Common Mistakes in PSV Sizing

Lessons Learnt and Case Studies from Years of Operation

Presenter

Suradech Kongkiatpaiboon
Sr. Process Engineer

Affiliation

Chevron Thailand
Exploration and Production

Event

TNCHE 2026

Chevron Thailand Operations

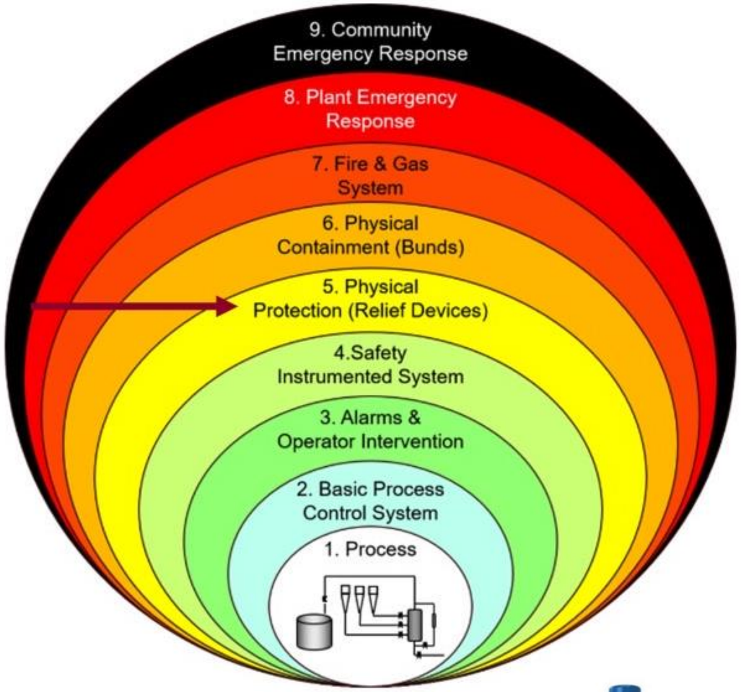
Offshore Concessions since 1981

- 2 Gas Central Processing Platforms (CPP)
- 1 Oil Central Processing Platform (CPP)
- 106 Wellhead Platforms

Production

- Gas Production: 565 MMSCFD
- Condensate: 16,245 BPD
- Oil: 19,744 BPD

as of April 2026



Pressure Safety Valves — The Last Line of Defense

Final Protection Layer

PSVs are the last barrier preventing loss of containment when all other safeguards have failed.

Mandated by Standards

ASME Section VIII, API 520/521 — regularly updated. Compliance is not optional; it is a legal and engineering obligation.

Recurring Audit Findings

Design reviews across aging platforms repeatedly uncover PSV sizing errors — many introduced at the original design stage.

Drivers Behind the Reengineering Effort

20–30

Years of Platform Age

Designed before current API 520/521 editions were in force

$M+

Cost of PSV-Related Shutdowns

Historical unplanned shutdowns traced directly to sizing errors

7th

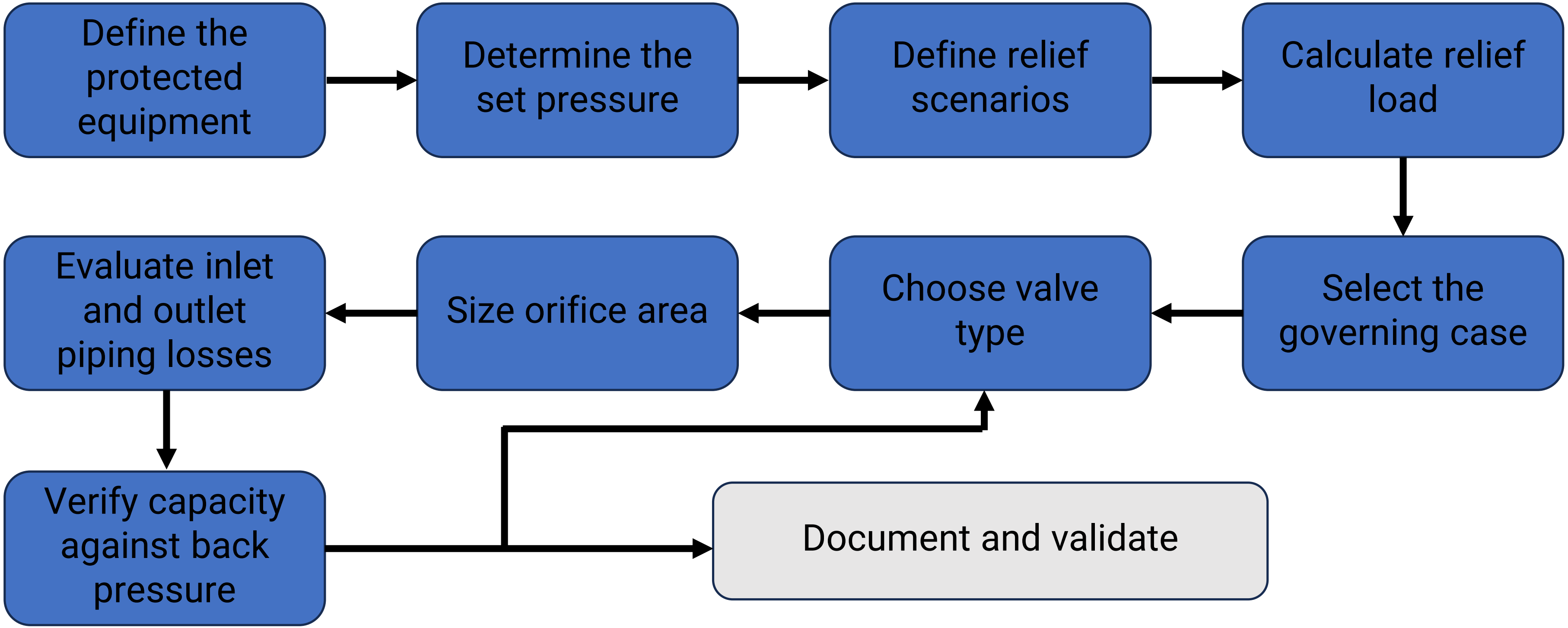
API 520 Edition

Two-phase equations, backpressure treatment, and EOS guidance all substantially revised

Standards Have Evolved — Legacy Designs Have Not

Pre-2014 installations were sized using methods now considered non-conservative. Many have never been revalidated against current API guidance.

The Standard PSV Sizing Workflow per API 520 / 521



Each of these ten steps is a potential failure point. The case studies that follow map directly onto steps 3, 4, 5, 8, and 9 — the steps most often executed incorrectly in practice.

⚠ MISTAKE 1

The Orifice-Sizing Case Is Not Always the Worst Case for Pressure Drop

Table 8—Design Basis for PRD Laterals and Disposal System Headers

Device	Lateral/Tail Pipe	Main Header (If Applicable)
Pop-action, pilot-operated PRV	PRV rated capacity	Required relieving rate
Modulating-action, pilot-operated PRV	Required relieving rate	Required relieving rate
Spring-loaded PRV	PRV rated capacity	Required relieving rate
Rupture disk (stand-alone)	Required relieving rate	Required relieving rate
Pin-actuated device (stand-alone)	Required relieving rate	Required relieving rate

NOTE 1 Consult the manufacturer, as some types of spring-loaded PRVs can have some modulating capability. In these instances, the required relieving rate may be used.

NOTE 2 The mechanical and hydraulic design of the system should consider that the instantaneous flow rate upon opening can exceed the required relieving rate, particularly in cases where the relief device is oversized.

NOTE 3 The user is cautioned that if the required relieving rate is used for design of the lateral (see 3.1.38), any process changes that raise the required relieving rate can increase the backpressure above the acceptable limits.

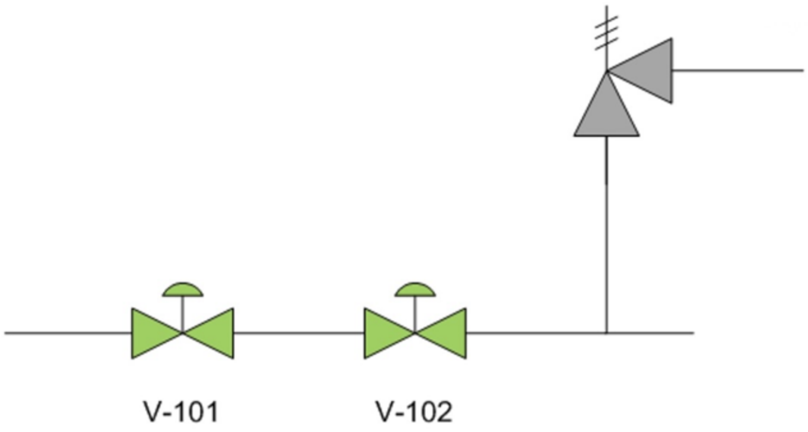
(Image taken from API 521, Guide for Pressure-Relieving and Depressuring Systems. American Petroleum Institute)

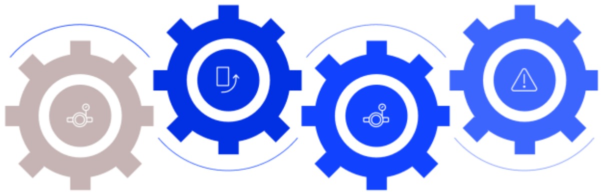
Contingency Scenarios | Filter: | • Add All Std.OVPs • Adjust Scenarios • Scenario Notes • ☐ Show Relief Equip't Links? • Post • Done

#	OVP Type - Extension / Hazard Type - Flow Type - Code	Required Area, Flow or MUP	Inlet Drop / Back Press.	AIV Status	Apply	Status
1	Block Valve Misoperation Given Flow Rate - Vapor - ASME Sec. 8	0.39357 in² Pressure	3.4014 % 8.7867 %	Passed	☑	Piping
	Critical: PRSM.280123: Scenario has piping losses with critical trouble.					
2	Check Valve Failure - -				☐	
3	Control Valve Misoperation Given Flow Rate - Vapor - ASME Sec. 8	2.8927 in² Pressure	3.4014 % 8.6933 %	Passed	☑	Piping
	Critical: PRSM.280123: Scenario has piping losses with critical trouble.					
4	Exchanger Tube Rupture - -				☐	
5	Blocked Exits - -				☐	
6	Fire Given Flow Rate - Vapor - ASME Sec. 8	0.050475 in² Pressure	3.5001 % 9.0667 %	Passed	☑	Piping
	Critical: PRSM.280123: Scenario has piping losses with critical trouble.					
7	Instrument Air Failure - -				☐	

MISTAKE 2

Two Events Are Not Always Independent (Overclaiming Double Jeopardy)





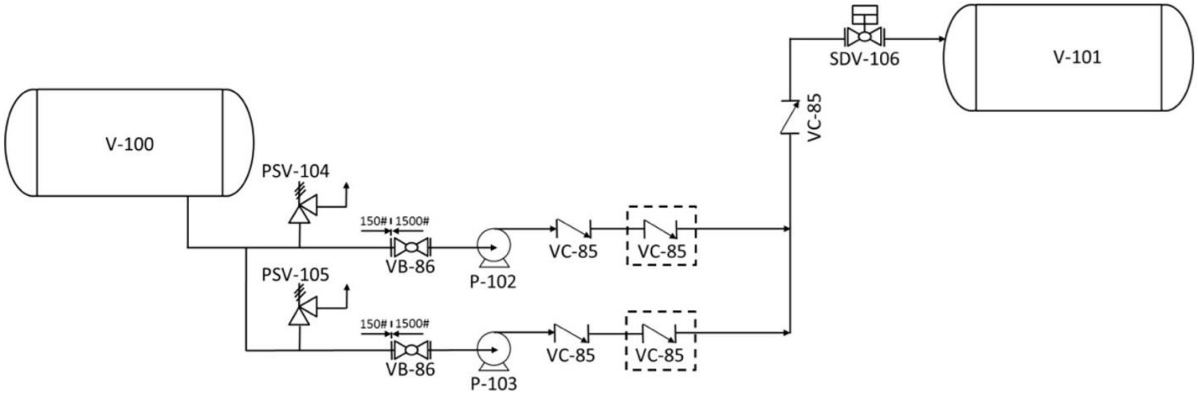
Consider this installation of regulators/valves in series

- Operator can intentionally open the line from ineffective startup/shutdown procedure.
- If V-102 fails open, downstream pressure of V-101 will drop. This results in V-101 open further to response.
- Another design overlook is selecting the design pressure of V-102 is often inadequate to withstand condition when V-101 fails.

Claiming double jeopardy to avoid PSV installation or reduce orifice size is one of the most common — and most dangerous — shortcuts in PSV engineering.

MISTAKE 3

Latent Failures Should Never Be Credited as Protection

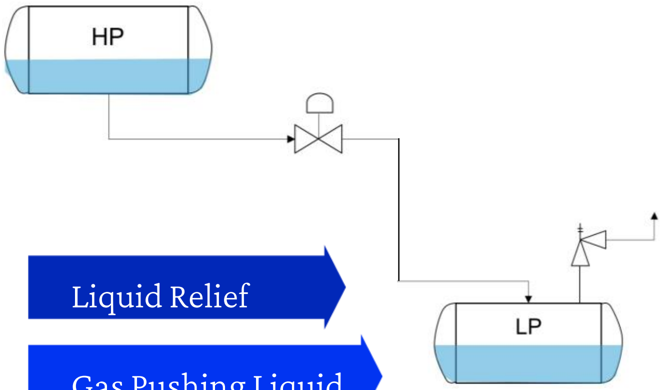


- Check valves are frequently excluded from preventive maintenance programs — failures go undetected until a demand occurs.
- Always assume a **single check valve has failed**. Dual check valves in series provide only partial credit (10–50% reduction in relief load).
- For differential pressures ≥ 750 psig, it is recommended that two check valves in series as a minimum.

Industry Fatality: Motor-driven pump shut down. Discharge check valve failed silently. Reverse flow drove the motor as a generator. Suction strainer over-pressured and ruptured. Hydrocarbons released and ignited. One operator killed.

⚠ MISTAKE 4

Multiphase and Transient Phenomena Are Routinely Oversimplified



Liquid Relief

Gas Pushing Liquid

Gas Blowby

⚠ **Case Study:** Gas blowdown case — liquid carryover underestimated. PSV undersized by approximately 30%. Orifice area was retrofitted post-commissioning at significant cost and schedule impact.

Sizing for two phase relief

When a **PSV** must relieve a **liquid and gas,** it may be sized by

Determine the **rate** of **gas** and the **rate** of **liquid** that must be **relieved**

Calculate the orifice area required to **relieve** the **gas and liquid**

Sum total areas calculated for liquid and vapor to **obtain** the **total required orifice area**

When the **material** to be relieved through a PSV is a **flashing liquid,** it is **difficult** to **know** what **percentages** of the **flashing** actually **occurs** in the valve in order to **estimate** the **total required area** using the above **steps**

>> Part of outdated training material

>> Method from API 520 6th edition

>> Deleted in API 520 7th edition

Current API 520 8th edition shows two acceptable methods:

1. Direct Integration
2. Omega method (Have some limitation)

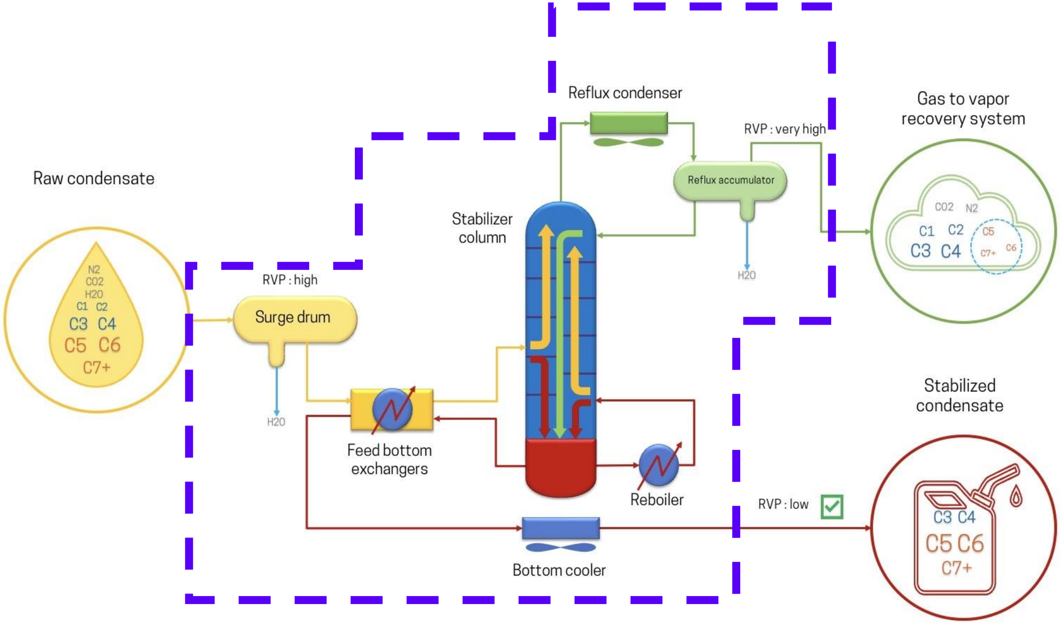
Wrong sizing method conducted by PSV vendor

SUMMARY PAGE

Variable Type	Variable Name	Symbol	Input Value	Equation Value
Fluid Properties	Gas/Vapor Density at Outlet	ρg2		
	Liquid Density at Outlet	ρl2		
Process Cond.	Required Mass Flow - Gas	Wg	193683.784 lb/hr	193683.784 lb/hr
	Required Mass Flow - Liquid 1	WL1	40230 lb/hr	40230 lb/hr
	Required Mass Flow - Liquid 2	WL2	7817 lb/hr	7817 lb/hr
	Required Area - Gas	AG	1.895 in²	1.895 in²
	Required Area - Liquid 1	AL1	0.105 in²	0.105 in²
	Required Area - Liquid 2	AL2	0.018 in²	0.018 in²
	Atmospheric Pressure	Patm	14.696 psia	14.696 psia
	Outlet Gas Mass Fraction	x2		
	Outlet Static Pressure	Po	-14.696 psig	-14.696 psig
Valve Data	Orifice Area	A	2.853 in²	2.853 in²
	Outlet Diameter	Do	3.83 in	3.83 in
Calculate 2-Phase Required Orifice Area		**Areq**	2.019 in²	2.019 in²
Areq = AG + AL1 + AL2				

MISTAKE 5

Unbalanced Heat Calculations



Why Equipment-Centric Sizing Fails

- A heat-input upset (fail-open reboiler valve, fan failure, tube rupture) propagates **across the entire system**, not just one vessel.
- Identify the **weakest point** in the pressure envelope — that is the correct location for relief protection.
- Steady-state simulation is often insufficient. Dynamic simulation (e.g., HYSYS Dynamics) is required to capture transient peak loads correctly.

MISTAKE 6

Wrong Fluid Model = Undersized PSV

Glycol Dehydration Package: HYSYS (Peng-Robinson EOS) predicted latent heat of 681 Btu/lb for rich glycol. Under fire case, water flashes off, leaving near-pure TEG at ~170–180 Btu/lb. The installed PSV was grossly undersized — required full replacement.

#	Scenario	EOS Used	Issue	Impact
1	Lean glycol stream modelling	Peng-Robinson	Poor H-bonding prediction and polarity	Latent heat overestimated (600 btu/lb vs 180 btu/lb) → PSV undersized
2	Regen reboiler fire case	SRK	Inaccurate high-T phase behavior	Boiling point underestimated → Incorrect Vapor Load → PSV undersized
3	Fire case on Contactor	Peng-Robinson	Misleading phase split, assumes water dominates	Averaged latent heat too high → Relief load underestimated
4	Surge vessel flash	Peng-Robinson	Wrong phase envelope & Incorrect flash curve	Relief Temp & Latent Heat wrong → PSV Fails fire-case duty

Recommendation: Use NRTL or UNIQUAC for non-ideal polar systems (TEG–water). Never apply cubic EOS to glycol systems without validation against experimental data.

MISTAKE 7

Cascading Failures Are Easy to Miss

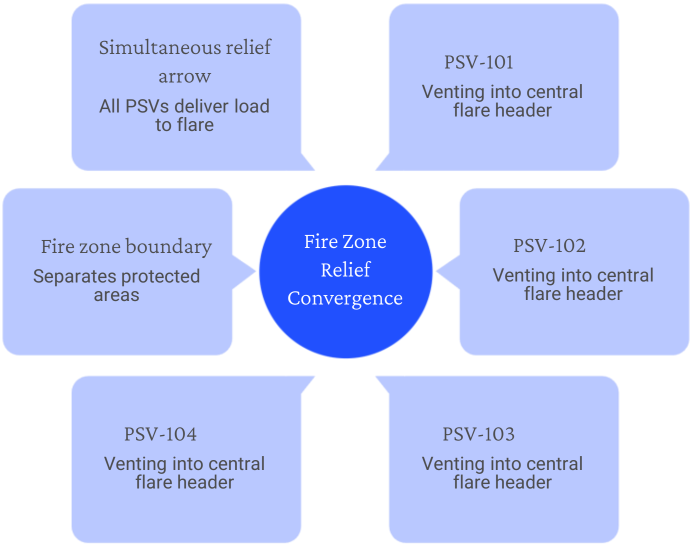
Instrument Air System Failure

A small tubing leak triggers compressor shutdown → loss of critical utilities → plant-wide upset. Each PSV is sized in isolation; the **cascade effect is never modeled**. The resulting relief load far exceeds what any single equipment-based sizing would predict.

Fire Zone Aggregation

Flare headers must accommodate **simultaneous relief of all PSVs** within the same fire zone. Traditional sizing treats each PSV individually — headers are undersized when all valves lift concurrently during a fire event.

Global scenarios require system-level boundary definition — not equipment-by-equipment analysis.

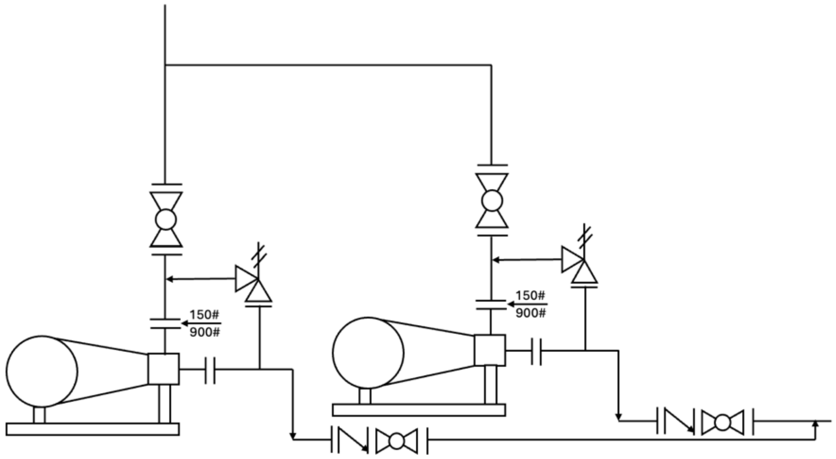


When all PSVs in a fire zone lift simultaneously, the aggregate load can be 3–5× the single-valve design basis — a systemic blind spot in traditional PSV programs.

MISTAKE 8

Where the Class Break Sits Decides What's Protected

✕ Bad Design — Pump Configuration



Class break on pump suction flange; PSV outlet routed back to suction piping → static head and vibration create **PSV instability** and potential chatter.

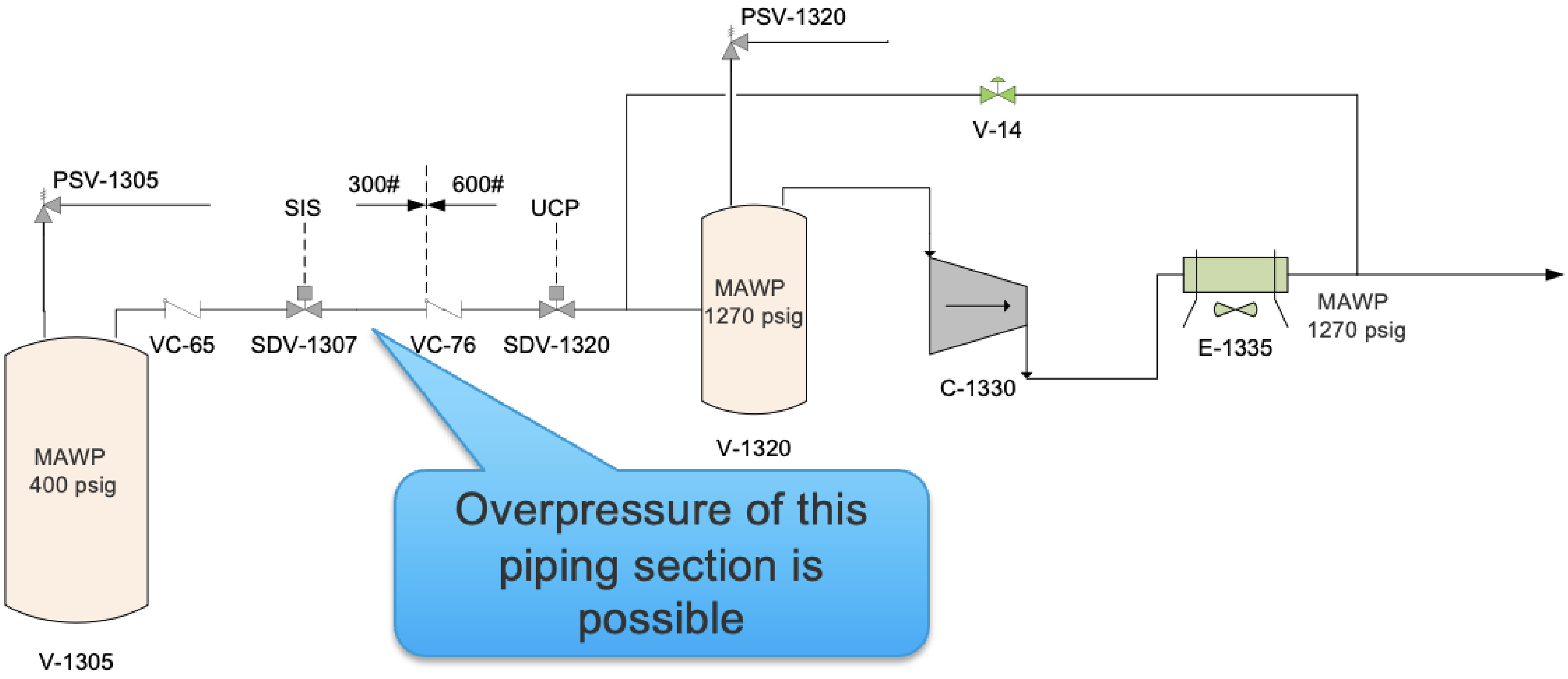
☑ Better Design — Pump Configuration

Class break upstream of block valve; PSV discharge routed to suction drum → stable operation, correct overpressure protection boundary maintained.

⚠ Compressor skid: place class break **upstream of SDV**, not between SDV and check valve — check valves can fail latently and must never be credited as isolation.

MISTAKE 8

Where the Class Break Sits Decides What's Protected



Root Causes & Recommendations

Eight documented mistake categories share a common failure pattern: design assumptions that were never revisited, and thinking that stopped at the equipment boundary.

Root Causes vs. Recommendations

Root Causes

Legacy Design Assumptions

Pre-API 520 7th edition installations never revalidated against modern methods.

Poor Scenario Definition

Sizing basis tied to equipment, not credible upset scenarios.

Overreliance on Steady-State Tools

Transient and multiphase cases inadequately captured.

Loss of Institutional Memory

Sizing basis and assumptions not retained in living documentation.

Recommendations

Systematic PSV Revalidation

Prioritize pre-2014 installations; apply API 520 7th ed. criteria.

Scenario-Based Sizing

Replace equipment-centric sizing with all-credible-scenario methodology.

Dynamic Simulation

Mandatory for transient and multiphase relief cases.

Living PSV Register

Maintain sizing basis, assumptions, and scenario log — version-controlled.

Five Takeaways

Scenario-Based, Not Case-Based

Size for **all credible scenarios** — not just the largest single-case load.

Modern Methods Only

Abandon pre-2014 two-phase shortcuts. API 520 7th ed. is the minimum standard.

Thermodynamic Accuracy Matters

Wrong equation of state = undersized PSV. Validate EOS selection for every fluid system.

Latent Failures = Single Failures

Never credit silent components (check valves, controllers). Treat as failed at the worst moment.

System-Level Thinking

Define boundaries. Find the weakest point. Use dynamic simulation when behavior is transient.

> **PSVs are the last line of defense. Question every assumption.**

Acknowledgements

Special thanks to **Chevron Thailand Exploration and Production** — all team members, project sponsors, and technical reviewers who contributed to the operational experience behind this paper.

Thanks to the **TNCHE 2026** organizing committee for the opportunity to share these lessons with the broader engineering community.

Author

Suradech Kongkiatpaiboon
Chevron Thailand E&P

Event

TNCHE 2026

Questions?

www.linkedin.com/in/suradechk

Thank You

Q&A

tnche1

QR Code - Evaluation