WHEN TRUST MATTERS

Data-Driven Performance Standard Compliance Boosts Performance

IChemE Advances

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20-21 October 2021

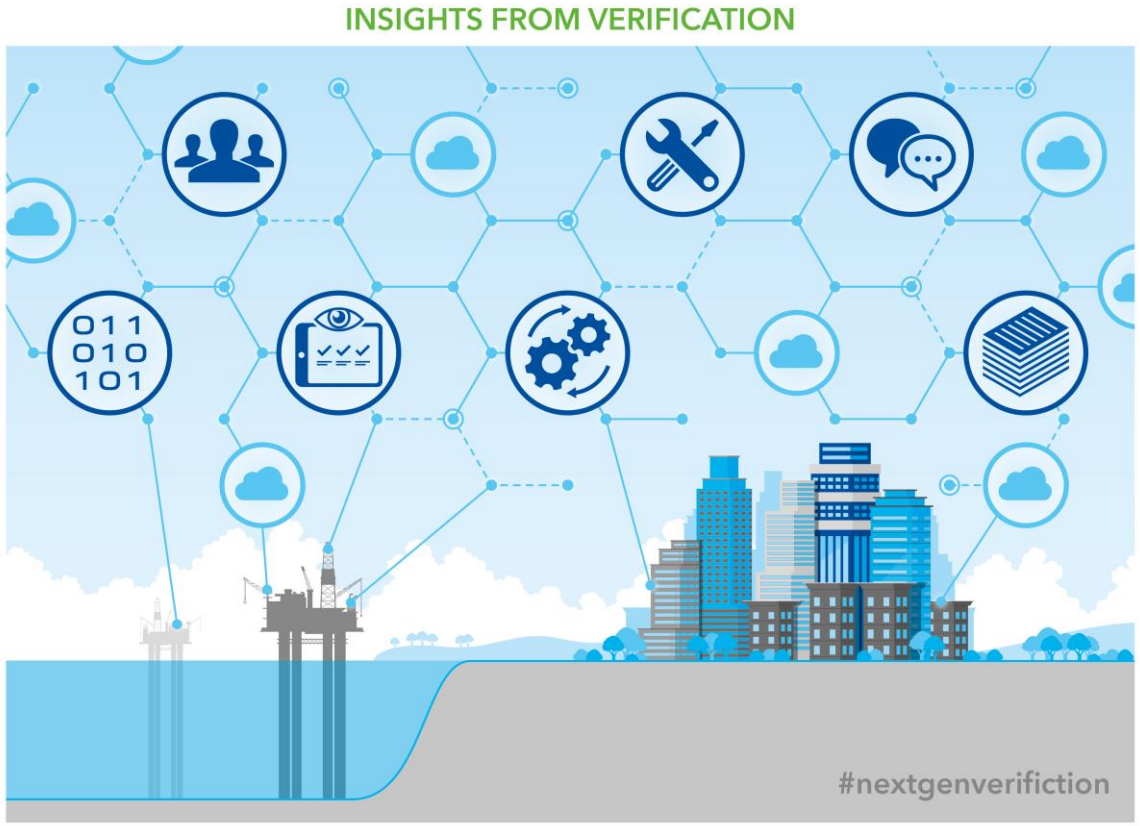
Welcome

Agenda

- Overview
- CRISP-DM
- Data/Models/Evaluation
- Other applicable solutions

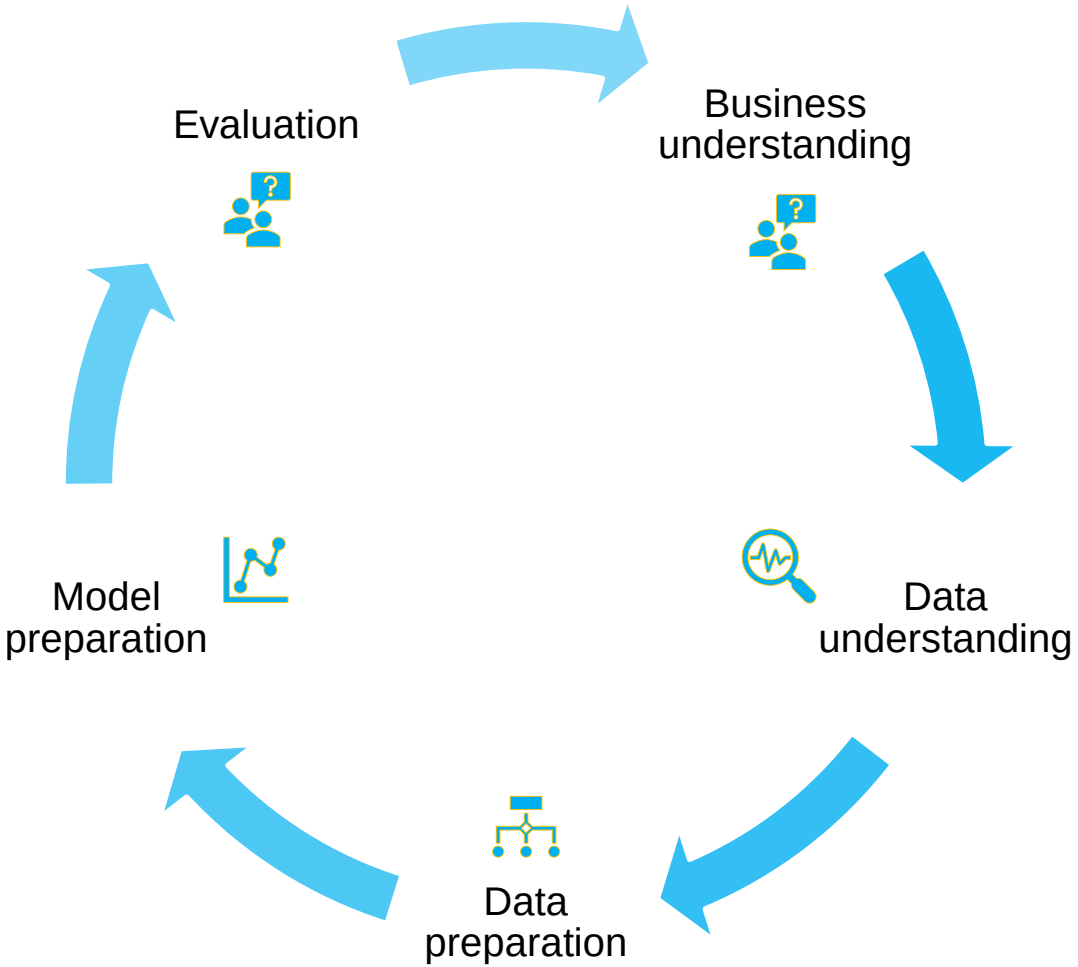
Problem Overview

- Wanted to understand how systems were being operated on a day to day basis.
  - What equipment items were being inhibited routinely?
  - What systems were consistently operating outside of their design envelope?
- Reduced the cost incurred from verification test witnessing of PS criteria.
- Reduced the cost incurred from routine testing.
- Gain a holistic view of how their PS criteria was being met i.e. not just looking at staged testing when the system has been set up in preparation for a test.



CRISP-DM Sprint (cross-industry process for data mining)

1. **Business understanding**: develop and understand the business/user requirements.
2. **Data understanding**: review and understand the data; what anomalies are present in the data, and can it be used to provide insights?
3. **Data preparation**: prepare the data to be analysed; remove anomalies, reshape as required, merge with other sources etc.
4. **Model preparation**: develop algorithms and models to read the prepared data, and provide statistics, plots or insights to be evaluated.
5. **Evaluation**: evaluate the model's effectiveness and ability to provide the answers required? Does it raise more questions that should be answered before proceeding further?



CRISP-DM Sprint

~1-2 weeks to develop an analytical tool

Business understanding

We work with you to understand the business requirement, and design sprint tasks accordingly.

http://devops.azure.com

Data understanding

Use standard tools to explore the data, understand its structure and start to prepare model inputs.

https://jupyter.org

Data preparation

Model preparation

Build model to solve business need. Codify steps to enable re-use in web apps at scale.

https://www.python.org

Evaluation

Power BI dashboards can be valuable deliverables for you to evaluate the sprint outcomes.

https://powerbi.microsoft.com/en-us

https://www.veracity.com

Data available

DCS

- 04Feb2021-07Mar2021.xlsx
- 07Mar2021-11Mar2021.xlsx
- 11Mar2021-28Mar2021.xlsx
- 12Apr2021-28Apr2021.xlsx

Date_Time	Event Type	Category	Area	Node	Unit	Module	Module Descriptio	Attribute	State	Event Level	Desc1	Desc2
07/03/2021 12:24:02	EVENT	PROCESS	10_OIL_SEP	SER01	LIT10007	LIT10007_C	Calibration		ACTIVE	4-INFO	LIT10007_C/CALC1	I/O Output Failure
07/03/2021 12:24:03	EVENT	PROCESS	10_OIL_SEP	SER01	LIT10007	LIT10007_C	Calibration		ACTIVE	4-INFO	Error Cleared	I/O Output Failure
07/03/2021 12:24:10	EVENT	PROCESS	10_OIL_SEP	SER02	LIT10025	LIT10025_C	Calibration		ACTIVE	4-INFO	LIT10025_C/CALC1	I/O Output Failure
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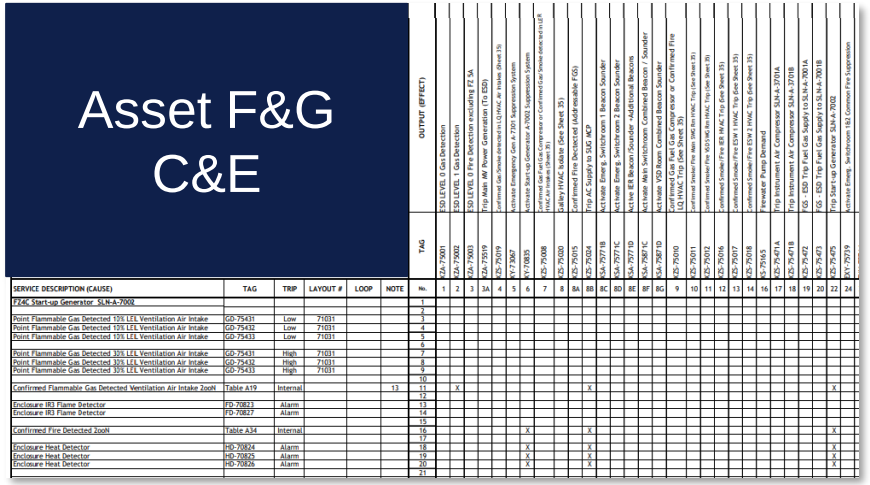
07/03/2021 12:24:56	ALARM	DEVICE	44_WATER_INJ	PCS04		PDIT-44510		MAINT_ALM	ACT/UNACK	07-SIS_PVBAD	MAINT	Loop Current Saturated

Docs

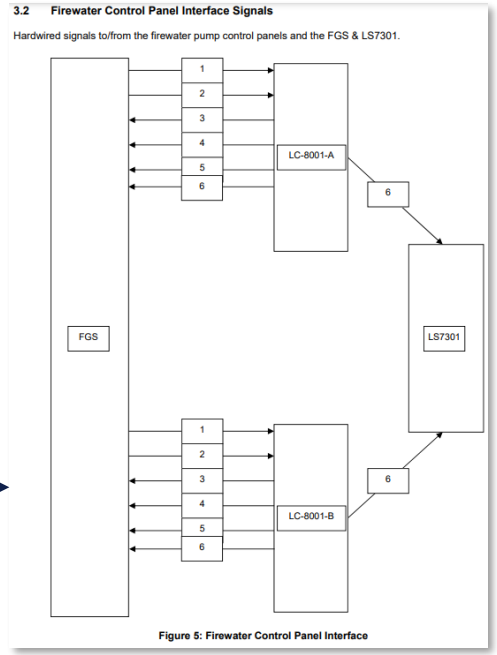
NAME

- Cause and Effects
- Operating Philosophies
- Perf_Stds

Asset F&G C&E



SERVICE DESCRIPTION (CAUSE)	TAG	TRIP	LAYOUT #	LOOP	NOTE
PZ4C Start-up Generator SLN-A-7002					
Point Flammable Gas Detected 12% LEL Ventilation Air Intake	GD-75431	Low	71031		
Point Flammable Gas Detected 12% LEL Ventilation Air Intake	GD-75432	Low	71031		
Point Flammable Gas Detected 12% LEL Ventilation Air Intake	GD-75433	Low	71031		
Point Flammable Gas Detected 32% LEL Ventilation Air Intake	GD-75431	High	71031		
Point Flammable Gas Detected 32% LEL Ventilation Air Intake	GD-75432	High	71031		
Point Flammable Gas Detected 32% LEL Ventilation Air Intake	GD-75433	High	71031		
Confirmed Flammable Gas Detected Ventilation Air Intake ZooN	Table A19	Internal			13
Enclosure IR3 Flame Detector	FD-70823	Alarm			
Enclosure IR3 Flame Detector	FD-70827	Alarm			
Confirmed Fire Detected ZooN	Table A34	Internal			
Enclosure Heat Detector	HD-70824	Alarm			
Enclosure Heat Detector	HD-70825	Alarm			
Enclosure Heat Detector	HD-70826	Alarm			



3.2 Firewater Control Panel Interface Signals

Hardwired signals to/from the firewater pump control panels and the FGS & LS7301.

Figure 5: Firewater Control Panel Interface

Fire Pump Starting.

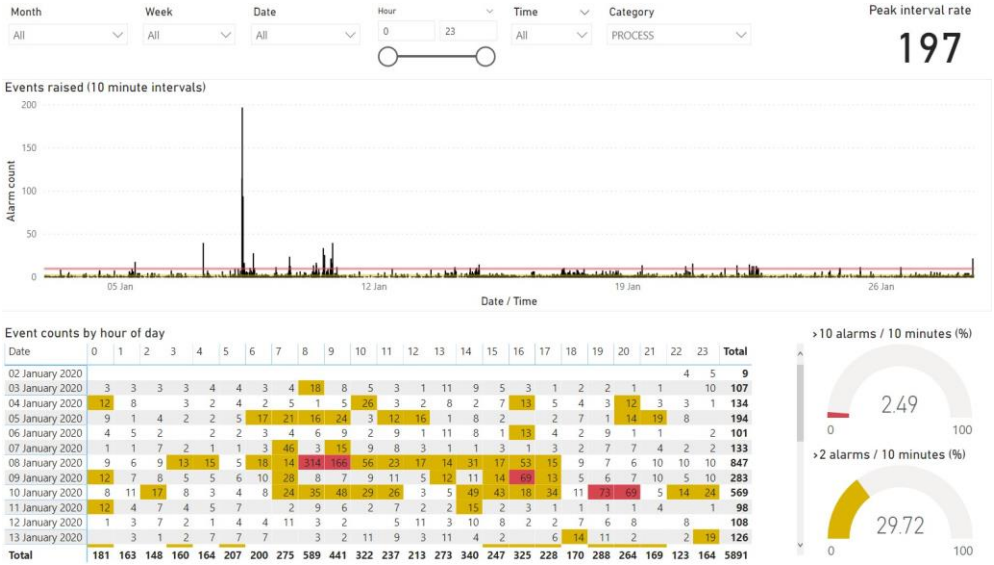
The fire pumps (P-8001A, P-8001B) shall start on demand following a signal from:

- Local Firewater Pump Control Panel
- Pushbutton on the Fire/Foam Pump Panel on the Fire & Gas Matrix
- 'Confirmed Fire' signal from the Fire & Gas Panel
- Operation of Manual Call Point (MAC)
- Firewater Ringmain low pressure switch

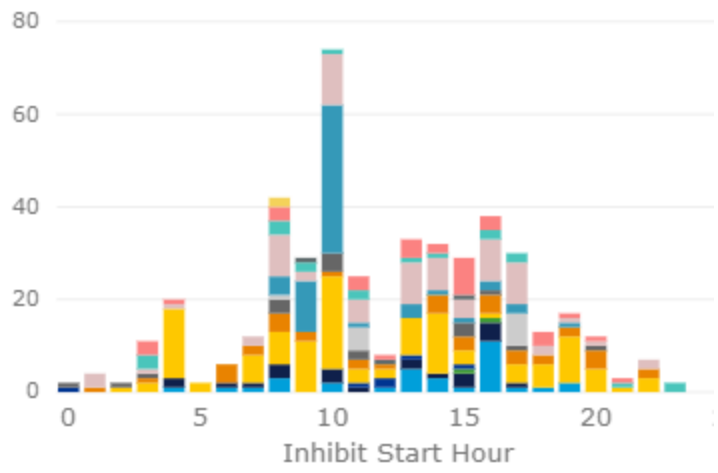
Inhibit & Alarm Log Miner

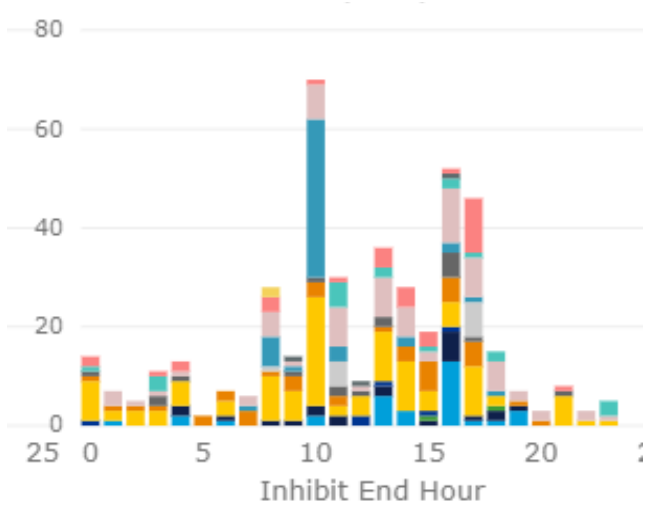
- High-level stats let us identify areas for deeper investigation. For example, short/long duration inhibits, failure patterns and daily routines which may deviate from procedure.

Group	Duration Bucket [Days]	Inhibit Duration [m]
1st Stage Separator	**10**	**14,854.70**
LSLL-35A	0	314.73
LSLL-35B	0	313.85
LSLL-37A	0	47.08
LSLL-37B	0	43.87
LSLL-37C	0	28.43
PSLL-41	10	14,106.73
2nd Stage Separator	**5**	**8,955.70**
LSHH-441A	0	57.35
LSHH-441B	0	60.85
LSHH-441C	0	47.95
LSLL-64A	0	13.35
LSLL-64B	0	12.23
LSLL-66A	0	3.35
LSLL-66B	0	1.80
LSLL-66C	0	4.55
PSHH-71	0	44.92
PSLL-70	5	8,709.35
Booster Pumps	**0**	**117.67**
PSLL-1648A	0	0.57
Total	**1202**	**1,743,832.88**

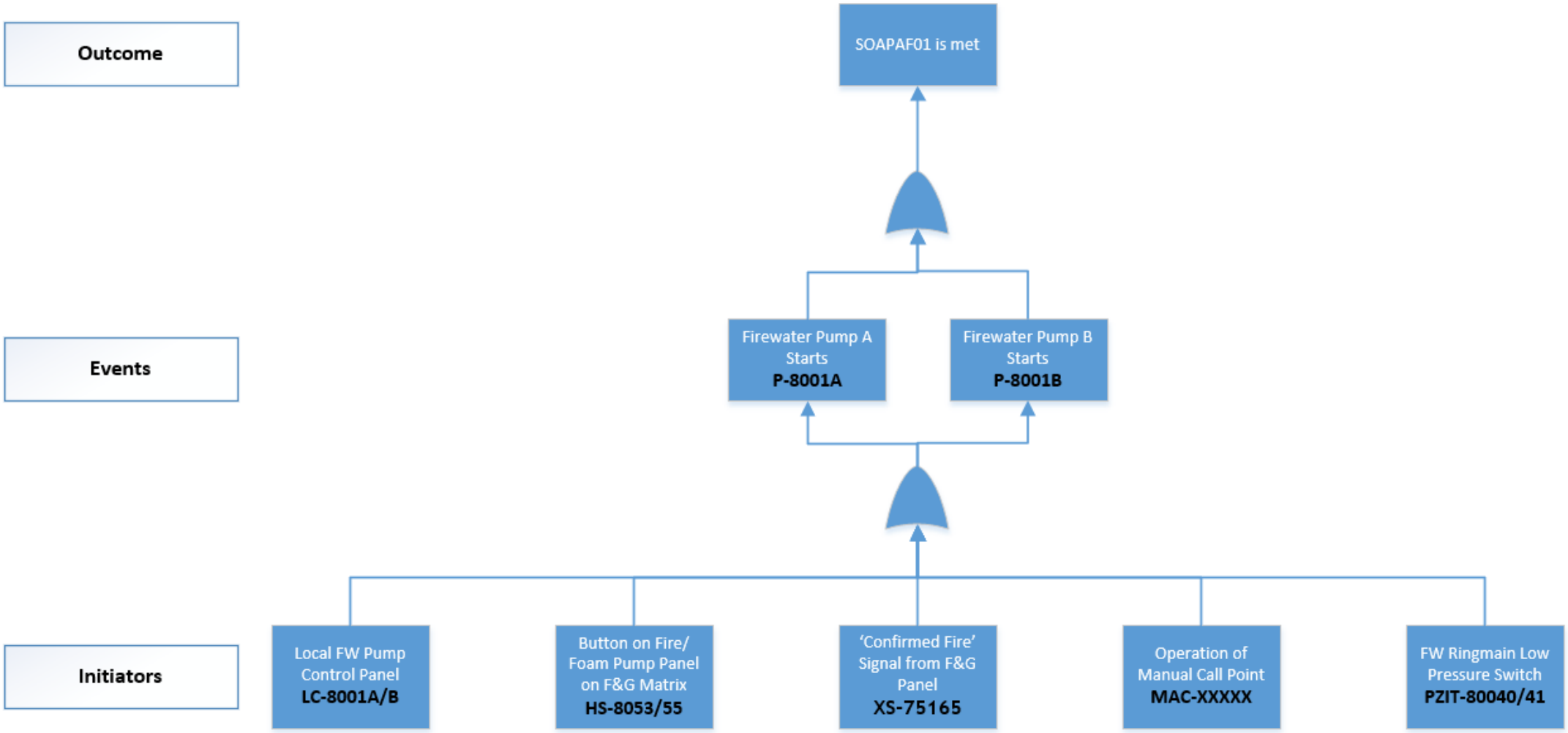


Date	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
02 January 2020																							4	5	9
03 January 2020	3	3	3	3	4	4	3	4	18	8	5	3	1	11	9	5	3	1	2	2	1	1		10	107
04 January 2020	12	8		3	2	4	2	5	1	5	26	3	2	8	2	7	13	5	4	3	12	3	3	1	134
05 January 2020	9	1	4	2	2	5	17	21	16	24	3	12	16	1	8	2		2	7	1	14	19	8		194
06 January 2020	4	5	2		2	2	3	4	6	9	2	9	1	11	8	1	13	4	2	9	1	1		2	101
07 January 2020	1	1	7	2	1	1	3	46	3	15	9	8	3	1	1	3	1	3	2	7	7	4	2	2	133
08 January 2020	9	6	9	13	15	5	18	14	314	166	56	23	17	14	31	17	53	15	9	7	6	10	10	10	847
09 January 2020	12	7	8	5	5	6	10	28	8	7	9	11	5	12	11	14	69	13	5	6	7	10	5	10	283
10 January 2020	8	11	17	8	3	4	8	24	35	48	29	26	3	5	49	43	18	34	11	73	69	5	14	24	569
11 January 2020	12	4	7	4	5	7		2	9	6	2	7	2	2	15	2	3	1	1	1	1	4		1	98
12 January 2020	1	3	7	2	1	4	4	11	3	2		5	11	3	10	8	2	2	7	6	8		8		108
13 January 2020		3	1	2	7	7	7		3	2	11	9	3	11	4	2		6	14	11	2		2	19	126
Total	**181**	**163**	**148**	**160**	**164**	**207**	**200**	**275**	**589**	**441**	**322**	**237**	**213**	**273**	**340**	**247**	**325**	**228**	**170**	**288**	**264**	**169**	**123**	**164**	**5891**





Model Prep


Outcome
Events
Initiators
SOAPAF01 is met
Firewater Pump A Starts
P-8001A
Firewater Pump B Starts
P-8001B
Local FW Pump Control Panel
LC-8001A/B
Button on Fire/ Foam Pump Panel on F&G Matrix
HS-8053/55
'Confirmed Fire' Signal from F&G Panel
XS-75165
Operation of Manual Call Point
MAC-XXXXX
FW Ringmain Low Pressure Switch
PZIT-80040/41

Model Prep

Create criteria mapping

InitiatorGroup	Votes-ooN	PerfStd	ResponseGroup	Criteria	CriteriaValue
Soft Hand Switch Pump A	1	SOAPAF01-5	Fire Pump A Running	Time	15
Soft Hand Switch Pump B	1	SOAPAF01-5	Fire Pump B Running	Time	15

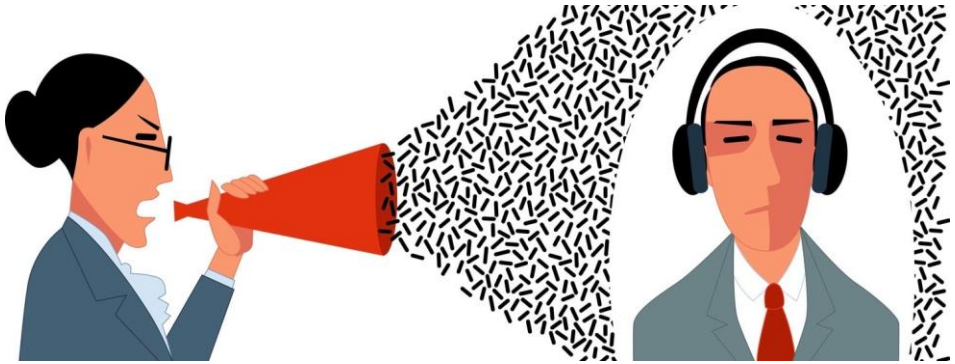
Find Causes in DCS logs

InitiatorGroup	Tag
Soft Hand Switch Pump A	HS-80053
Soft Hand Switch Pump B	HS-80055

Find Effects in DCS logs

ResponseGroup	Tag
Fire Pump A Running	XZS-80112
Fire Pump B Running	XZS-80117

- Effect happened and achieved PS criteria as expected.
- Effect happened but failed to meet criteria.
- Effect never happened after cause.

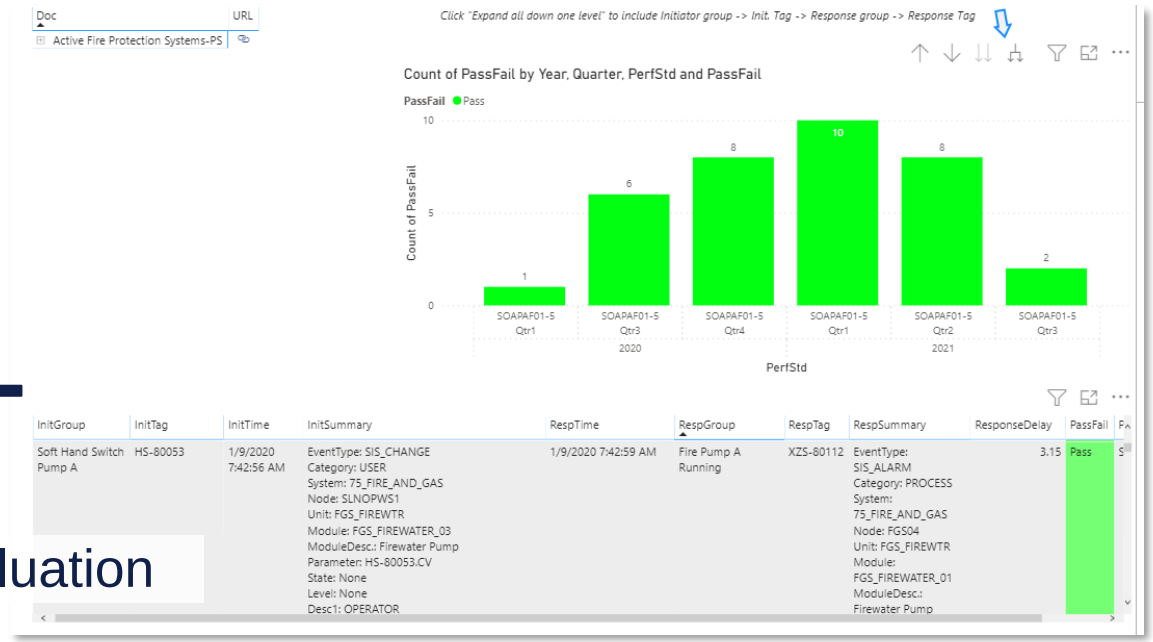


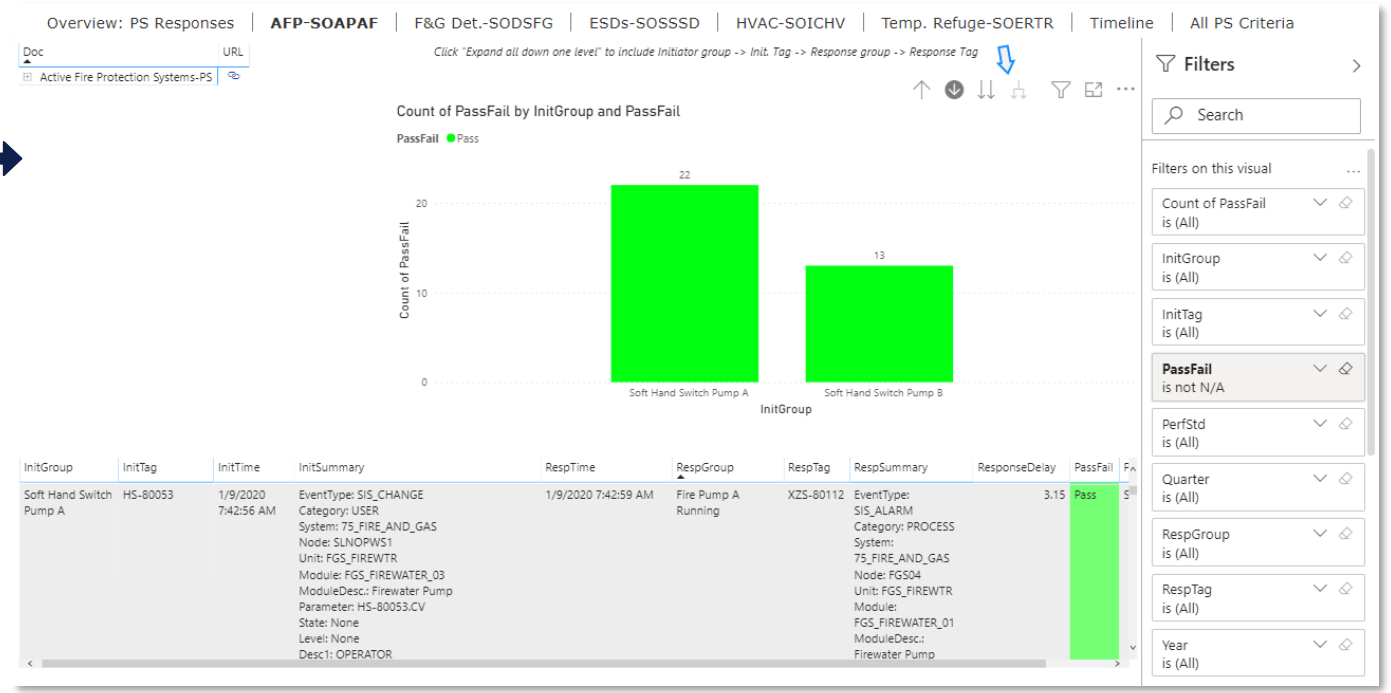
- Need to ignore calibrations, bypasses maintenance lines etc.
- What if effect has already happened before cause is triggered?

Evaluation

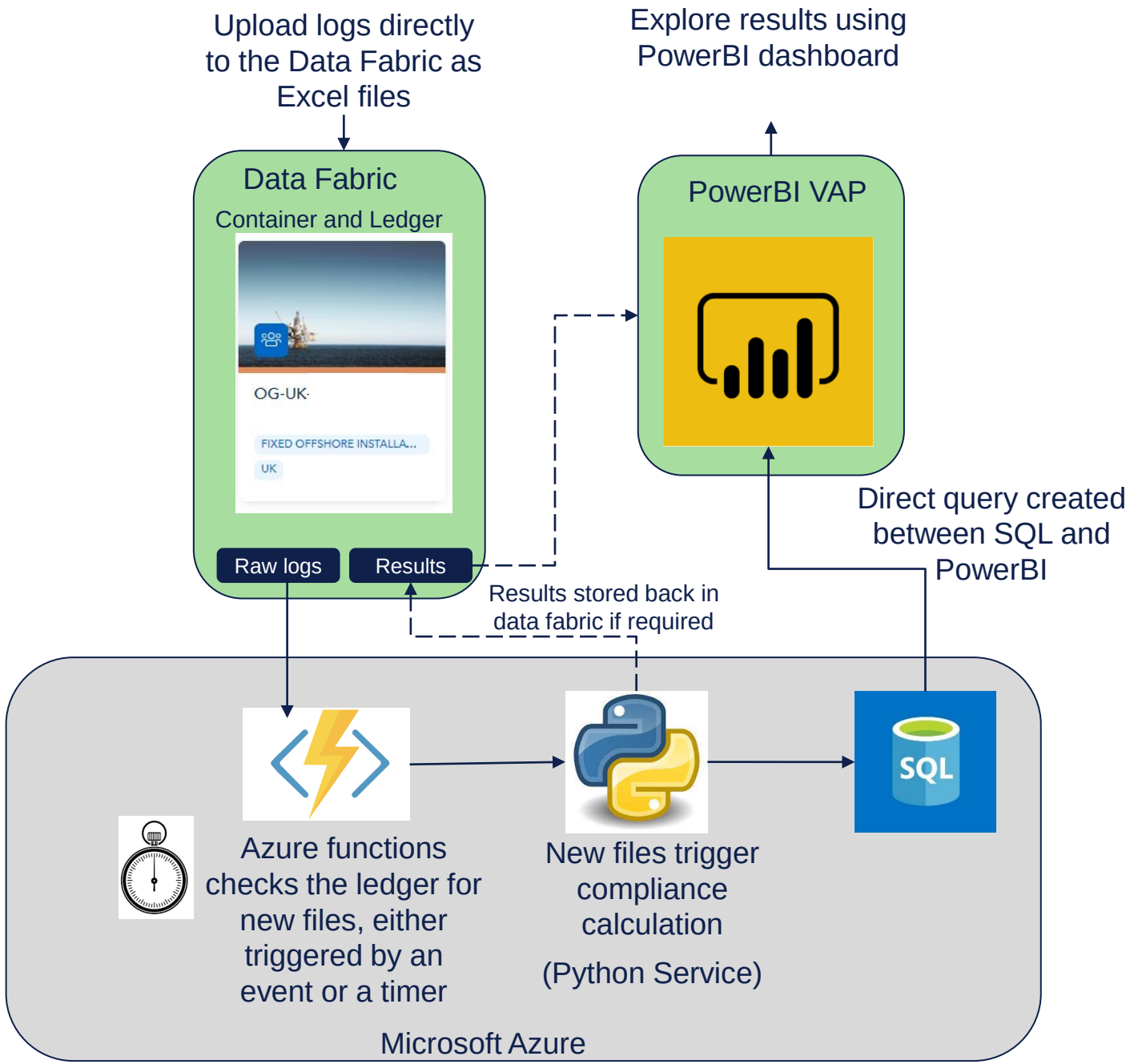
- Looks good but views aren't useful to some staff
- Filters need customised for different users
- Data in table needs more details
- Is the data presented correct?
- Other systems to be onboarded ESD, HVAC etc.

Post-Evaluation



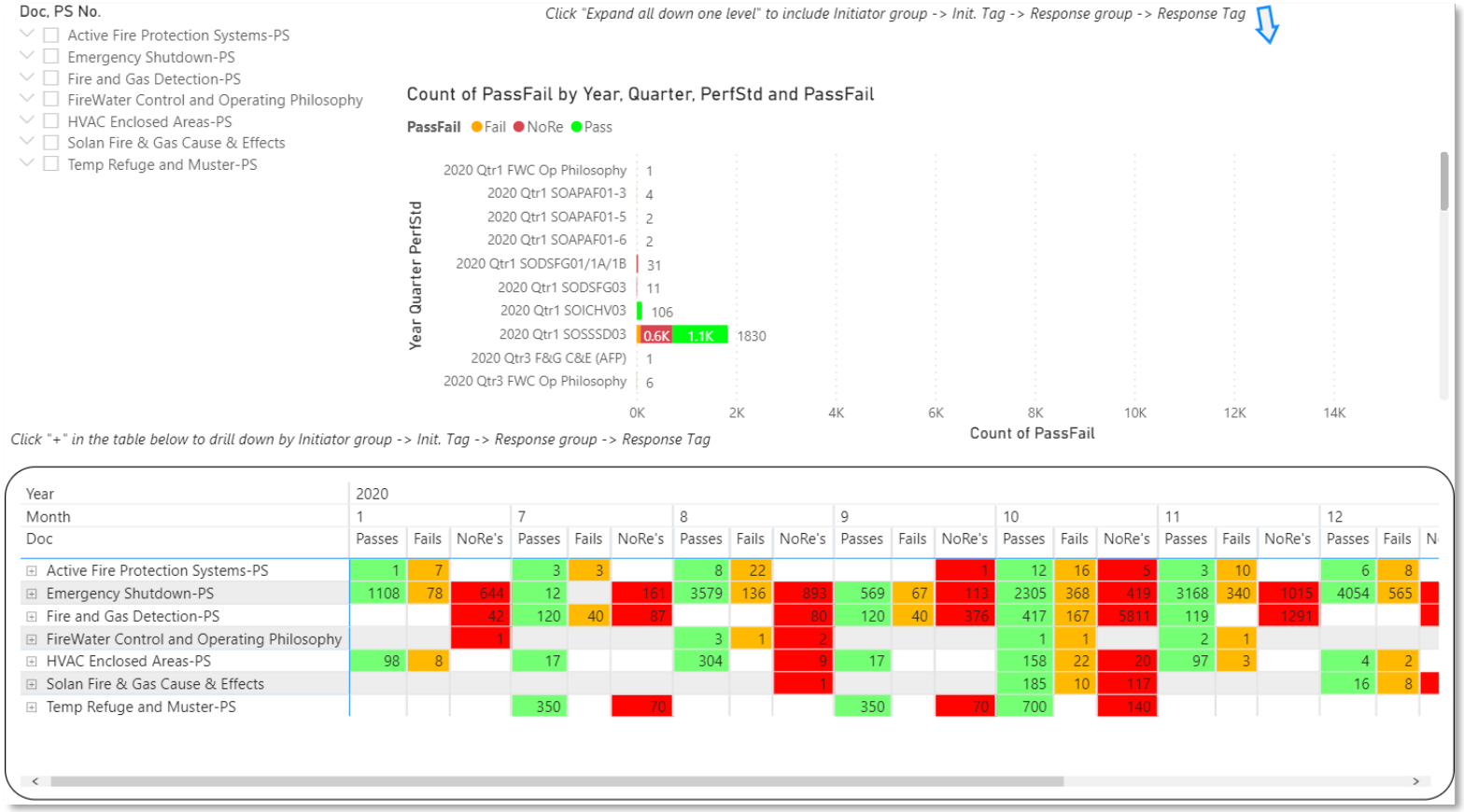


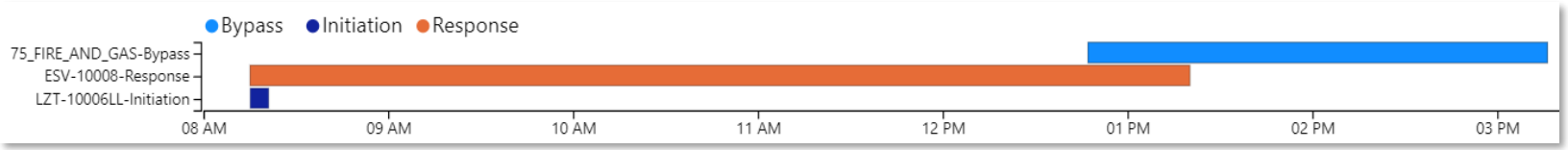
Final Product



Automatically Determine Performance Standard Compliance

- Cost & efficiency savings.
  - Reduce the need for planned assurance tests on systems.
  - Performing more verification work remotely.
  - Create more targeted plan for offshore inspection and witnessing.
- Monitor events during real operations & planned tests.
  - Planned tests may include unintended bias or be configured, differently to normal operations.
- Monitor features difficult to verify.
  - For example, reliability of fire pumps to engage on demand during normal operations (e.g. to maintain ring-main pressure).
- Monitor data from system cause and effects **not just performance standards.**
  - Ensure systems respond as expected.





Automated Ex Inspection Reports

- Used by both the operator electrical TA and the ICP, this tool provides a visual summary of Ex inspections.
- System uses text analytics and rule set based on EI guidance and EN 60079-17 to:
  - Ensure inspection philosophy is followed.
  - Ensure failures are categorized and prioritized correctly.
  - Trend hazardous and significant failures
  - Trend failures by type i.e. earthing vs tagging
  - Trend failures by location on asset

Failure Rate Calculator & Maintenance Interval Optimiser

- Reads maintenance data as stored in Maximo/SAP
- Using real asset data
  - Text analytics (machine learning/AI) can be used to identify incorrect classified pass or failure records.
  - Text analytics can be used to identify child location failures.
  - Mean Time Between Failures (MTBF) can be calculated
  - Reliability on demand (RoD) can be calculated
  - Maintenance interval can be adjusted to optimise the RoD

IChemE Advances

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DNV