UPDATE ON HYDRAULIC FLUIDS DEVELOPMENT

SUBSEA CONTROLS DOWNUNDER 2018

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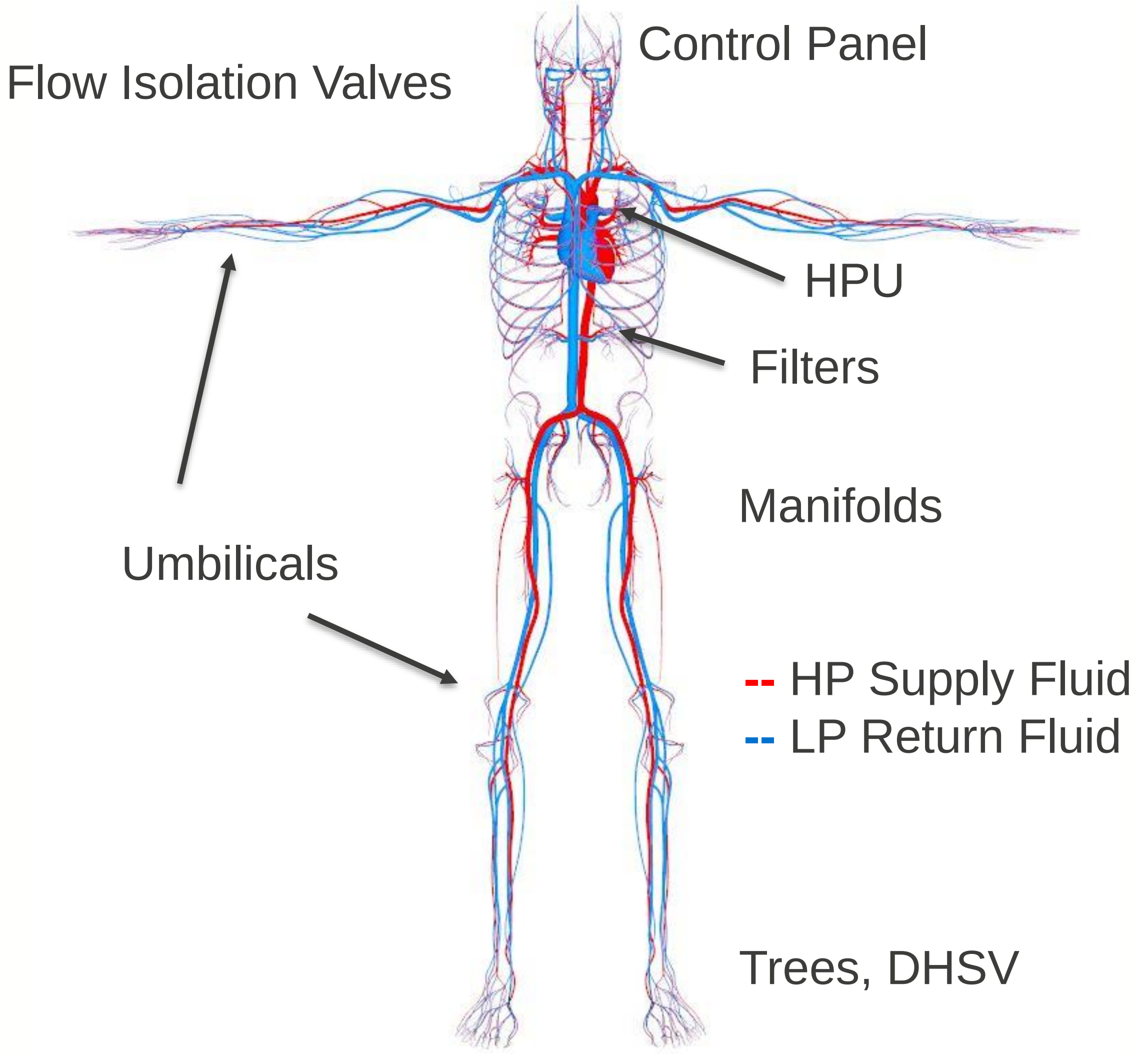
Continued Development

- I am an Engineer and work with PhD Chemists
- I tell them what the industry needs
- They make it
- They tell me how it works
- I try to understand
- Then my team and I test it
- I feel like Howard in the Big Bang Theory most of the time

Anatomy of a control system



- Hydraulic fluid can be thought of as the blood of a control system.
- Transferring energy to the functional components
- Fluid maintenance built in
- Condition monitoring for diagnostics are essential
- More closed systems are being proposed

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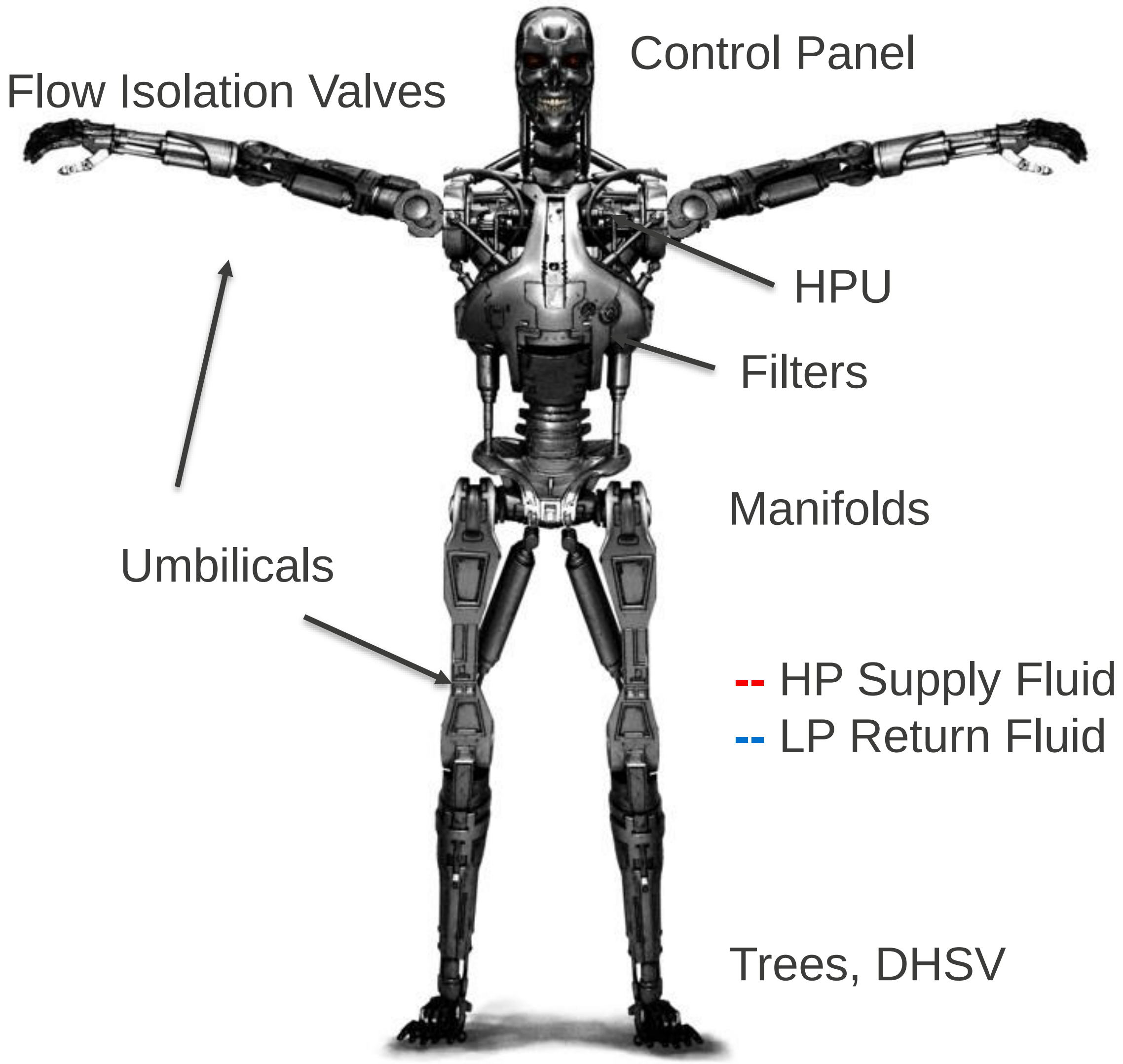

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Hi-Tech Future Fluid Developments

- Long-term stability is paramount
  - Separation
  - Thermal degradation
  - Chemical compatibility
- Efficient energy transfer without damaging the system
  - Viscosity
  - Density
  - Bulk Modulus
- Recyclability in closed systems
  - Solid contamination removal
  - Liquid contamination removal/tolerance
- Environmental efficiency in open systems

Environmental Future

- Standard Tests
  - Biodegradation, toxicity, bioaccumulation
- Contradictions in long term stability and envir
- Introduction of Health and Safety elements
  - New substitution warnings due to updated ass
- Exposure and degradation methods
- Degradation Oxygen Demand
  - High biodegradation rates are no

ISO 13628-6 migration to API 17F

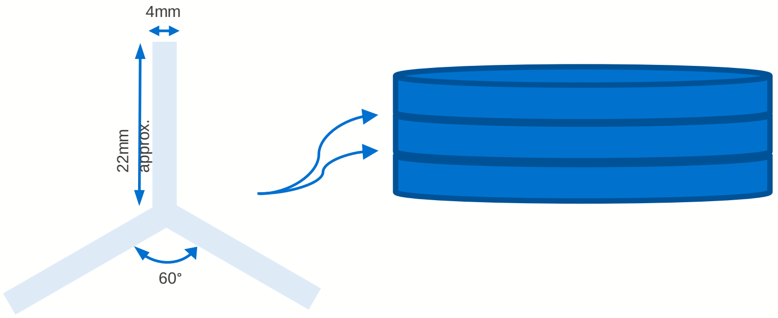
- Updates to make procedures clearer and more defined.
- API 17F is not a qualification (pass/fail) procedure
  - API 17F produces an information document highlighting limitations and capabilities of the hydraulic fluid
  - Can be used as a starting point for specific project requirements
- Defined visuals for hydraulic fluid degradation
- Distinct procedures for aqueous and non-aqueous fluids
- Fluid compatibility testing continues to examine longer term system impact.
  - If solids are formed what happens if this travels into other parts of the system
- New Nickel plating test.

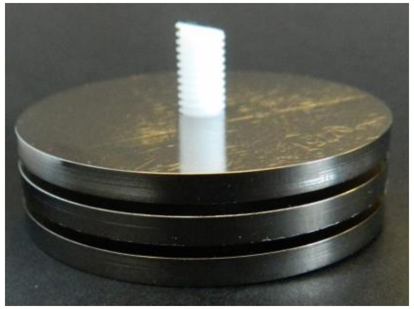
API 17F Fluid and Solid Standard Description

	Liquid Descriptors		Solid Descriptors
1	Clear	A	No Solids
2	Slight Haze	B	Very slight mobile deposit <2%
3	Hazy	C	Mobile Solid Deposit 2-10%
4	Opaque	D	Mobile Solid Deposit >10%
		E	Very slight non-mobile deposit <2%
		F	Non-mobile solid deposit 2-10%
		G	Non-mobile solid deposit >10%

Additional comments and photographs should be used to supplement the descriptor

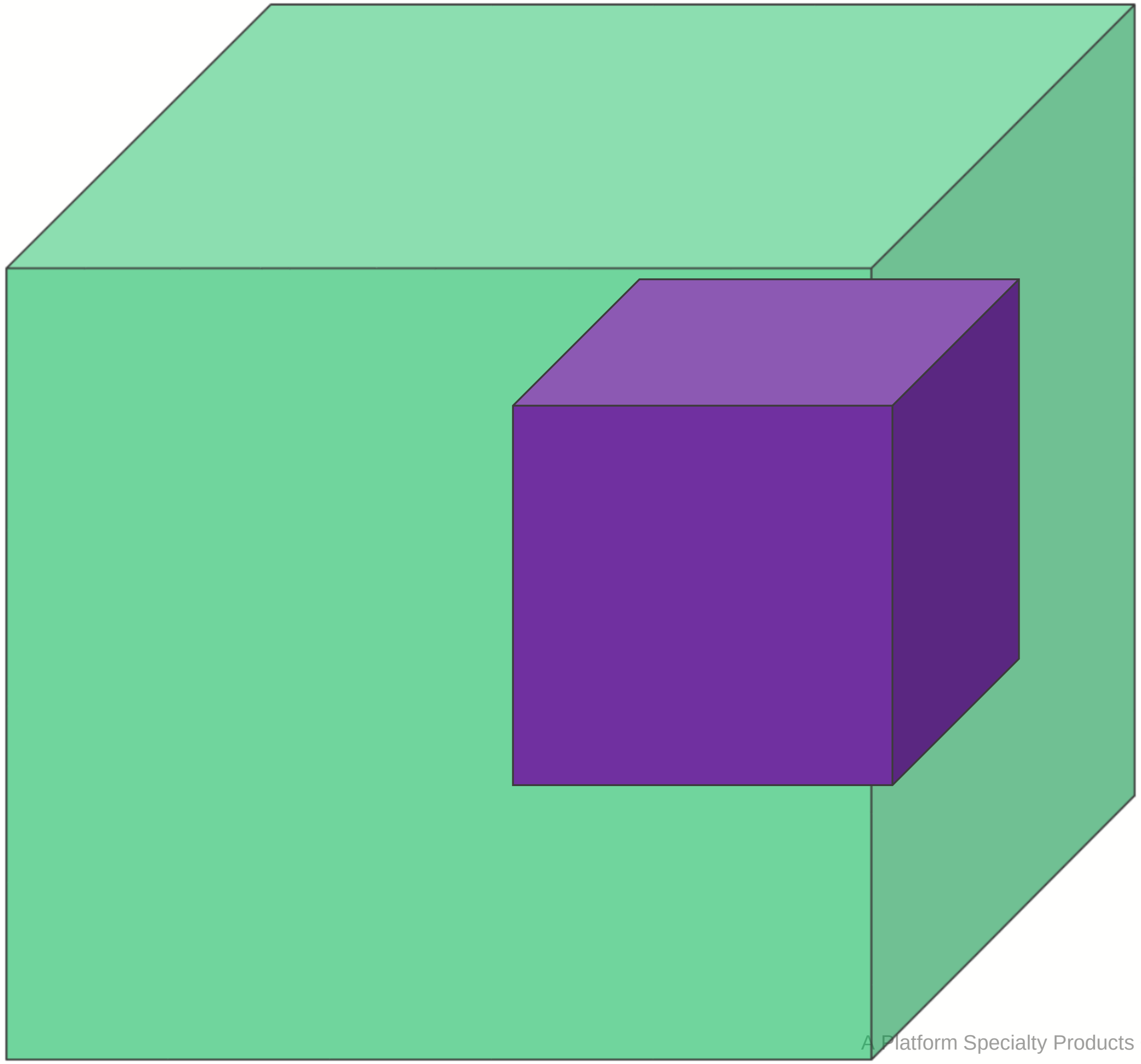
- Specified by OEMs following build up of sticky residues on solenoids
- Test method same as metals
- Maximum Spacing 25 microns between Electroless nickel pieces
- Low Volume test (3 Surface Area : 1 Fluid Volume)





Chemical Oxygen Demand

- 1 litre of MEG
- Will deplete all the Oxygen in 78,000 litres of seawater during degradation



COD Reduction

Table I – COD Values for Freeze Protection Additives & Formulated Fluids

In-house COD testing (Table I) show that an 85% reduction in COD can be achieved by adopting a Glycol Free formate salt based fluid.

		COD (mg/l)	% Reduction
Freeze Protection additive	MEG	1566000	-
	Formate	264500	83%
Fully Formulated Fluid	MEG	870000	-
	Formate	126000	85%

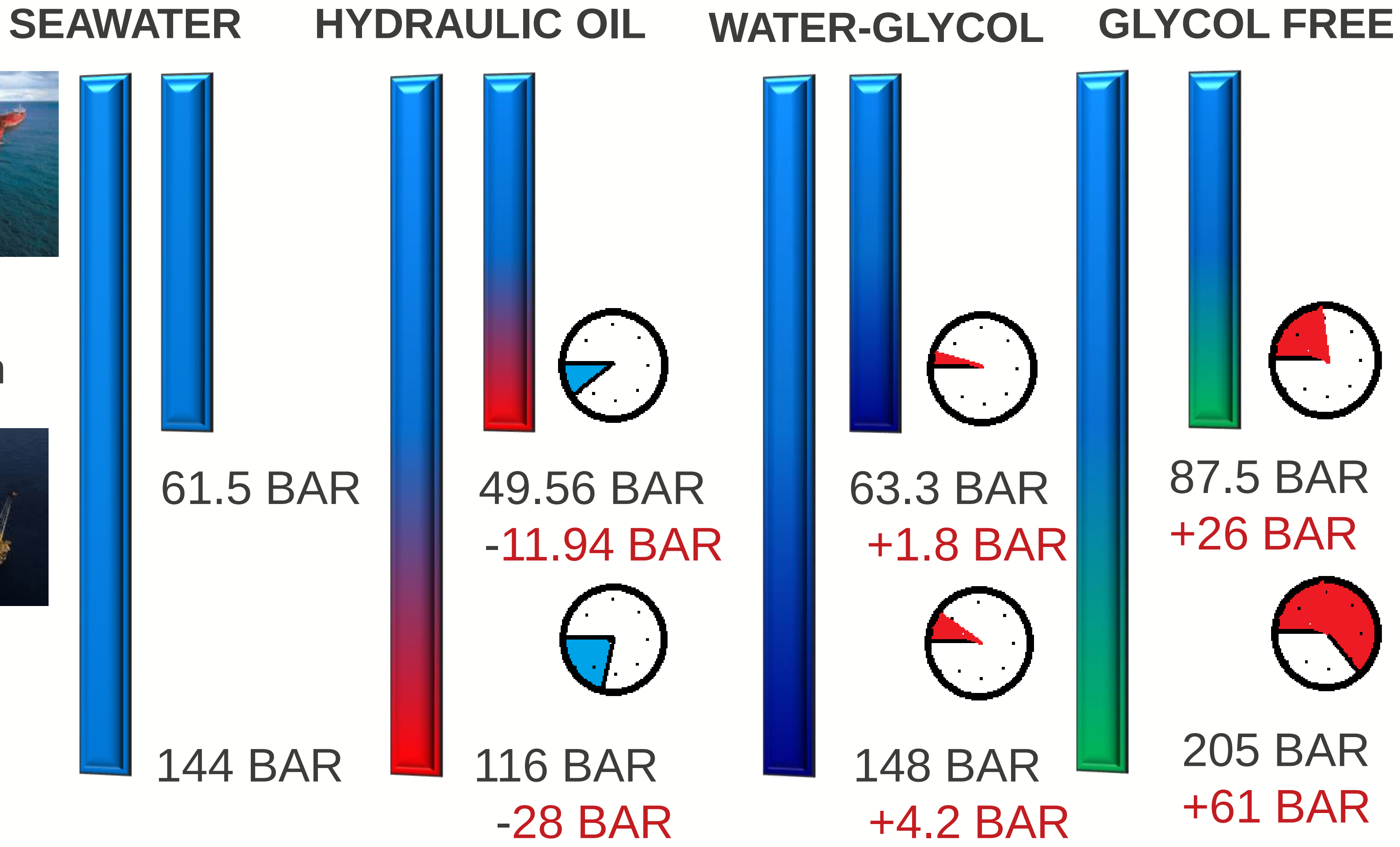
Physical Properties

	Oceanic GFF
Appearance	Clear pale straw liquid
pH	9.2
Specific Gravity @15.6°C	1.28
Kinematic Viscosity (cSt)	
-40°C (-40°F)	29.1
-20°C (-4°F)	10
0°C (32°F)	4.8
20°C (68°F)	2.7
40°C (104°F)	1.8
Pour Point	< -40°C (-40°F)

Hydrostatic Pressure Head

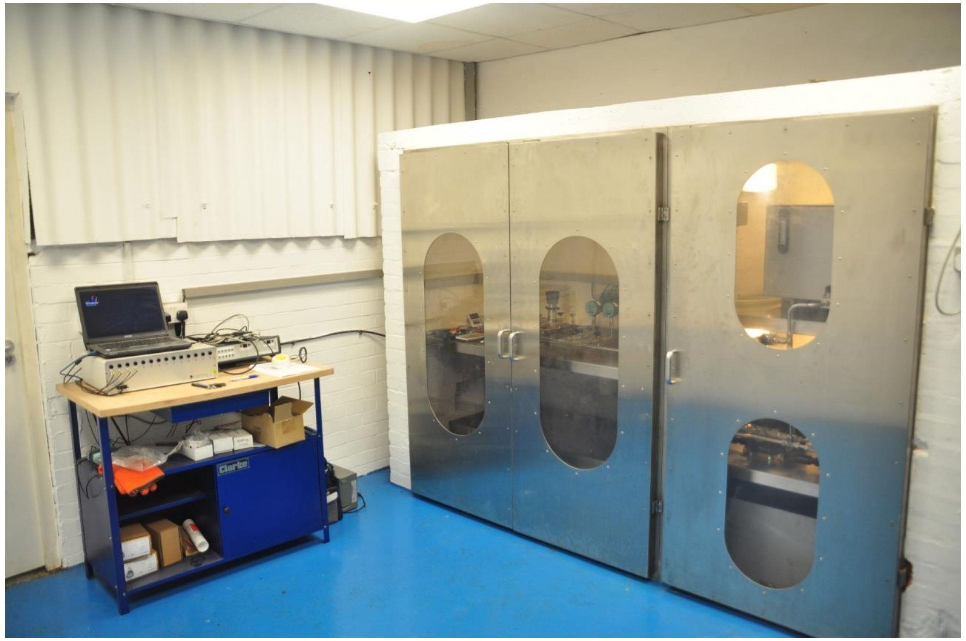
Foinaven
400-600m

Girasol
1405m



Function Testing

- DCV's perceived as the most susceptible part of the control system.
- Three DCV types supplied for testing.
- Unusual results on the first set of tests.
- 100000 cycle DCV test has been completed



HTHP Testing

- Specific material are now specified for testing over 205°C
- Up to 205°C 316ss and 174PH are used for corrosion qualification.
- Above 205°C Inconel 625 is utilised
- All the high temperature samples are exposed for up to 6 months with an assembled crevice.

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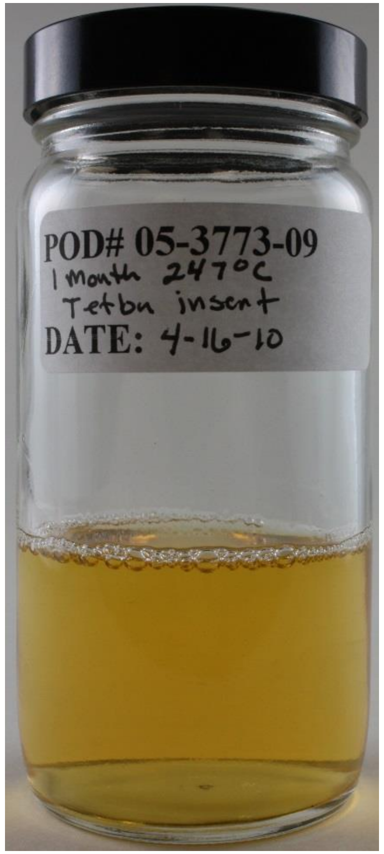
Why Testing over 205°C

- Development with Shell and FMC for Appomatox
- Originally set to 400°F (204.5°C)
- Fluid needed API qualification to 214.5°C with safety margin. (MacDermid ran 220°C)
- New HTHP equipment also needed development and qualification.
- Oceanic XT900 aqueous hydraulic fluid was fully qualified and the project is installed.

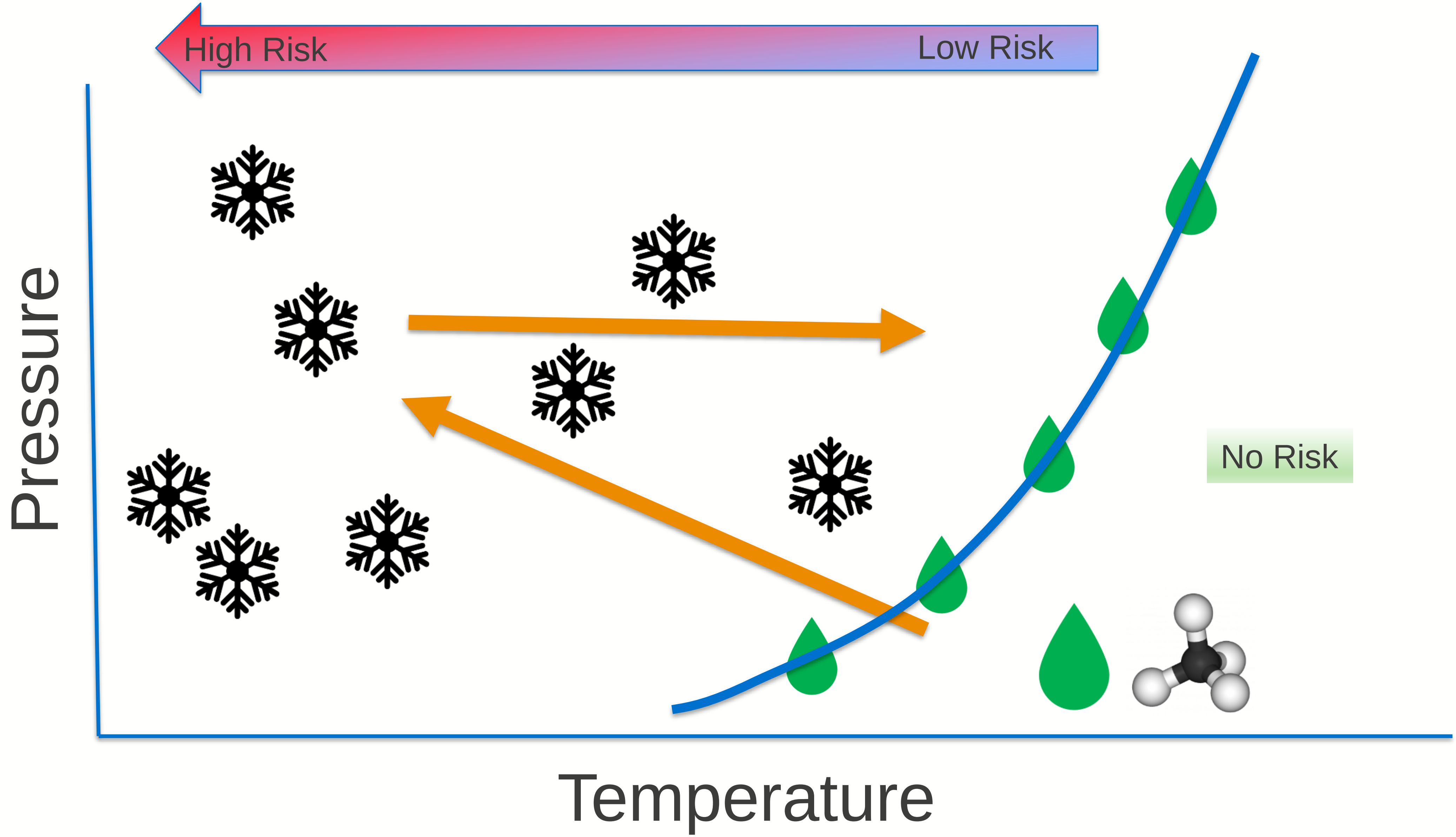
6 months @ 220°C

Drive to Failure 247°C one month

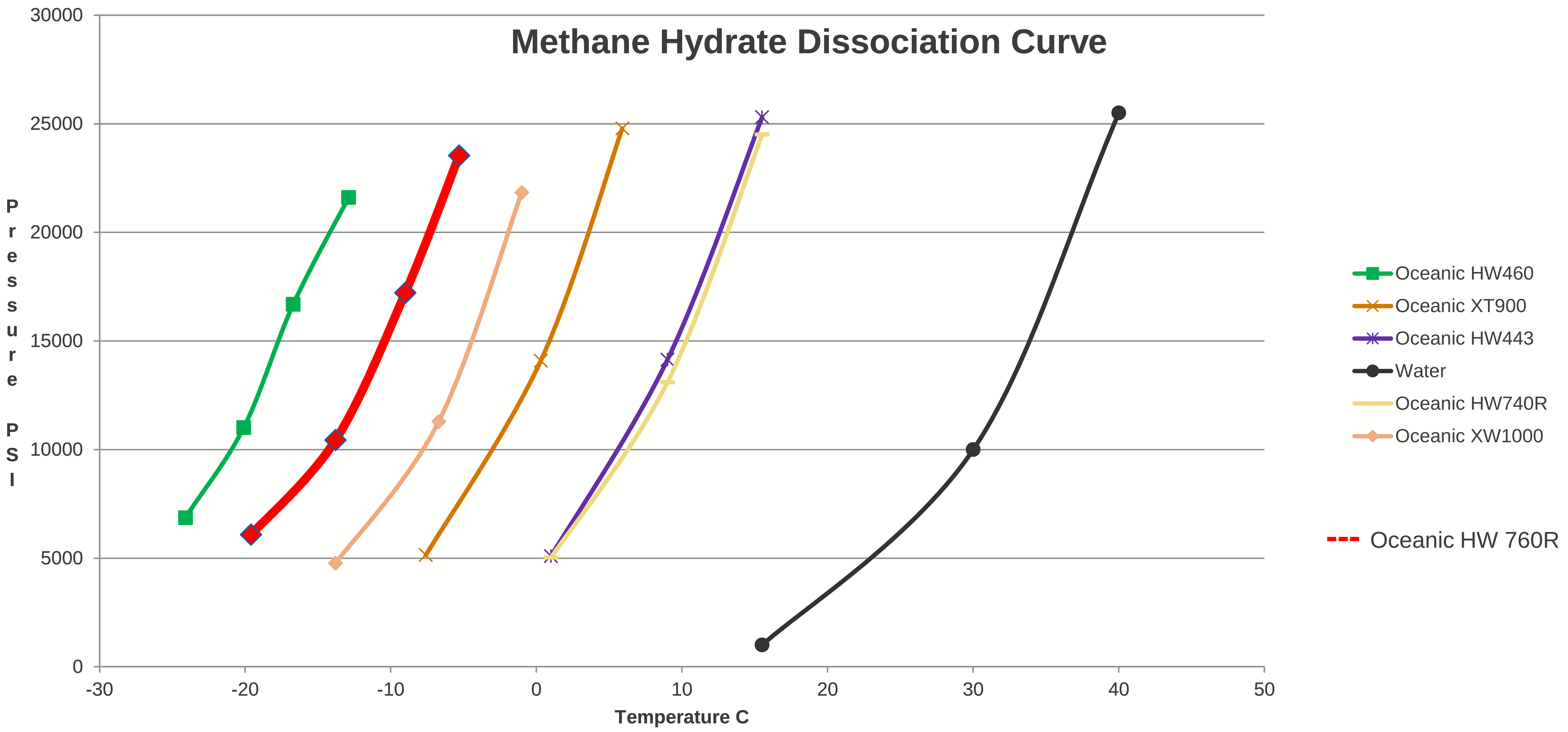


- Drive to Failure @ 247 °C
  - Tested Equipment limitations
  - Tested Metallurgical limitations
  - Tested Fluid limitations
  - Tested Technicians
- Failure at 6 month duration
  - Separation of fluid components
  - Able to predict failure mode

Hydrate Resistance Testing



Hydrate Resistance and High Temperature



And if Electric Trees Take Off?

Thankyou

I hope you found it interesting

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