4th Chemical Process Safety Sharing (CPSS)

The Optimize Design Approach for Flare System Rating

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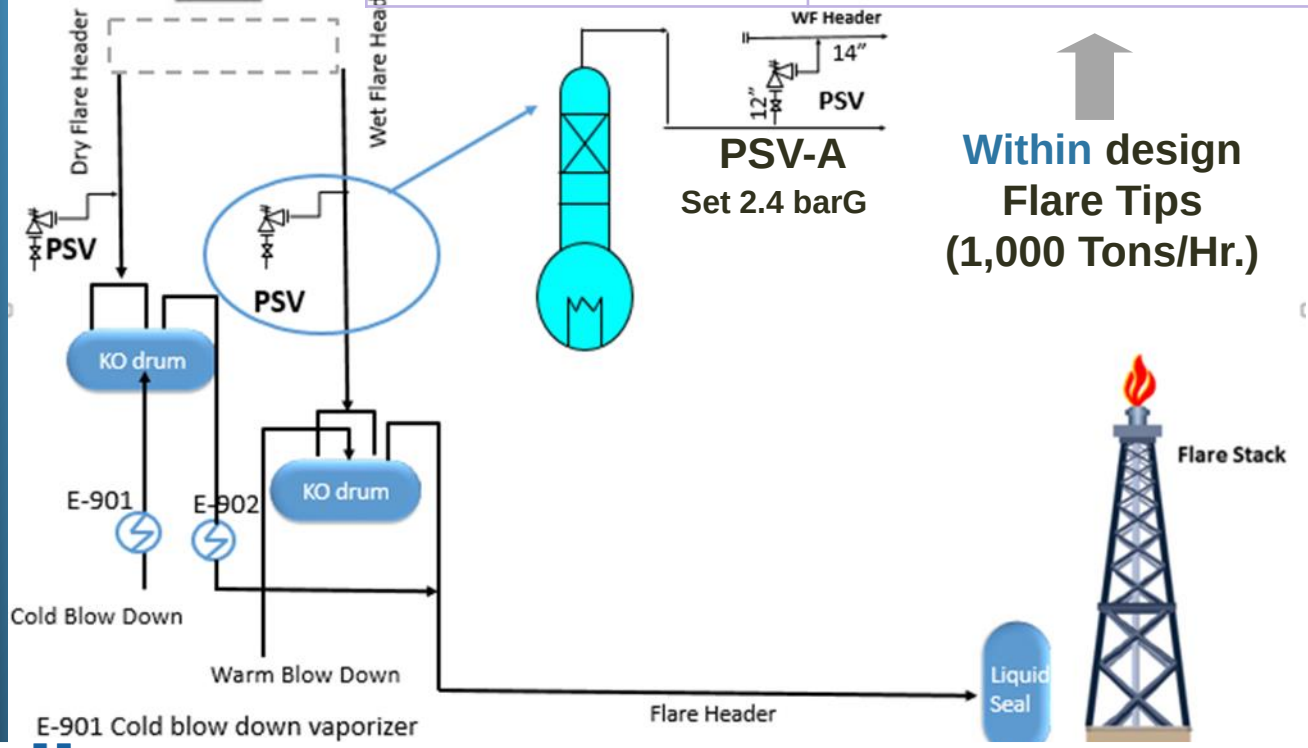
Why is the flare hydraulic important?

The flare hydraulic will evaluate *the back pressure of each PSV.*

Cooling water failure	Flare relieving load (Tons/Hr.)	PSV-A back pressure (barG)
Before expansion	730	1.17 (40% of set pressure)
After expansion	820	**1.22** (**51%** of set pressure)"



Within design Flare Tips (1,000 Tons/Hr.)

Over design of *PSV allowable Back Pressure*

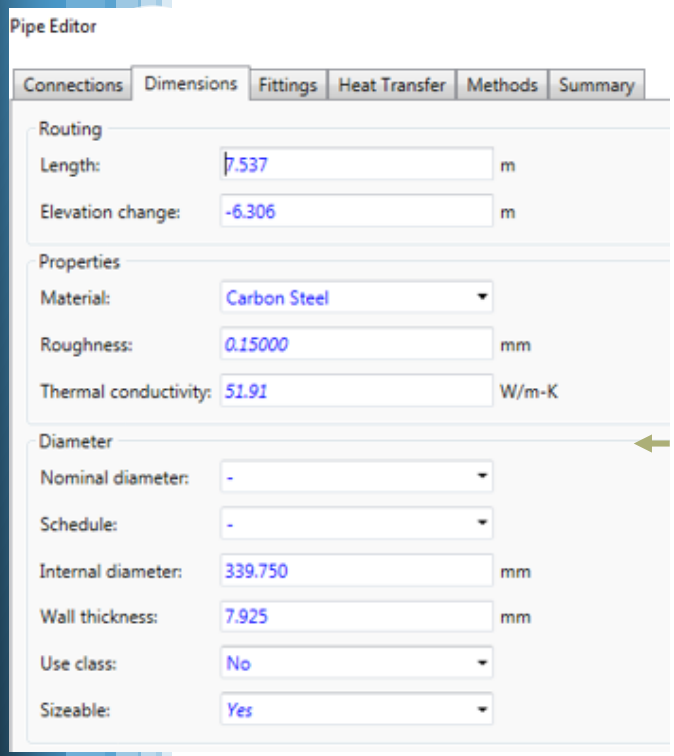
Note:"*" Allowable back pressure of PSV-A **is 50% (balance bellow type)**. If the actual back pressure is higher than allowable back pressure, PSV rated capacity is reduced.

Flare Steady State Vs Dynamic Simulation

State	Available Software	Required Input	Results
Steady	Aspen Flare System Analyzer	• Relieving condition* • Case study • PSV datasheet • Isometric drawing	• Back pressure of each PSV • Header sizing • Pressure Profile • Mach Number
Dynamic	Aspen Hysys Dynamic Or Aspen Plus Dynamic	• More process detail required • Process Simulation file of existing plant • Logic scenario (ESD/DCS) • Specify the sequence of unit start up/shut down.	• Transient pressure profile • More accurate relief load • Foresight the start up/shut down procedure for minimize flare load

***Relieving condition**: Relief flow, Relief temperature, Relief pressure, component (or Ave. MW)

How to Simulate Flare Steady State



Select Calculation method

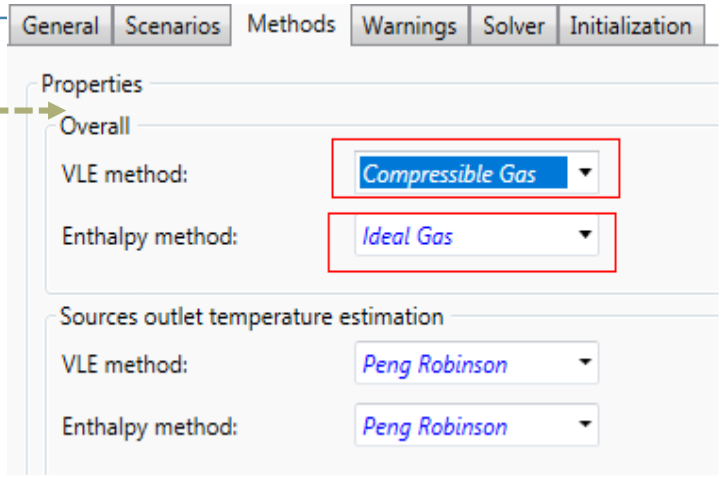
Define Relieving Scenario (CW, EE or reflux fail)

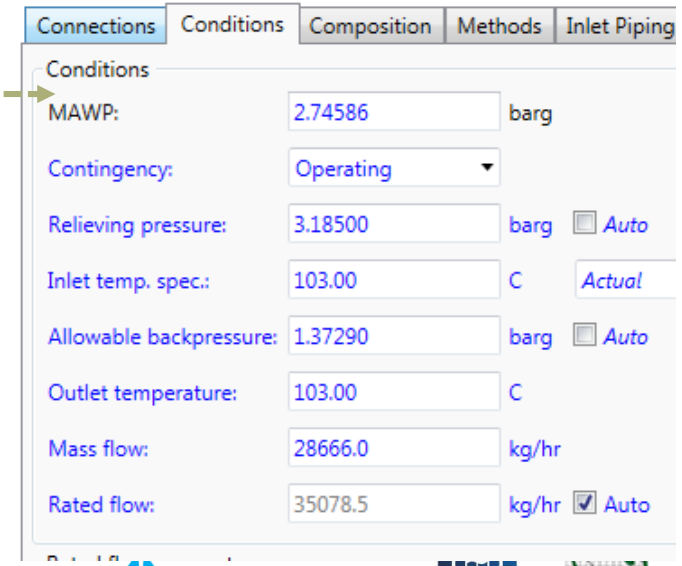
Built Flare System (PSV, pipe header, KO drum, flare)

Define Relief Conditions

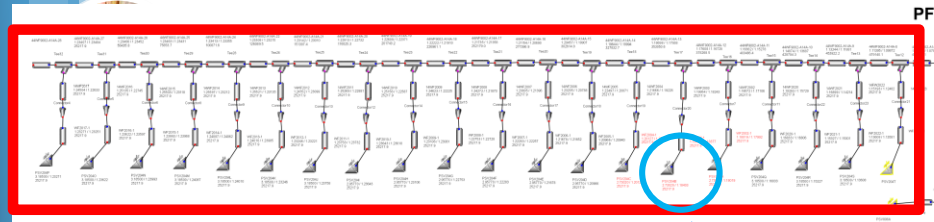
Validate Model

Evaluate Results

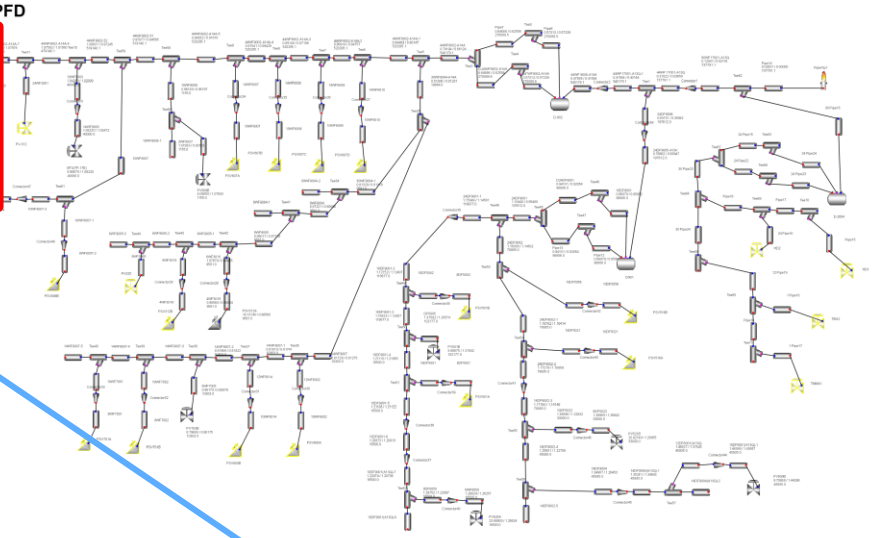




Example report – Aspen Flare



PFD



PSV-A (Quench Tower)
19 +(1spare)

PSV-204B

Property	UpStream	DownStream
Static pressure (bar_g)	2.73020	1.18118
Total pressure(bar_g)		
Temperature (C)	105.00	105.00
Velocity(m/s)	27.895	68.0
Mach number		0.202
Rho V2 (kg/m/s2)		10408

116% of set pressure

51% of set pressure

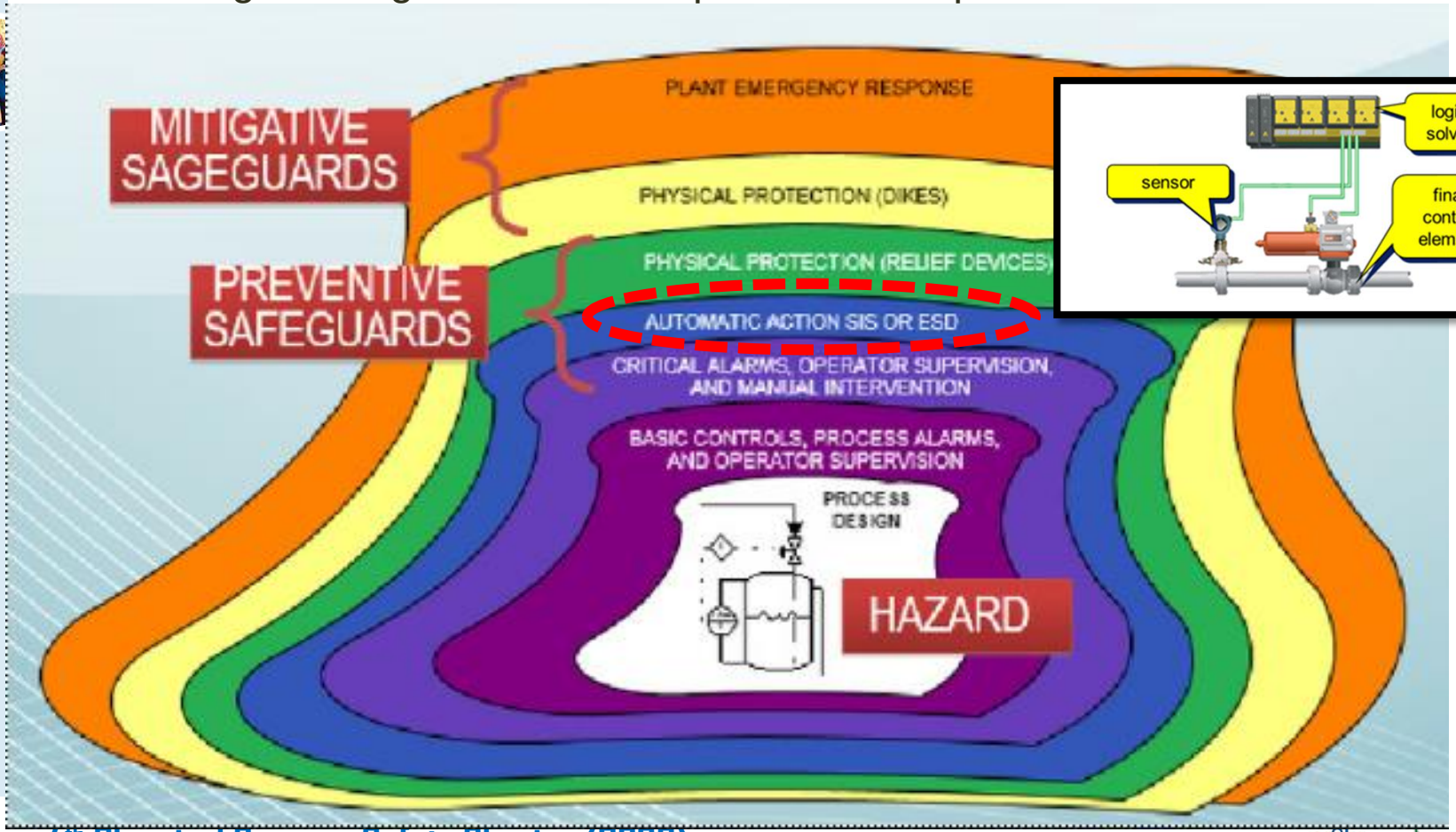
Options for Reduce PSV Back Pressure

Options	Results
1. Increase PSV set pressure	**Not possible** - Limit by equipment maximum allowable working pressure (MAWP) of Tower
2. Replace pilot PSV instead of balance bellow type	**Not possible** - Due to service dirty fluid risk of plug (not recommend by licensor)
3. Modify the flare header	**Possible.** - Routing new line 30” and add 3 new PSVs and new KO drum and KO pump
4. Enhance the SIL of the flare mitigation interlock to meet SIL-3	**Possible** - Add redundancy of the final element (shut off valve) and sensor in safety integrity system (SIS) for reduce the failure of SIS

Safety Integrity System (SIS)

SIS or ESD is basically composed of a combination of sensor, logic and final element.

e.g. cooling water low low pressure to trip feed furnace and fuel.



Safety Integrity Level (SIL)

- Higher SIL that means a greater process hazard and higher level of protection required from the SIS
- Flare load mitigation require SIL-3

Safety Integrity Level Table

Safety Integrity Level (SIL)	Probability of Failure on Demand (PFD)
4	0.0001
3	0.001
2	0.01
1	0.1

Budget

Modify Flare Header

Modification list

- Add 3 new PSV
- New wet flare header 30”, expand to 44” from KO drum to flare.
- New KO drum and drain pump

Concern Point

- Check the available stack slot for new header
- Evaluate the stack support strength and loading

Time during Turn Around

Est. Cost 150 MB

Improve SIL (Interlock Cut Feed Furnace)

Existing : SIL-2
Modify to SIL-3

Modification list

- Add shut off valve for naphtha & LPG feed to furnace A,B,C = 6 XV
- Piping Modification for add XV
- Add Pressure transmitter & Temperature transmitter = 3

Time during Operate (Can Mange Furnace Shutdown)

Est. Cost 15 MB

Note: The budget is specified for magnitude estimate only. The actual budget is confidential data.

Key Take Away

I. For plant expansion, the **rating of knock out drum and flare tips aren't the completed approach** for the flare system rating. **The PSV back pressure shall be determined by flare hydraulic study.**

II. The **steady state simulation** are the recommend approach to evaluate the flare hydraulic.

III. Enhance the **SIL of flare mitigation system** (e.g. feed furnace SIF, tower heat source SIF) is the optimum option in both cost and time.

Thank you for your attention