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100 YEARS

Driving Pipeline Decommissioning Best Practice Through Experiential Learning

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Safety Moment: Cave Creek Disaster, New Zealand

- What Happened?
  - 28 April 1995
  - Paparoa National Park, New Zealand
  - Scenic viewing platform collapsed
  - Platform fell approximately 40 m into chasm
  - 14 people died

- Why?
  - Platform not designed or approved by a qualified engineer
  - No one involved in its construction was a qualified engineer
  - Nails were used to secure the platform instead of bolts because an appropriate drill had not been taken to the building site
  - Steps to the platform, which were supposed to act as a counterweight, had not been properly attached
  - No building consents were obtained
  - Platform not listed on any inspection register
  - Warning sign for the platform, suggesting a maximum limit of five people, had been ordered but was never installed at the site

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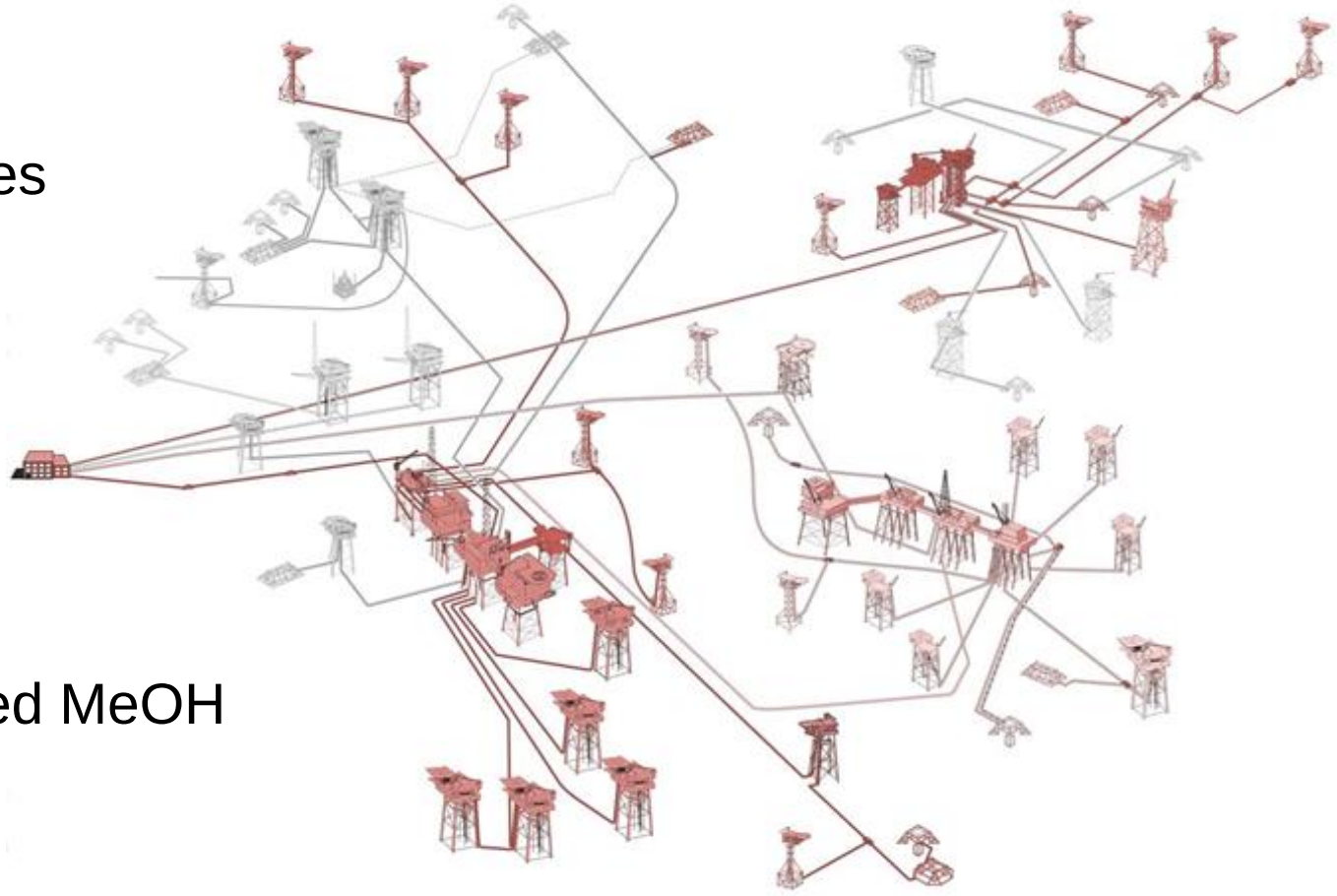
Safety Moment: Cave Creek Disaster, New Zealand

- Lessons to be learned
  - Follow correct design and construction processes
  - Seek expert advice where required
  - Use the correct tools and materials for the job
  - Manage any changes to the design or job execution
  - Be aware of design limitations and communicate them

Introduction: Decommissioning Scope of Work

- UK Southern North Sea
- Three major gas fields
  - Gas and associated methanol lines
- Large infield infrastructure
  - 84 lines: 3 to 20 in.
  - 50m to 43 km
- Export pipelines
  - 5 lines: 16 to 36 in. with associated MeOH lines
  - 10.9 to 188 km



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Challenges

- Pipelines still contained:
  - Hydrocarbon gas
  - Condensate
  - Water
  - Methanol
  - Sludge (causing blockages in some lines)
  - NORM contaminated debris
- Some lines never pigged since commissioning
- Other lines not pigged for decades
- Lines with stuck spheres
- Some lines badly corroded

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Challenges

- Multiple stakeholders
- Platform limitations (NUIs, laydown areas, craneage, etc.)
- Aging infrastructure
- SIMOPS for P&A and decom
- No established industry standards

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Objectives

- Remove line inventory
- Reduce hydrocarbon content to less than 30 mg/l
- Leave lines flooded with seawater
- Inject displaced fluid and solids down nominated disposal wells

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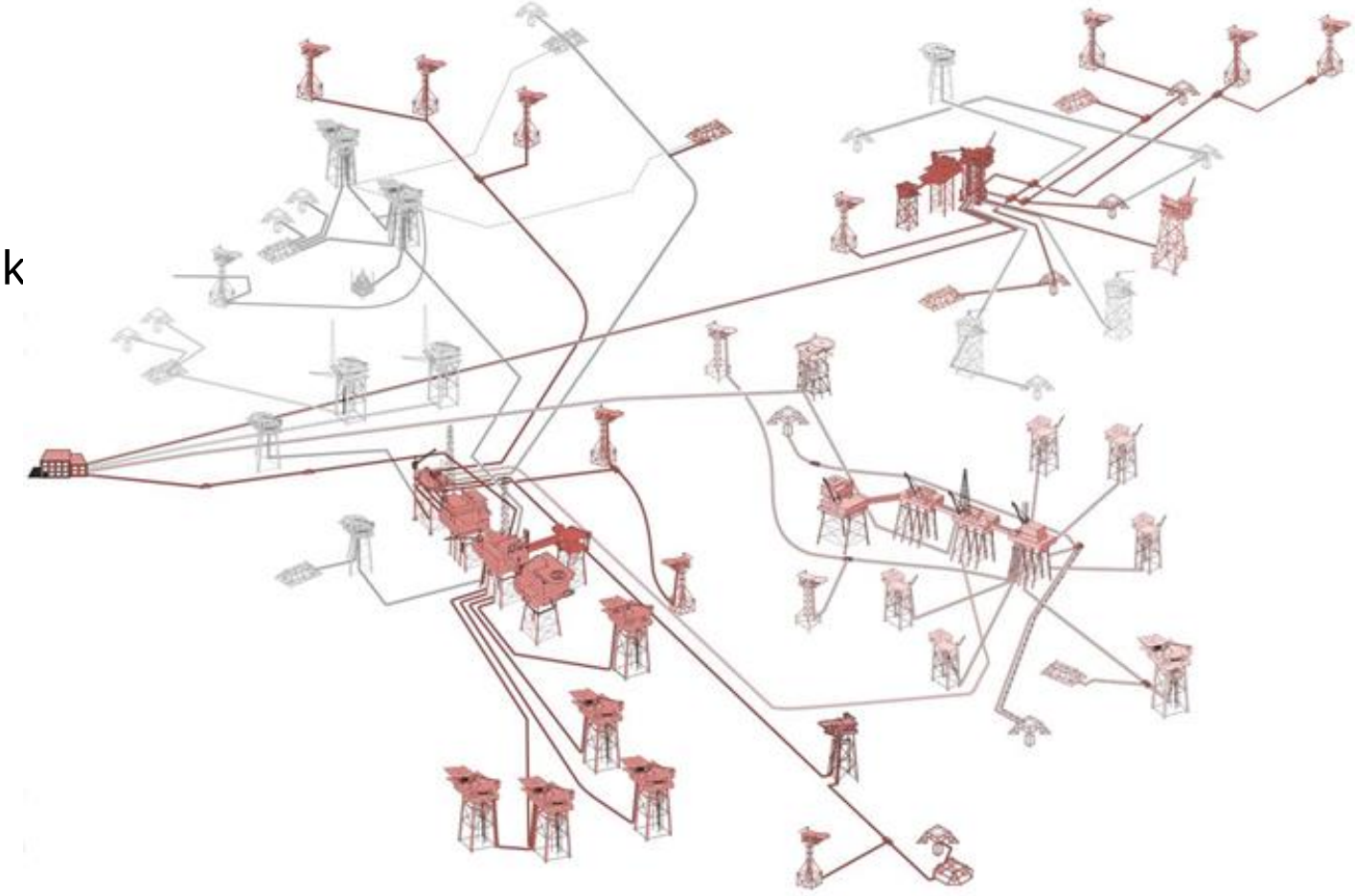
Operations

- 3 distinct projects for the primary client: 1 for each field
- 5-year duration
- 89 pipelines: 1970 km
- 35 worksites: platforms and vessels
- Additional line (detail not included here)
  - Taking total length to more than 2000 k
- 7 scenarios
  - Satellite to satellite
  - Topsides to topsides
  - Topsides to subsea
  - Subsea to topsides
  - Topsides to shore
  - Topsides to shore to topsides
  - Onshore to onshore



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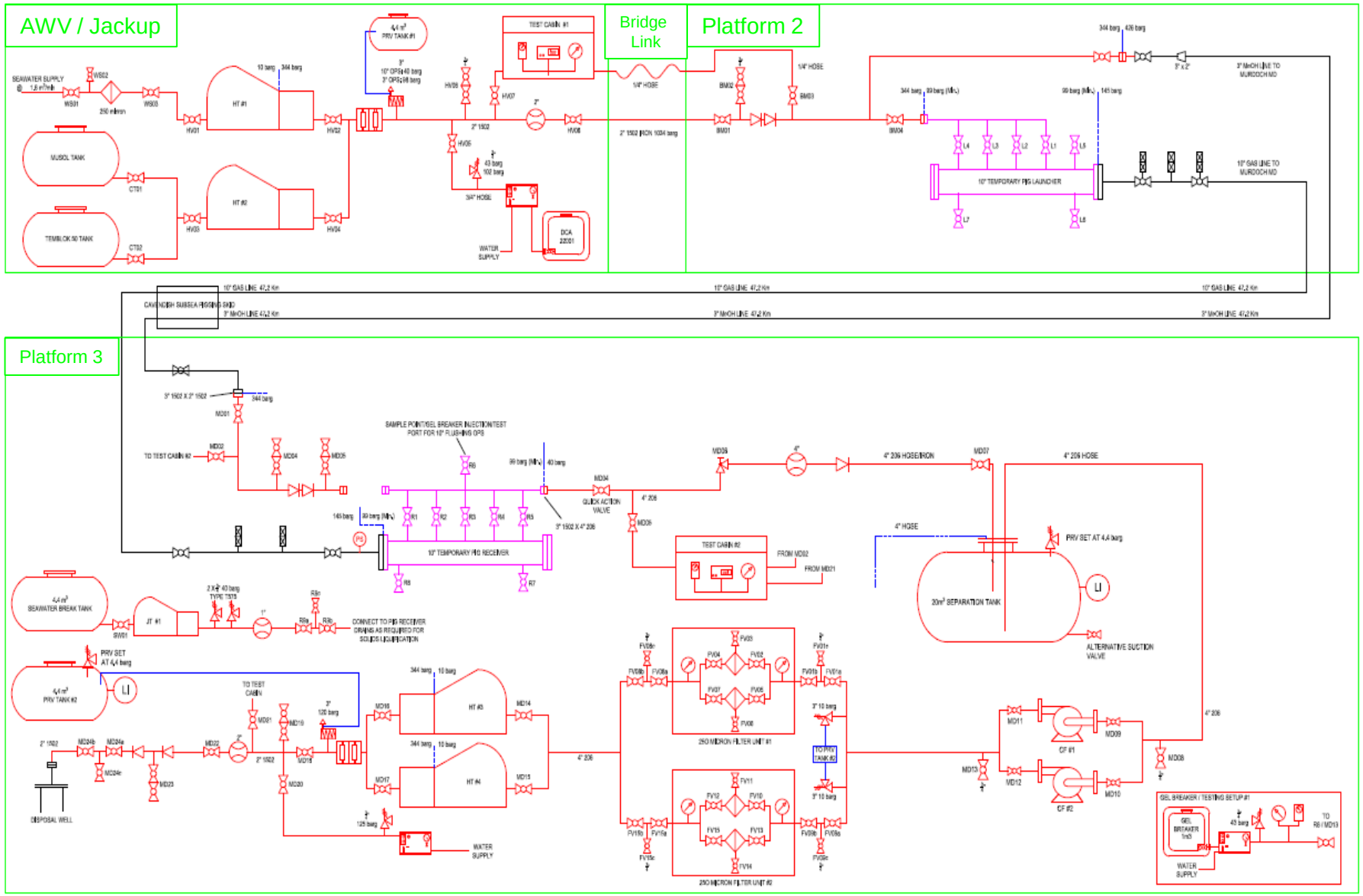
Typical Equipment Rig Up: Satellite Platform to Hub Platform Operation



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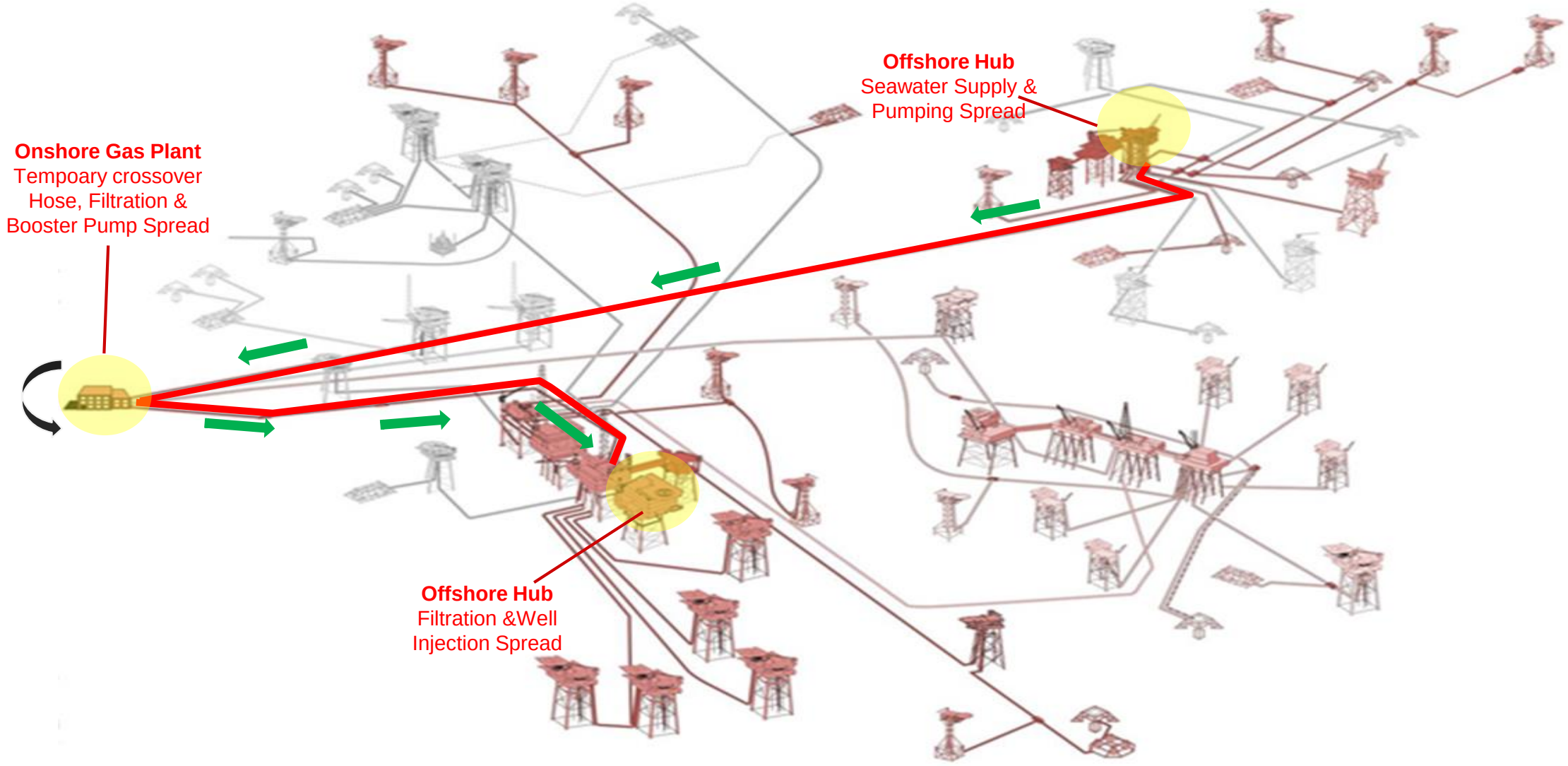
26” and 36” Gas Export Trunk Line Flushing 307km Loop



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Operations: First Two Fields

- Typical cleaning train: gas lines

- MeOH lines
  - Typical three-line volume flush
- Export lines
  - Pigged offshore to onshore
  - Pigged back from onshore to offshore for disposal
  - Bidirectional pigs used over foam pigs

36” X 118.7km Gas Export Flushing Station

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Operations

Worksites

- Accommodation work platform (AWP)
- P&A drill rig
- Normally manned platforms
- Normally unmanned satellites
- Work vessels
- Onshore gas terminal

Supply Vessel Based Flushing Spread c/w Flushing 2” HP Hose Deployed to Satellite

Onshore Receiving and Pumping Spread at Terminal

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Operations

- Foam pigs used with chemicals on infield lines
- Bidirectional pigs and chemicals used on export lines
- Initial flushing of infield MeOH lines was three times the line volume
- Overflush reduced to a maximum of 20% based on received results
- Overflush on export MeOH lines at 5% in conjunction with gel slug

Example of Debris Displaced by Cleaning Trains

Debris Removed from 4” MeoH 118.7km Pipeline

36” 118.7km Gas Export Pipeline Offshore Pig Receipt

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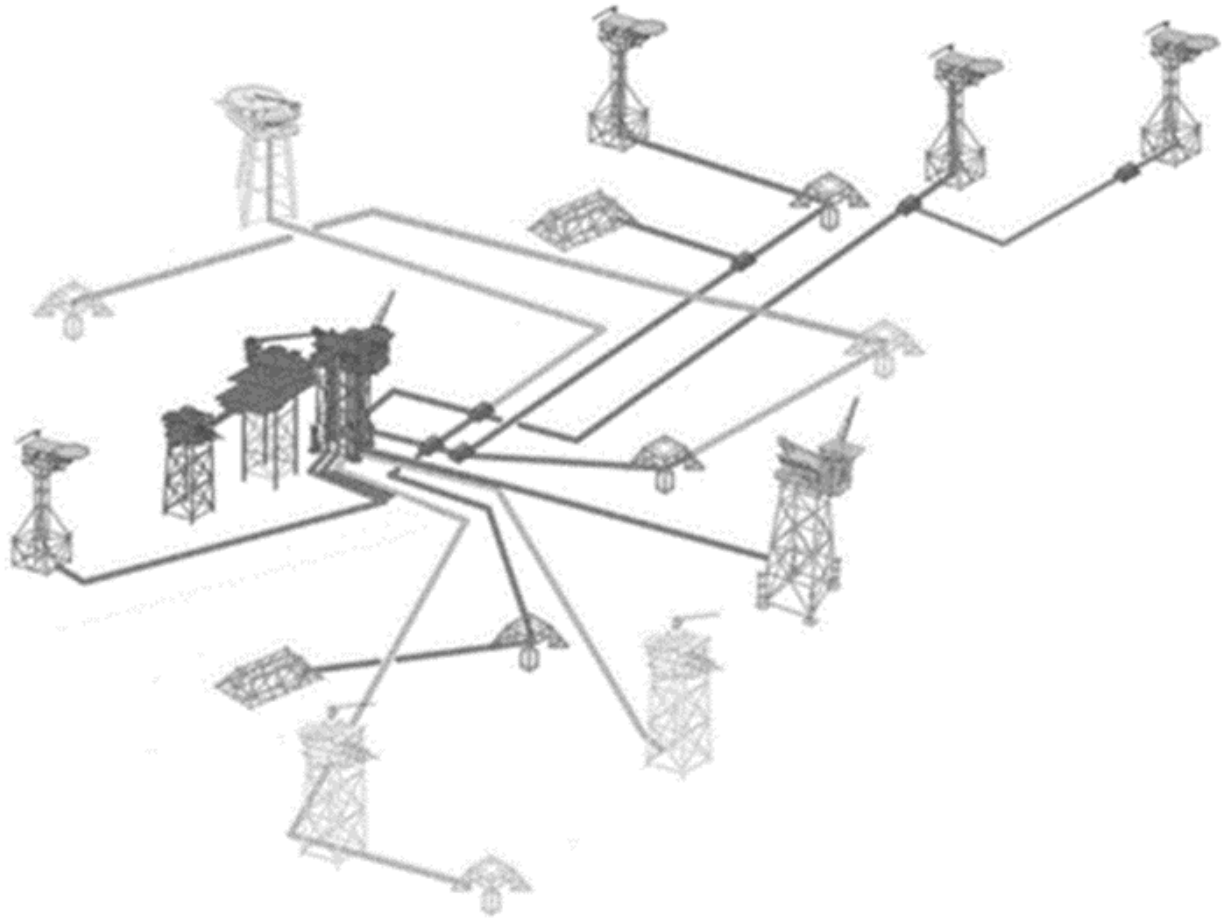
Operations: First Two Fields, Learnings

- Cleanliness achievable with flushing alone
- Cleaning efficiencies increased with a combined chemical/mechanical approach
  - Reduced overflush requirement
  - Reduced chemical requirement
  - Reduced volume for waste handling and disposal
  - Improved cleanliness results (typically)
  - Reduced operational time
  - Less impact on other ongoing decom operations (e.g., rig movements, well P&A, etc.)
  - Associated reduction in overall cost

Operations: Final Field Additional Challenges

- Dead legs
- Unpiggable tees
- Difficulties associated with subsea sampling of flush fluid



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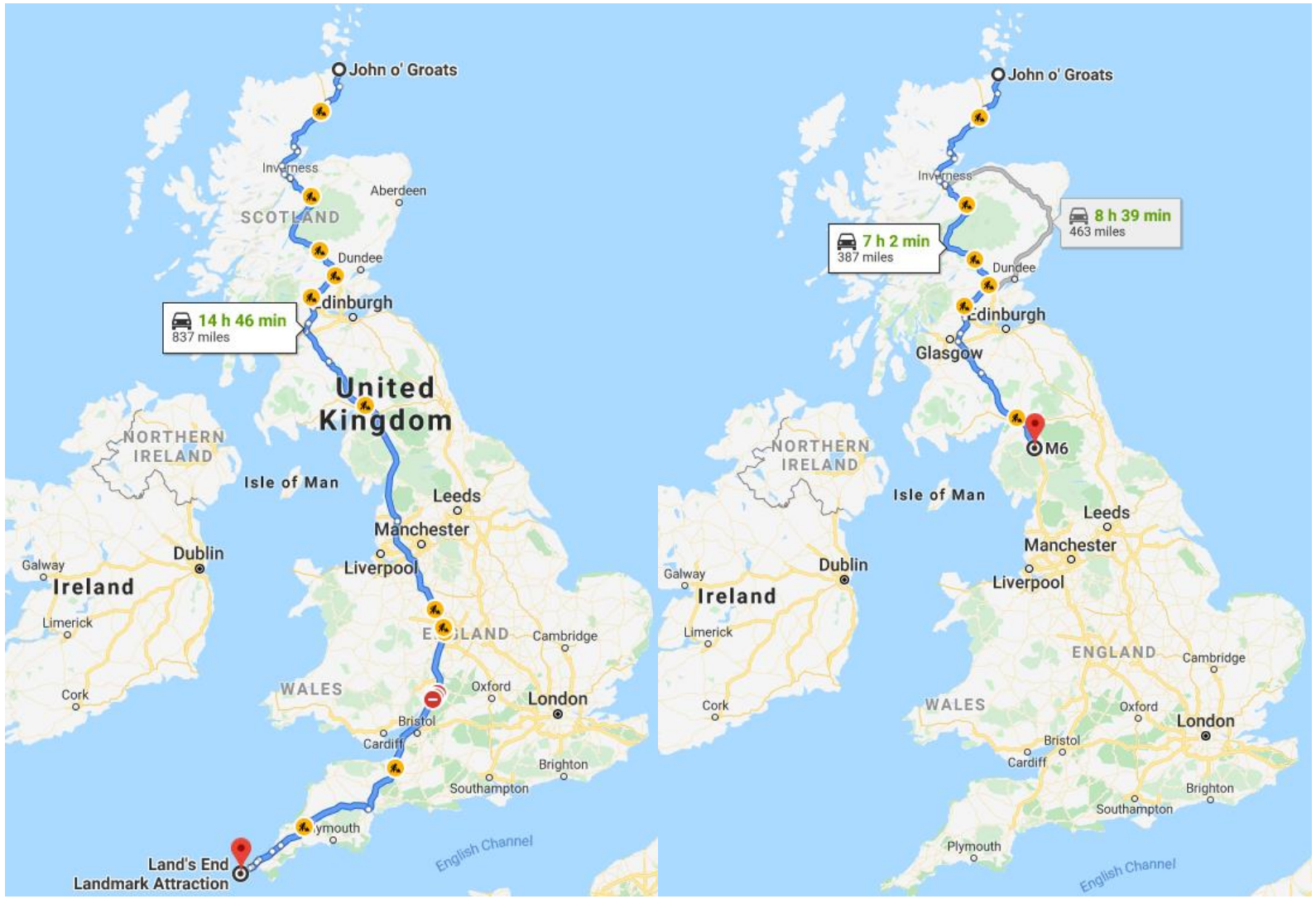
Operations: Final Field

- Combined pigging and chemical approach was still considered best
- Where “solid” pigs were not an option, a customized gel was designed
  - Trial performed on a platform-to-platform line
  - Trial results comparable to “solid” pig with overflush of 1.4 x line volume and 1.5 mg/l OIW
- Where sampling was impractical, agreed overflush of 1.6 x line volume was used
- This was based on previous experience and trial results
- Multiple techniques deployed
  - Solid pigs plus chemicals where architecture would allow
  - Gel and chemicals where architecture would not allow solid pigs
  - Sampling where possible
  - Calculation and agreed overflush where sampling not possible
  - Debris pickup gel included in 4-in. methanol export line

Results

- Total length of lines cleaned
  - 1970 km
  - 1,224 miles

- In 1,224 miles, you can
  - Drive from Land's End to John o'Groats
  - Then drive back to Penrith



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Results and Conclusions

- Average volume pumped per line: 1.132 x line volume
- Average OIW for field: 11.57 mg/l
  - Based on three consecutive reducing samples below 30 mg/l at 15- to 30-min intervals
- 240, 530 bbl (38,240 $m^{3)}$ of fluids and NORM-contaminated debris pumped into disposal wells
  - Reduced waste handling, minimal fluids dumped overboard

#	Size (")	Designation	Length (km)	OIW (mg/l)	#	Size (")	Designation	Length (km)	Year
1	12	Gas	3.7	7.7	49	3	MeOH	3.7	2015
2	12	Gas	5.1	16.4	50	3	MeOH	5.1	2015
3	12	Gas	5.6	22.9	51	3	MeOH	5.6	2016
4	12	Gas	4.1	14	52	3	MeOH	4.1	2016
5	12	Gas	3.9	6	53	3	MeOH	3.9	2016
6	12	Gas	12	9.1	-	-	-	-	2016
7	16	Gas	0.15	By Calc	54	3	MeOH	0.15	2016
8	16	Gas	13.4	10	55	3	MeOH	13.4	2016
9	12	Gas	5	4.3	56	3	MeOH	5	2017
10	16	Gas	13.5	20.4	57	3	MeOH	13.5	2017
11	10	Gas	3.8	9.9	-	-	-	-	2017
12	16	Gas	26.9	12.2	58	3	MeOH	26.9	2016
13	24	Gas Export	10.9	14.2	59	3	MeOH	10.9	2017
14	28	Gas Export	138	18.5	60	3	MeOH	138	2017
15	12	Gas	4.5	By Calc	61	3	MeOH	4.5	2017
16	8	Gas	0.05	By Calc	-	-	-	-	2017
17	12	Gas	14	1.55	62	3	MeOH	14	2017
18	18	Gas	20	6.8	63	3	MeOH	20	2017
19	16	Gas	11	8.39	64	3	MeOH	11	2016
20	12	Gas	0.2	By Calc	65	3	MeOH	0.2	2018
21	12	Gas	20.3	26.5	66	3	MeOH	20.3	2018
22	12	Gas	42	11.3	-	-	-	-	2017
23	8	Gas	0.05	By Calc	-	-	-	-	2017
24	10	Gas	17.8	11.8	-	-	-	-	2018
25	14	Gas	4.5	6.9	67	3	MeOH	4.5	2018
26	10	Gas	22.3	16.4	68	3	MeOH	22.3	2018
27	20	Gas	16.8	10.6	69	3	MeOH	16.8	2018

#	Size (")	Designation	Length (km)	OIW (mg/l)	#	Size (")	Designation	Length (km)	Year
28	10	Gas	7.5	20.2	70	3	MeOH	7.5	2018
29	10	Gas	4.3	3.5	71	3	MeOH	4.3	2018
30	10	Gas	10.6	22.6	72	3	MeOH	10.6	2018
31	18	Gas	16.1	2.5	73	3	MeOH	16.1	2018
32	12	Gas	22	4.6	74	3	MeOH	22	2018
33	12	Gas	16	4.1	75	3	MeOH	16	2018
34	10	Gas	13.5	0.8	76	3	MeOH	13.5	2018
35	14	Gas	43	16.6	77	3	MeOH	43	2018
36	10	Gas	3.7	By Calc	78	3	MeOH	3.7	2018
37	26	Gas Export	188	8.8	79	4	MeOH	188	2019
38	36	Gas Export	118.7	14.9	80	4	MeOH	118.7	2019
39	18	Gas	28	6	81	3	MeOH	28	2019
40	16	Gas	30	25.6	82	3	MeOH	30	2019
41	6	Gas	15.5	By Calc	-	-	-	-	2019
42	10	Gas	11	12.5	83	3	MeOH	11	2019
43	10	Gas	0.05	By Calc	-	-	-	-	2019
-	-	-	-	-	84	3	MeOH	10.4	2019
44	8/10	Gas	27.9	By Calc	-	-	-	-	2019
-	-	-	-	-	85	3	MeOH	8.5	2019
-	-	-	-	-	86	3	MeOH	5.5	2019
45	10/12	Gas	26.6	8	-	-	-	-	2019
46	10/12	Gas	14.2	By Calc	87	3	MeOH	14.2	2019
-	-	-	-		-	-	-	-	2019
47	12	Gas	13		-	-	-	-	2019
-	-	-	-		88	3	MeOH	12.5	2019
48	10	Gas	17.1		-	-	-	-	2019
-	-	-	-		89	2	MeOH	17	2019

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Results and Conclusions

- Where possible, use a combination of pigs and chemicals for optimal cleaning with minimal pumping
- Where pigging facilities are not available, gel or viscosified fluids are a viable alternative
- Where OIW sampling is not practical, a sensible overflush volume can be calculated
- Where possible, use disposal well to minimize waste handling—consider contingency
  - Spare disposal well and alternative disposal using treatment and overboarding

THANK YOU