

CUI JIP

Improved management of corrosion under insulation

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07 June 2018

CUI – Why go for a JIP?

“Corrosion under insulation (CUI) is a well-understood problem, and mitigation methods are well established.”

Still, CUI remain a major challenge to the industry both with respect to safety as well as cost

JIP ID 54 - Improved management of corrosion under insulation

CHALLENGE

Corrosion Under Insulation (CUI) continues to be one of the most severe technical integrity challenges to the global oil & gas industry, for both offshore and onshore operations.



- A detailed guideline to support optimised CUI risk management. The guideline shall be easy to implement and lead to a cost efficient and safe handling of CUI compared to present practice.

- An acknowledged and transparent risk based work process for improved CUI management in the industry.
- The industry is making huge investments to mitigate the uncertainty related to CUI. The conservatism has been a cost driver for the industry and the potential savings for each installation is in the range of + 10 MNOK yearly cost.

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Region: NORWAY

CUI – The Challenge in Brief

- Over 20% of the major oil and gas accidents reported within the EU since 1984 have been associated with CUI
 - PSA “CUI has a major accident potential”
- Corrosion costs 40 trillion NOK globally a year
 - Billions are spent on CUI in Norway every year
- CUI poses a significant safety, operational and economic challenge



Improved safety by removal of unnecessary insulation

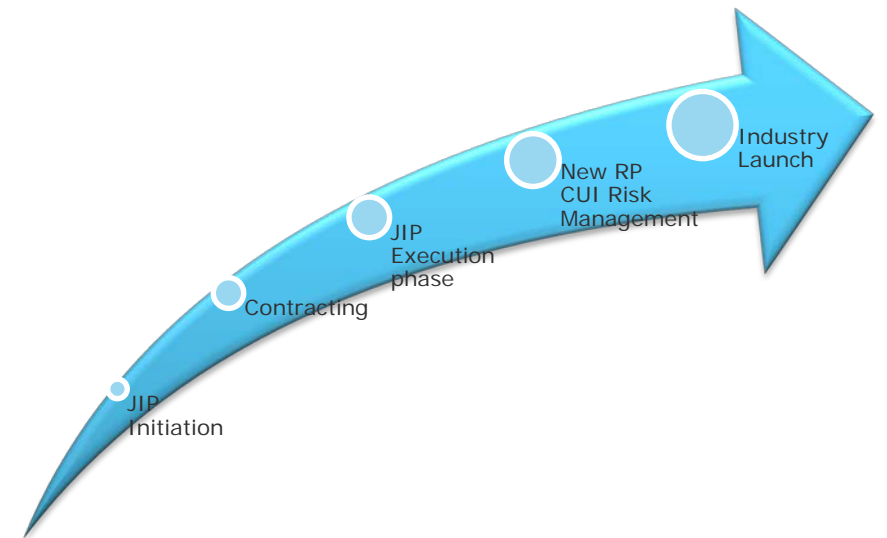
CUI JIP – The Team

- Participants
 - ConocoPhillips Skandinavia AS
 - Gassco AS
 - Aker BP AS
 - Neptune Energy Norge AS
- Observators
 - PSA (No)
 - HSE (UK)
- DNV GL core team
 - Frode Wiggen (Technical lead)
 - Geir Egil Eie (Project sponsor)
 - Thom Fossellie (Project manager)



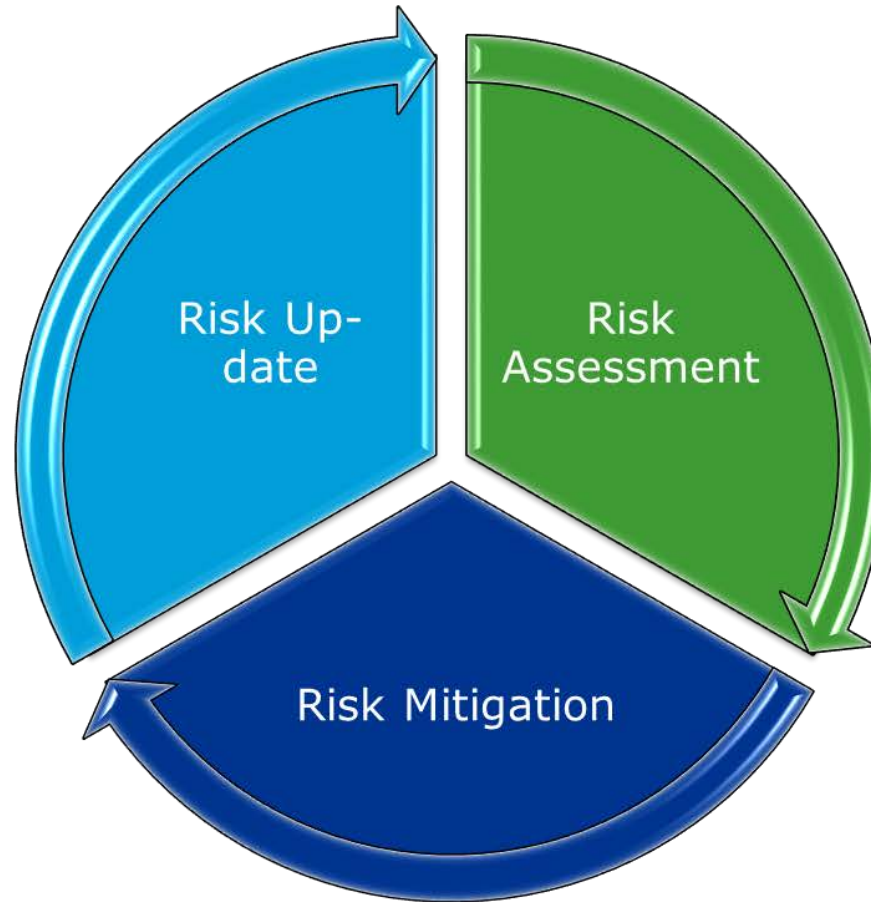
CUI JIP – The Timeline

- First attempt in 2014
- Renewed approach in 2016-17 with a single CUI specific scope
- Contracting and kick-off in Q3 2017
- Workshops and team meetings
 - CUI risk management framework
 - Material
 - Coating & insulation
 - Mitigation
 - Hotspot
 - NDT
 - CUI risk management model
- Draft project report out for comment on 21st of June 2018
- Final project report in Q3 2018
 - New DNV GL RP on CUI Risk Management in 2019



*User-friendly Guideline for threat identification,
risk assessment and risk mitigation of CUI*

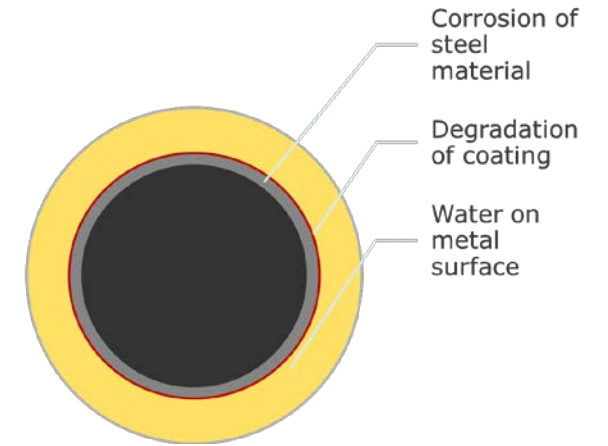
CUI JIP – The Model



Acceptable risk in an evergreening process

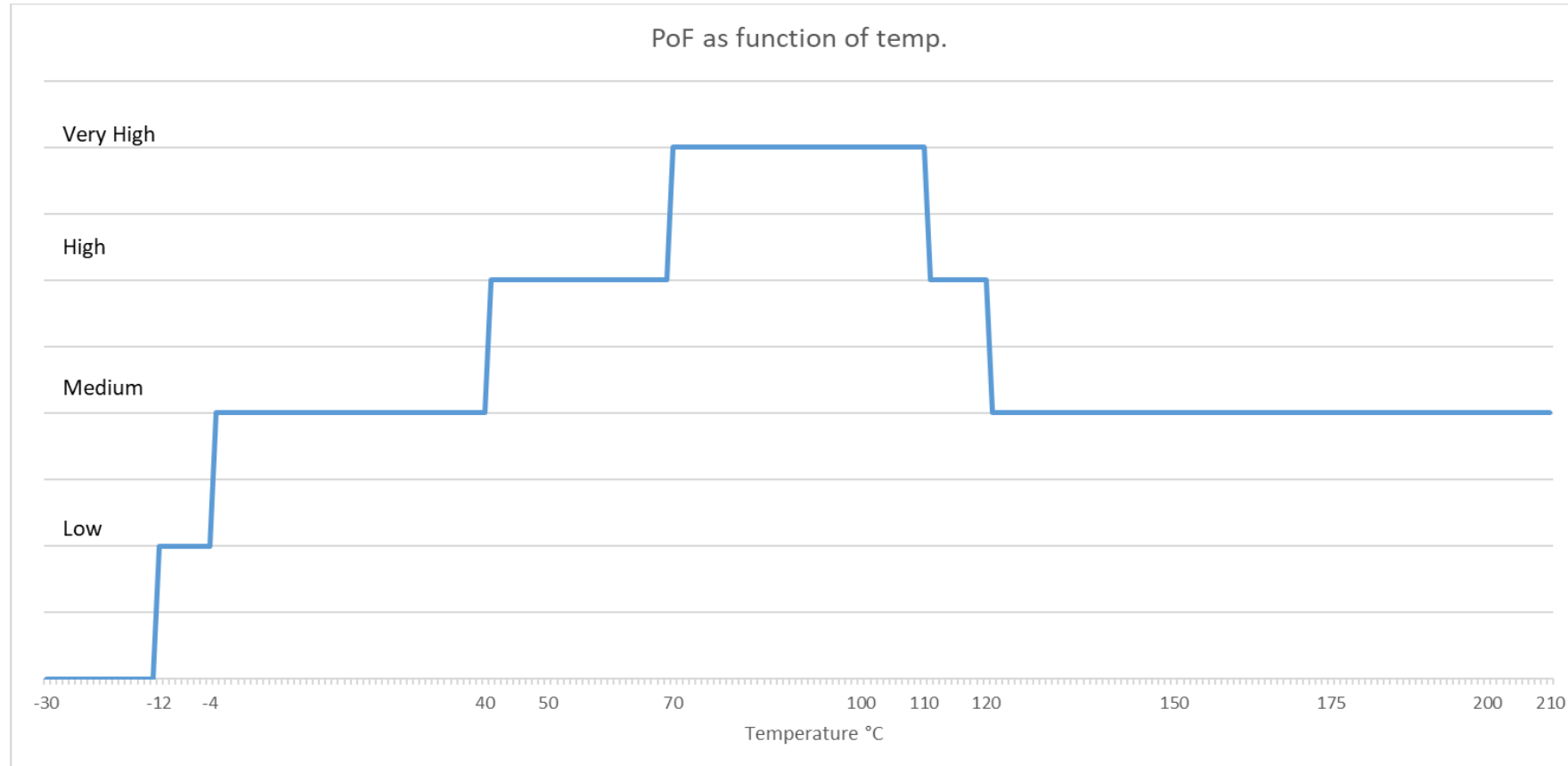
CUI JIP – Barrier Management

- Steel degradation (Corrosion potential)
- Coating condition
- Water wetting
- Design (dimension, wall thickness, hot-spot)



CUI JIP – PoF Steel (CS) Barrier

- The PoF of Carbon Steel is related to surface temperatures and aligned with API



- The JIP has also discussed PoF for Pitting & ESCC in typical stainless steels

CUI JIP – PoF Coating Barrier



- Coating suppliers: *Generic coating systems positioned correctly in the table*

Description	NORSOK M-501 system ref	NACE SP0198-2010 system ref	Temp. area	0-5	5-10	10-15	15-20	20-25	25-30	30-35	>35	Comment
Primer (<50my)				VH	VH	VH	VH	VH	VH	VH	VH	Only shop primer, not intended to be used as a protective layer under insulation.
2 or 3 layer on zinc primer (vinyl, polysiloxane etc.)	System 1			M	H	VH	VH	VH	VH	VH	VH	Not to be used under insulation according to NORSOK M-501.
Two component epoxy or polyester based coating	System 7A			VL	VL	L	M	H	VH	VH	VH	Not to be used under insulation according to NORSOK M-501. Need prequalification
3 layer on epoxy primer (zinc free)	System 6 (A/B)			L	M	H	VH	VH	VH	VH	VH	Not to be used under insulation according to NORSOK M-501
2 layer epoxy coating	System 7 (B/C)	SS-1/CS-1	-45 to 60°C	VL	L	M	H	VH	VH	VH	VH	Not to be used under insulation according to NORSOK M-501. Need prequalification
2 layer modified epoxy (novolac)	System 6C (SS) System 9 (CS)	SS-2/3 / CS-3/4	-45 to 205C	VL	VL	L	M	H	VH	VH	VH	Normativ ref Norsok M-501. Chosen for higher temp service than 2 comp epoxy above
2 layer modified epoxy(phenolic)	System 6C (SS) System 9 (CS)	SS-2/3 / CS-3/4	-45 to 150°C	VL	L	M	M	H	VH	VH	VH	Normativ ref Norsok M-501. Chosen for higher temp service than 2 comp epoxy above
Fusion Bond Epoxy (FBE)	NA	CS-2	-45 to 60°C	VL	VL	L	M	H	VH	VH	VH	Shop application only
TSA with top coat/sealer	System 2A	SS-6/CS-5	-45 to 595°C	VL	VL	VL	L	M	H	VH	VH	Normativ ref Norsok M-501
Air dried silicone or Modified silicone	NA	SS-4	-45 to 540°C	M	H	VH	VH	VH	VH	VH	VH	Limited information of this system available. Assessment based on one single product.
Inorganic copolymer or coatings with an inert multipolymeric matrix	NA	SS-5 / CS-6	-45 to 650°C	VL	VL	L	M	H	VH	VH	VH	Evaluation based on testing, less practical experience

- It all comes down to the quality of application

CUI JIP – PoF Water Wetting Barrier

- Location
- Op. temp vs dew-point
- Design solution of water proofing
- Insulation material
- Workmanship
- Inspection & maintenance routines

CUI JIP – PoF Design

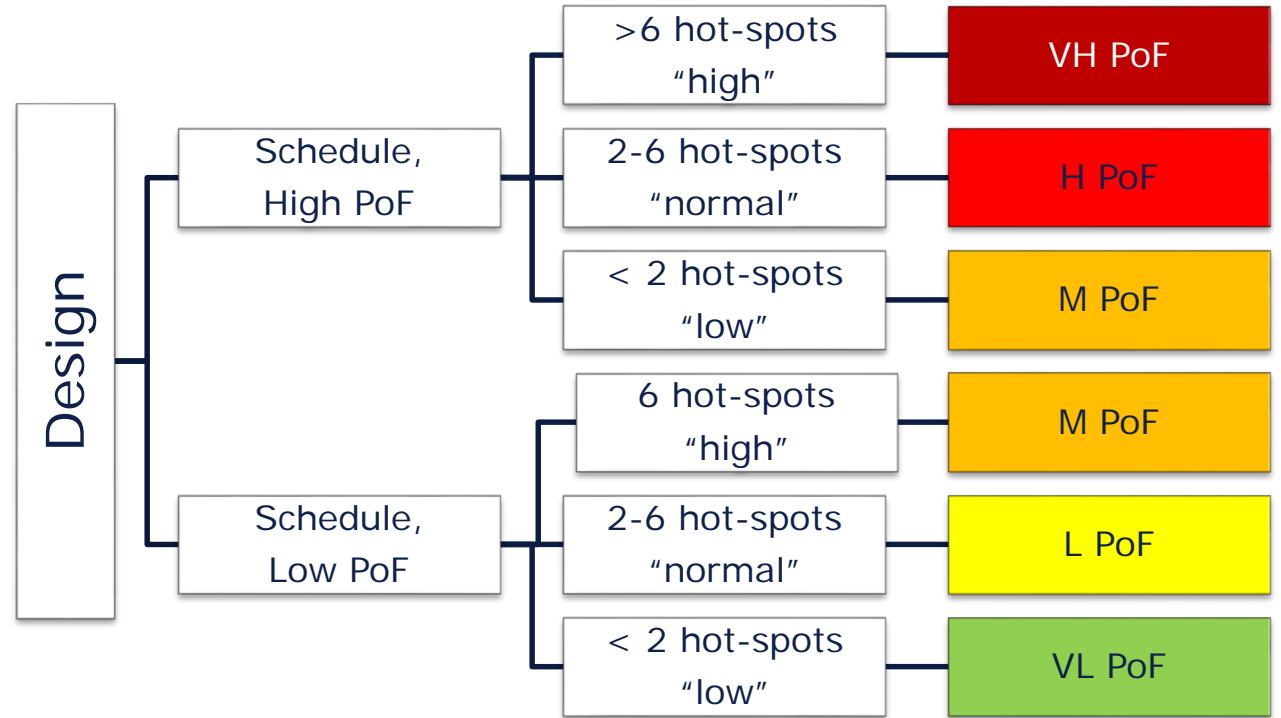
- Most CUI failures on 4" down
- CUI in complex geometries

The table contains numerical data organized in columns and rows, likely representing different design parameters and their corresponding values. A red line traces a path through the table, starting from the top left and moving generally downwards and to the right, indicating a specific design configuration or sequence of values.

Design factors:

- Schedule (combination of dia and wall thickness)
- Number of hot-spots

- The Design PoF will only be given a negative effect on the overall CUI PoF



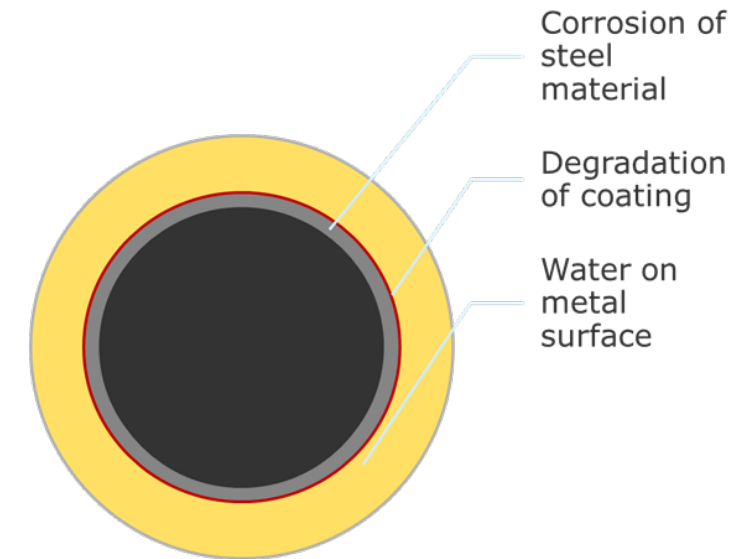
CUI JIP – Hotspots

- Hotspot - Susceptible locations for CUI (Ref API 583)

Hot-spot	Material deg.	Coating	Water wetting	Design	Other
Field joints		X		X	
Complex geometries		X	X	X	
Penetration to cladding / weather proofing		X	X	X	
Areas with restricted availability for coating application, ie deck penetrations or under supports		X		X	
CS bolts and nuts in SS systems	X			X	
Damaged cladding or degraded water proofing			X		Area with potential for water ingress from damage
Branch connections with temperature in higher PoF area than main pipe.	X			X	
Areas subjected to excessive water exposure			X	X	
Vessel insulation support rings and other elements that trap water			X	X	
Branch connections		X	X	X	

- 90% of all findings relate to hotspots

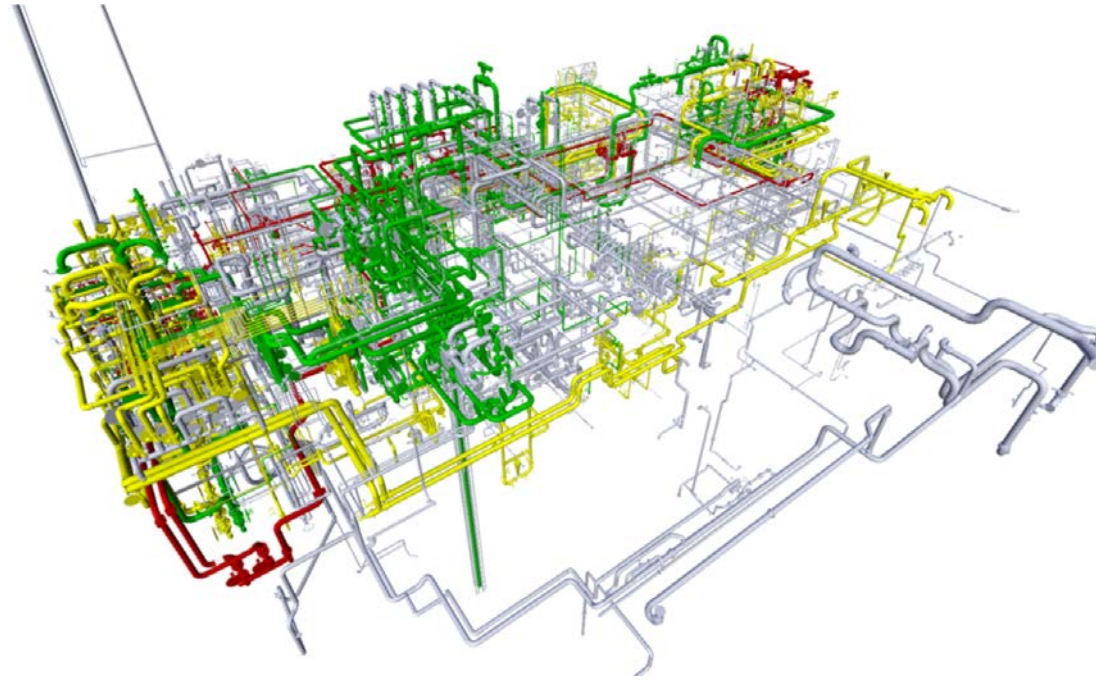
- Can NDT give the required PoD?
 - RT can, but what about the rest.....
- HOIS: *No “silver bullet” for NDT of CUI and world awaits improved technology*
 - HOIS/OGTC project starting to better quantify the inspection performance of key methods for CUI inspection
- Time bound effect of NDT wall thickness measurements
- Potential in NDT developments focusing coating degradation and water wetting



CUI JIP - Effect of mitigation



The effect of mitigation is



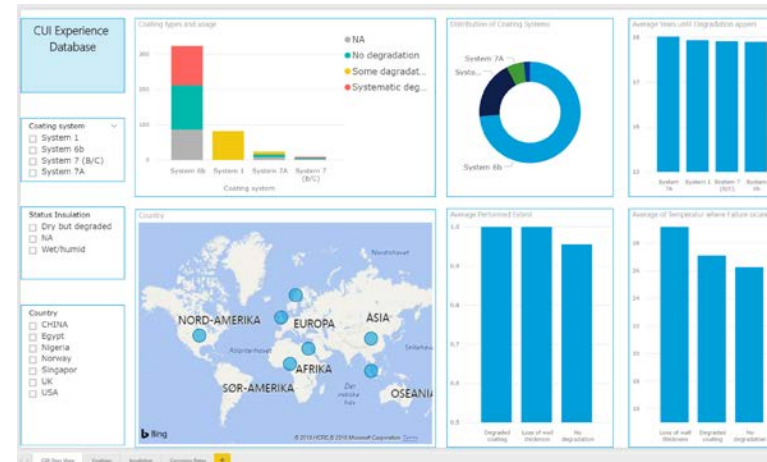
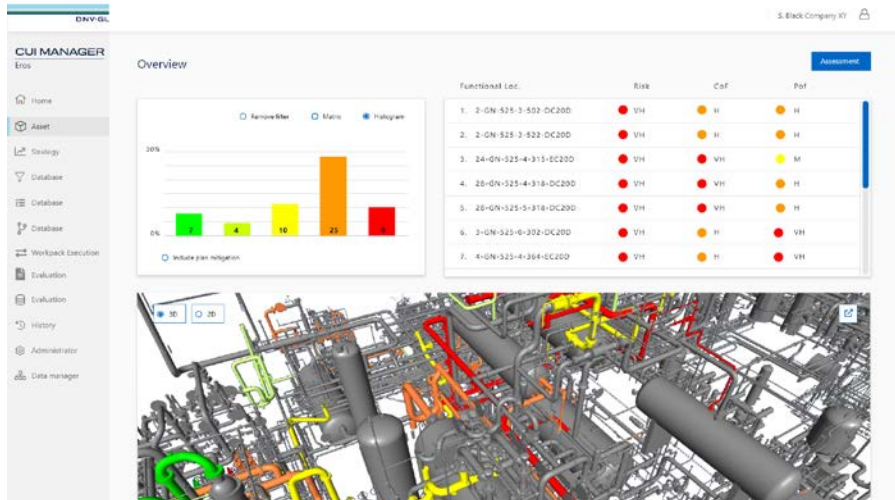
Hot Spots are the key to smart CUI risk mitigation strategies

	VH	M	M	H	VH	VH
POF	H	L	M	H	VH	VH
	M	L	L	M	H	H
	L	VL	L	L	M	M
	VL	VL	VL	VL	L	M
		VL	L	M	H	VH
				COF		

Risk management through corrective response to restore degraded barriers

CUI JIP – The Way Ahead

- The CUI JIP Report issued to participants in Q3 2018
- DNV GL to launch the new RP in 2019
- The CUI APP ready by end 2018 (EIP Project)
- DNV GL will invite the industry to a CUI Forum – start-up Q4 2018



- Digital Solutions will strengthen data sharing and cross industry learning
- DNV GL will take initiative on further testing for better CUI risk management

Thank you!

JIP CUI

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