PFPNet

Developing Early Stage Fireproofing Schemes

1ST MAY 2025

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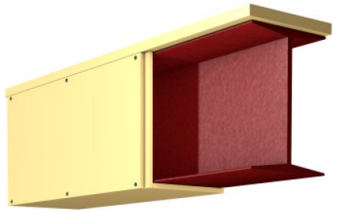
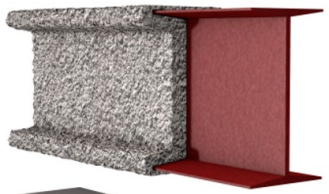
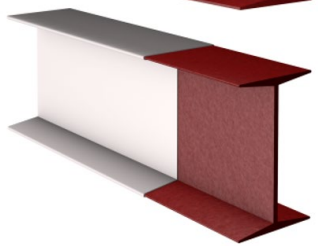
Early Information is as good as GOLD

- We don't all agree on much, BUT we can all (generally) agree that a more refined understanding of risks at early stages in a project, helps to improve the final outcome.
- With PFP we have primarily relied on prescriptive approaches or broad rule sets for early specifications (mostly driven by sparse data and lack of available approaches).
- These approaches have multiple failures:
  - Can easily result in overlooking critical systems or structures.
  - Can easily overlook critical fire types or mis-categorize fire types.
  - They largely ignore the specifics of a facility; layout, unique features, processes, and compositions.
  - They are general developed with little "aim".
  - **They can yield both conservative and unconservative specifications.**

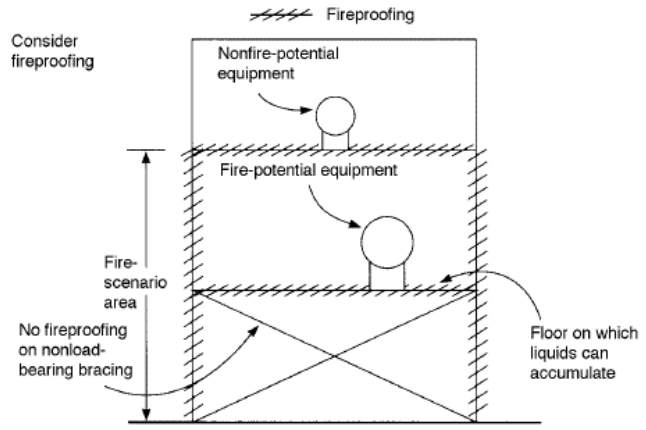






How do we improve?

- It's early in the process:
  - We anticipate limited information.
  - We anticipate changes (refinements) as the design progresses.
  - But we want a better understanding and a solid foundation to work with.
- We want:
  - Relatively limited effort (no rigorous calculations) – a detailed assessment will (should) be conducted later.
  - To incorporate risk – or at least develop an initial profile and understanding.
  - An approach that can be broadly utilized/applied.
  - **Improve the overall end state – better protection, better performance, and better alignment with objectives.**



Photographs courtesy of DNV Spadeadam Research & Testing.

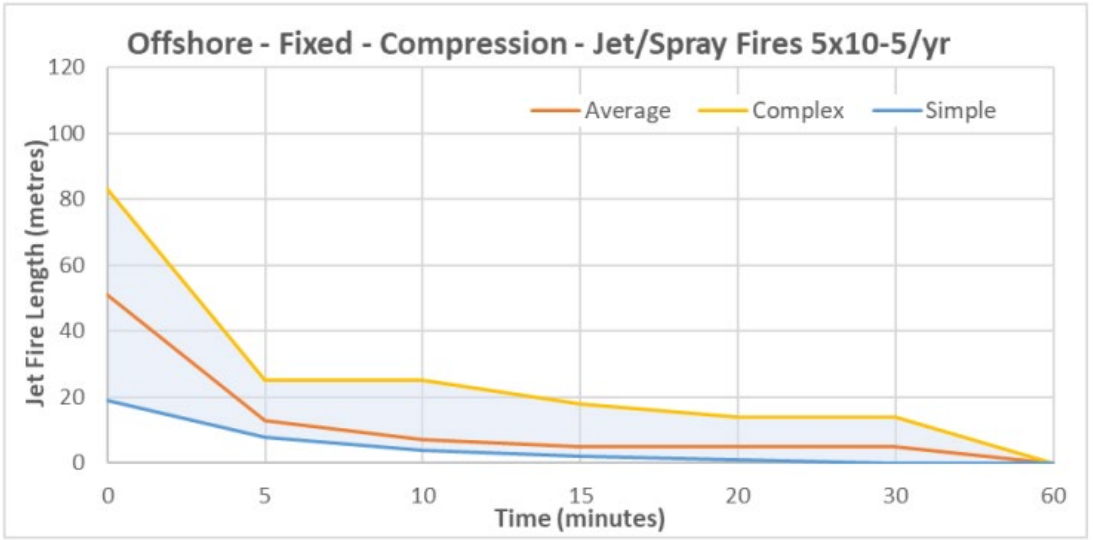
Leveraging the PFPNet Design Fire Scenarios

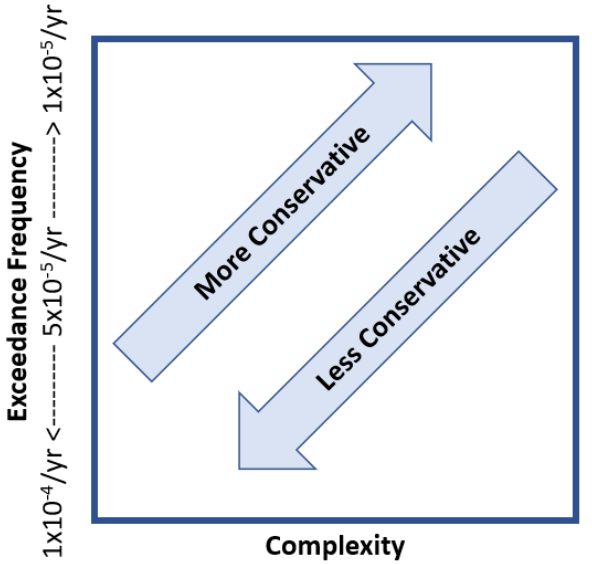
- PFPNet Guidance on Developing Preliminary PFP Systems contains a set of twenty-two (22) Design Fire Curve Sets; representing various conditions, facility types, process modules, etc.
- Includes a basis of onshore, offshore, and LNG processes

Location Category	Facility Category	Included Module Types and Process Areas	Description	Fire Types
Onshore	**All** These represent a sample of facility types and process operations that would be found at various onshore facilities. Examples of these include chemical plants with storage and blending, gas processing and handling, reaction and column processes, loading and unloading systems for rail, truck, and marine. Note that onshore facilities have large variation when compared to offshore facility types. The selection of curves is provided as a sample of primary processes likely to have fire scenarios that may be considered for protection.	Storage and Transfer	Includes transfer pumping and storage control equipment such as valving, manifolds, and recycle systems. This selection is not representative of fires resulting from atmospheric storage tank fires.	Jet/Spray Pool
		Reaction and Processing	Includes scenarios resulting from active processing systems such as reactors and columns, as well as releases from associated feed systems and process loops (i.e., heat exchangers).	Jet/Spray Pool
		Vapour Systems	Includes vapour handling systems such as recycle compressors, vapour recovery unts, and drying systems.	Jet/Spray
		Loading/ Unloading	Includes product handling processes for marine, rail, and truck loading systems, specifically pumps, flexible hoses and hard lines.	Jet/Spray Pool
	All These represent the main processes		Includes production and liquefaction processes related to the conversion of vapour to liquified natural gas.	

The Design Fire Approach

- Curve envelopes, based on thousands of detailed fire calculations, which allow for / include variations in:
  - Process Designs,
  - Facility Layouts and Sizes,
  - Design Safety Philosophy, and
  - Assessment Goals, based on project influences.





Complexity Selection	Description
Complex	Large modules – relative to facility but on a scale of 1000m² or greater (sum of all levels or footprint). - or Includes multiple trains of equipment or multiple large vessels, process items and/or complex interconnected piping. - or Has large inventory or limited isolation and blowdown capabilities (expected durations greater than 15 mins – e.g., 15 mins to 50% of operating pressure). - or Project is utilising a more Conservative Design Approach
Average	Average modules – relative to facility but on a scale of 250-1000m² (sum of all levels or footprint). - or Average equipment layout with 1-3 major vessels/process items. - or Has average inventory, isolated from incoming and outgoing streams as well as major vessel sources.
Simple	Small modules – relative to facility but on a scale of 250m² or less (sum of all levels or footprint). - or Includes small or limited process vessels and limited leak sources. - or Has limited inventory or above average isolation and blowdown capabilities (less than 15 min design approach that is typical for design using API 521).

The Process

Identify the Protection Philosophy and study goals. (risk threshold, state of design, etc.)

Characterize the Facility (modules, composition, inventory, complexity, safety systems, etc.)

Identify Critical Elements and Characteristics (type, survivability requirements, inherent survivability, etc.)

Extract Design Fires and **Map** extents (recommend graphical, could be tabular)

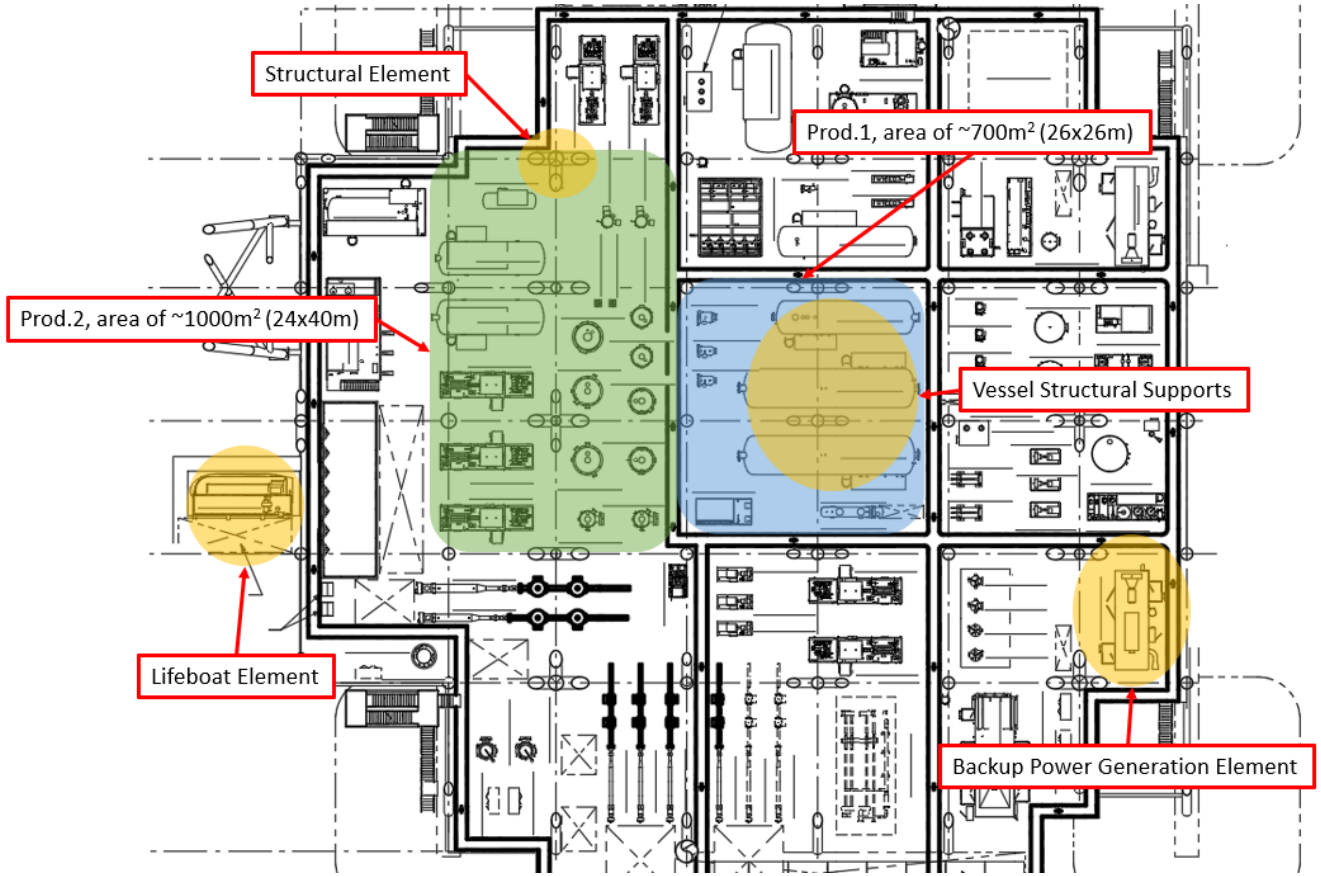
Assess impact to targets and need for protection;
Develop the protection Specification.

Identify the Philosophy and Goals

- Let's look at a (hypothetical) Offshore Floating Production Unit.
- Consider a single deck structure.
  - But the approach can easily address multiple decks, interactions between decks and hazards (with simple rule sets).
- Safety Philosophy for the Project (example).
  - Desired risk tolerability of:
    - $1x10^{-5}$ /yr, for elements that directly affect personnel safety (e.g., lifeboats)
    - $1x10^{-4}$ /yr, for elements whose failure could lead to significant escalation (e.g., critical structures)
  - Faculty requires a 20 min minimum endurance time for evacuation, muster, and egress.

Characterize the Facility

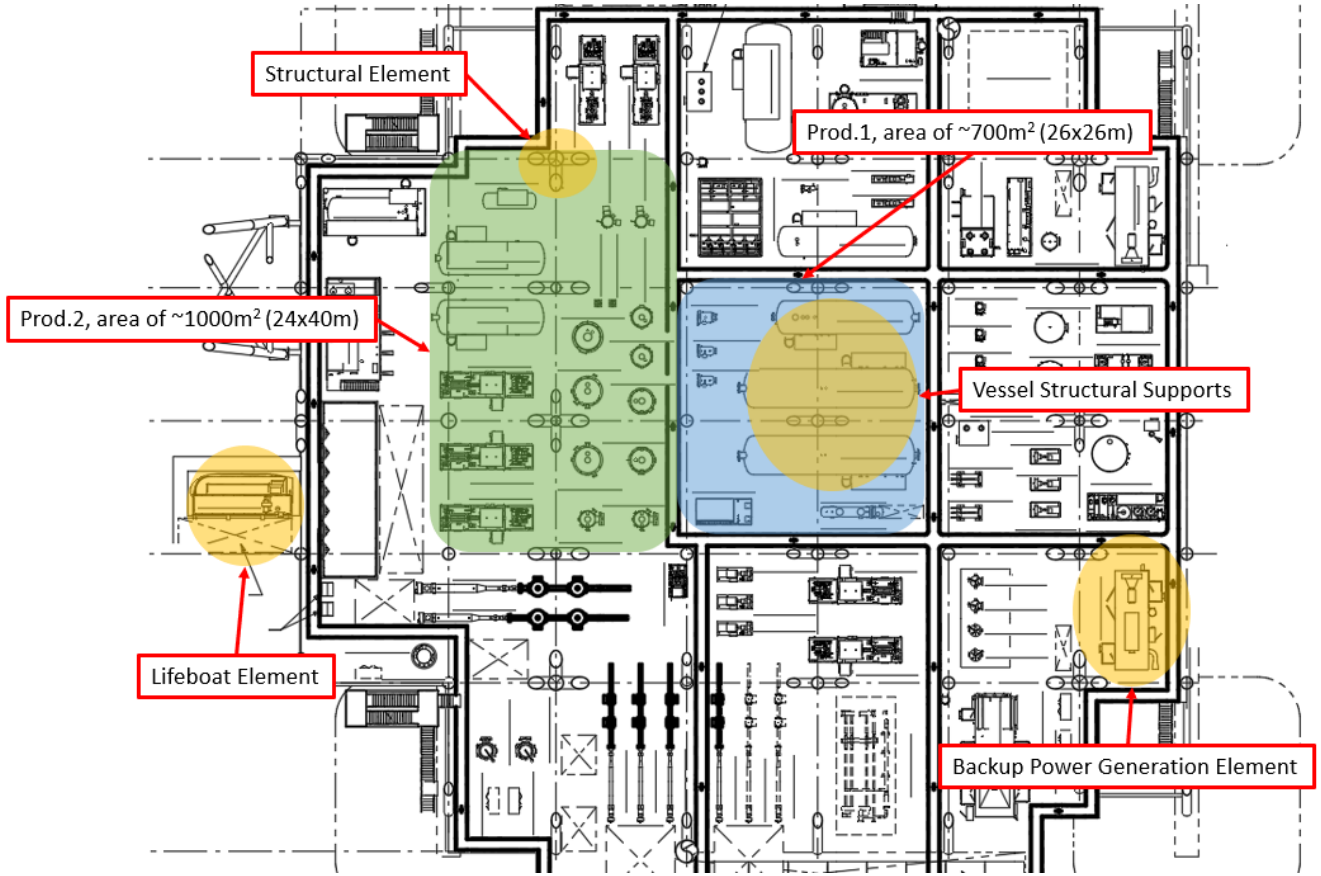
- Identify and define modules with flammable inventory:
  - Prod.1, production equipment
  - Prod.2, production and compression equipment
- Module Prod.1
  - LP and MP Separation
  - Both **jet fires** and **pool files**
  - Average size, with typical contents - choose **Average** complexity
- Module Prod.2
  - HP Separation and Compression
  - **Jet fires** only
  - Large module size – choose **Complex** complexity



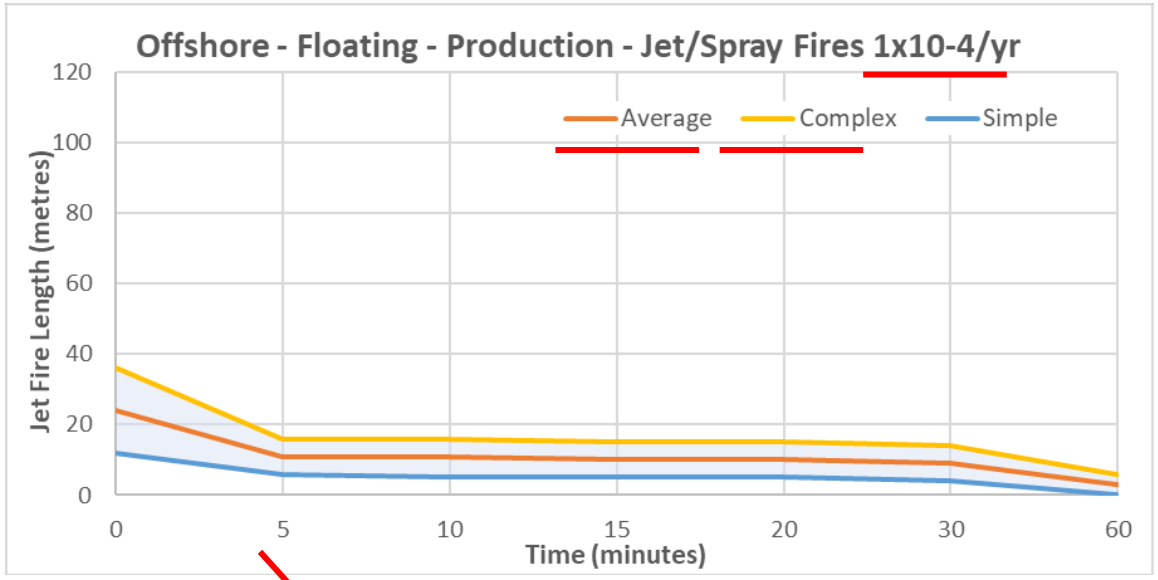
Identify Critical Elements and Characteristics

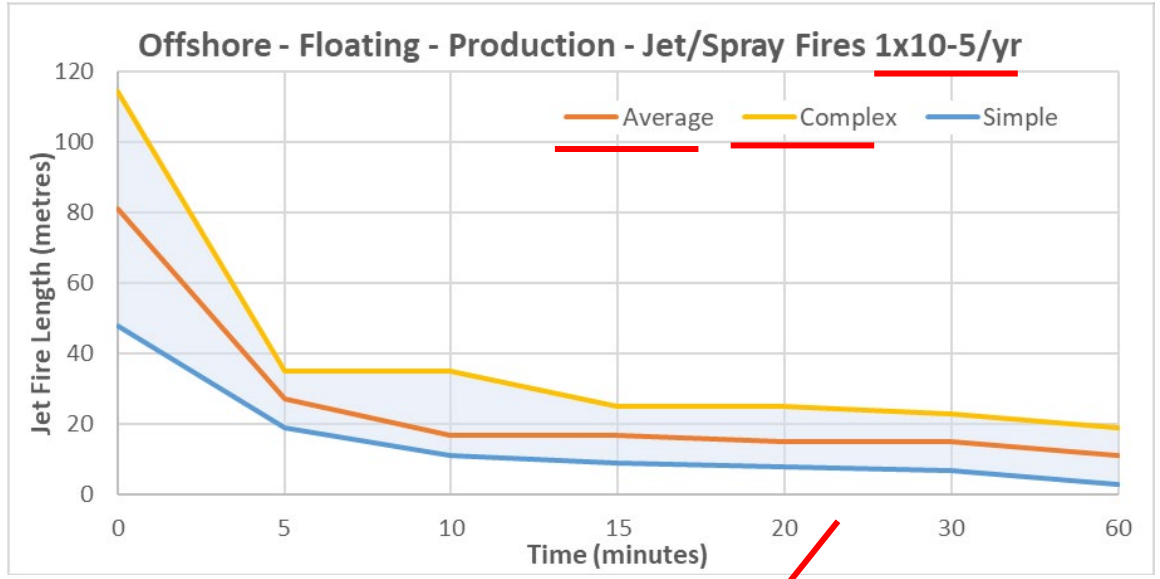
- Identify Key Elements (targets of interest)
  - Lifeboat, assume <1 min of endurance
  - Major Structural Supports, assume 20 min of endurance
  - Separator Vessel Supports, assume 2-5 min of endurance
  - Emergency Power Generation, assume <5 mins of endurance

(generalized target vulnerability assumptions, given as examples only)



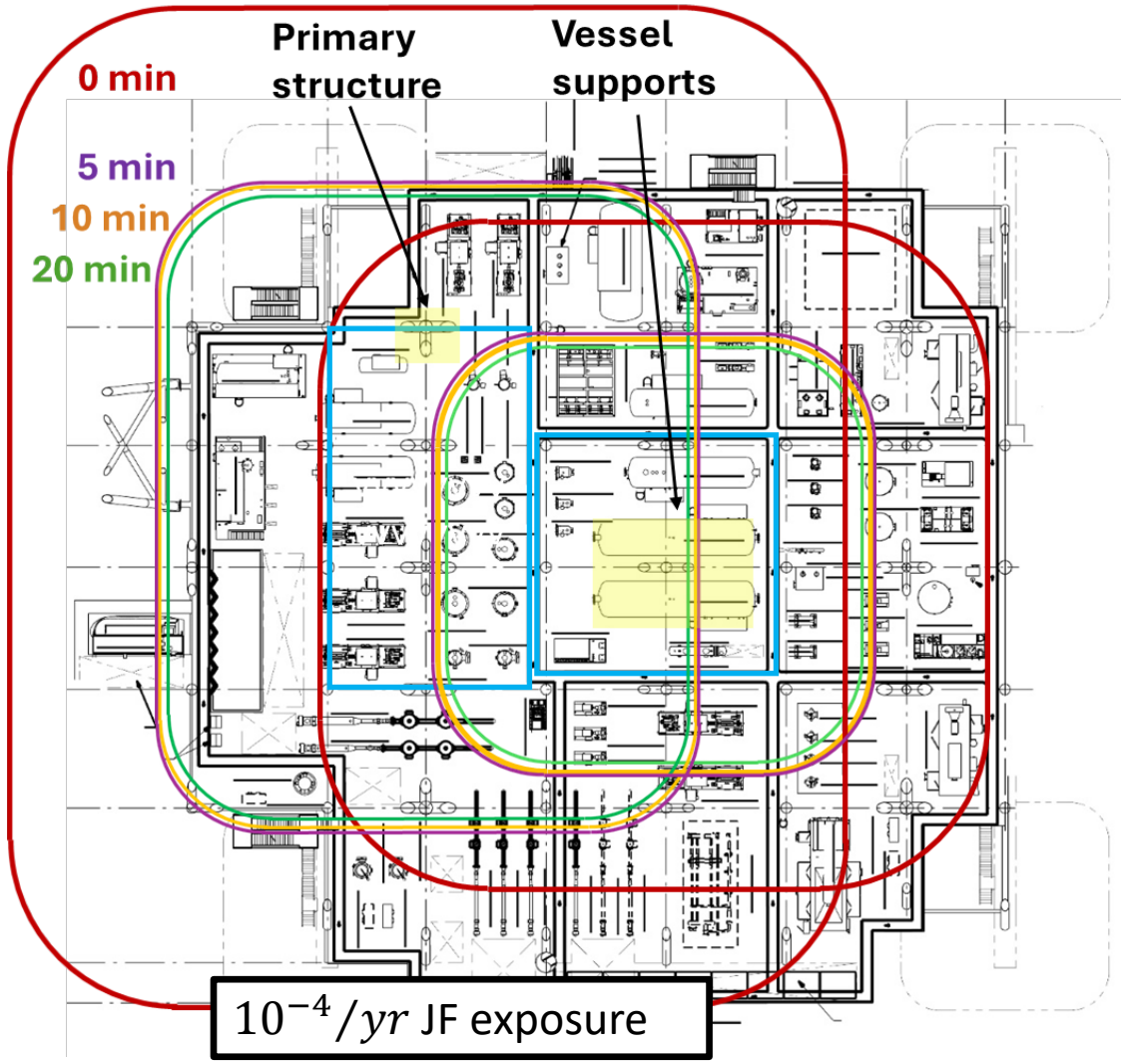
Extract Design Fire and Map Impacts

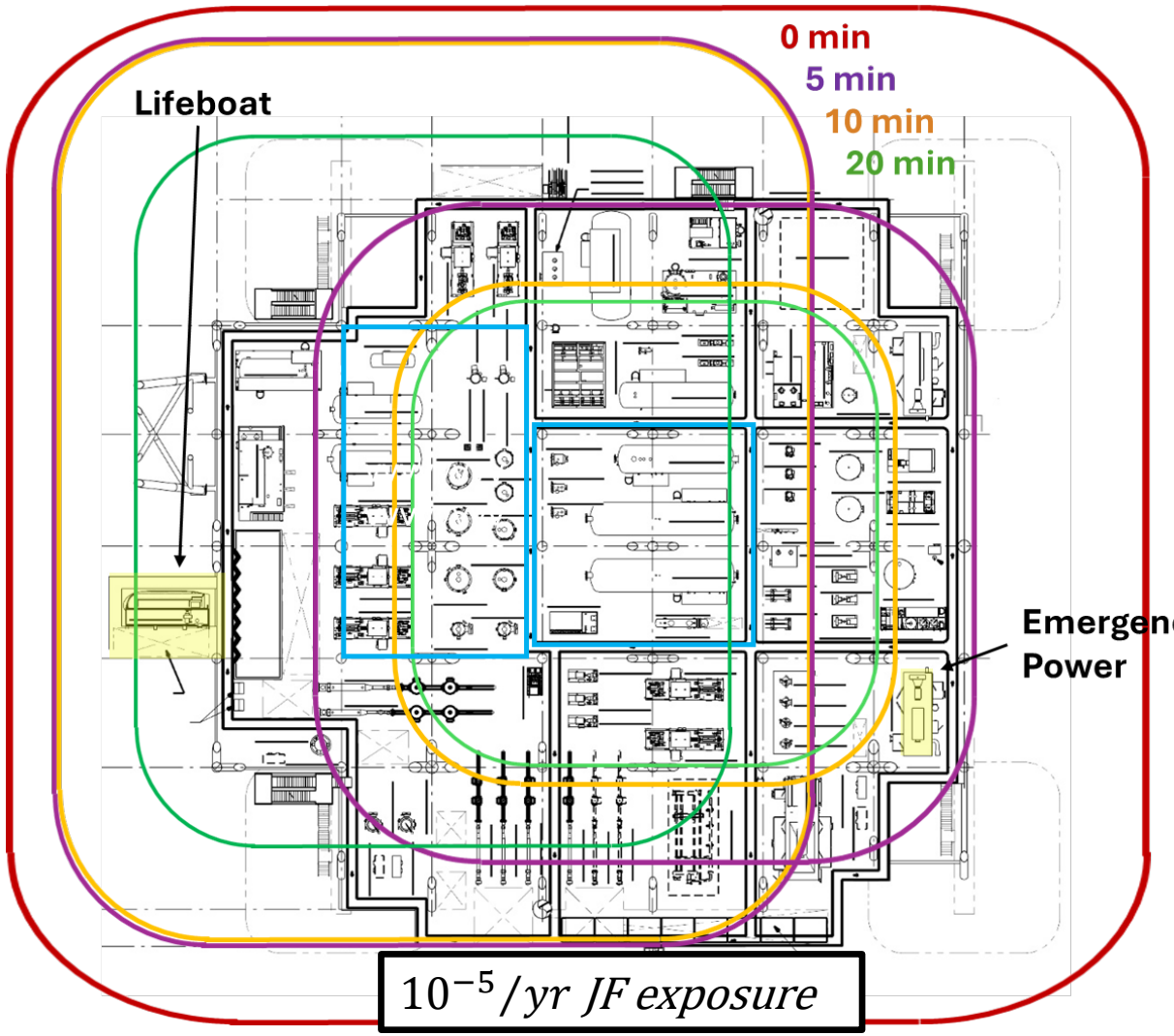




Module / Complexity	Exceedance Level (/yr)	Fire Length (metres) Time (mins) 0	5	10	15	20	30	60
Prod.1 Average	$1x10^{-4}$	24	11	11	10	10	9	3
	$1x10^{-5}$	81	27	17	17	15	15	11
Prod.2 Complex	$1x10^{-4}$	36	16	16	15	15	14	6
	$1x10^{-5}$	114	35	35	25	25	23	19

Assess Impact and Develop a Specification





Assess Impact and Develop a Specification

- Determine whether protection is required or desired based on protection philosophy/goals.
- Build an initial specification.
  - Can be simple or carry relatively complex information into the next project phase.
- Additional details "could be" examined, such as:
  - The implications of high heat flux jet fire conditions
  - Specific endurance of elements
  - Integration of layered protection systems

Target	Fire exposure	Comments
Lifeboat	10 min HHF JF, 10 min SHF JF	Requires protection (or relocation)
Emergency power	5 min HHF JF, 5 min SHF JF	Requires protection
Primary structure	20 min HHF JF	Sufficient redundancy in the structure; no protection required
Vessel supports	20 min HHF JF 20 min PF	Requires protection if the fire escalation hazard is viewed significant

Summary

- Does this type of approach require "more work" than that of a prescriptive approach, Of Course, but the value add is significant.
- The approach lends itself to easy tailoring of the effort based on state of information, goals of the analysis/project, desired level of work, etc.
- The goal (value add) is to have early and improved development of:
  - An actual protection philosophy (why are we protecting anything?), not just a generic protection statement.
  - A good basis of critical elements of the facility that may need protection.
  - An understanding (through characterization of sources) of the inherent fire risks and details that may be driving impacts (e.g., layouts, locations, unique conditions).
  - A refined specification, that can carry a varying degree of details into the next stages of design; and support the final development of better designs and protective schemes (better integration of protection methods, e.g., Do I need a firewall or would I be better suited with strategic application of PFP, or some of both?).

Protection with a purpose, not just because.

Questions

Thanks to additional contributors.

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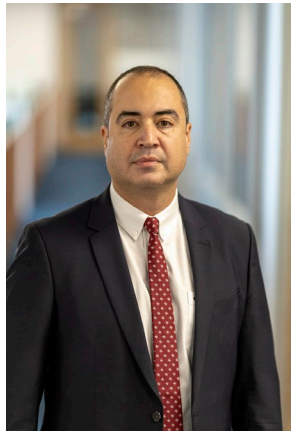

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- Keith Clutter (SciRisq)
- Mike Stalh
- And Others