CHEMISTRY THAT MATTERS™

ASSOCIATED PROTECTIVE DEVICES

HOW DO YOU KNOW THAT ALL PARTS OF YOUR RELIEF SYSTEM ARE EFFECTIVE?

Richard Hodges
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INTRODUCTION

Richard Hodges

Staff Engineer, Process Risk Management

Joined ICI in 1991, on Teesside Site, UK, and remained in the business through transfer to Huntsman then SABIC.

- Process Engineering for PTA business
- Operations management on Olefins6 plant and Logistics
- Customer technical service and product stewardship
- Development of EHSS management system including adopting SABIC standards
- Technical safety, process safety and regulatory compliance

Recently joined global process risk management group.

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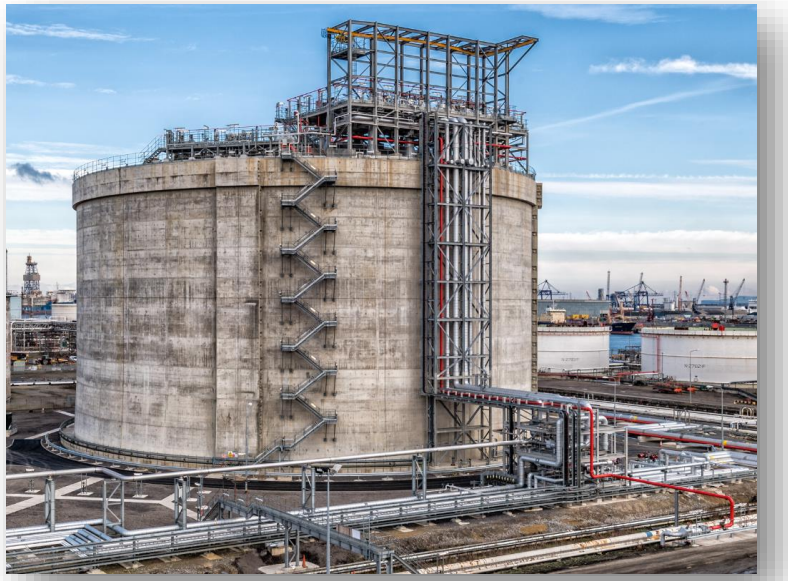
CONTENT

- Associated Protective Devices – what are they and how might they fail?
- Example – Williams Geismar, 2013
- SABIC UK Case Study
- Relief Stream Documentation
- Discussion



ASSOCIATED PROTECTIVE DEVICES

What is an Associated Protective Device and how might it Fail?

Any device which is required to ensure the proper operation of a relief stream

Device	Failure Mechanism	Controls
ROP	Worn or damaged orifice ROP not replaced after maintenance	Inspections of ROP Procedural
Valve Cv	Cv altered during valve maintenance Modification	Procedural Process Safety Information
NRV	Not functioning Bypass left open (should be carseal closed)	Inspections of NRV
Valve stop	Removed during maintenance and not replaced	Procedural Process Safety Information
Carseal (locked) valve	Valve locked in incorrect position Lock missing	Control of carseal lock keys Routine audits
Trace Heating	Isolated for maintenance Failed in service Inadequate lagging	Temperature alarms Procedural Routine plant tours

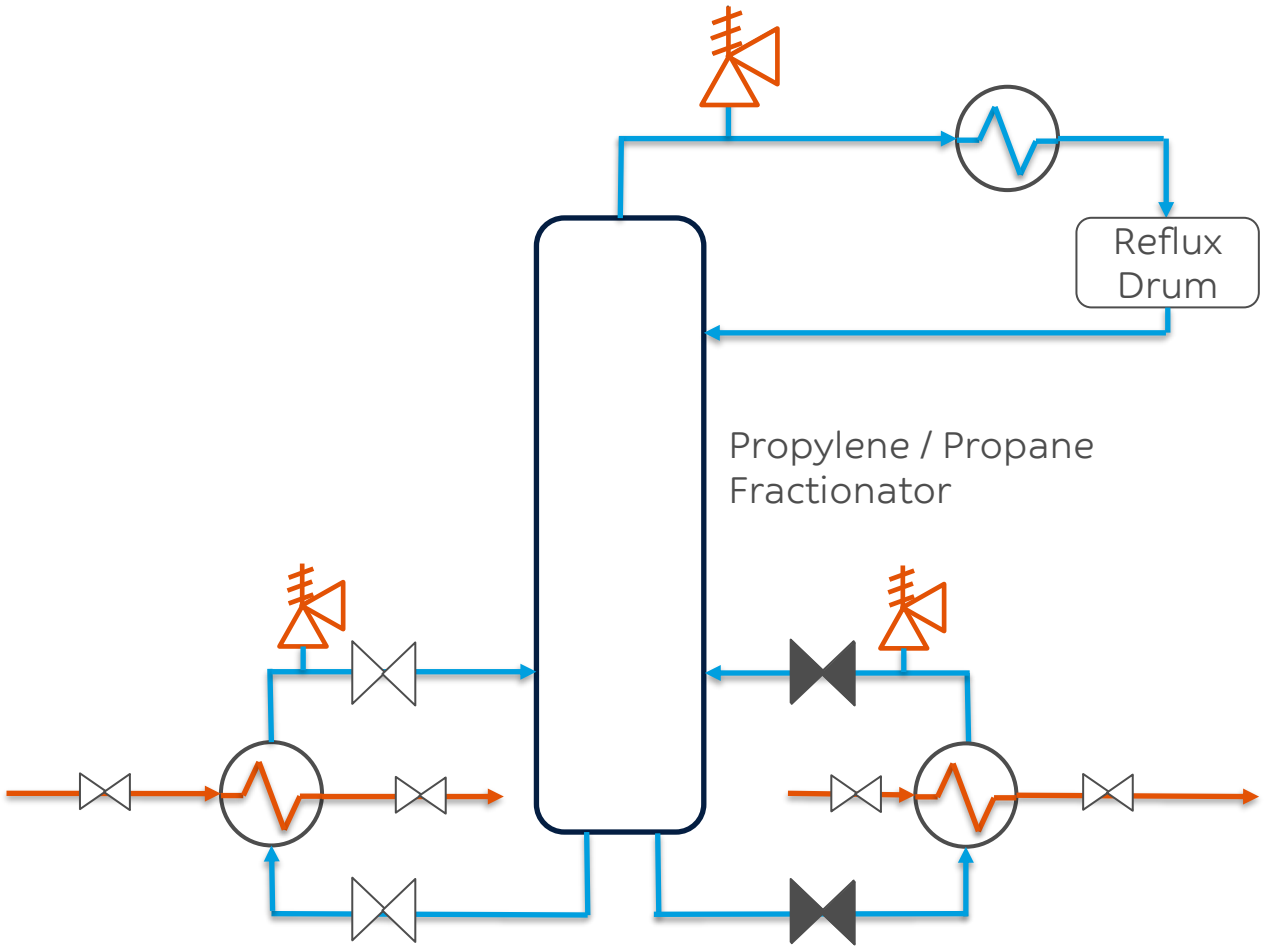
ASSOCIATED PROTECTIVE DEVICES

How can an Associated Protective Device Fail?

Device	Failure Mechanism	Controls
Fire cladding	Cracked / damaged cladding Old cladding does not meet current standard	Inspection Routine plant tours
Interlock	Damaged interlock Interlock removed for maintenance	Control of interlock keys Routine audits
Instrumented systems	Instrument failed Alarm normalised – nuisance alarm Inadequate operator response	Inspection / testing Alarm prioritisation Procedural
Drainage	Blocked Modified Restricted by maintenance activity	Routine drain cleaning Routine audits Procedural
Flame Arrestor	Blocked Restricted	Inspection
Procedural	Human Error	Clear, simple instruction Accessible process safety information

ASSOCIATED PROTECTIVE DEVICES

Williams Geismar – Explosion and Fire – 13/06/13



- Propylene Column as designed and installed
- Fouling of reboilers requires periodic column shutdown
- Isolation valves installed 2001
- The heat exchanger can be isolated from the column for maintenance
- But the process (shell) of the heat exchanger is isolated from its relief protection
- A safer installation

http://www.csb.gov/williams-olefins-plant-explosion-and-fire-/

ASSOCIATED PROTECTIVE DEVICES

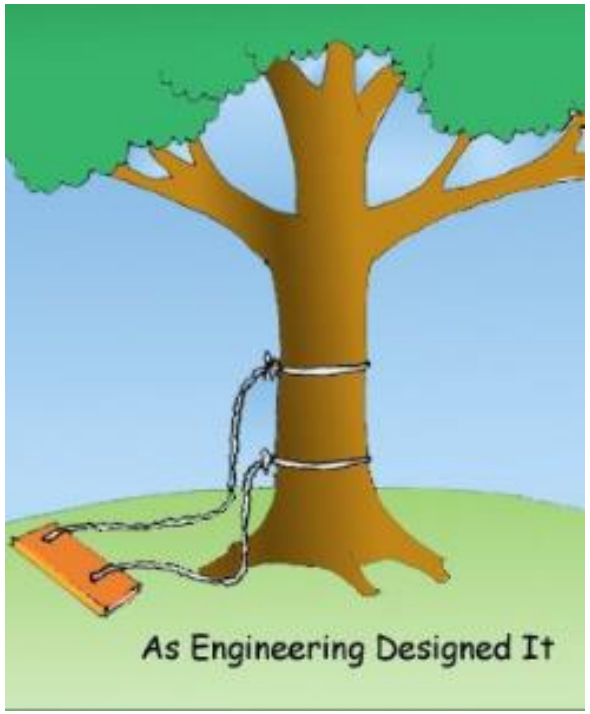
Williams Geismar – Explosion and Fire – 13/06/16

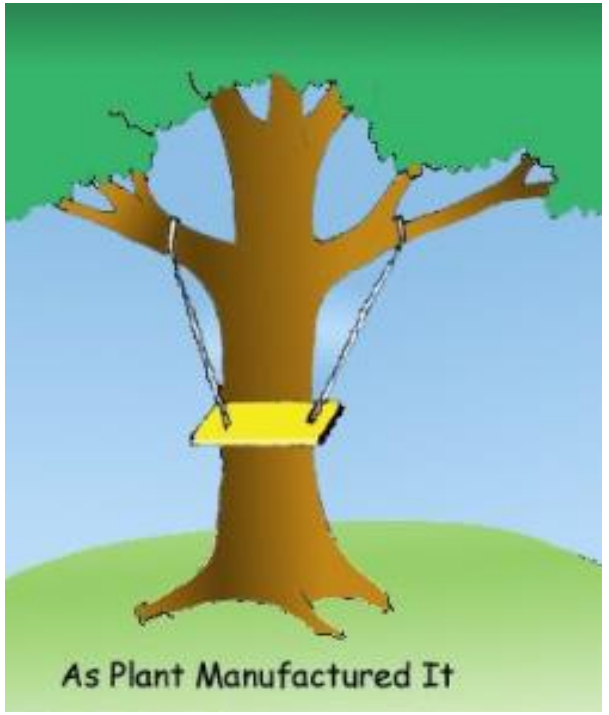
ASSOCIATED PROTECTIVE DEVICES

Williams Geismar – Explosion and Fire – 13/06/16

- This incident highlights the concept of an associated protective device.
- The original design for pressure relief was acceptable, but a subsequent modification installed an isolation valve between the heat exchanger shell and its relief valve.
- The relief provision was being provided through procedural controls, and reliant on the integrity of manual isolation valves.
- The deficiencies in design and operational control are very obvious in this example – but how can you be sure that your design intent for a well-designed relief stream is correctly implemented, inspected and maintained over the life of the plant?

BEWARE CHANGES IN DESIGN!

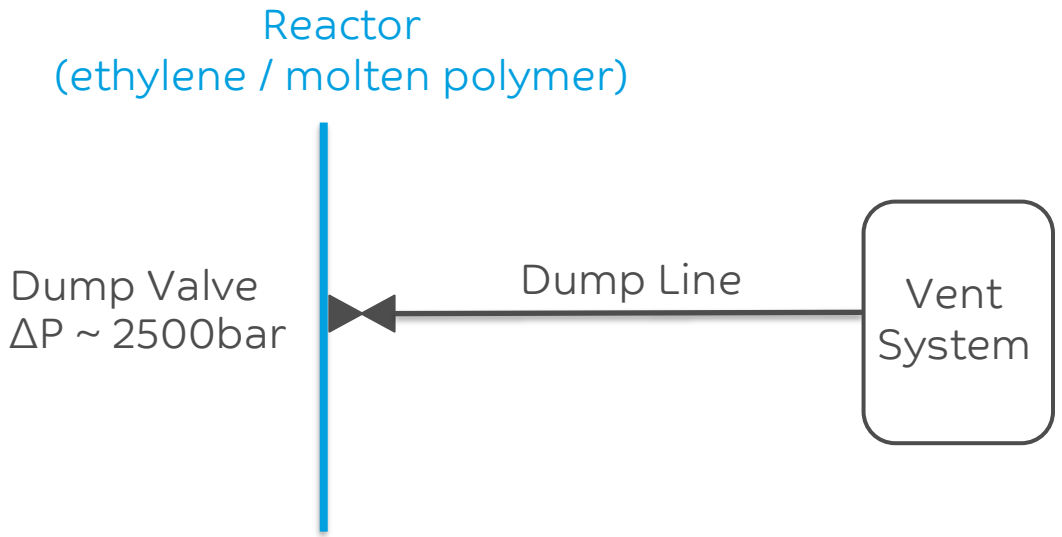




CASE STUDY

SABIC UK Polyethylene Plant – August 2016

- Reactor overpressure protection is provided by a Safety Instrumented System, which dumps the reactor to an emergency vent system.
- Pre-startup checks identified evidence of polymer blockage in the emergency vent system.
- Investigation revealed a full blockage of the Dump Line which required several days to physically clean.



CASE STUDY

SABIC UK Polyethylene Plant – August 2016

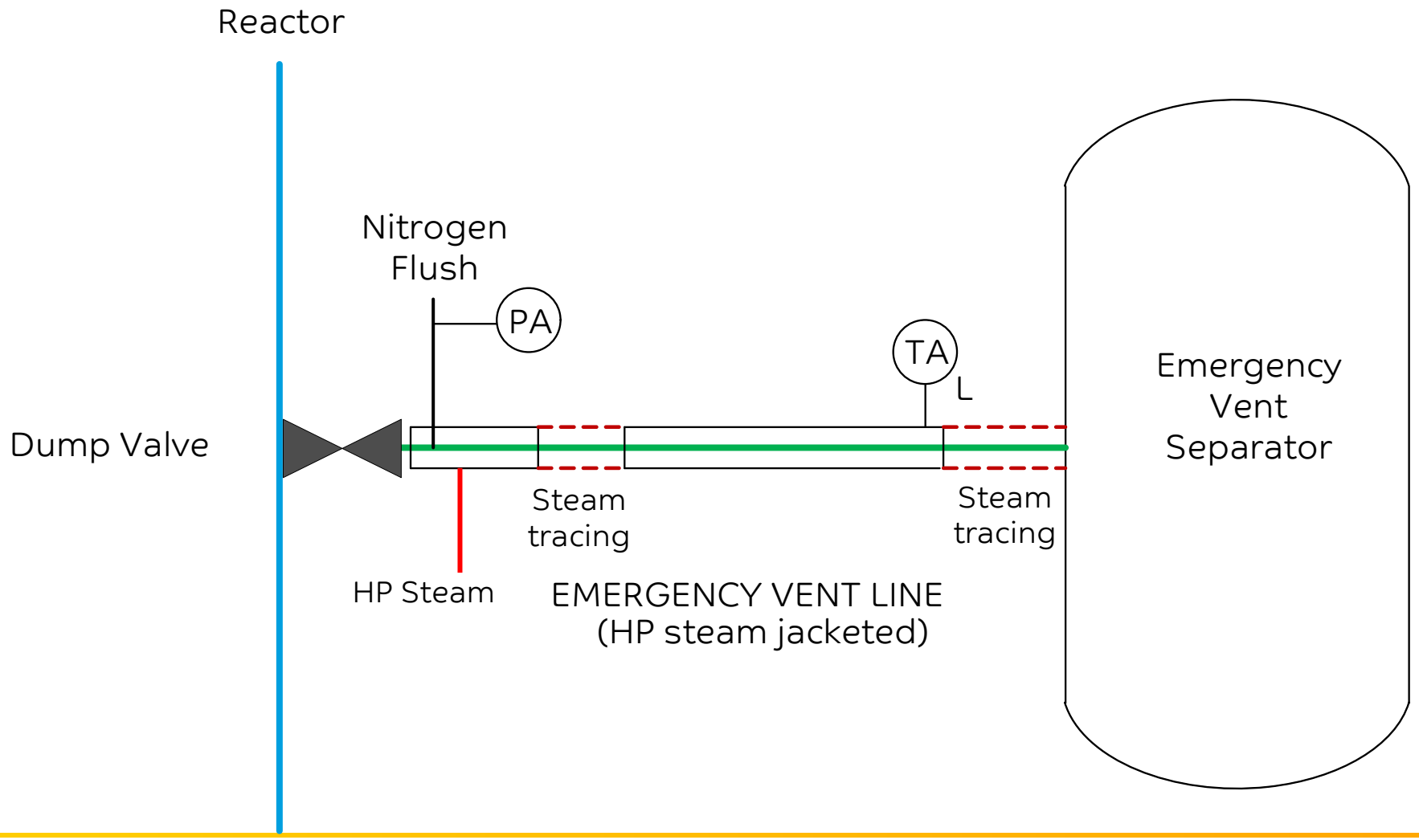
Design Safeguards

- Dump line is jacketed with HP steam.
- Steam jacket is fitted with a temperature indicator and low alarm.
- N2 pulse which alarms if the pressure within the dump line does not decay quickly enough.

Deviation from Design

- Commissioning team (2009) found complex sections of the Dump Line were not jacketed.
- MOC implemented to provide steam tracing to these sections.

CASE STUDY


Reactor
Nitrogen
Flush
PA
TA
L
Dump Valve
Emergency
Vent
Separator
Steam
tracing
Steam
tracing
HP Steam
EMERGENCY VENT LINE
(HP steam jacketed)

CASE STUDY

Learning from Incident

Commissioning MOC did not provide equivalent layers of protection to detect steam tracing failure as per the original design:

- No low temperature alarm on the traced sections
- Local isolation valve on the steam tracing supply – inaccessible with the plant in commission.

The investigation found this local isolation valve shut

- Steam-traced section of the Dump Line was at ambient temperature.
- Polymer blockage was found in this section.

CASE STUDY

Learning

The Dump Valve is the primary protective device, but the operation of the relief stream relies on additional associated protective devices:

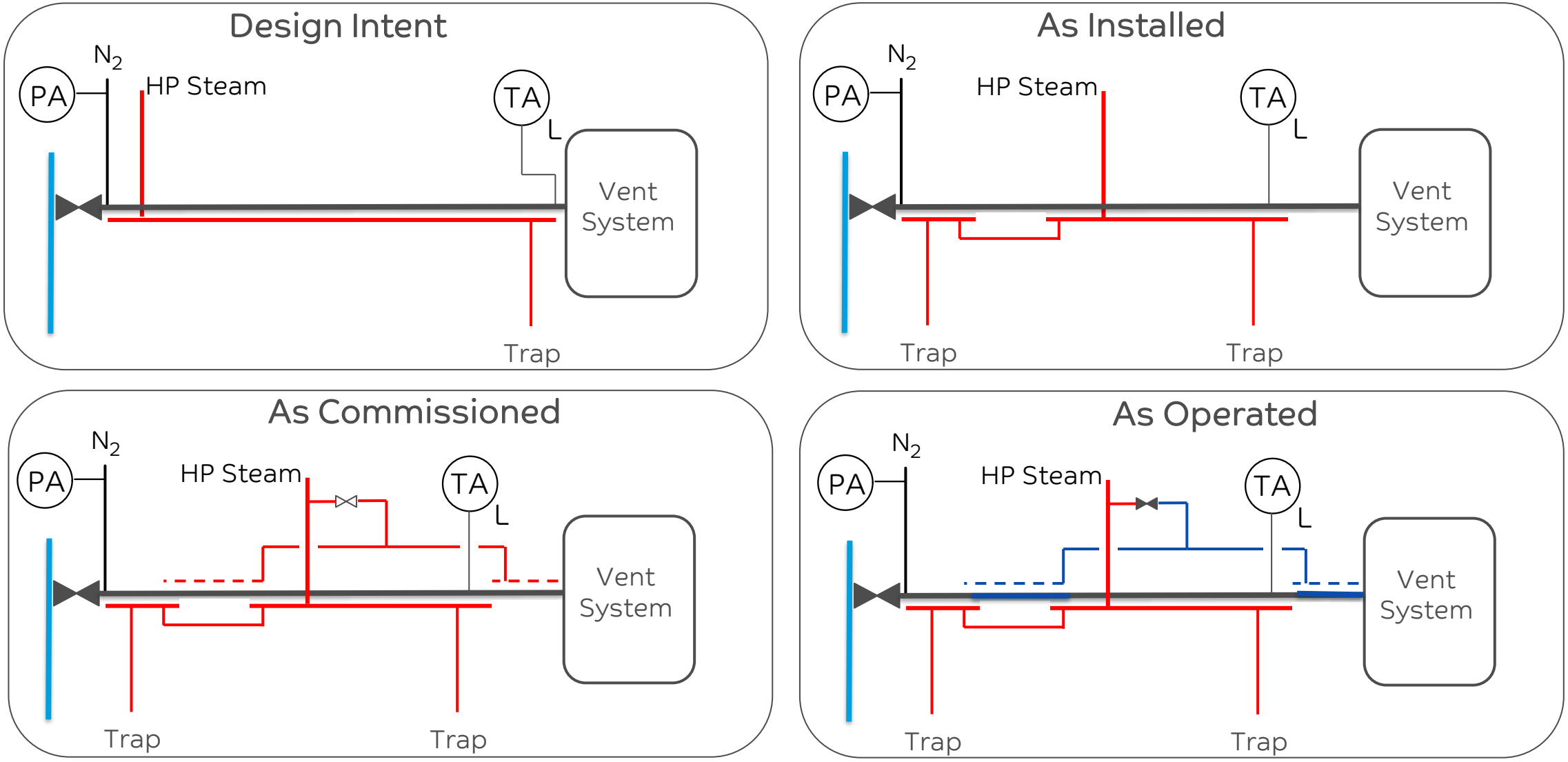
- Steam Jacket
- Steam Trap / condensate drain
- Temperature indication and Low T alarm
- N_2 flush and alarm

The installed Dump Line did not meet the design intent with a continuous steam jacket.

The consequences of this were not appreciated and the deficiency was only picked up during pre-commissioning checks.

The modification installed steam tracing to the non-jacketed sections, but this introduced another potential failure mechanism.

CASE STUDY


Design Intent
N2
PA
HP Steam
TA
L
Vent System
Trap
As Installed
N2
PA
HP Steam
TA
L
Vent System
Trap
Trap
As Commissioned
N2
PA
HP Steam
TA
L
Vent System
Trap
Trap
As Operated
N2
PA
HP Steam
TA
L
Vent System
Trap
Trap

RELIEF STREAM DOCUMENTATION

Identification of Associated Protective Devices

SABIC UK Relief Stream Documentation requires:

Details of the protective device and other equipment to be registered, including specific reasons for their selection.

This includes associated protective devices, which applies to any other equipment on which the sizing/design of the protective systems depends.

This detail may be summarized on a sketch, but this is not mandatory.

It is essential to ensure that sometimes complex information is transferred clearly to other discipline engineers who will complete detailed design; and then to operations and maintenance personnel who will be responsible for ensuring that the relief stream remains functional.

RELIEF STREAM DOCUMENTATION

Example of Relief Stream Documentation

This is from Olefins6 (1980), as re-validated during the 1990s.

PROTECTIVE DEVICE NUMBER: PD 17039 (Mod.304)				1 Working	0 Spare
Design Pressure, psig: 50 MAWP, psig:		Set Pressure, psig: 50		Disch to: Atmos	Size: 6Q8
P&ID No: 51C-1		Calcs in PD File No: P.3568			
Location: E 1704A outlet pipework			Relief Device Summary Sheet: D2-38		
Equipment Protected	Associated Protective Devices			Other Equipment Protected	
	Number	Location	SP (psig)	Equipment No	PD No
E 1704A	PD 17161 (Mod.201) (RO) PD 17162 (NRV) PD17163 (NRV) PD17164 A/C (NRV)				

It lists the Associated Protective Devices – but it doesn't state where they are.

To see the entire relief stream you have to look at three P&IDs

RELIEF STREAM DOCUMENTATION

Example of Relief Stream Documentation

This is documentation for the Emergency Vent Separator used in this case study. The relief stream number is RS94942 and all Associated Protective Devices have a number linked to this.

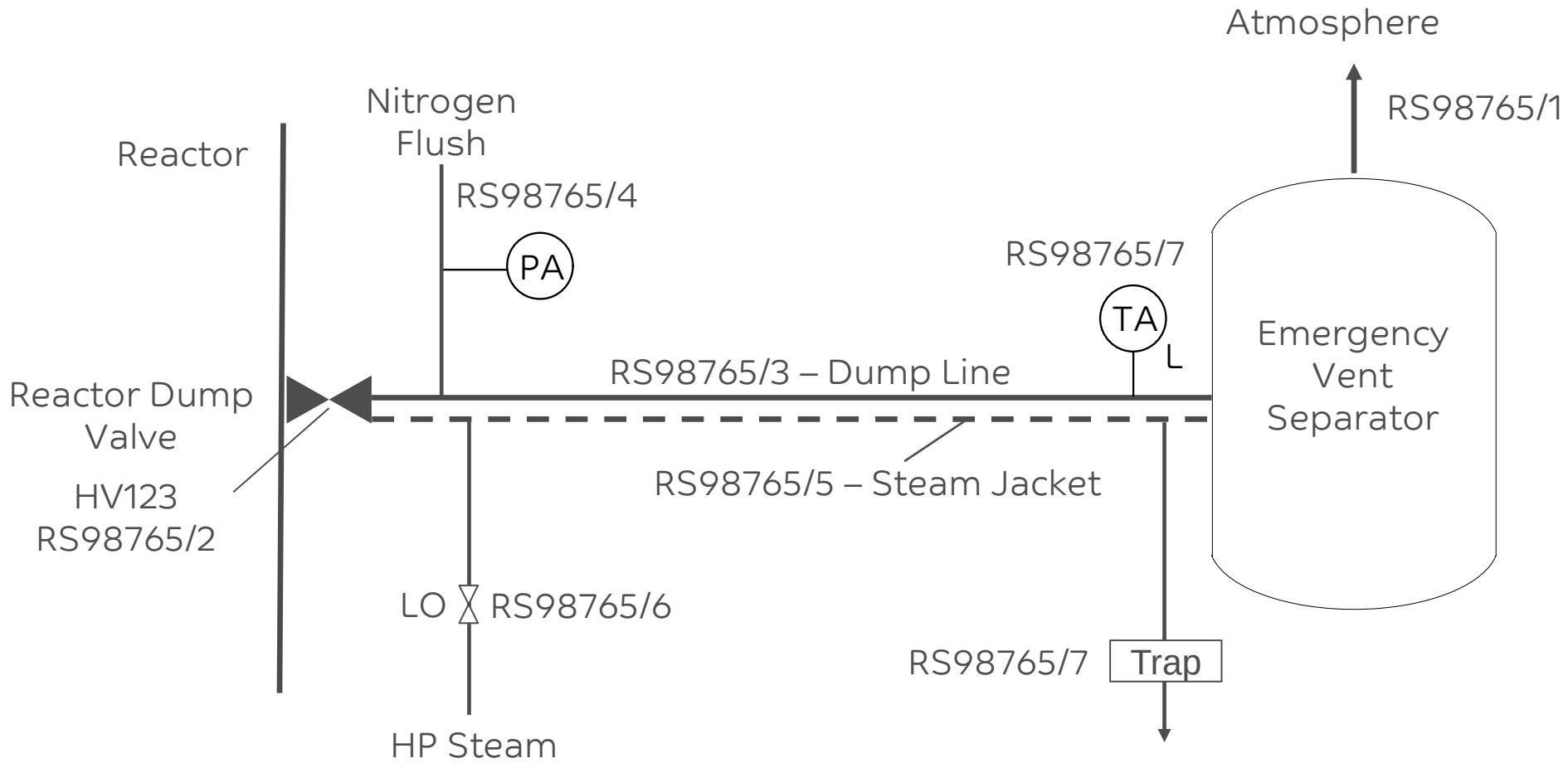
However, there is no sketch and the devices are shown on three P&IDs.

The sketch used in the case study is simplified, but the concept would enable the information in this document to be more clearly understood.

EQUIP No.	LINE DIAG. No.	DESCRIPTION	DESIGN PRESSURE barg	PRESSURE RELIEF STREAM(S) STREAM No	DEVICE TYPE(S)	SIZE	SET P barg	ASSOCIATED PROTECTIVE DEVICE	REMARKS
D-401	Y94-016Y Y94-016M Y94-016W Y94-016M Y94-016W Y94-016Y	Emergency Vent Separator		RS 94942	PRD		ATM	D-401 Stack 94-HV-807A 94-HV-807B 94-PT-800A 94-HV-807A Steam Trace 94-PT-800B 94-HV-807B Steam Trace Dump Valve Tail Pipes Steam Trace VW102-L	RS94942/1 RS94942/2 RS94942/3 RS94942/4 RS94942/5 RS94942/6 RS94942/7 RS94942/8 RS94942/9

RELIEF STREAM DOCUMENTATION

A picture tells a thousand words!



RELIEF STREAM DOCUMENTATION

Example of Relief Stream Documentation

A table as shown would provide an effective handover from process engineering to asset management / inspection, and also forms the basis of an FMEA

Item	ID	RS Tag	Purpose	Failure Modes	Inspection / Control
EVS Vent	O-1224-16	98765/1	Outlet for overpressure	Polymer blockage Vibration reduces integrity	Visual inspection every 4 years Check structure integrity every MWO
Dump Valve	HV123	98765/2	SIS – open to remove overpressure	Failure of SIS Mechanical failure of valve	Trip test and visual inspection at each MWO
Dump Line	O-1225-10	98765/3	Outlet for overpressure	Polymer blockage	Visual external inspection of lagging each MWO
N_2 purge alarm	PA-2345	98765/4	Test for dump line blockage	Instrument failure	Periodic alarm test Operator response to alarm
Steam jacket	O-8765-12	98765/5	Keep dump line warm to prevent polymer solidifying	Steam isolated Lagging break-down Steam trap failed	Operations quarterly check of carseal Visual inspection at MWO Monthly inspection of steam traps

RELIEF STREAM DOCUMENTATION

Discussion

- Do other delegates have any similar experiences with failure to maintain relief streams?
- Is a sketch mandatory for a complex relief stream with associated protective devices?
- Are detailed designs validated against the relief stream documentation prior to construction?
- How do you ensure that relief streams are commissioned as intended?
- How do you ensure the an appropriate hierarchy of controls?
- What information do you provide to operations to ensure that they understand the relief stream and don’t defeat it?
- How do you ensure that all requirements are fully embedded in operations, inspection and maintenance systems?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THANK YOU