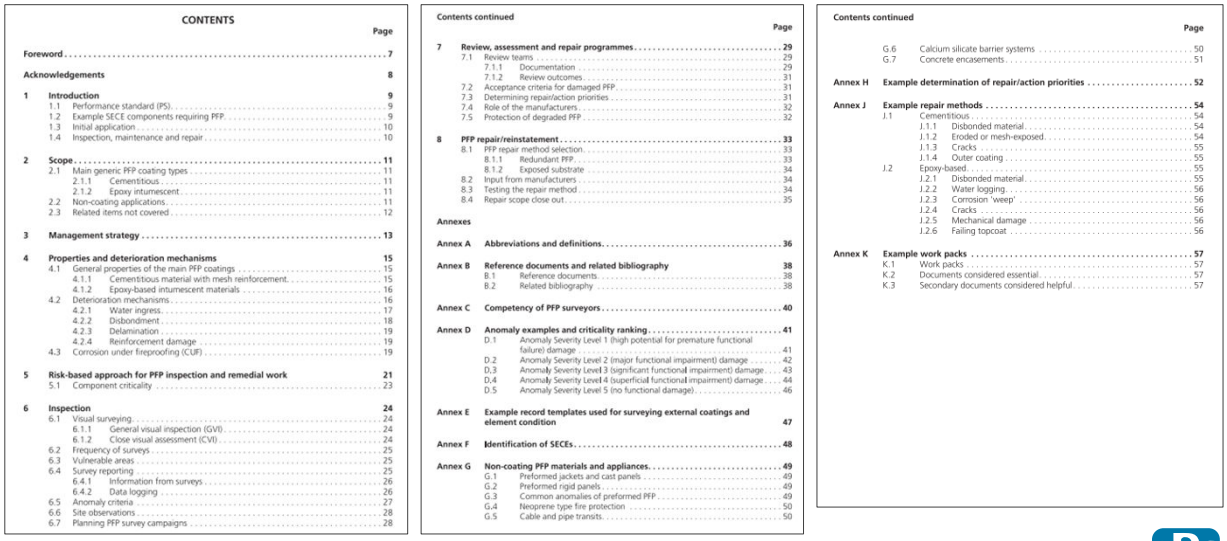
Comprehensive and Risk Based



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Which Approach Should Be Taken To Inspection?

- Inspection methods and intervals are normally set out within an organisations Asset Integrity Management (AIM) strategy and may be based on Risk Based Inspection (RBI) techniques such as those described in API 580 “Recommended Practice - Risk-based Inspection”

Criticality	Consequence				Anomaly			
					1	2	3	4
	People	Environment	Asset	Business	Potential dropped object	Multiple anomalies that exceeds acceptance criteria or PFP absent	Individual anomaly exceeds acceptance criteria	Anomaly currently acceptable but can degrade if not repaired or PFP in good condition, no anomalies
1	Multiple fatalities	Catastrophic, long-term environmental damage	Extensive damage to key assets or several areas of plant	Business disruption > 6 months	1	1	2	4
2	Single fatality	Severe mid to long term environmental damage	Extensive damage to a single area of plant	Business disruption up to 6 months	1	1	2	4
3	Major injury, possible incapacity	Minor environmental damage	Major damage to plant	Major damage but operations possible	1	2	4	4
4	LTI	Temporary environmental damage	Minor asset damage	Operations as normal	3	3	4	4

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Example risk matrix.

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Inspection of PFP

Guidance on Inspection Techniques

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Types of Inspection Required

- 4 types of Inspection are commonly used:
  - **Baseline Inspection**
    - What was the starting point when constructed?
    - As-built record keeping is vital
  - **Periodic inspection**
    - Typically, annual inspection in line with structures and equipment
    - Basic competency required
  - **Special inspection**
    - To investigate anomalies and concerns
    - In depth expertise required, root cause analysis techniques used
  - **Unscheduled inspection**
    - Following an unscheduled incident, e.g. Earthquake
    - Following plant modifications

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Inspection Techniques

Inspection	Scope	Access	Tools & Techniques
General Visual (GVI)	A visual examination to detect obvious damage, failure or irregularity.	Made from ground level, existing walkways or available access platforms or ladders	Use of binoculars and/or zoom lens camera can be used to assist inspection.
Close Visual (CVI)	As for GVI inspection but made from within touching distance where practical.	Dedicated access may be required. Rope access techniques may be utilised.	Use of mirrors, torches, magnifying lenses, cameras, or other visual aids can be used to assist inspection.
Non-destructive Examination (NDE)	Physical contact required to check aspects such disbondment, cracking, blistering, etc.	Purpose built access and supplementary lighting may be required.	Surface cleaning may be required. Tap testing, thickness measurement, moisture meters, gap gauges, etc.
Special Detailed Inspection (SDI)	Utilising destructive examination techniques to investigate failures	Purpose built access and supplementary lighting may be required.	Pull-off testing, drill depth gauge, sampling for analysis, etc.

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Recommended Minimum Inspection Intervals

Criticality / Exposure level (a)	Level I Inspection (b)	Level II Inspection (c)	Level III Inspection (c)
Level 1	Annual	3 Years	5 Years
Level 2	Annual	5 Years	10 Years
Level 3	Annual	5 Years	Not Required

a) The exposure levels are defined in section 6.6 of ISO 19902:
b) The timing of the first periodic level I inspection shall be determined from the date asset or installation was completed.
c) The timing for the first periodic level II and level III inspections shall be determined from the date of the baseline inspection

Example - Aligned with Structural Steel – ISO 19902

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Competency
Who should inspect the PFP?

Independent Competent Person (ICP) is an individual (or an organisation) who:

- must have the sufficient skills and knowledge to carry out this function,
- and must be free from any external pressures (e.g. financial, production or management) which could affect their objectivity when carrying out verification activities.

4.5 INDEPENDENT COMPETENT PERSONS

Independent Competent Persons (ICPs) are required to carry out various functions under the verification scheme to ensure that the process of managing risks associated with the Major Accident Hazards is working effectively. It is a requirement that ICPs must be sufficiently independent so as to be impartial and objective in their judgement such that safety is not compromised. The role of the ICP can either be undertaken by a single organisation or by a number of different individuals or organisations considering separate aspects of the installation. In the latter case however, greater co-ordination will be required by the duty holder to ensure that all parts of the scheme have been adequately addressed and that interfaces are effectively managed. Although not mandatory, it is generally recommended that where multiple ICPs are employed, one has an overseeing role.

Energy Institute:
Guidelines on the Management of Safety Critical Elements

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Inspection Findings
How should you categorise anomalies?

Anomaly Level	
1	Immediate Risk
2	Major Anomalies
3	Significant Anomalies
4	Minor Anomalies
5	Acceptable

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Inspection Findings
How should you categorise anomalies?

Anomaly Level		Description	Examples
1	Immediate Risk	Condition deteriorated so that there is an immediate risk, even before any fire or explosion	• Corroded hydrocarbon containment • Dropped object hazard • Serious structural corrosion • Degrading asbestos containing material

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Inspection Findings
How should you categorise anomalies?

Anomaly Level		Description	Examples
2	Major Anomalies	PFP not present, condition degraded or original design so poor that little or no protection offered against identified, **current** fire and explosion hazards	• PFP not installed or has been extensively removed • Condition deteriorating rapidly and likely to become an immediate risk before next inspection • Multiple or large PFP anomalies • System would not survive initial explosion

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Inspection Findings
How should you categorise anomalies?

Anomaly Level		Description	Examples
3	Significant Anomalies	Condition degraded or poor original design such that premature failure is probable for identified fire and explosion hazards	• Not suitable for fire hazards (e.g. not resistant to jet or hydrocarbon fires) • Poor Designs and specification (e.g. not suitable for environmental conditions or operating conditions, 3-sided protection in fire envelope, no coat-back protection) • Deteriorating condition (early stages) such as loss of thickness, but not down to mesh. • Through depth or wide cracking • Would be damaged by initial explosion

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Inspection Findings
How should you categorise anomalies?

Anomaly Level		Description	Examples
4	Minor Anomalies	Individual and small anomalies, possible reduction in protection level for identified fire and explosion hazards but not likely to cause global collapse or premature failure	• Chips and dents in the surface • Minor cracking • Damaged top-coat

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Inspection Findings
How should you categorise anomalies?

Anomaly Level		Description	Examples
5	Acceptable	Meets or exceeds requirements	• Good condition • Coat-backs protected • Well maintained • Fully documented capabilities

Hints:

- Capture best practice
- Share experience
- Understand where you exceed requirements
- Review on regular basis
- Manage change

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How to Set Priorities

Managing remedial work program

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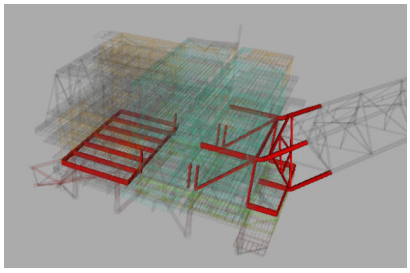
Define Criticality

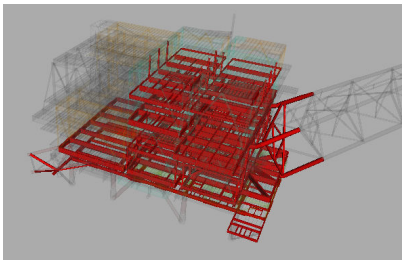
Essential to Establish Prioritisation

Example:

- 30 mins for Escape, Evacuation & Rescue (EER)
  2,092 m^2 (22,518 sq. ft.)



- 60 mins for Asset Protection
  17,514 m^2 (188,519 sq. ft.)



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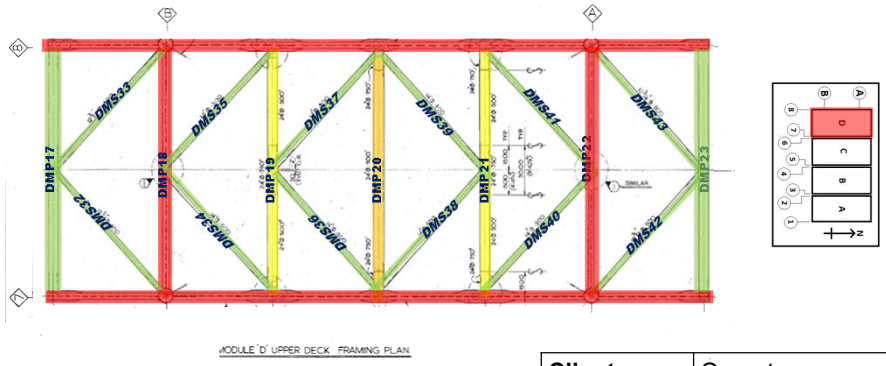
Define Criticality
Essential to Establish Prioritisation



PFP Criticality	
	1. High
	2. Medium
	3. Low
	4. Non-Critical

Client:	Operator
Platform:	Example
Module:	Module D
Drawing:	Upper Deck Frame
Revision	02

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Inspection Findings
What do you do next?

Criticality \ Anomaly	1	2	3	4
4	3	3	4	4
3	1	2	4	4
2	1	1	2	4
1	1	1	2	4

Condition Status	
	Immediate action required
	Plan for repairs
	Monitor closely
	No action required

Example assessment matrix

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To Wrap Up

Are we serious about maintaining our passive fire protection?

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Some Answers to the Key Questions

- Who
  - Who should inspect the PFP?
    - An independent competent person
- What
  - What PFP do I need?
    - Suitable to meet the current fire threats and in the right places
- Why
  - Why has the PFP failed?
    - Generally, poorly selected for the environment and conditions or poor application
- Where
  - Where do I need to concentrate my repairs
    - Immediate threats (e.g. dropped object risk or corroding equipment) then most critical elements (RBI)
- When
  - When do repairs need to be completed
    - Before a fire incident occurs!

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Thank You

Questions?

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