OPTIMIZE™ | 26
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PROCESS Industries

inprocess
20 years

inprocess

Ensuring Refinery Lifecycle Safety with Dynamic Simulation

Wednesday, May 13th, 2026

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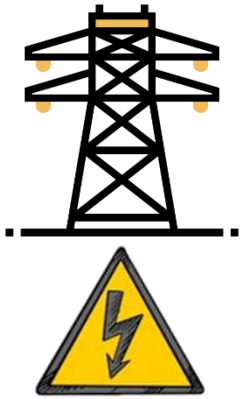
Senior Process Engineer

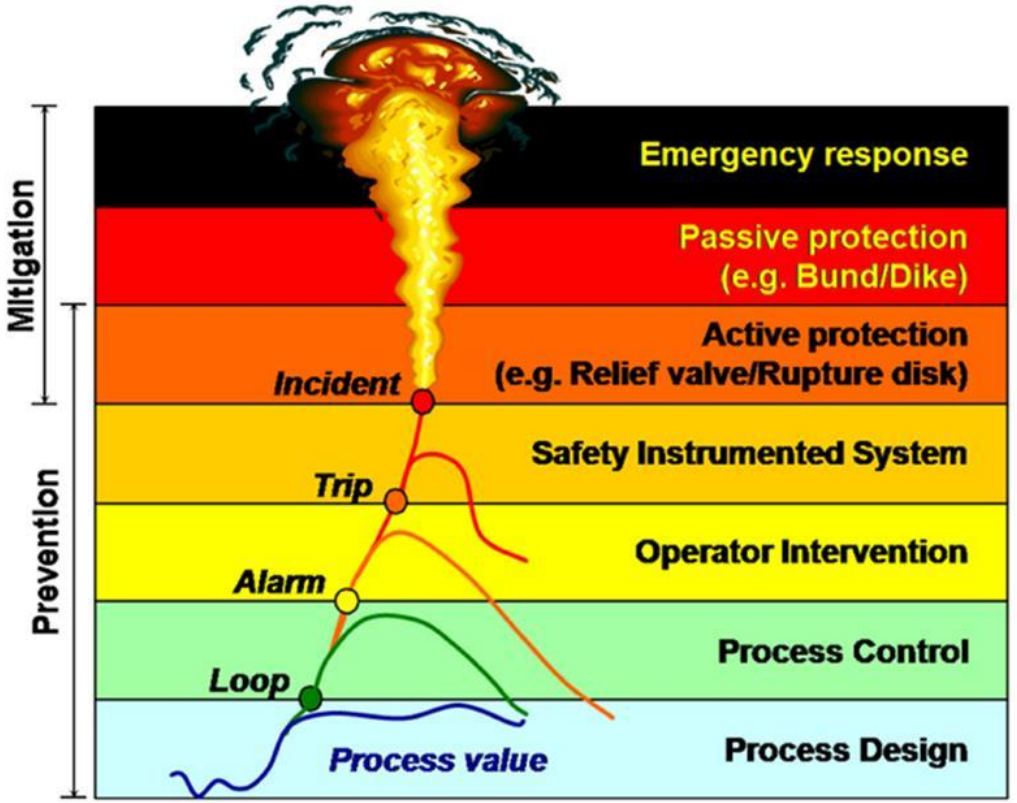
1. Context

Why lifecycle dynamic simulation matters for flare and PSM decisions

Flaring during Power Outage

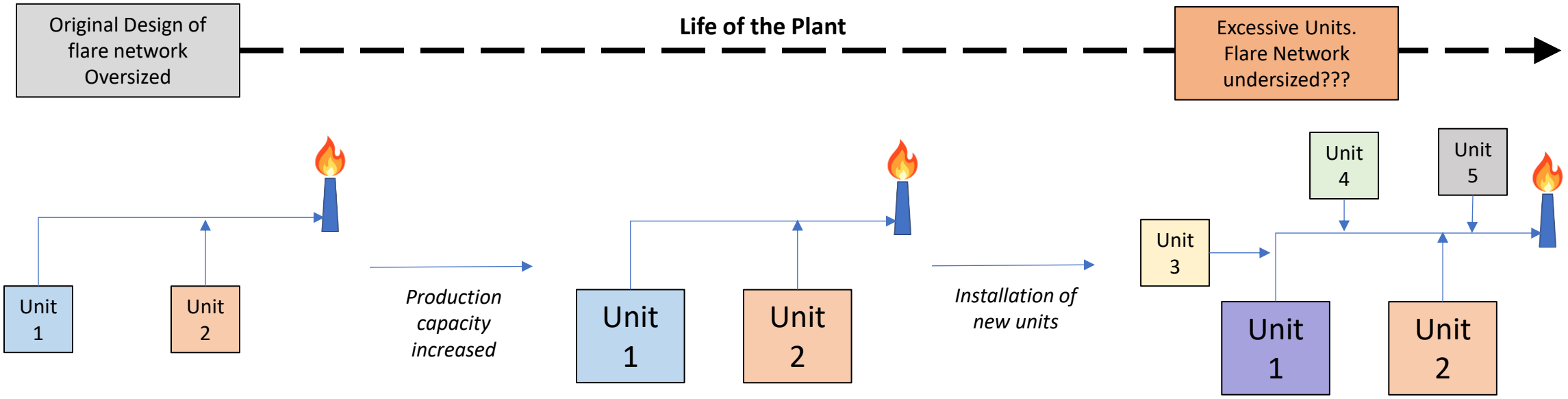


Layers of protection



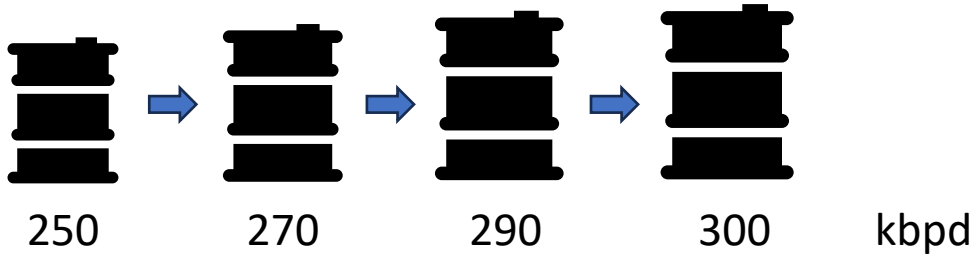
- **Pressure relieve valve (PSV) is the last layer of protection in case of upset of the plant.**
- **It is a mitigation measure when the process control and the safety system could not address the upset**

Design of safety in the lifetime of a plant



Operating facility expansion: safety challenges

- **A North American refinery expanded over >15 years through multiple upgrades.**



- **Flare system capacity and integrity must be verified as units and operating conditions change.**
  - Regulatory/insurance drivers required a rigorous flare system evaluation.

- **Goal: avoid unnecessary overdesign and identify real shortcomings early.**

Inprocess in Brief

Since 2006 helping the processing industries in solving design and operational issues by applying process simulation

our **core business** is Process Simulation

enthusiastic about **sharing our knowledge** with our clients

all technologies (process simulator and control system)

2006 est. in Barcelona by domain experts	Projects in 65 countries worldwide footprint	120+ process simulation engineers
600+ executed projects	>110 OTS Projects	500+ training courses

Inprocess Solutions & Services

Engineering Studies

Engineers Training

Operators Training

Process Digital Twins

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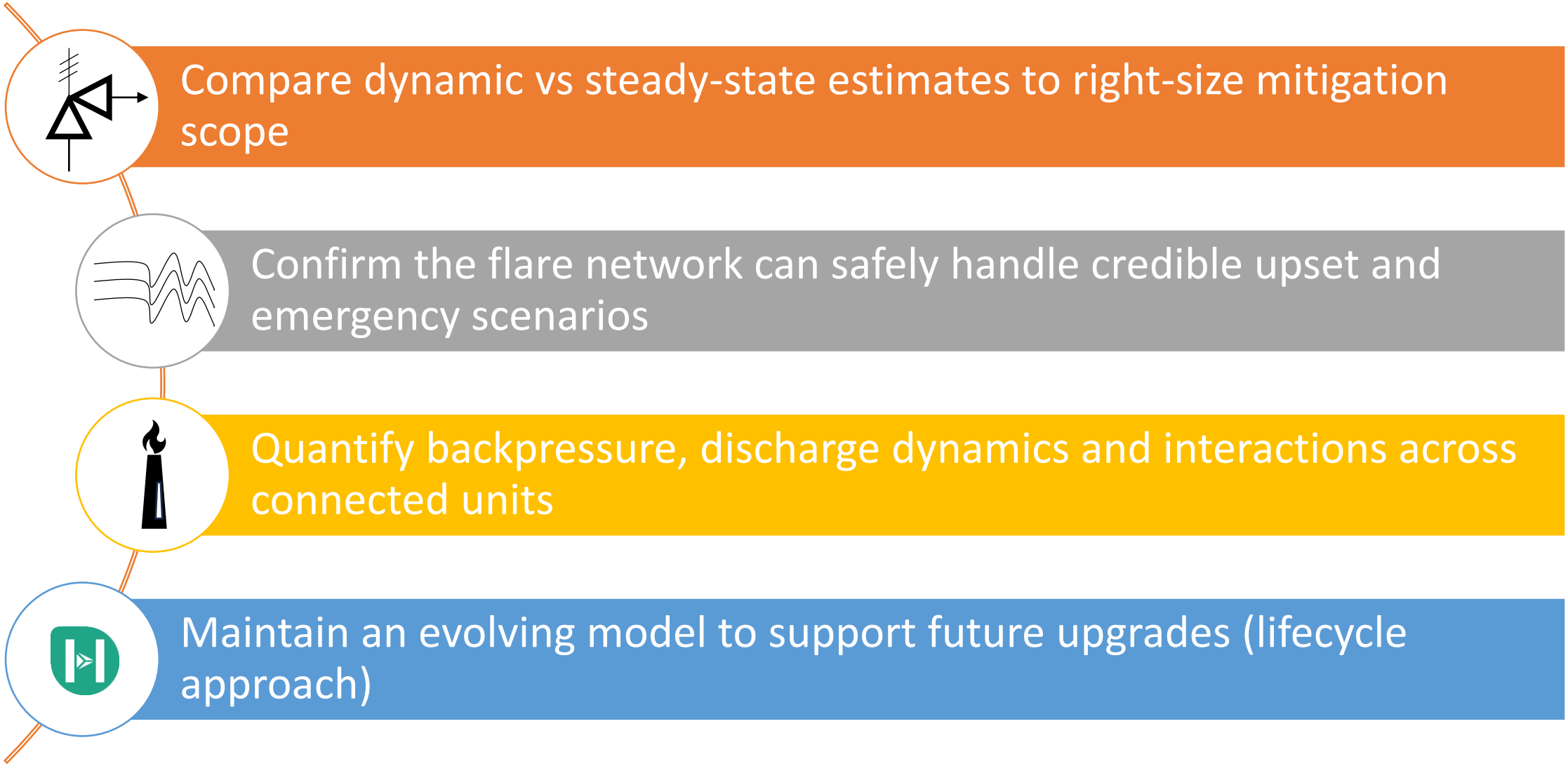
2. Approach

Integrated dynamic simulation in Aspen HYSYS: units + flare network

Study objectives

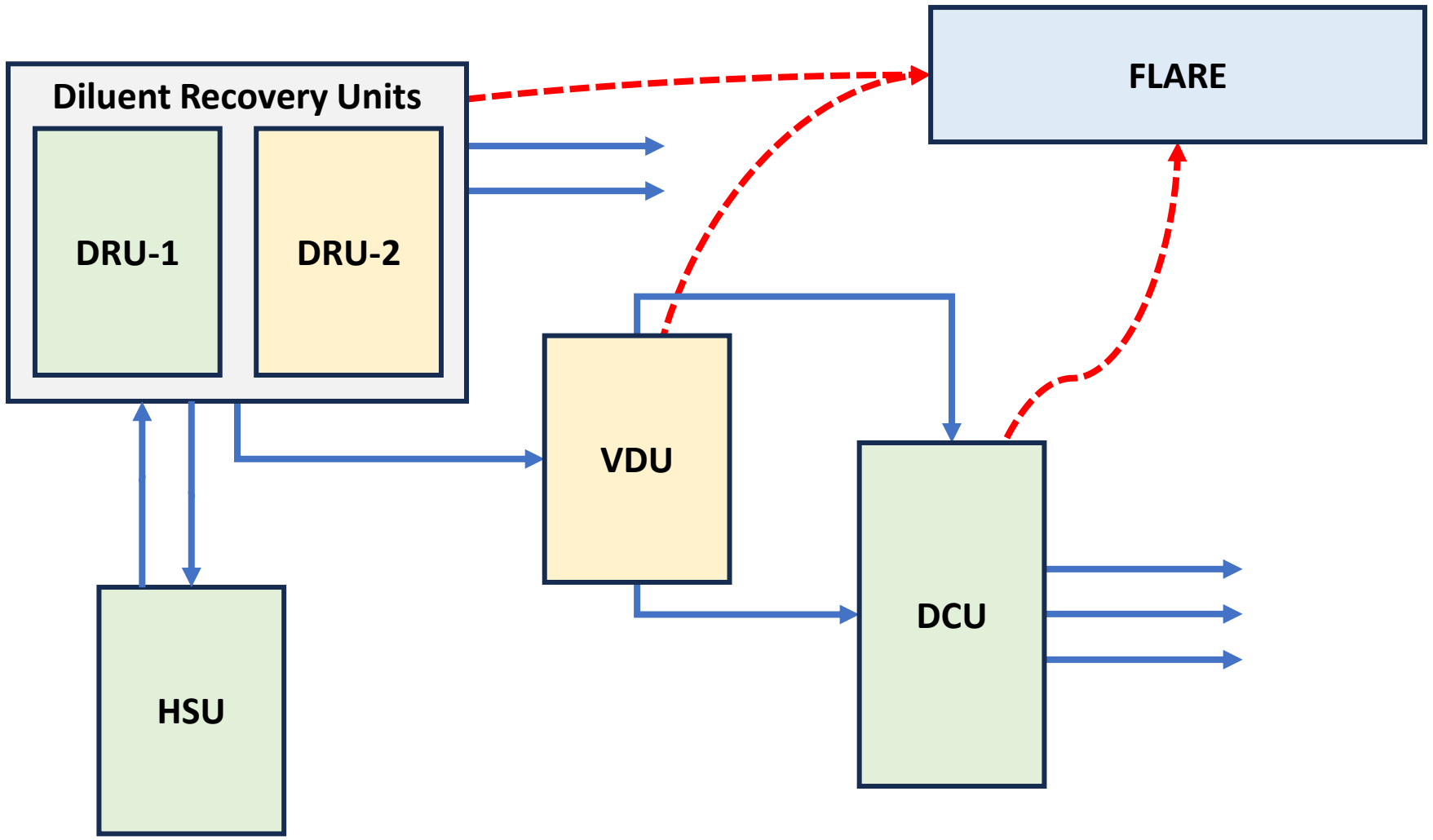


Integrated model Scope

Dynamic Simulation Primary Upgrading Units

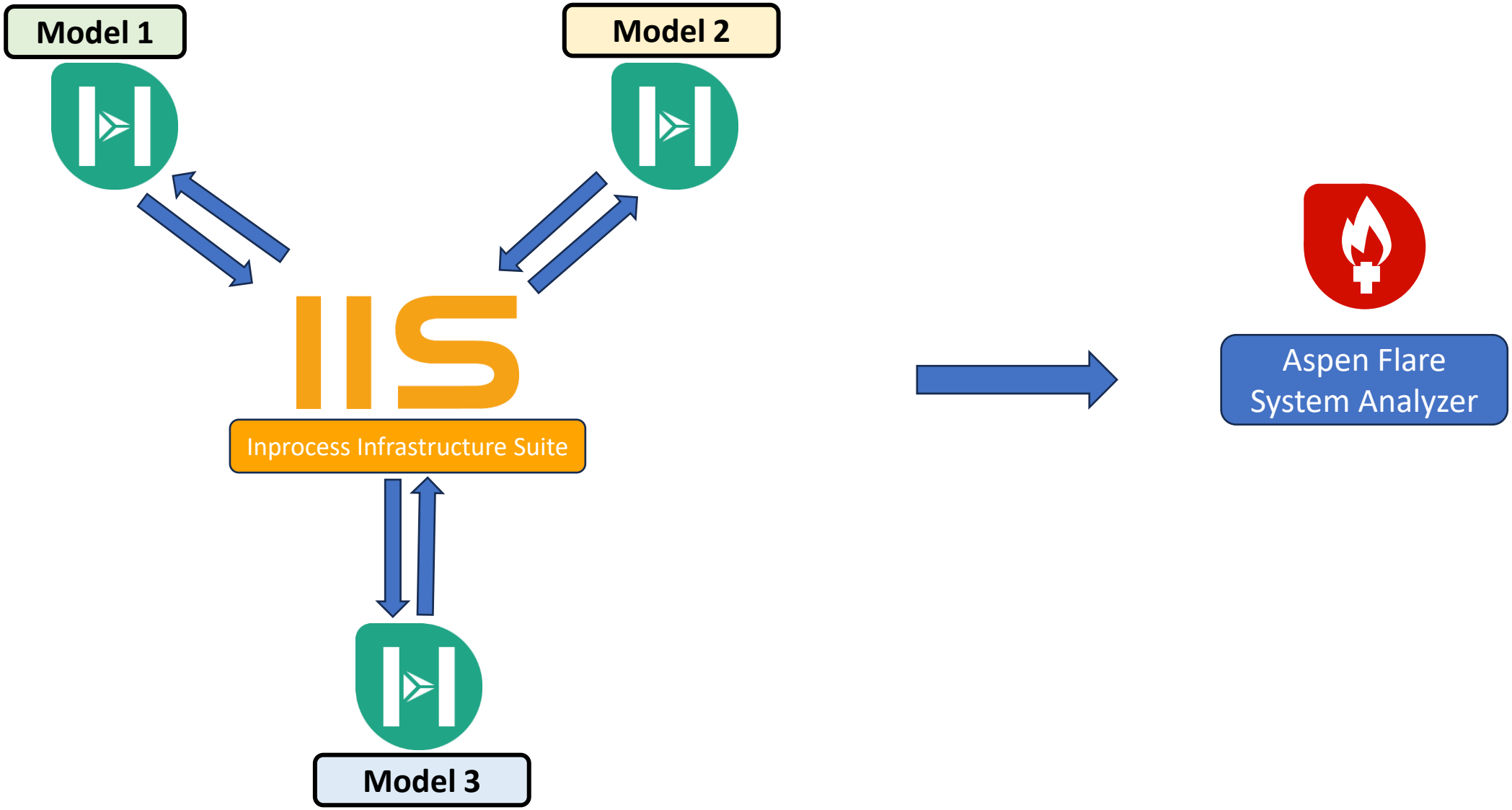
3 HYSYS models:

- Model 1
- Model 2
- Model 3



Integrated model Scope

Dynamic Simulation Primary Upgrading Units



Key modeling techniques

- **Pressurizing sources: conservative first, refined with plant data**
  - API-based assumptions as starting point
  - Data-driven tuning where available
  - E.g.: Furnace tube residual energy modelling

- **Complex phenomena included where it matters**
  - Two-phase relief behavior
    - In 2013 - Inprocess manually programmed a biphasic correlation
    - Since 2017 – HEM from Hysys was used
  - Network line-pack and transient backpressure
  - Control/valve actions and utility dependencies

- **Model governance: version control, change logs, repeatable scenario scripts**

3. Scenarios & Validation

Credible cases + alignment with operations

Emergency & upset scenarios evaluated

Common contingencies

C-1	Site-wide power Failure
C-2	Site-wide Cooling Water Failure
C-3	Site-wide Inhibited Water Failure
C-4	Local Inhibited Water Failure

Single relief scenario

S-1	Flash Drum Vapor Blocked Outlet
S-2	DRU Column Vapor Blocked Outlet
S-3	Blowdown Area Vapor Blocked Outlet
S-4	Coker Vapor Blocked Outlet

Model validation & credibility checks

- **Validate plant operating data**

- **Sensitivity studies on key uncertainties**
  - two-phase fraction,
  - availability of utilities,
  - duty of natural air draft,
  - etc.

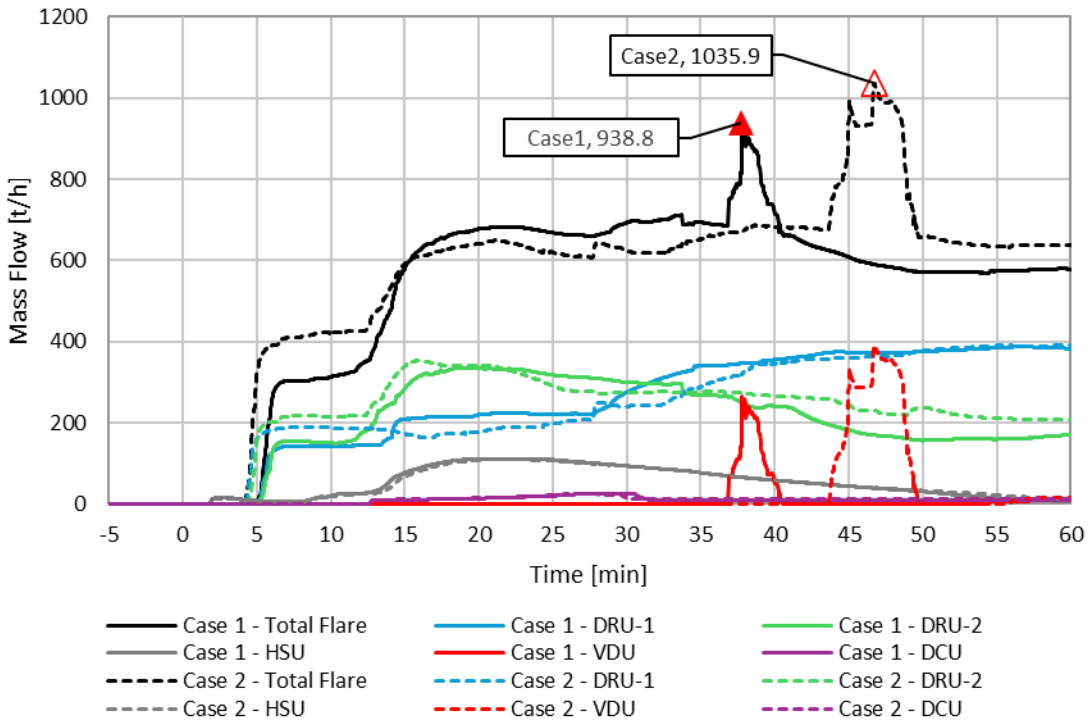
- **Stakeholder review: operations, safety, engineering aligned on assumptions**

4. Results

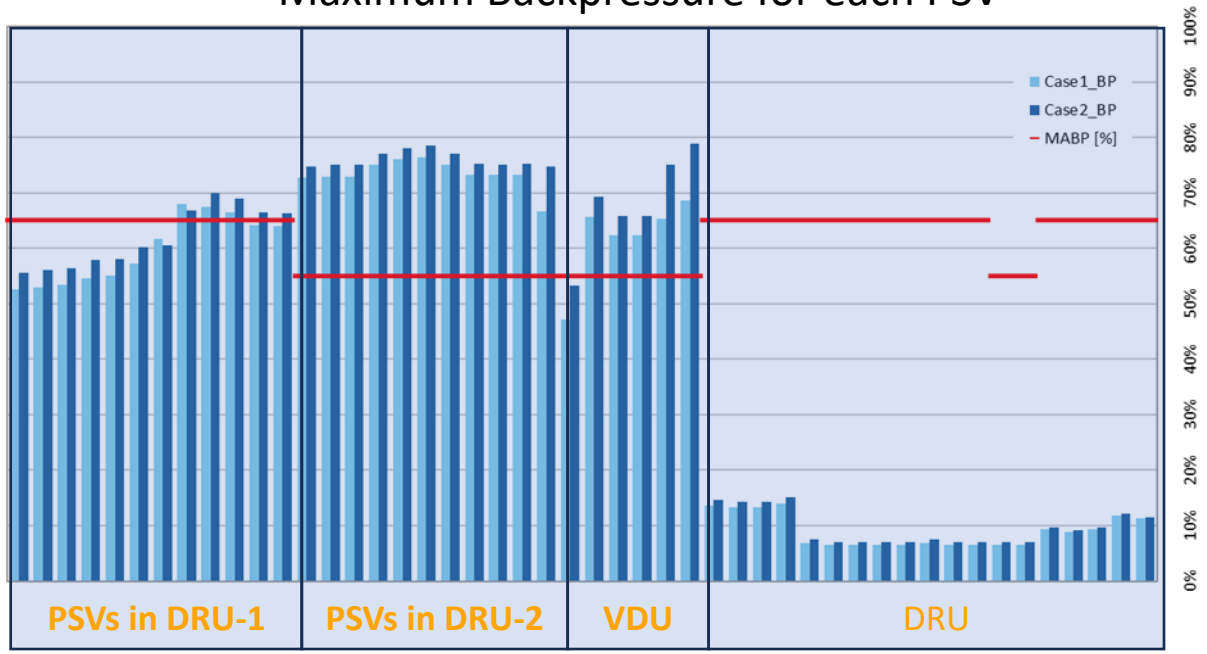
What changed and why it mattered

Flare load and backpressure

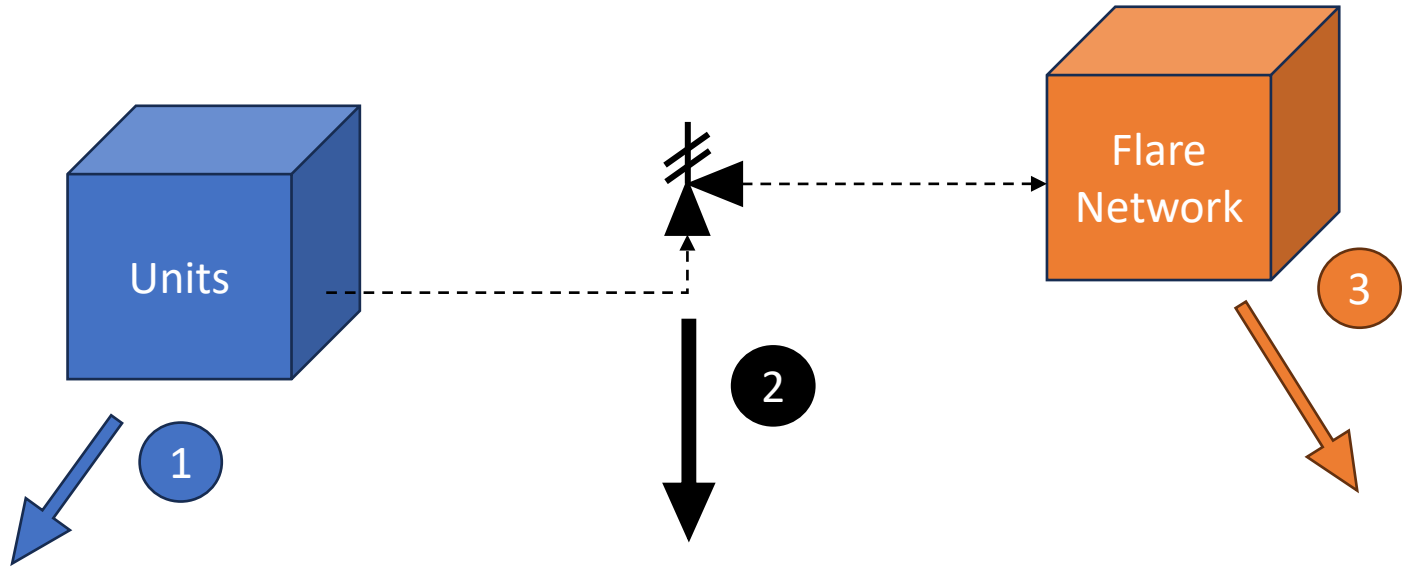
Flare load with time



Maximum Backpressure for each PSV



Mitigation options and decision logic



Mitigations to reduce the relief (Actions within Units)

- Assessment of pressurization sources
  - ✓ New interlock actions
  - ✓ Limitation of feed flowrates
  - ✓ …

Relief System Adjustments for Overpressure Mitigation (PSVs)

- Increase of Installed Relief Capacity (Addition of New PSVs)
- Replacement of Balanced Bellows PSVs with Pilot-Operated PSVs

Mitigations to reduce the Backpressure

- Increase Pipe Diameter in Critical Sections (segments with the highest-pressure losses)
- Implement New Routing to Expand Overall Flare Network Capacity

Mitigation Actions Summary Table - 2025

Mitigation Actions Summary Table

	DRU-1	DRU-2	VDU	DCU			Flarenet Modifications
	PSV-2	PSV-5	PSV-1	PSV-1	PSV-3	PSV-4	
C1 - SWPF		Add PSV		Add PSV			Yes
C2 - SWCWF			Add PSV				-
C3 - SWIWF	Add PSV	Add PSV					Yes
S4 - COKER_BLOCK					Add PSV	Add PSV	-
S3 - BD_BLOCK						Add PSV	-

Lifecycle model evolution (2013 → → 2025)

Before 2013: Development Plant – Phase I (DRU-1, DCU & HSU)

Cooling Water Failure
Inhibited Water Failure
Local Failure scenarios

Classified as remote events → Not considered for Design of Flare Network

In 2013: Inprocess was requested to reassess the existing plant and flare network through dynamic simulation

Year	*Scope of Work*	*Production*	*Issues*	*Mitigations Actions*
2013	Reassessment of Scenarios Including the Addition of New Units DRU-2 and VDU	250 kbpd	• Overpressurization DRU • Excessive Backpressure	***Installation of HIPPS***
2017	Scenario Reanalysis for Production Increase to 270 kbpd and New Equipment Installation	270 kbpd	• Overpressurization VDU • Chattering • Excessive Backpressure	***New PSVs*** ***New Actions in HIPPS***
2021	Reanalysis of Scenarios Considering a Production Increase up to 290 kbpd	290 kbpd	• Overpressurization VDU • Chattering • Excessive Backpressure	**New PSVs** Different options: - Flare network modification - Action at unit levels - Replacement of existing PSVs with pilot-operated PSVs
2025	Increase Production and Installation of new equipment (furnace, mainly)	300 kbpd	• Overpressurization VDU • Excessive Backpressure	***In Progress***

Key safety findings

- **Revealed units lacking sufficient protection area in specific failure scenarios**
- **Quantified dynamic interaction effects:**
  - Simultaneous discharges
  - Backpressure evolution
- **Enabled evaluation of targeted protection strategies rather than broad overdesign**

5. Value & Lessons Learned

From one-off study to lifecycle capability

Business impact – Revamp 2017

- Avoided unnecessary flare/PSV/network modifications driven by over-conservative steady-state results.

15 MM$

Conventional approach
Modifications CAPEX

2.5 MM$

Dynamic Simulation approach
Modifications CAPEX

- Reduced turnaround scope and schedule risk through targeted upgrades
- Improved confidence in compliance
- Reusable model foundation for each subsequent expansion phase
- Modifications by using dynamics costs 2.5 MM$, whereas the SS 15 MM$ + 10% increase in throughput (1.5 MM$/d) + reduced turnaround

Conclusions

- **Dynamic simulation provides a realistic, time-dependent view of flare performance**
- **Lifecycle model updates across upgrades preserve knowledge and reduce future study effort**
- **Holistic integration enables safer, more cost-effective mitigation decisions**
- **Next steps:**
  - Redesign relieving capacity
  - Improve Flarenet piping design
  - Digital Twin
  - Operator Training System

Thank you!
Q&A

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inprocess
20 years