

Vx Technologi

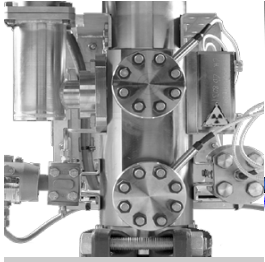


PhaseWatcher Vx

Rolf Rustad
Product Development Manager



Schlumberger



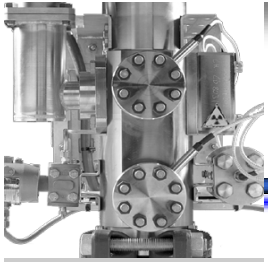
Presentasjon

- Vx Teknologi – Framo Engineering – Schlumberger
- Vx Teknologi – Målekonsept, spesifikasjoner
- Produktportefølje – Én teknologi - mange applikasjoner
- Fra tung olje i Venezuela til våt gass i Sibir
- PhaseWatcher Vx SubSea
 - Operasjonell historikk og pålitelighet
 - Levetid – Vedlikehold
- Applikasjoner innen allokering
- Videre utvikling – dypere, varmere, høyere trykk

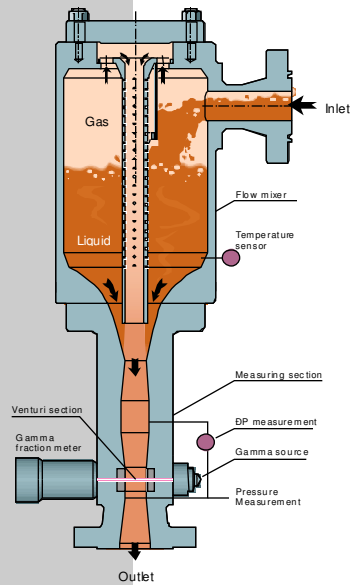


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Vx Bakgrunn

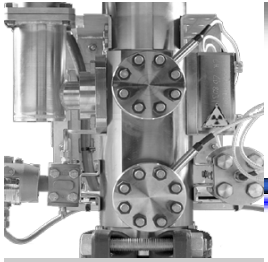


Schlumberger



Schlumberger

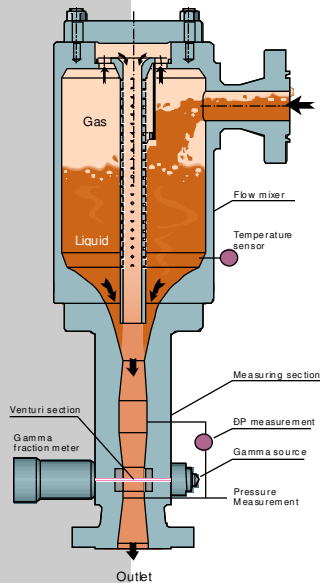
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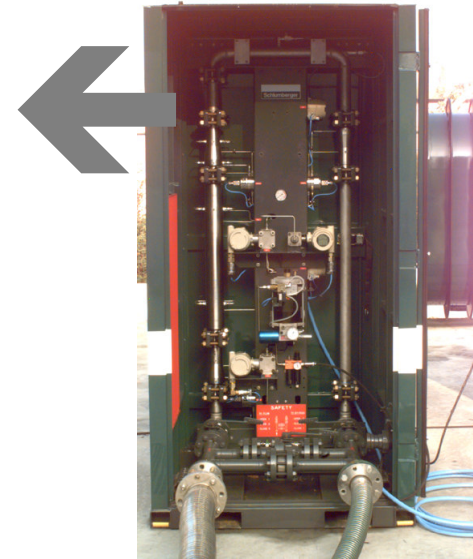
Vx Bakgrunn



Schlumberger



Vx

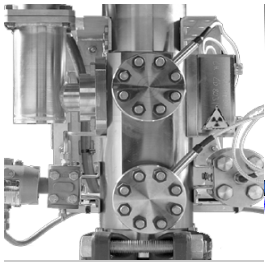


Over 400 årsverk i FoU siden 1989



Schlumberger

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Framo, Schlumberger og 3-Phase Measurements

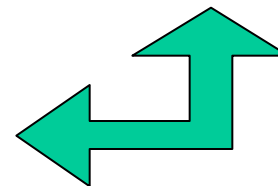
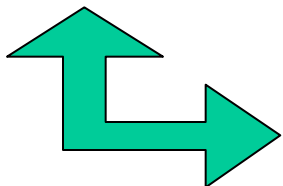
Framo Engineering og Schlumberger Sammen om flerfasemåling

- Norge
- Danmark
- United Kingdom
- Subsea hele verden

- Topside i resten av verden
- Testing service markedet over hele verden



Schlumberger

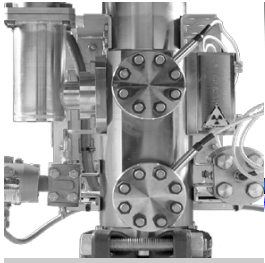


Produksjon og produktutvikling

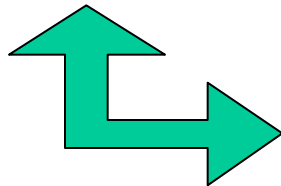
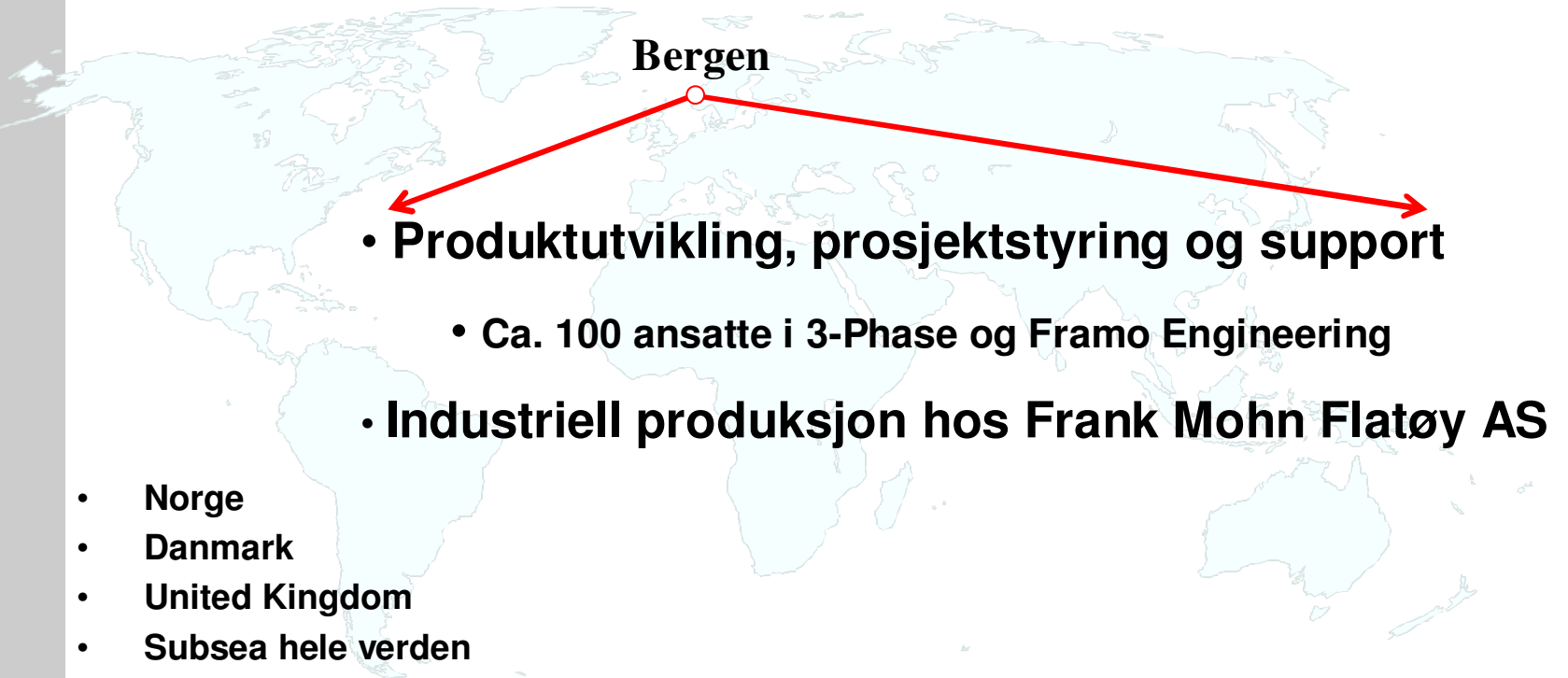


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Framo, Schlumberger og 3-Phase Measurements

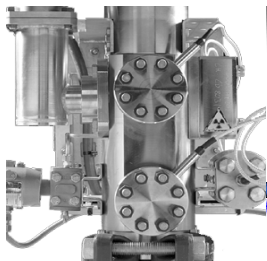


Produksjon og produktutvikling

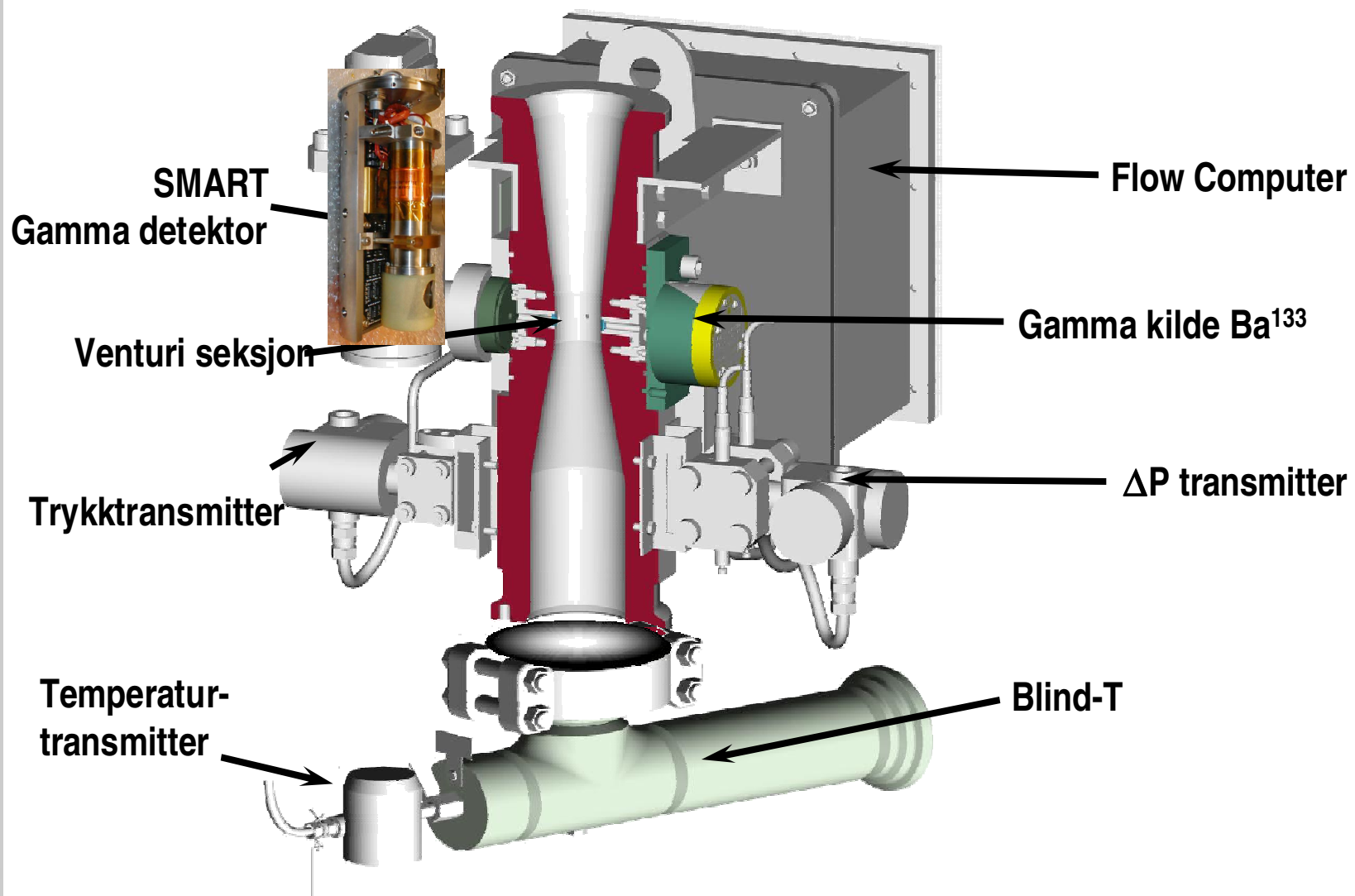


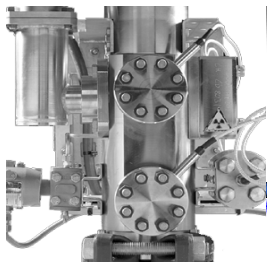
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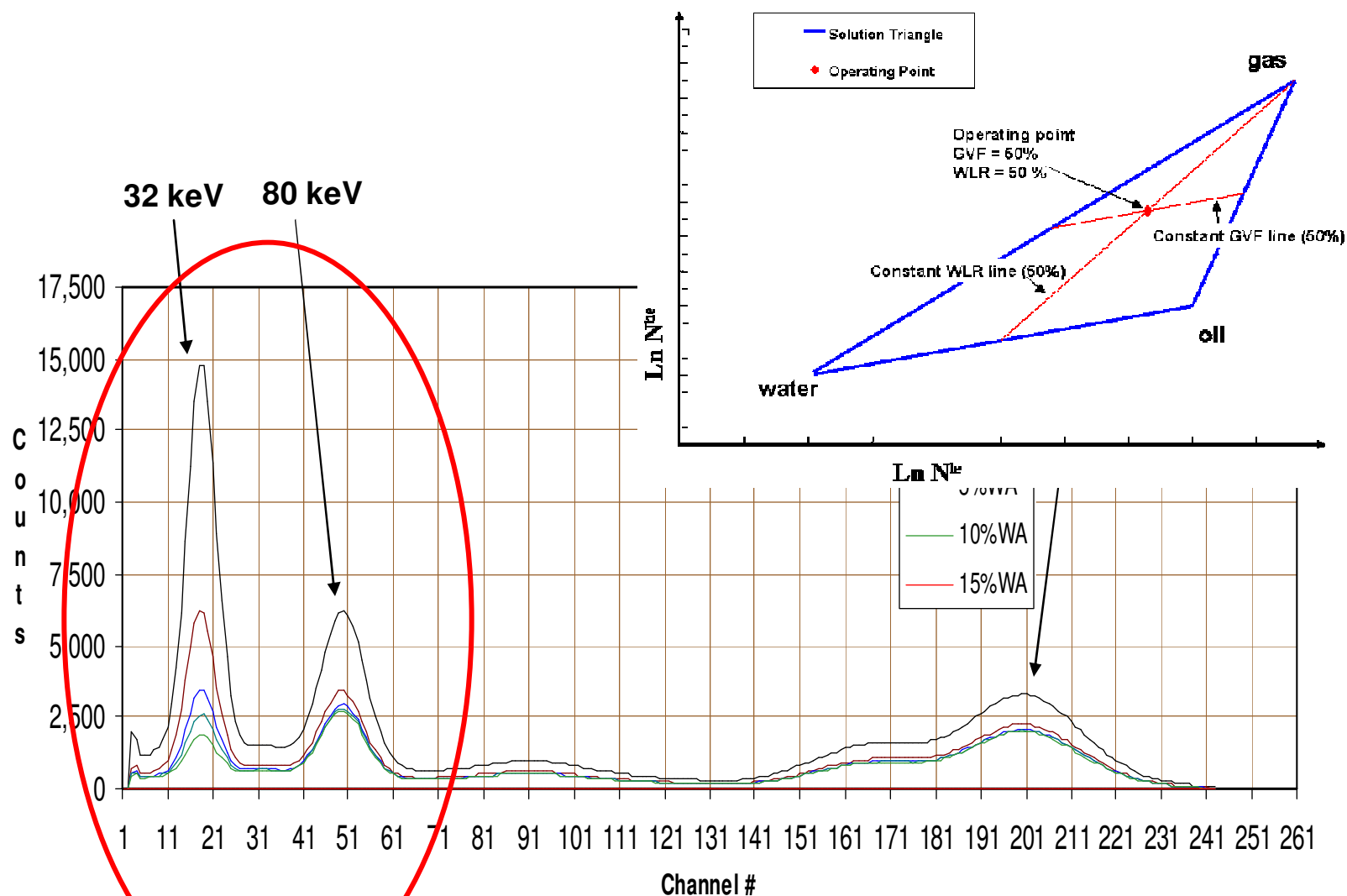


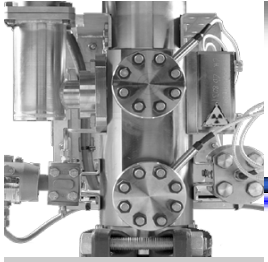
Vx flerfasemåler - komponenter





Ba133 spektrum - løsningstriangelet





Fraksjonsmålinger

Dual Energy Gamma målinger

$$N^{le} = N_0^{le} e^{-D[\mu_o^{le} \cdot \rho_o \cdot \alpha_o + \mu_w^{le} \cdot \rho_w \cdot \alpha_w + \mu_g^{le} \cdot \rho_g \cdot \alpha_g]}$$

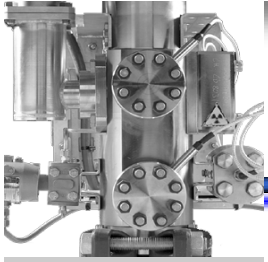
$$N^{he} = N_0^{he} e^{-D[\mu_o^{he} \cdot \rho_o \cdot \alpha_o + \mu_w^{he} \cdot \rho_w \cdot \alpha_w + \mu_g^{he} \cdot \rho_g \cdot \alpha_g]}$$

N_0 : måles (Referanse ved “Empty Pipe”)

ρ : beregnes fra PVT

μ : masseattenuasjon, en fysisk konstant for hvert grunnstoff

α : fraksjon

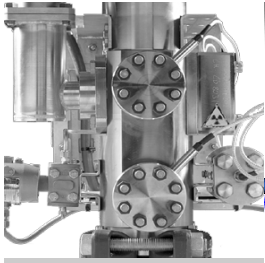


3 ukjente - 3 ligninger

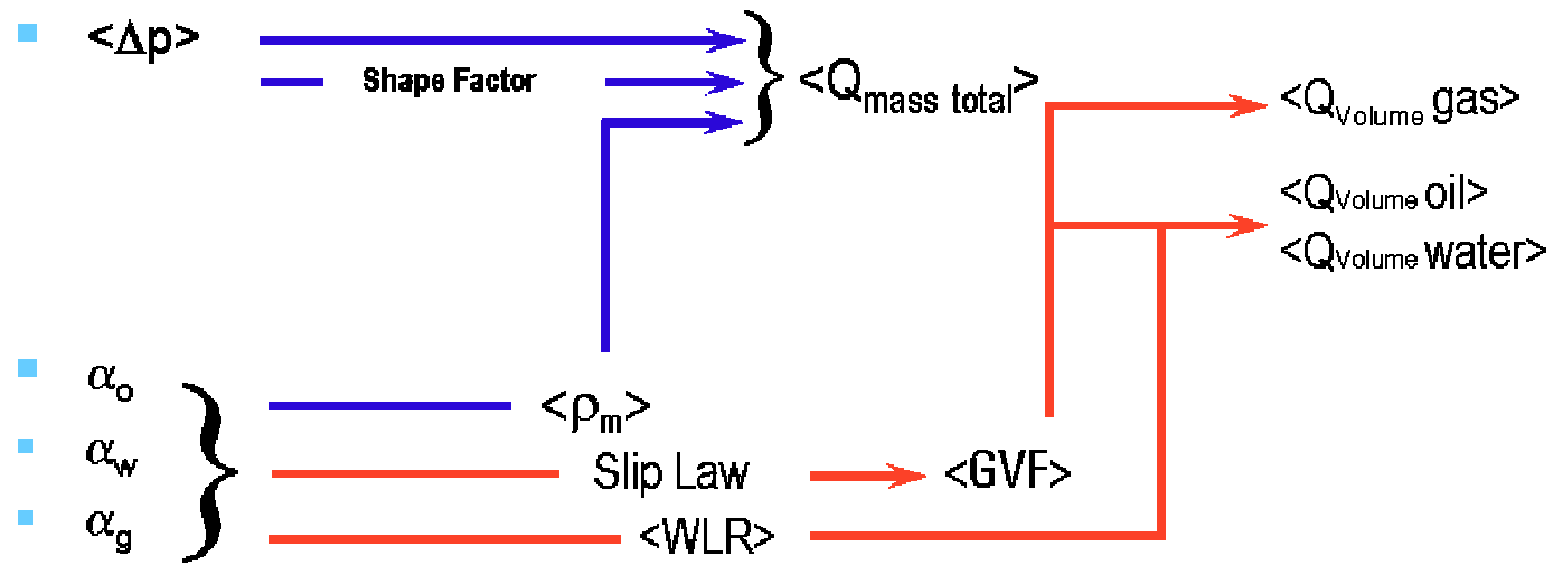
$$N^{le} = N_0^{le} e^{-D[\mu_o^{le} \cdot \rho_o \cdot \alpha_o + \mu_w^{le} \cdot \rho_w \cdot \alpha_w + \mu_g^{le} \cdot \rho_g \cdot \alpha_g]}$$

$$N^{he} = N_0^{he} e^{-D[\mu_o^{he} \cdot \rho_o \cdot \alpha_o + \mu_w^{he} \cdot \rho_w \cdot \alpha_w + \mu_g^{he} \cdot \rho_g \cdot \alpha_g]}$$

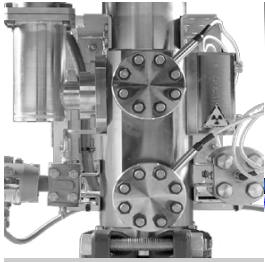
$$\alpha_o + \alpha_w + \alpha_g = 1$$



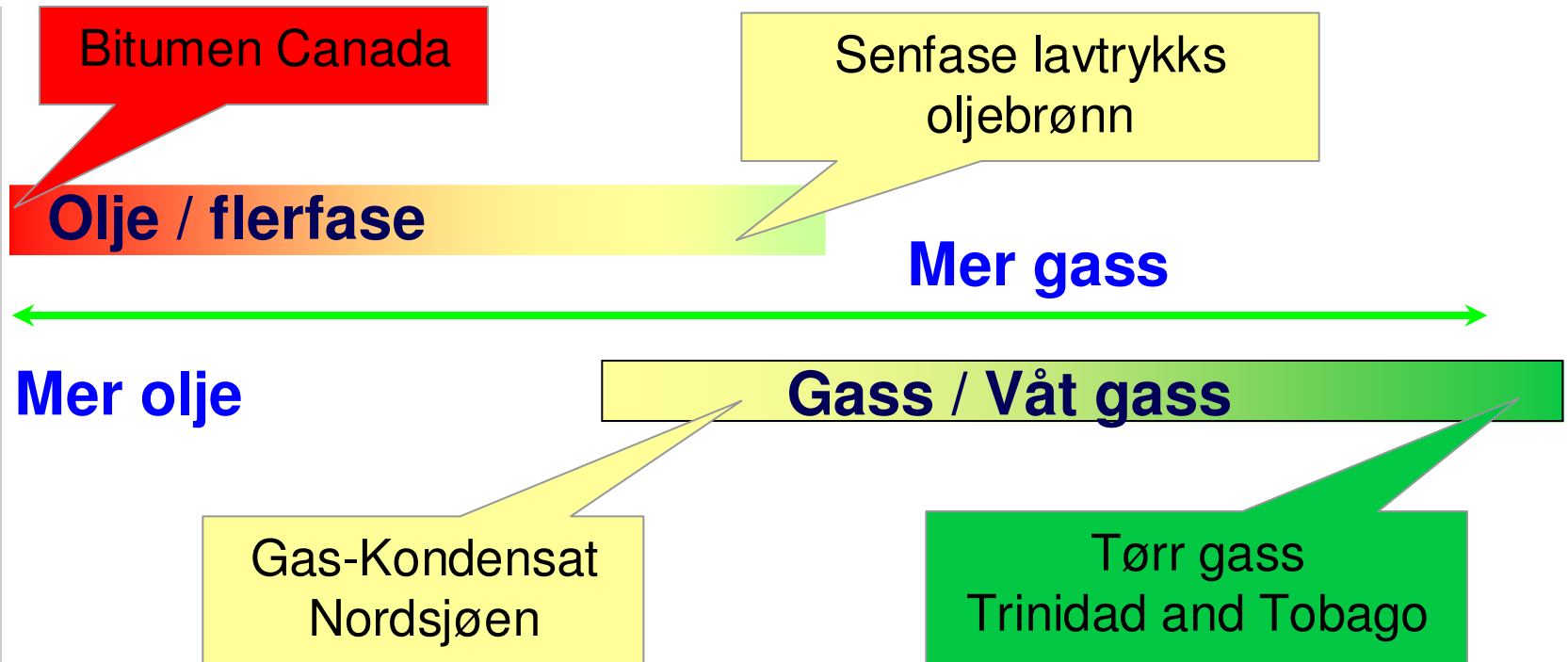
Virkemåte



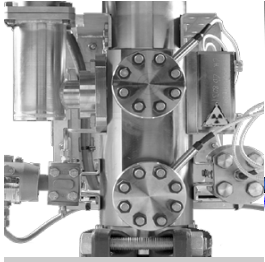
- Enkel, robust og fysisk modell
- Slip-modell for gass – væske
- Ingen slip mellom olje og vann
- Ingen kalibreringsfaktorer



Vx: Oil Mode – Gas Mode

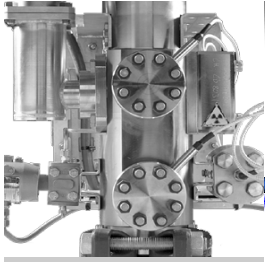


- Oljebrønner kan produsere mye gass
- Kondensatbrønner kan være veldig våte
- Glidende overgang mellom olje, kondensat, og gass
- Vx – Én måler – To strømningsmodeller



Vx: Oil Mode – Gas Mode

- Oil Mode
 - Opprinnelig Vx modell
 - GVF < 96 – 98% ved operasjonsbetingelser
 - Optimalisert for væskemåling
 - Total Mass Flow → Robust
- Gas Mode
 - GVF > 90% ved operasjonsbetingelser
 - Minimum trykk > 25bar
 - Volumetrisk modell
 - Optimalisert for gassmåling
 - Konvergerer til standard venturimodell ved tørr gass
 - Samme vannmåling som i Oil Mode



Hvordan fastsetter vi spesifikasjoner ?

Flow loop testing

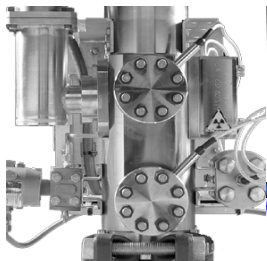
Et utvalg av de testene vi har gjort:

Flerfase

- NEL
- IFP
- Intevep (tung olje)
- Atalaya (tung olje)
- Egne laboratorier
- Framo Engineering
- Schlumberger Paris

Våt gass

- NEL
- SINTEF
- K-Lab
- CEESI
- Flow line
- Flow loop



Spesifikasjoner – Flerfase (Oil Mode)

S

52mm Oil Mode Performance

GVF Range

		0 – 90%	90 – 96%	96 – 98%
Liquid flow rate		3% or 1.1 m3/h	6% or 1.4 m3/h	12% or 1.4 m3/h
WLR		3%	3- 6%	6 – 10%
Gas flow rate	> 300 psi/ 20 bar	6%		

65mm Oil Mode Performance

GVF Range

		0 – 90%	90 – 96%	96 – 98%
Liquid flow rate		3% or 1.6 m3/h	6% or 2.0 m3/h	12% or 2.0 m3/h
WLR		3%	3- 6%	6 – 10%
Gas flow rate	> 300 psi/ 20 bar	6%		

95% konfidens

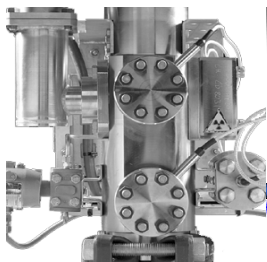


Schlumberger

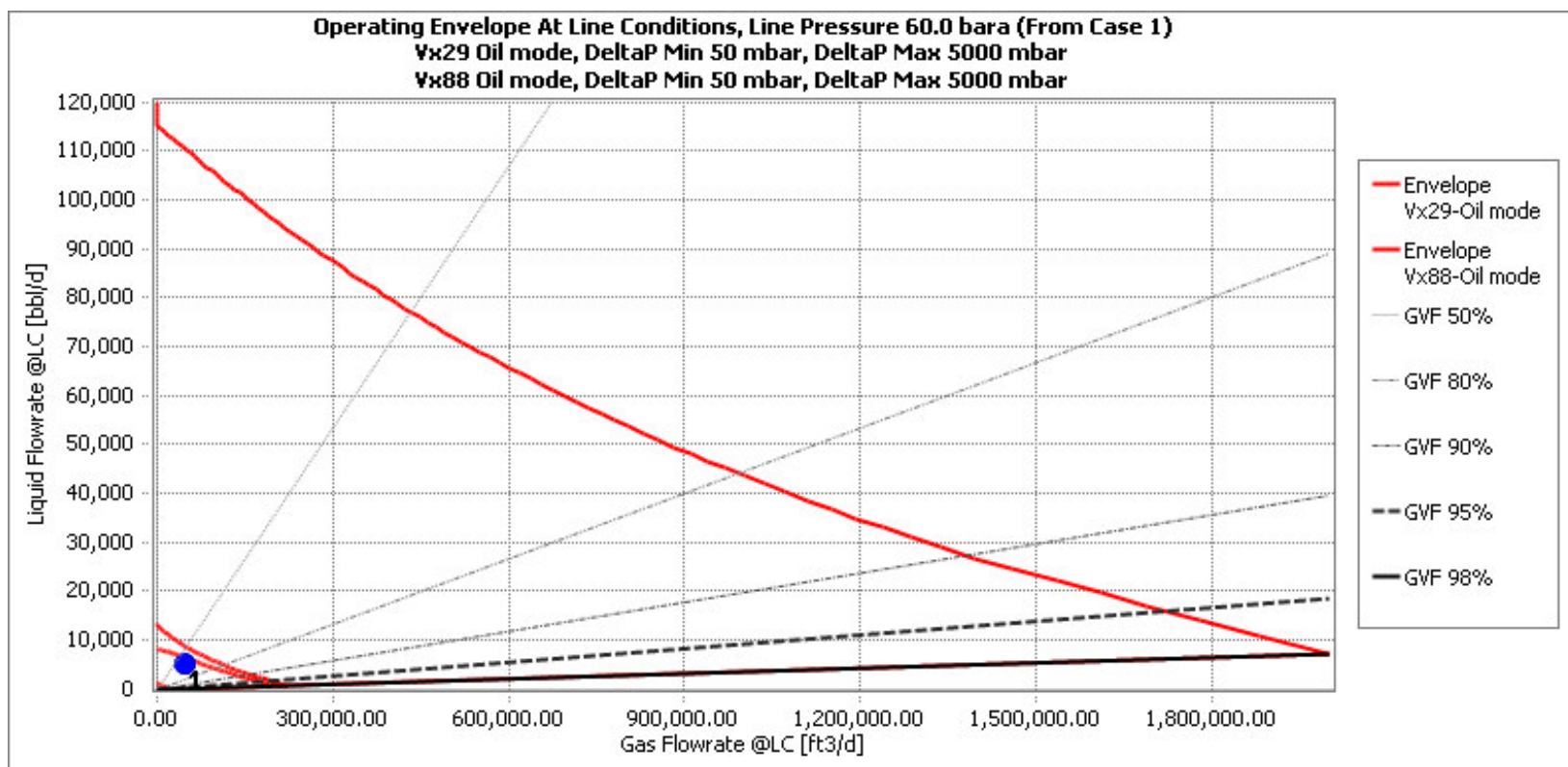
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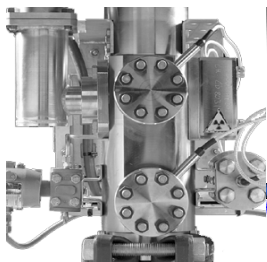
Slide 15

- S1** Schlumberger; 13.03.2009
- S2** Endre Gass $p < 300\text{psi}$
Schlumberger; 13.03.2009



Vx Oil Mode - Operating Envelopes (@ 60bar)





Spesifikasjoner – Våt gass (Gas Mode)

52mm Gas Mode

GVF Range

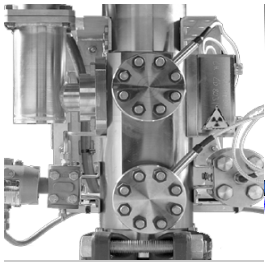
performance	90-95%	95-97%	97-99%	99-100%
Liquid flow rate ^{1,3}	6% or 1.1 m3/h	12% or 1.4 m3/h	18% or 1.4 m3/h	1.4 m3/h
Gas flow rate ¹	2.5% (PL > 35 bara) 5%(PL > 25 bara)			
WVF ²	0.2%			
WVF sensitivity ²	0.1%			

65mm Gas Mode

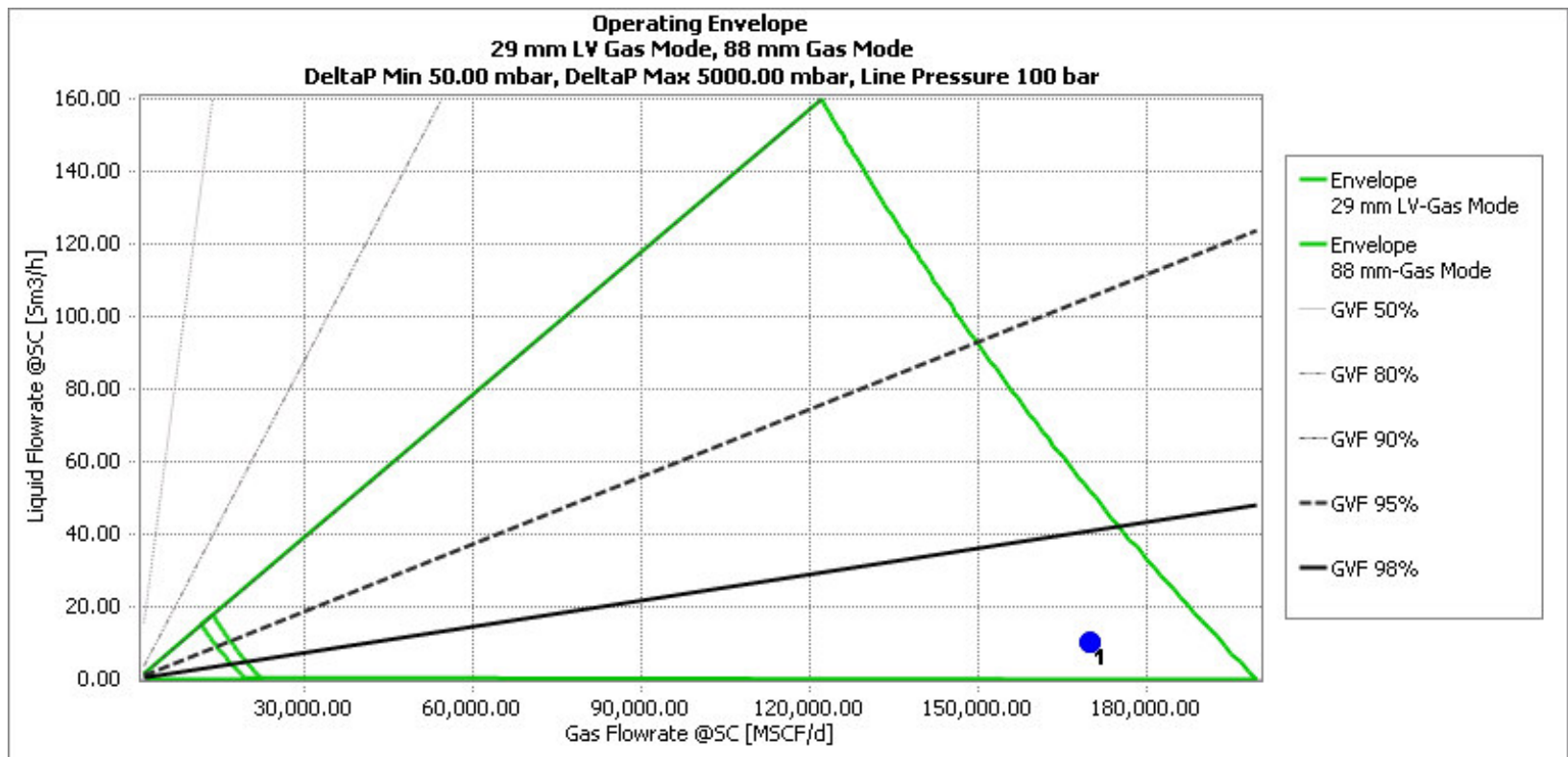
GVF Range

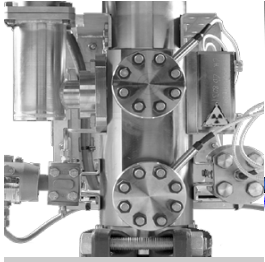
performance	90-95%	95-97%	97-99%	99-100%
Liquid flow rate ^{1,3}	6% or 1.6 m3/h	12% or 2.0 m3/h	18% or 2.0 m3/h	2.0 m3/h
Gas flow rate ¹	2.5% (PL > 35 bara) 5%(PL > 25 bara)			
WVF ²	0.2%			
WVF sensitivity ²	0.1%			

95% konfidens



Vx Gas Mode - Operating Envelopes (@ 100bar)





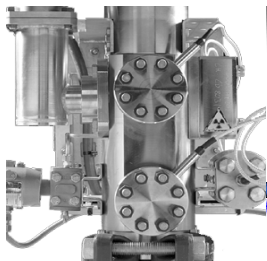
Valg av PVT løsning

Alle flerfasemålere trenger en PVT modell

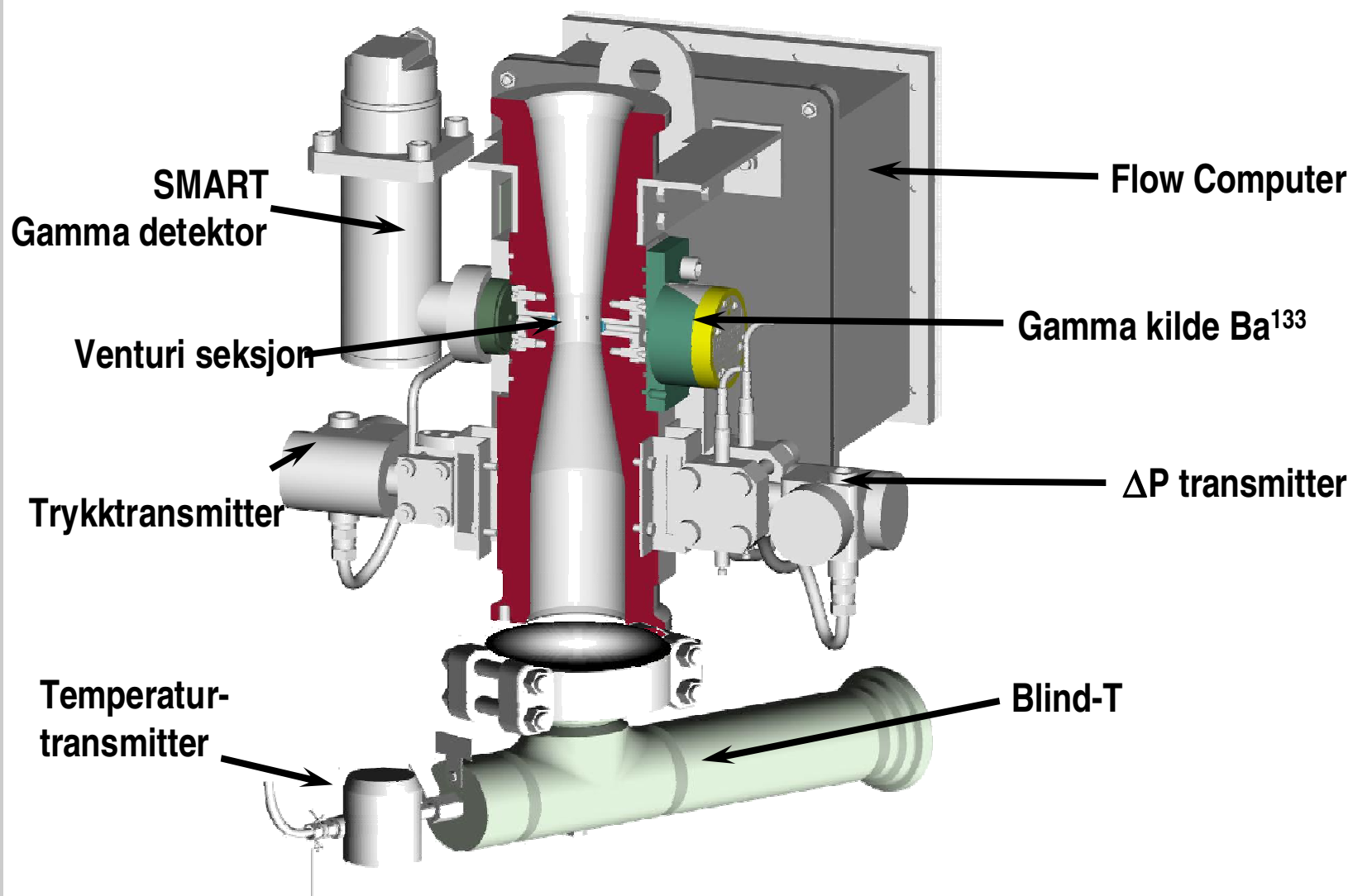
Hva er formålet med målingen?

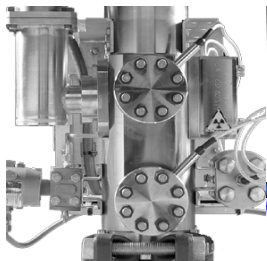
	Uncertainty	Repeatability	Resolution
Fiscal Allocation	+		
Back Allocation	+	+	
Production Diagnostic		+	+
Production Monitoring and Surveillance			+

- Black Oil Model
- Vx Fluids ID



Vx flerfasemåler - komponenter





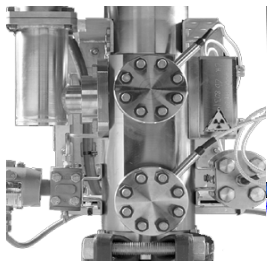
PhaseTester Vx – Mobil brønntesting



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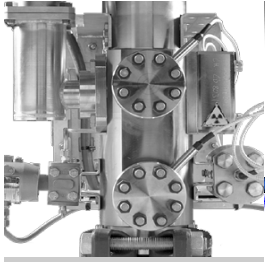
PhaseTester Vx – Mobil brønntesting - SAGD



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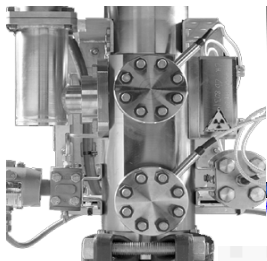


PhaseTester Vx for mobil brønntesting

- ~120 crew i operasjon
- > 6500 brønntester i 2008
- Operasjonsstøtte fra Bergen
- Erfaringen brukes i kontinuerlig forbedring og utvikling av nye produkter

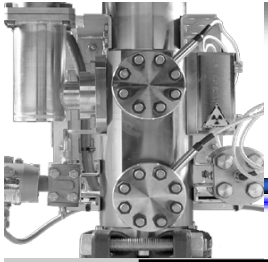


DCP02271.jpg



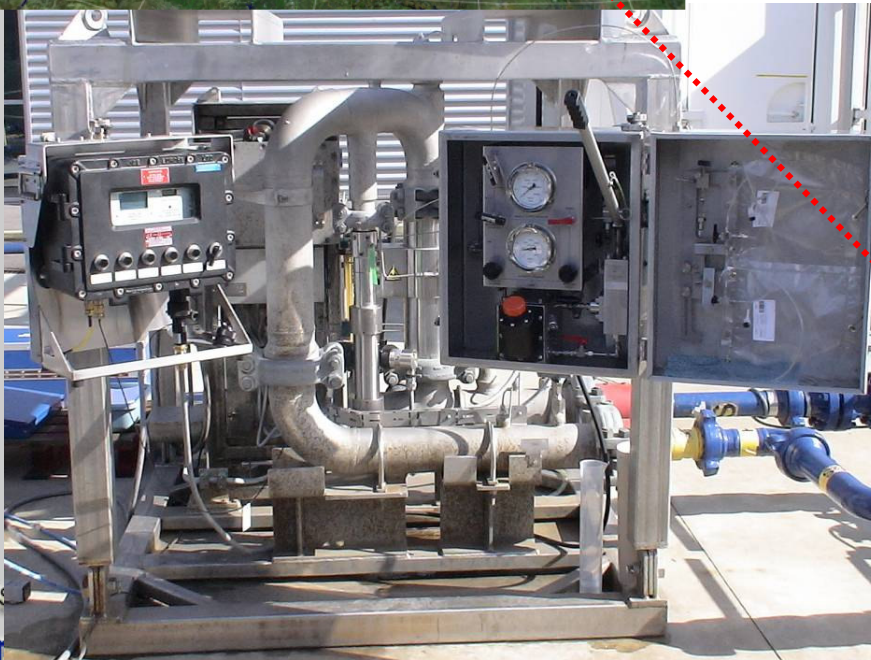
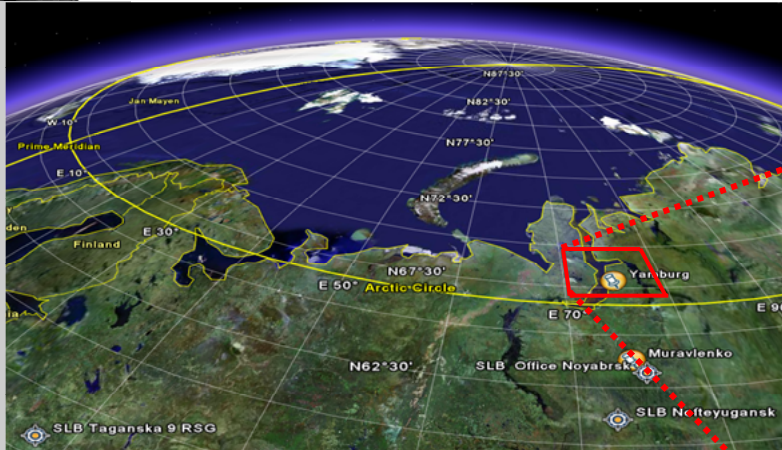
Testing av tung olje i Venezuela

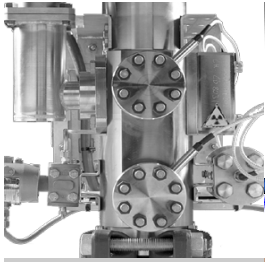




Gass-kondensat testing i Sibir

• Western Siberia

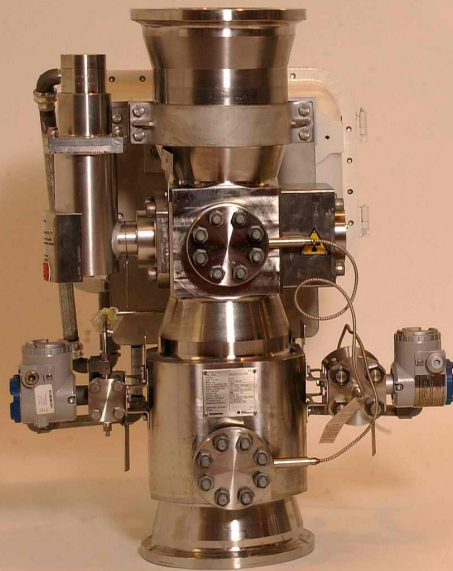




PhaseWatcher Vx for Topside applikasjoner

The PhaseWatcher Vx series

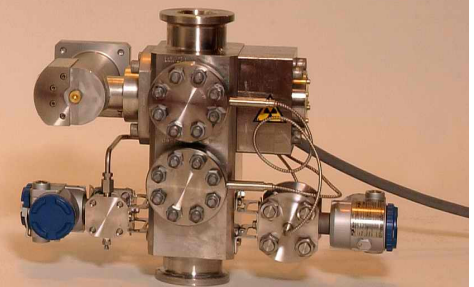
PhaseWatcher Vx 88

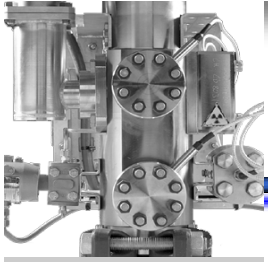


PhaseWatcher Vx 52



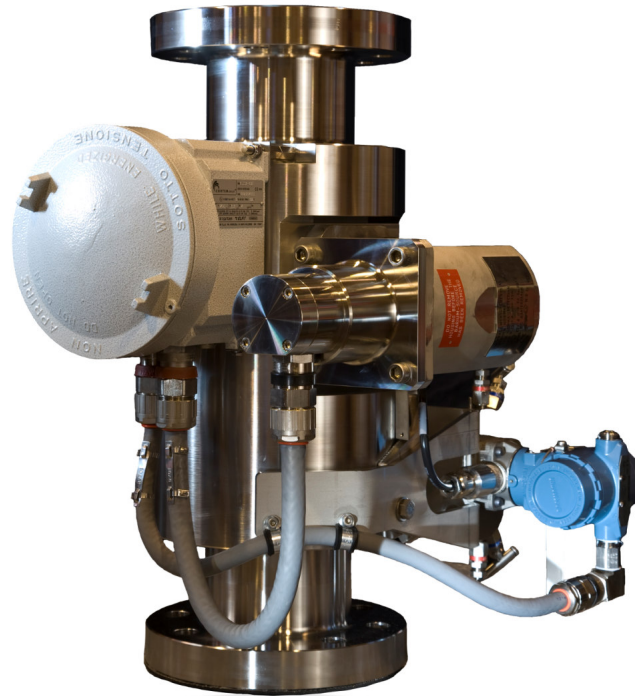
PhaseWatcher Vx 29



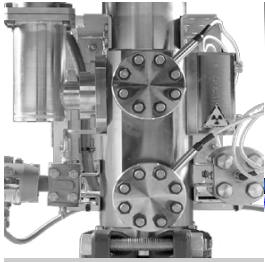


PhaseWatcher Vx for Topside applikasjoner

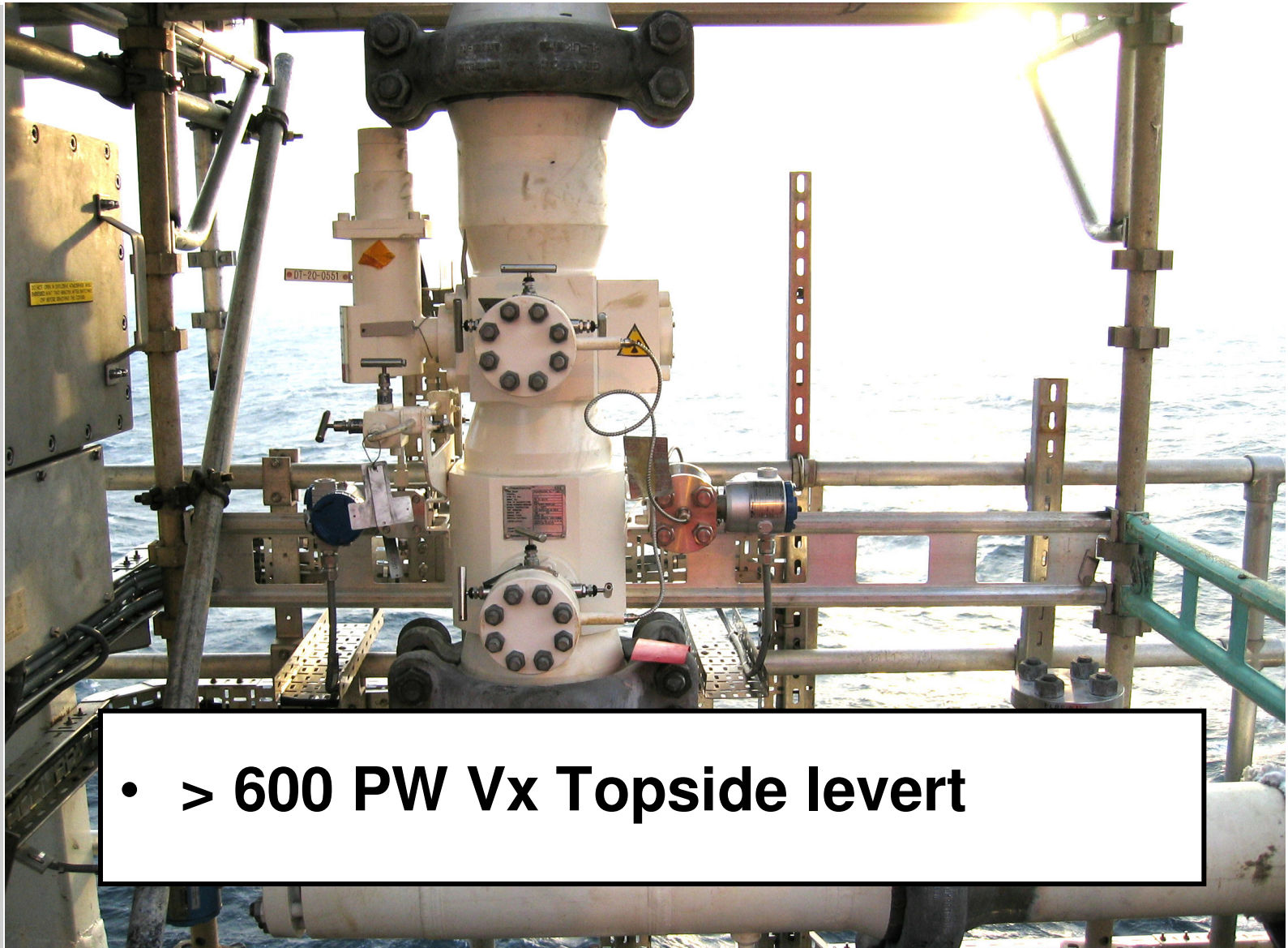
Lavkostversjon for lavere trykk – C600



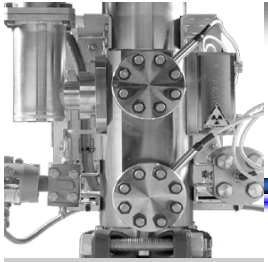
- 240 levert i 2008



Typisk installasjon i Nordjøn



- > 600 PW Vx Topside levert



PhaseWatcher Vx Subsea

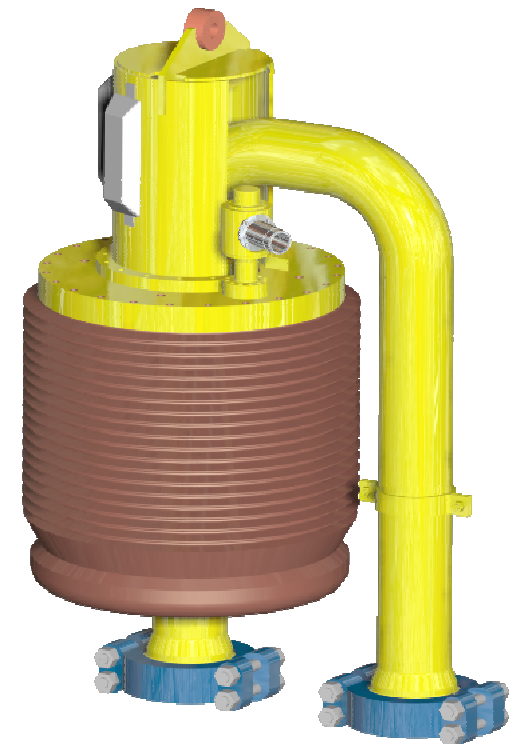
In-Line

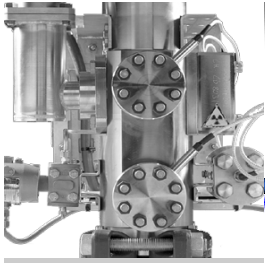


Single Hub Retrievable

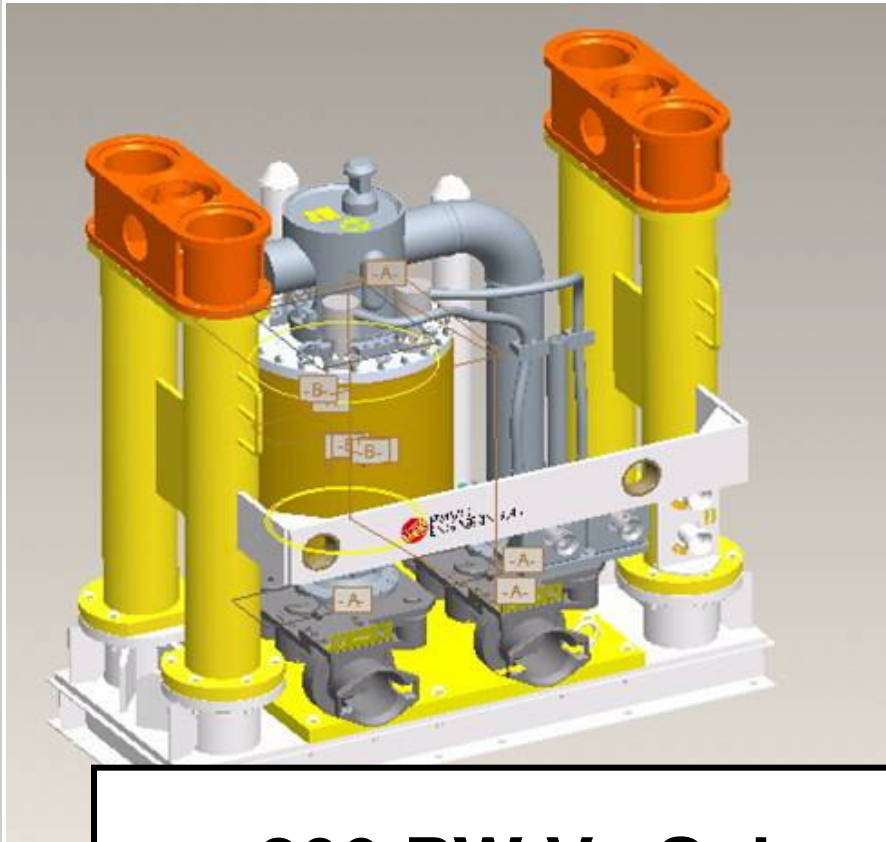


Dual Hub Version





PhaseWatcher Vx Subsea



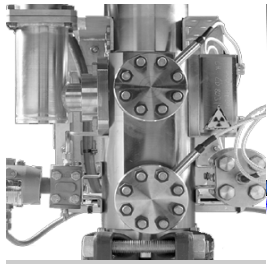
Strømforbruk

- 20 – 30W

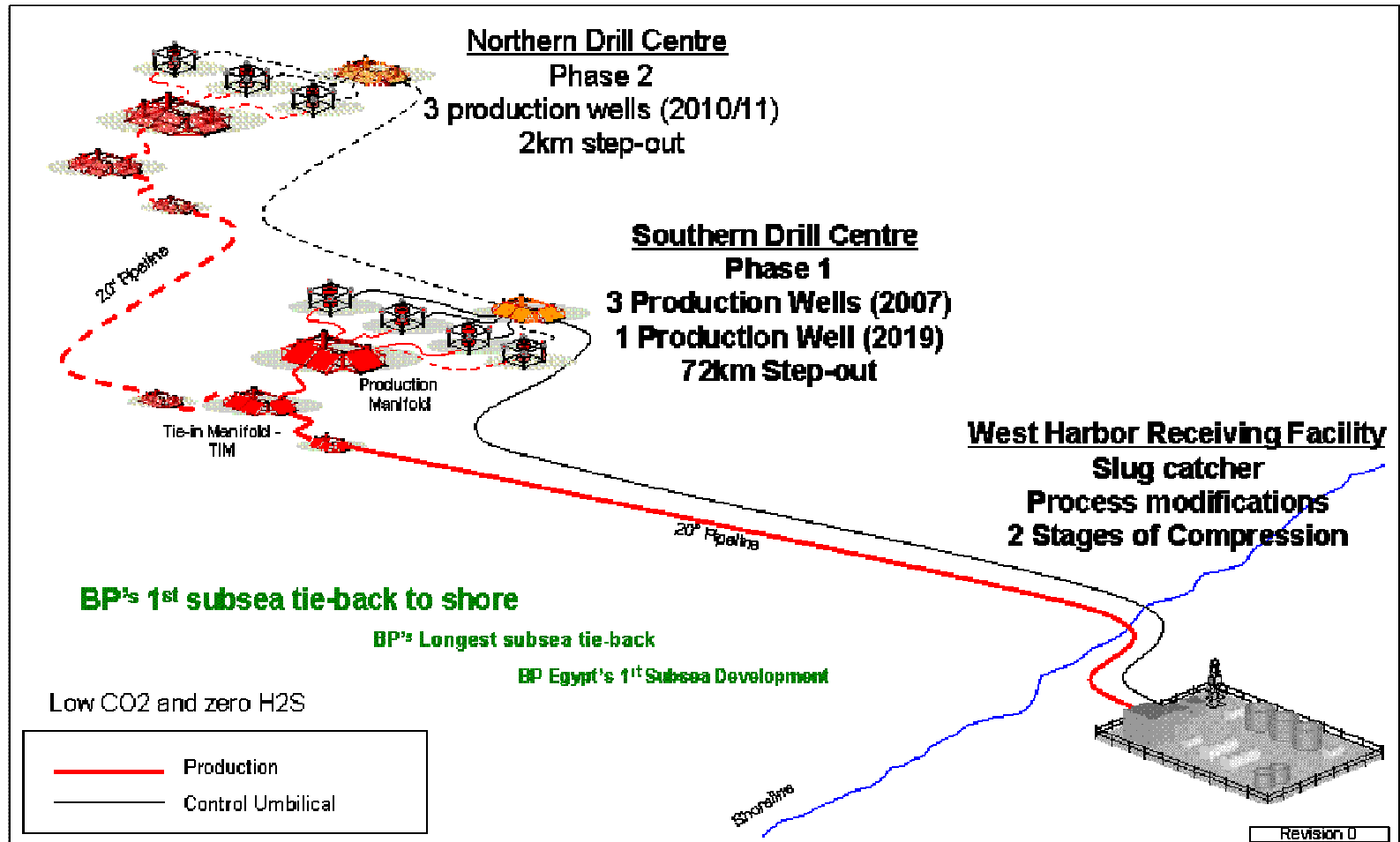
Kommunikasjon

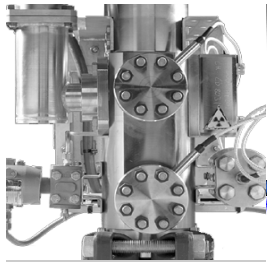
- Seriell RS 422 / 485
- Ethernet
- Can OPEN
- TCP/IP (Fiber)

- > 200 PW Vx Subsea levert



LNG T1 – Taurt Field Development

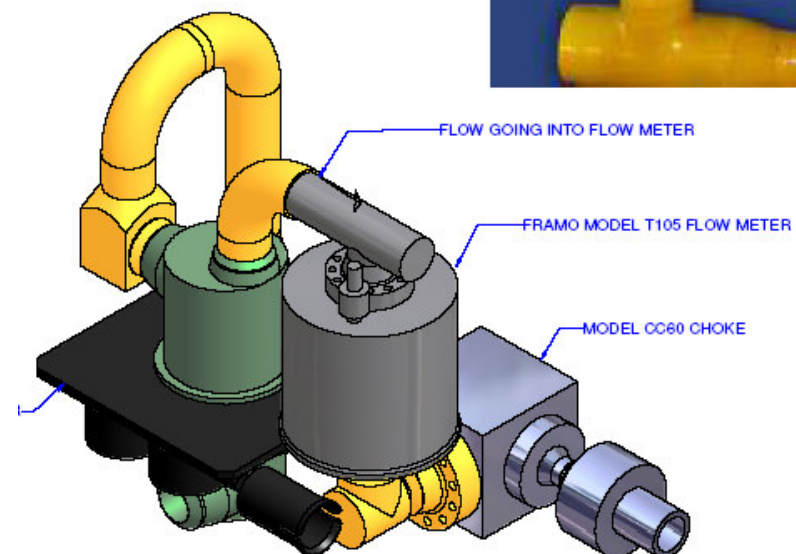




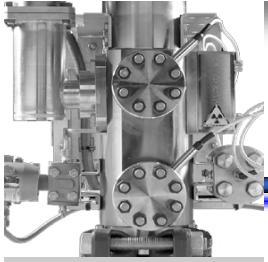
PW Vx SS – Våtgassapplikasjon

Leverandør – Framo Engineering

- 4 målere
- Retrieval-able choke bridge montering
- Egen on-shore computer
- Datatransmissjon til kundens kontor



CHOKE BRIDGE LAYOUT WITH CHOKE
LOCATED AFTER THE FLOW METER.
INCLUDES PIPE SECTION FOR INTRUSIVE
SENSOR WITH 3 x I.D. LENGTH PRIOR TO
SENSOR.



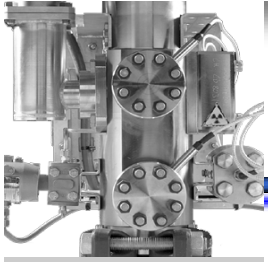
PW Vx – Operasjonell erfaring

- Ca. 500 PW Vx i operasjon topside
 - > 1000 års kummulativ operasjonstid
- Ca 100 PW Vx / Framo i operasjon subsea
 - > 200 års kummulativ operasjonstid



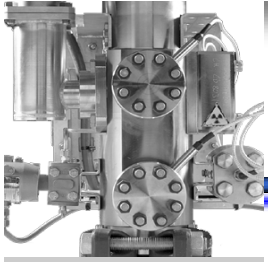
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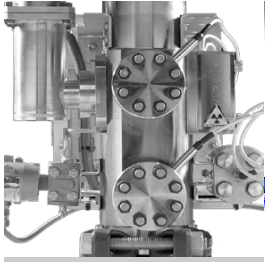
Levetid og vedlikehold

- Ingen slitedeler eller deler som trenger vedlikehold
- Levetiden vil subsea derfor vanligvis være feltlevetiden, eventuelt tiden frem til en feil oppstår
- Målenøyaktigheten til fraksjonsmålingen avtar svakt med tiden på grunn av at kilden svekkes
- Vil kun unntaksvis bringe den totale målusikkerheten utenfor spesifikasjon selv etter 20 år
- Denne usikkerheten avhenger av akvisisjonstiden og kan alltid reduseres ved å øke denne



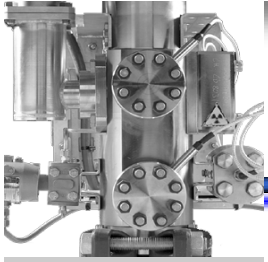
Levetid og vedlikehold

- Faktorer som kan påvirke målenøyaktigheten
 - Scale og voks
 - Drift i transmittere, P, T og ΔT
 - Endringer i fluidparametere
 - Tetthet
 - Komposisjon
 - Viskositet



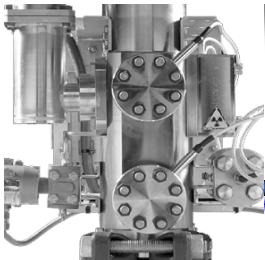
Levetid og vedlikehold - topside

- For topsideinstallasjoner er periodisk vedlikehold anbefalt
 - Sjekk av transmittere
 - forenkles ved bruk av double block and bleed ventiler
 - Sjekk av Empty Pipe tellerater for gamma fraksjonsmåler
 - Sampling og analyse av olje, gass og vann
- For felt med godt vedlikehold / serviceavtaler er oppetiden > 99%

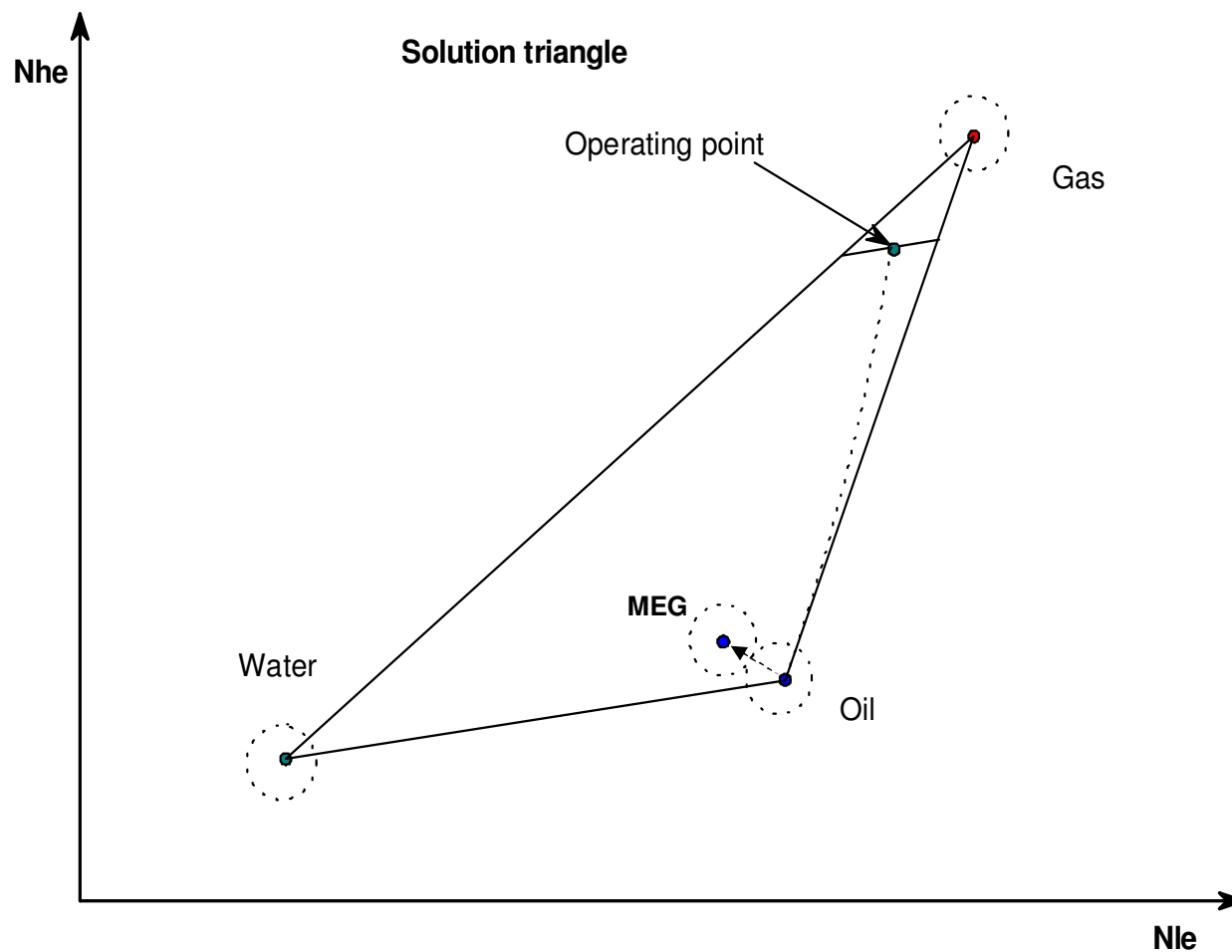


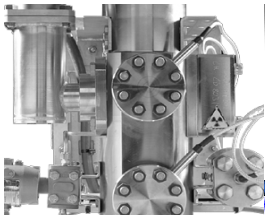
Levetid og vedlikehold - subsea

- For subseainstallasjoner
 - Bruk no-flow perioder til sjekk og diagnose av målere
 - F eks. Zero-trim av ΔP transmitter
 - Sjekk av P transmitter
 - Hvis kjent væske eller gass i måleren – sjekk tellerater
 - God kommunikasjon gjør diagnostisering enklere
 - Subsea sampling

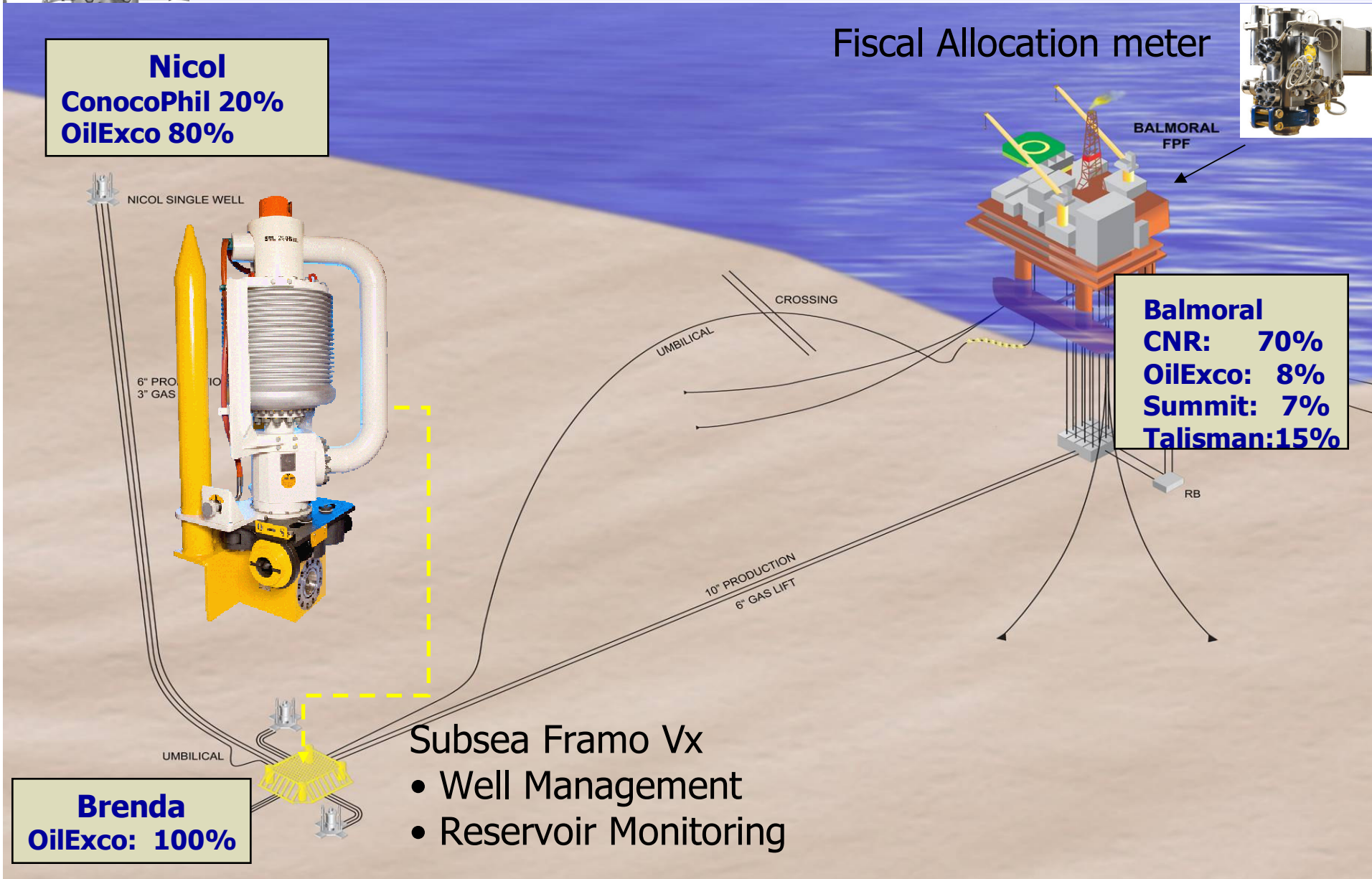


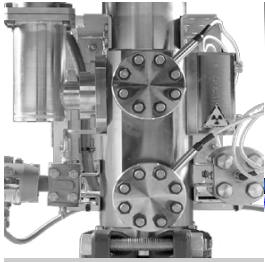
Eksempel – Analyse av tellerater ved shut-in





Allokering – Eksempel fra Nordsjøen





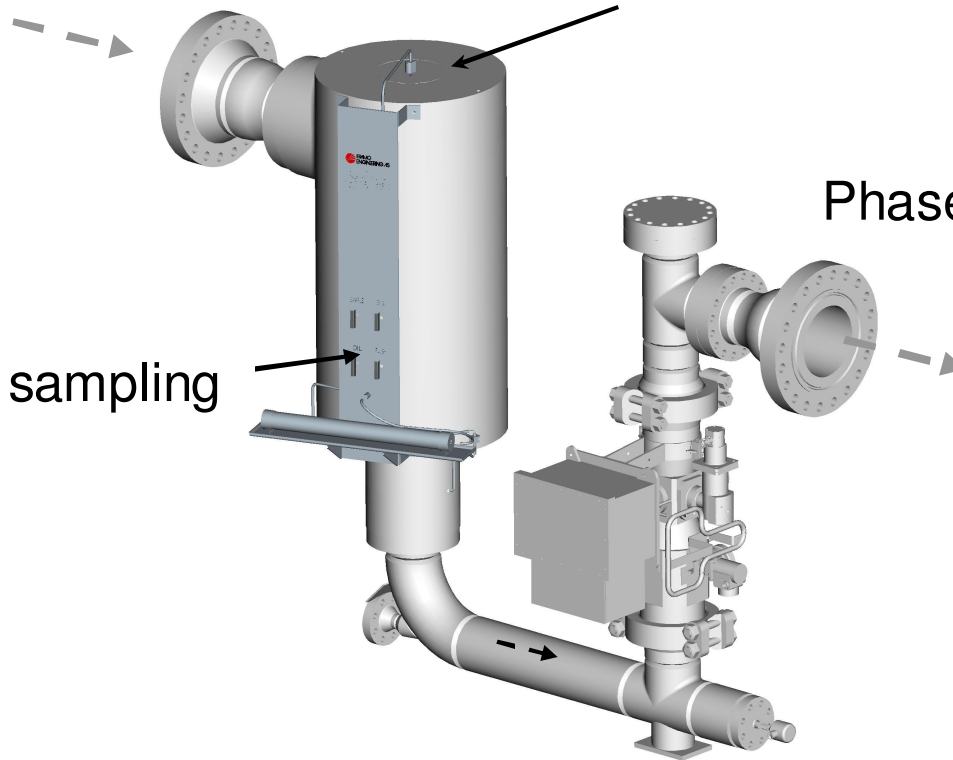
Fiskalt allokeringssystem for OilExco

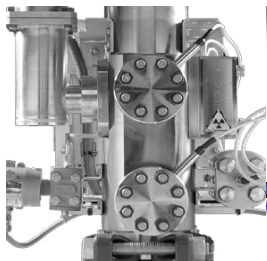
Brenda & Nicol Production

Gas Sampling

Liquid sampling

PhaseWatcher
Vx





Allokering – UK DTI



For the attention of:

Nils Vågen

Framo Engineering UK LTD.
Aberdeen Business Centre
Willowbank Road
Aberdeen AB11 6YG

Department of Trade and Industry
Energy Group
Licensing and Consents Unit
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Direct line	01224 254063
Facsimile	01224 254089
Gen Enq.	01224 254059
Email	douglas.griffin@dti.gsi.gov.uk
URL	http://www.og.dti.gov.uk/
Date	26/03/04

DTI Position on Multiphase Measurement for Fiscal Purposes

In response to your recent enquiry regarding the above, I can confirm that the DTI is fully prepared to accept multiphase measurement for Fiscal purposes under certain circumstances.

The point is that 'fiscal' refers to a meter's service and does not imply any particular standard of performance. A 'fiscal' measurement is that which is used to determine the production from any given licensed area. If this is a multiphase measurement, and no other measurement of that field's production is made before its fluids are commingled with those from another licensed area, then the multiphase measurement may well be of 'fiscal' significance.

Where field economics dictate that separation and single phase measurement is impossible, the measurement of all 3 phases simultaneously may well represent the optimum solution and indeed has the potential to allow the development of hydrocarbon accumulations that would otherwise be uneconomic.

For further details I would refer you to Issue 7 of the DTI's Measurement Guidelines

http://www.og.dti.gov.uk/upstream/measurement/MeasGuidelines_V7.pdf

, in particular Module 2.
I hope this clarifies our position.

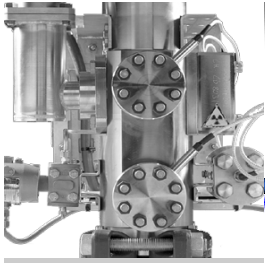
Yours sincerely,

Douglas Griffin
Head of Measurement

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Gulf of Mexico Subsea Tie-backs til Auger

Regulatory Approval

Regulatory stance...

- First application for MPFM for well testing (Mac, Se, Or)
- Habanero application approved Q4 03.
- Llano application approved Q1 04 (include well test application with Royalty Relief)

Kerry Williamson
Auger Facilities Eng
SEPCo USA

2004 Texas A&M Multiphase
Measurement Round Table

AUGER

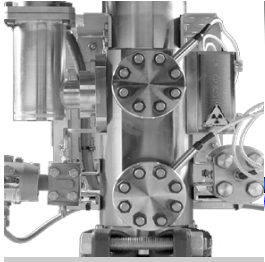


- 5 subsea satellittfelt knyttet til Shell Auger hub
- Komplekse eierstrukturer over 6 felt
- 9 PhaseWatcher Vx for allokering
- Godkjent av Minerals Management Service - MMS

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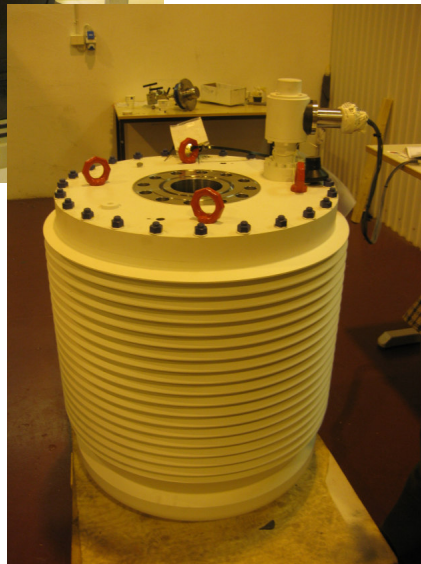


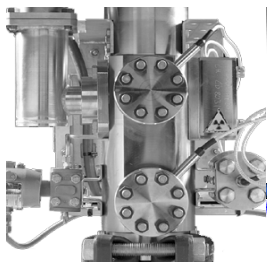
PW Vx SubSea - State of the Art

- **PhaseWatcher Vx SubSea, Type E.1 / E.2**



- **P = 10000psi / 689bar**
- **T = 121°C @ 2000m WD**
- **T = 90°C @ 3048m WD**

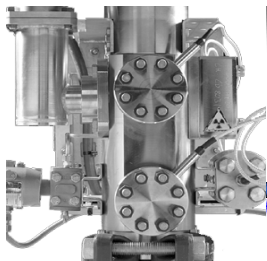




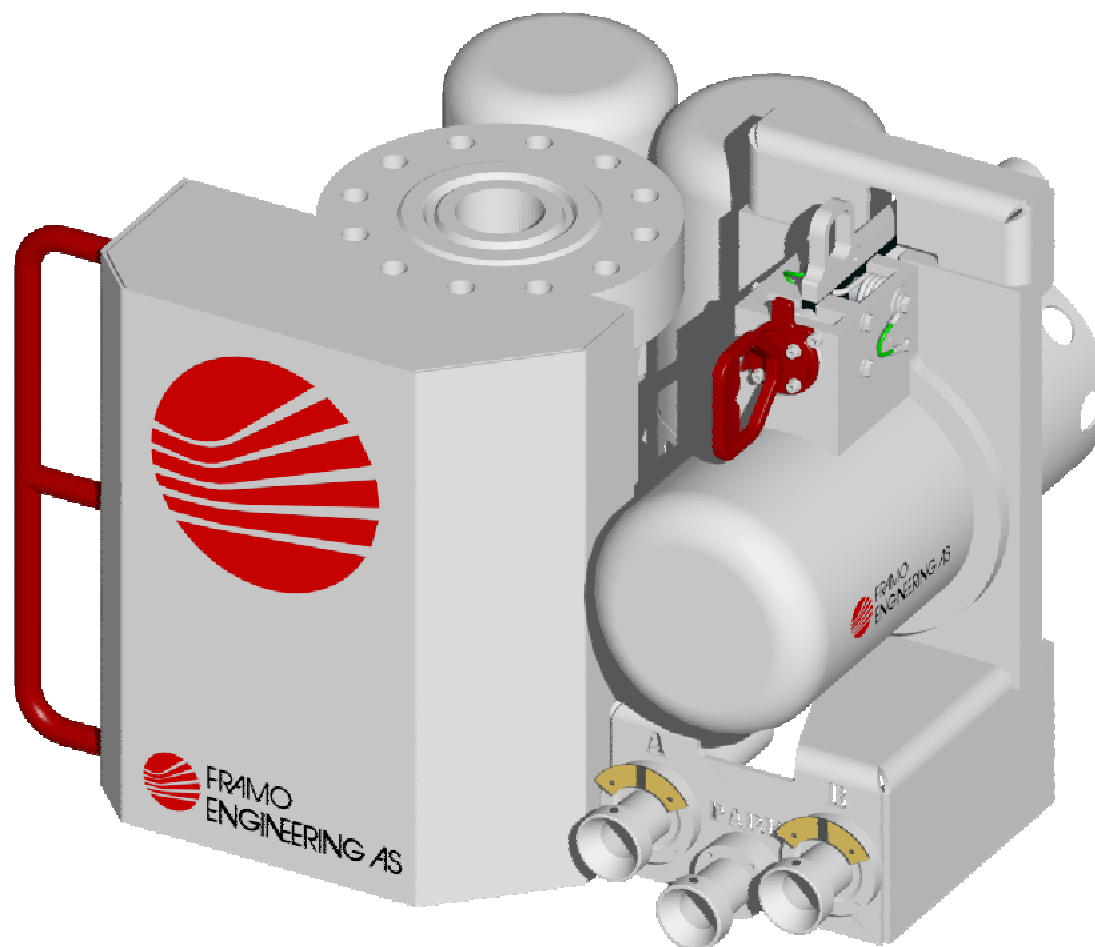
Neste Generasjon – PW Vx SS MkII

Spesifikasjoner

	SIZE 52			SIZE 65			SIZE 88		
Design pressures	5 K	10 K	15 K	5 K	10 K	15 K	5 K	10 K	15 K
Design temp	-46 – 205 deg C			-46 – 205 deg C			-46 – 205 deg C		
Max water depth	3500 m			3500 m			3500 m		
Materials	Duplex 22 % Cr / 25 % Inconel / Inconel clad			Duplex 22 % Cr / 25 % Inconel / Inconel clad			Duplex 22 % Cr / 25 % Inconel / Inconel clad		
Sour service	Yes			Yes			Yes		
Connections	SPO 1500	SPO 2500	SPO HOLD	SPO 1500	SPO 2500	SPO HOLD	SPO 1500	SPO 2500	SPO HOLD
	API	API	API	API	API	API	API	API	API
	Clamp			Clamp			Clamp		
	Weld prep			Weld prep			Weld prep		
Redundancy	Possible			Possible			Possible		
Retrievability	Possible			Possible			Possible		



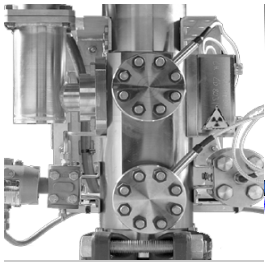
Neste Generasjon – PW Vx SS MkII



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Neste Generasjon – PW Vx SS MkII

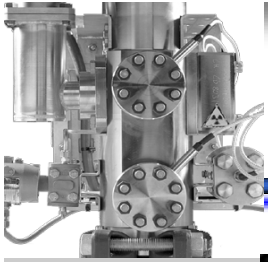
- Dobble barrierer mellom prosess og miljø
- Kvalifikasjonsprogram ihht. DNV-RP-A203
- Appliserbare standarder
 - ISO 10423 / API 6A
 - ISO 13628 / API 17D
 - NACE MR 0175
- Alle kritiske komponenter ferdig kvalifisert
 - Ingen teknologigap

Ferdig kvalifisert ihht. DNV-RP-A203
Q3 i år



Schlumberger

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Takk for oppmerksomheten!



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