ROV control system philosophy in coiled tubing drilling

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Coiled Tubing Drilling

- Drilling using Open Water Coiled Tubing

- Island Offshore has done this on two occasions until now:
  - Rogfast – core drilling
  - Centrica Energy – pilot hole drilling on the Butch field

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Pilot hole drilling for Centrica Energy

- A pilot hole is the topmost part of a well, typically drilled to look for shallow gas. The aim is to know if the location is suitable for a production well or not.
- Centrica Energy was the first company in the world to use Open Water Coiled Tubing Drilling for offshore purposes – and with great success!

- Conventionally these operations are performed using a drilling rig. Advantages by using a vessel and in open water (riserless), are:
  - Cheaper operation
  - Safer operation
  - Emissions to the environment are reduced

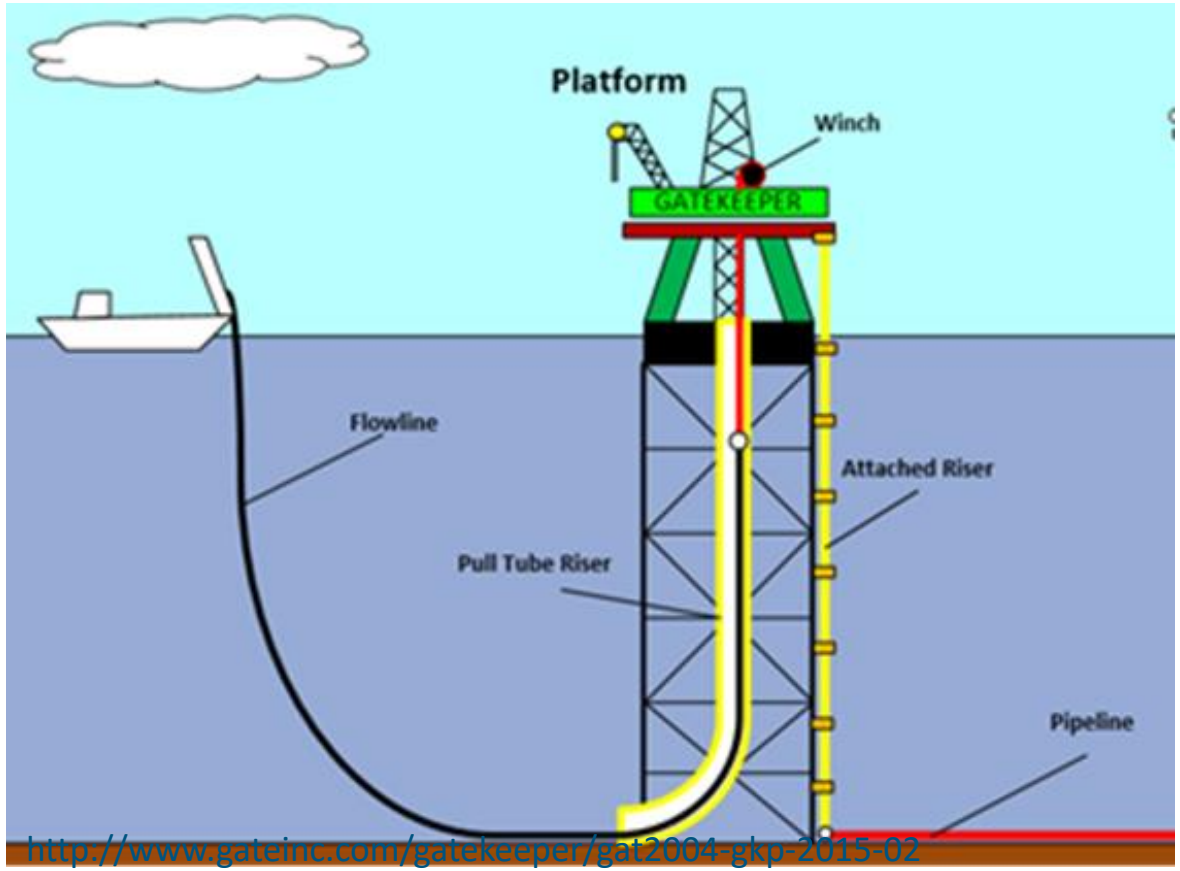
Pilot hole drilling for Centrica Energy - video

http://iosubsea.no/media/news-c9579l405

Open Water = Riserless

- Well operations are performed from a vessel
- Saves space and time due to no riser needed

Picture from «Oceanography», Vol 19, Dec 2006.



http://www.gateinc.com/gatekeeper/gat2004-gkp-2015-02

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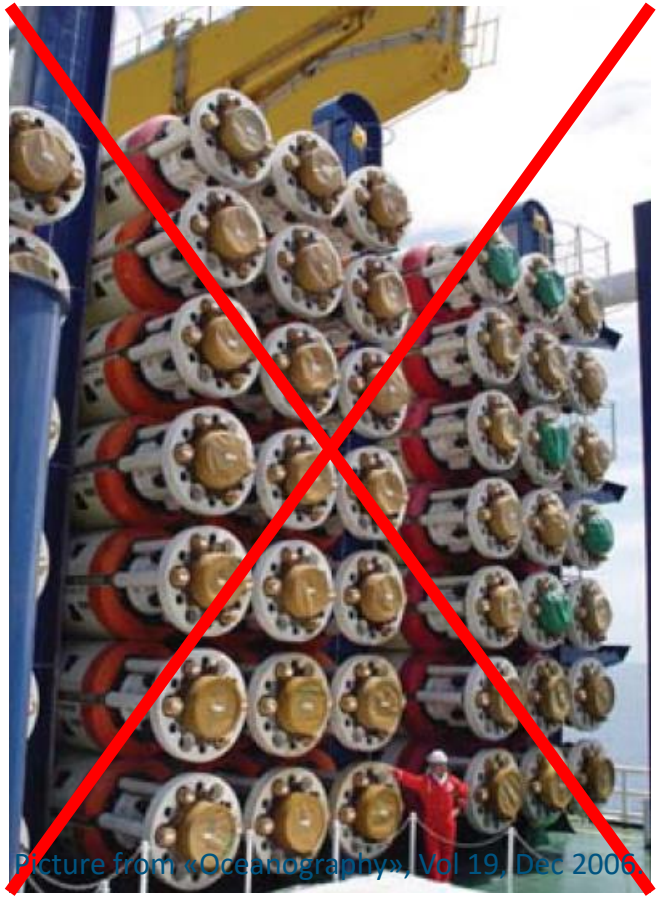

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Open Water Coiled Tubing (OWCT)

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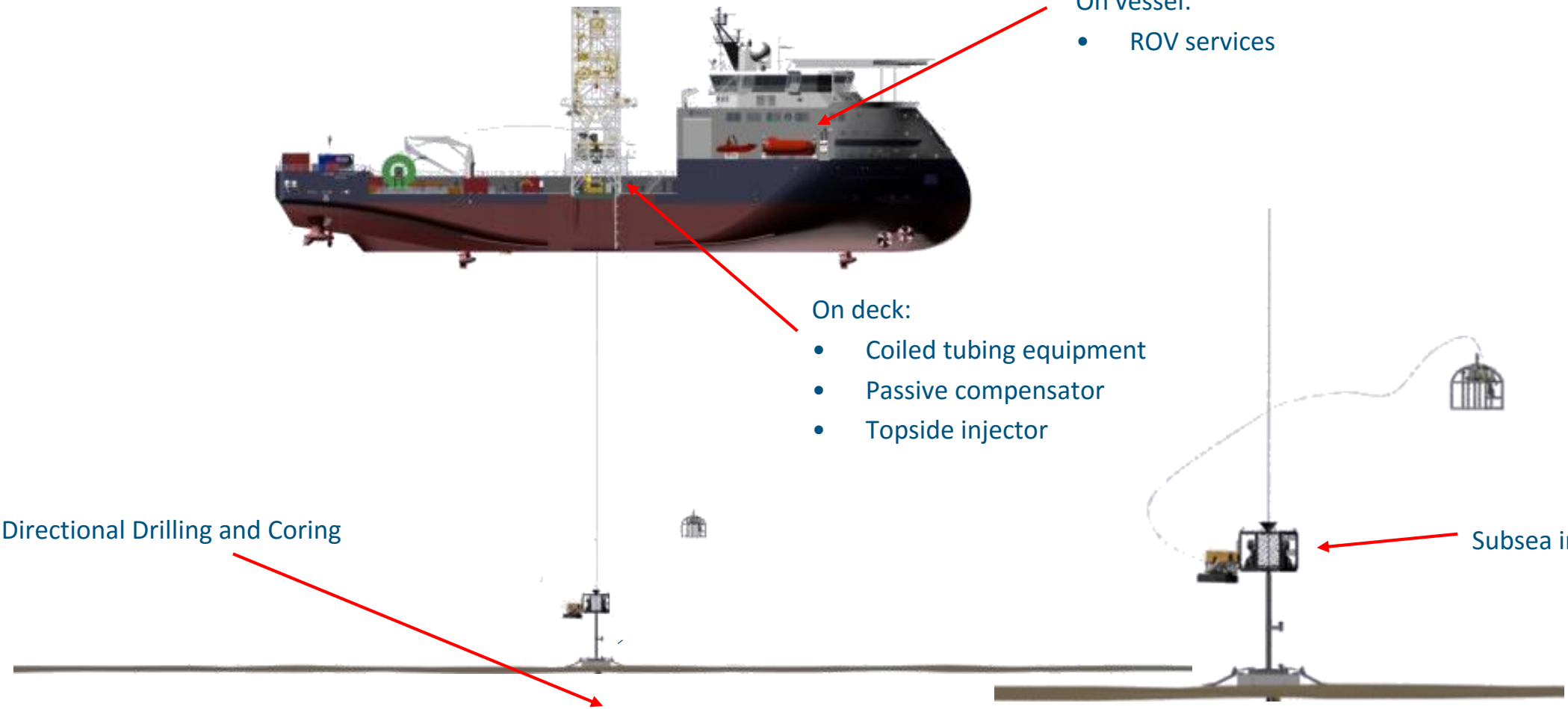
OWCT System Overview



On vessel:

- ROV services

On deck:

- Coiled tubing equipment
- Passive compensator
- Topside injector

- Directional Drilling and Coring

Subsea injector

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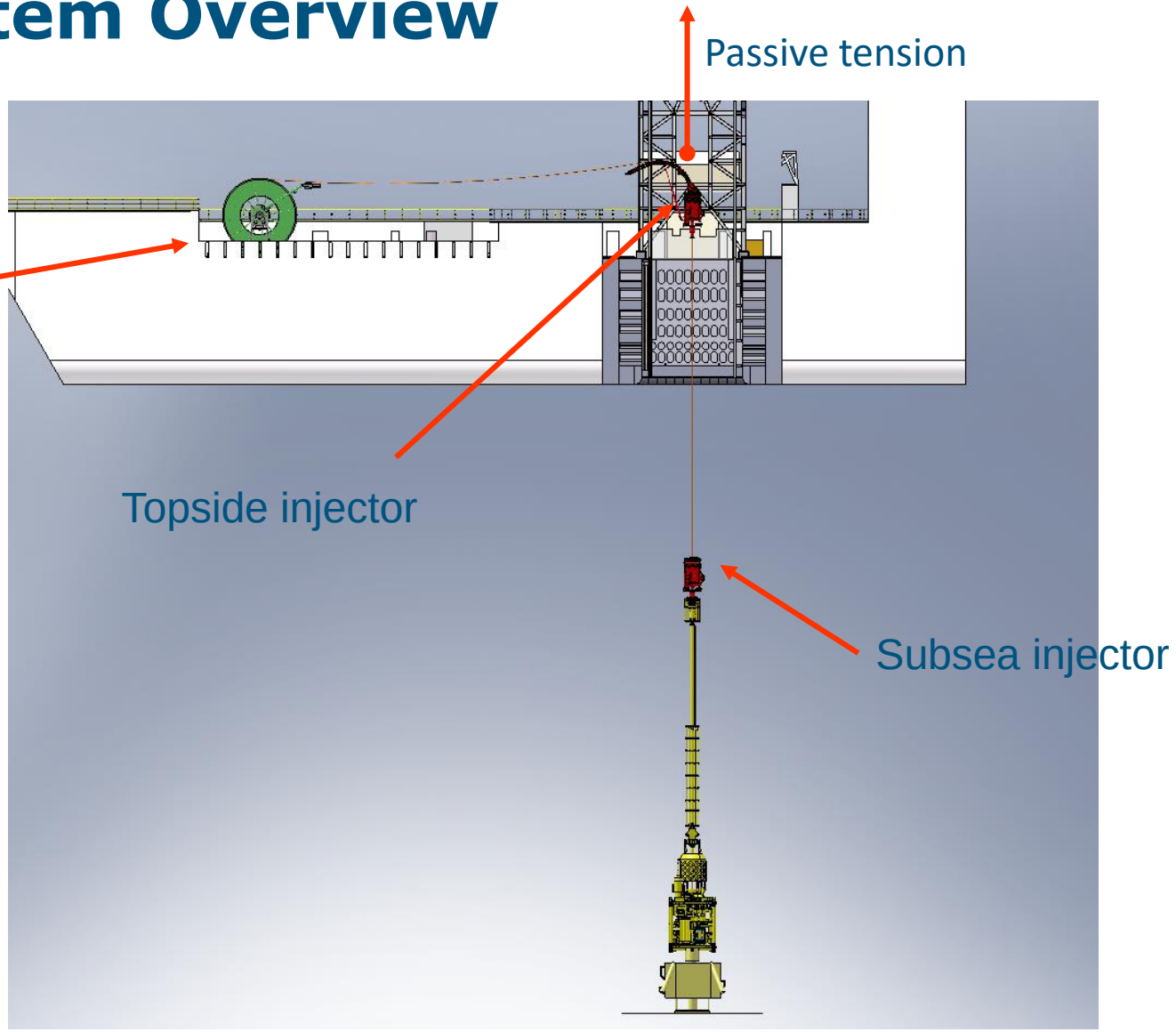
OWCT System Overview



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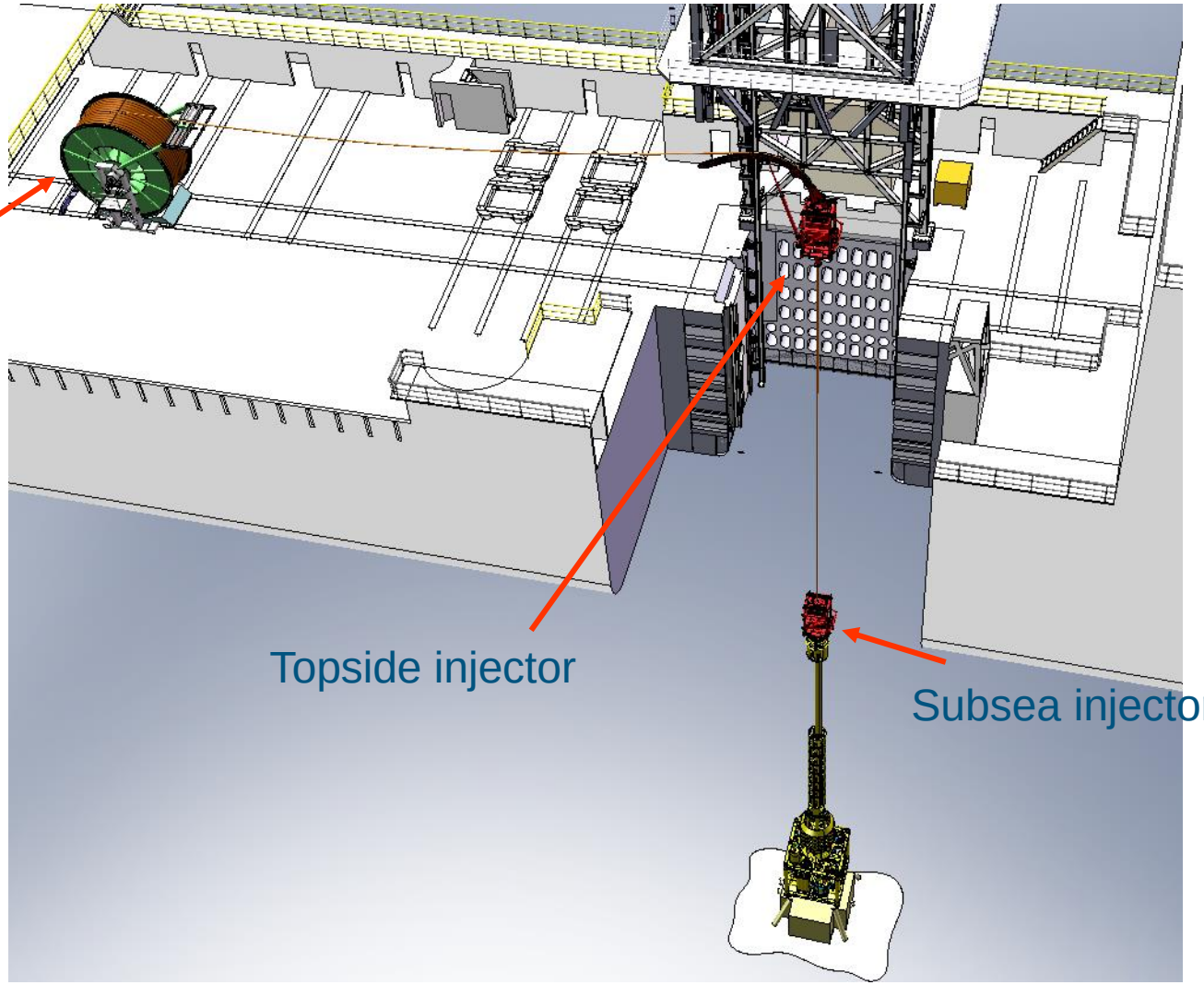
OWCT System Overview



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Subsea injector control

Hydraulic motors to control the coil tension and coil traction.

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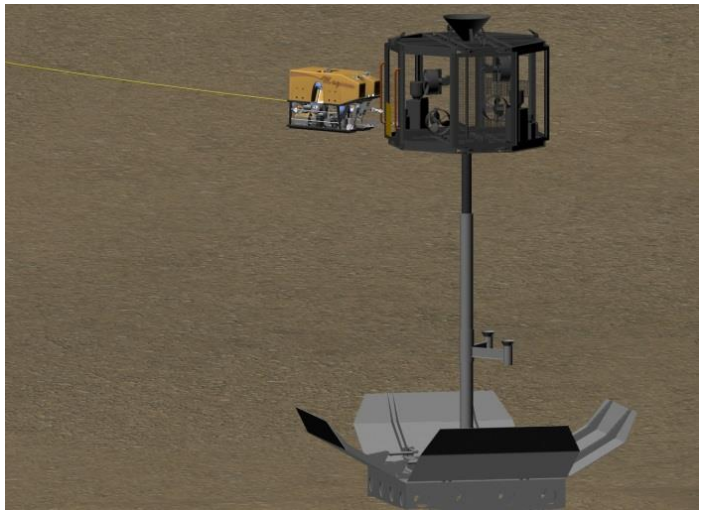
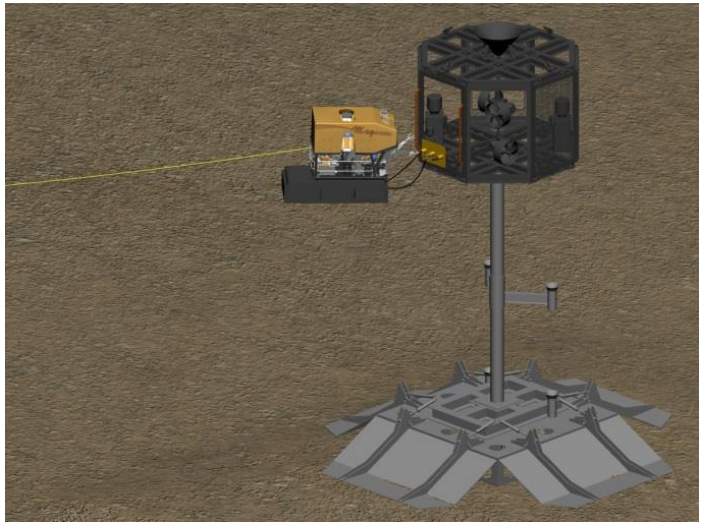
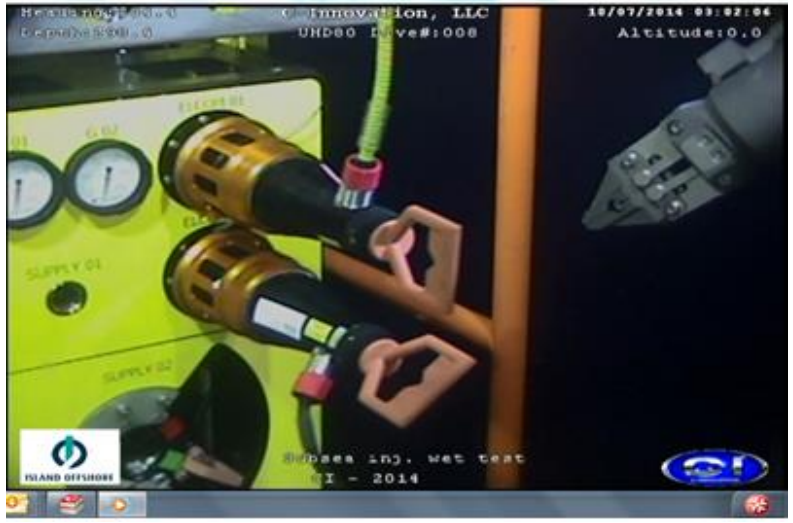
ROV connection to the subsea injector







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ROV connecting to subsea injector - video

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ROV control system philosophy

- The ROV industry is one of the most innovative industries within the oil and gas sector.
- Communication and power shall be supplied through the ROV-system. We use a closed loop hydraulic supply from the skid of the ROV.
- A valve pack and control module is installed on to the injector.

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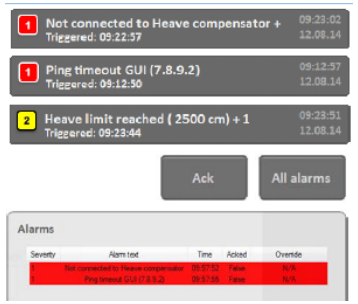
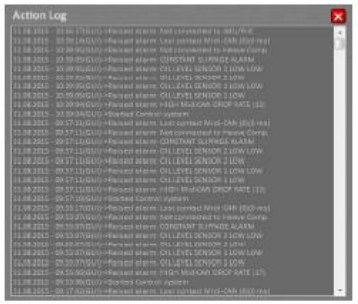
Subsea injector control, topside injector guidance and **passive heave control**

- Advanced controlling of operations subsea
- User of high level programming in C#
- Gives operator on vessel full overview and control regarding pressure and flow to injector functions, weight on bit, distance in hole, visual from cameras etc





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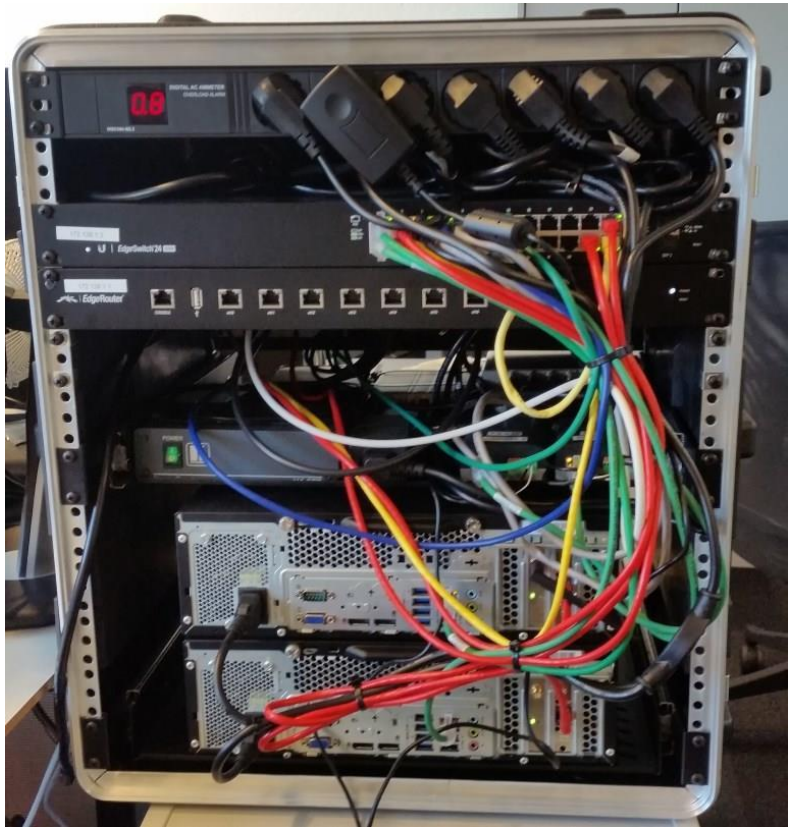
Topside system

- Computer rack
  - Two servers
  - Video recording
  - Connection to land for data and video transfer and diagnosis



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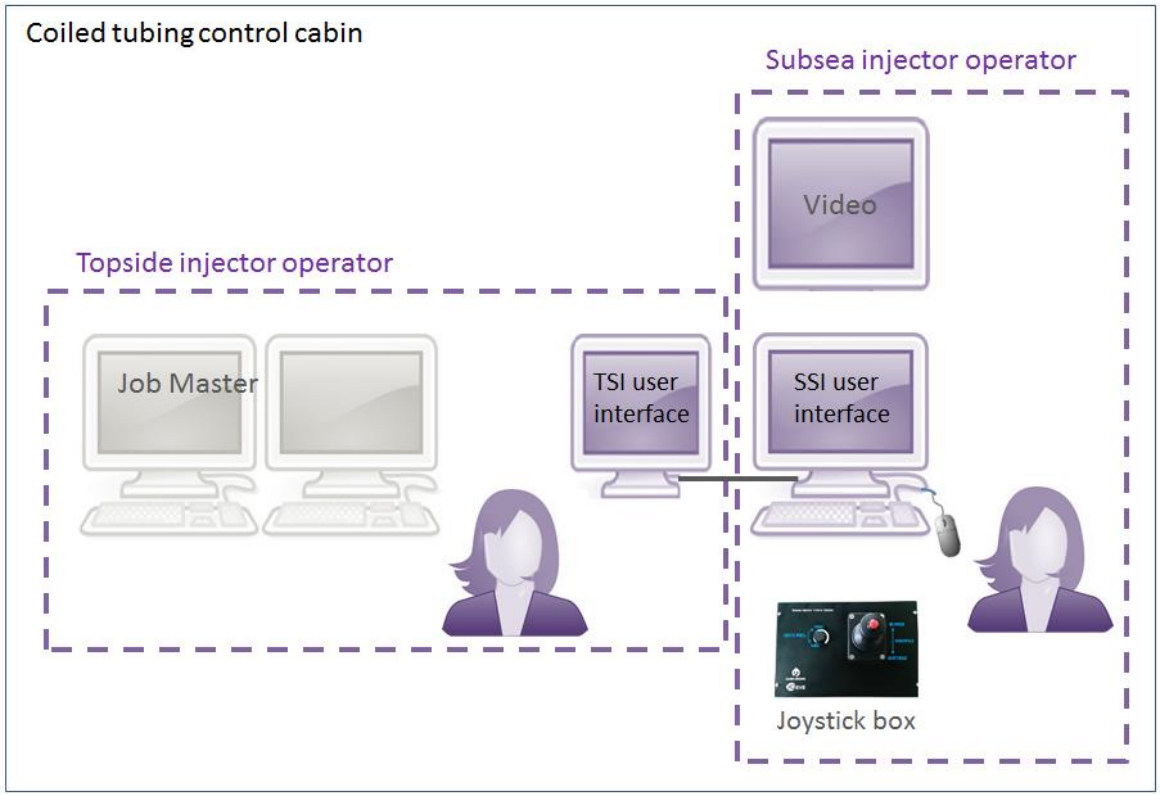
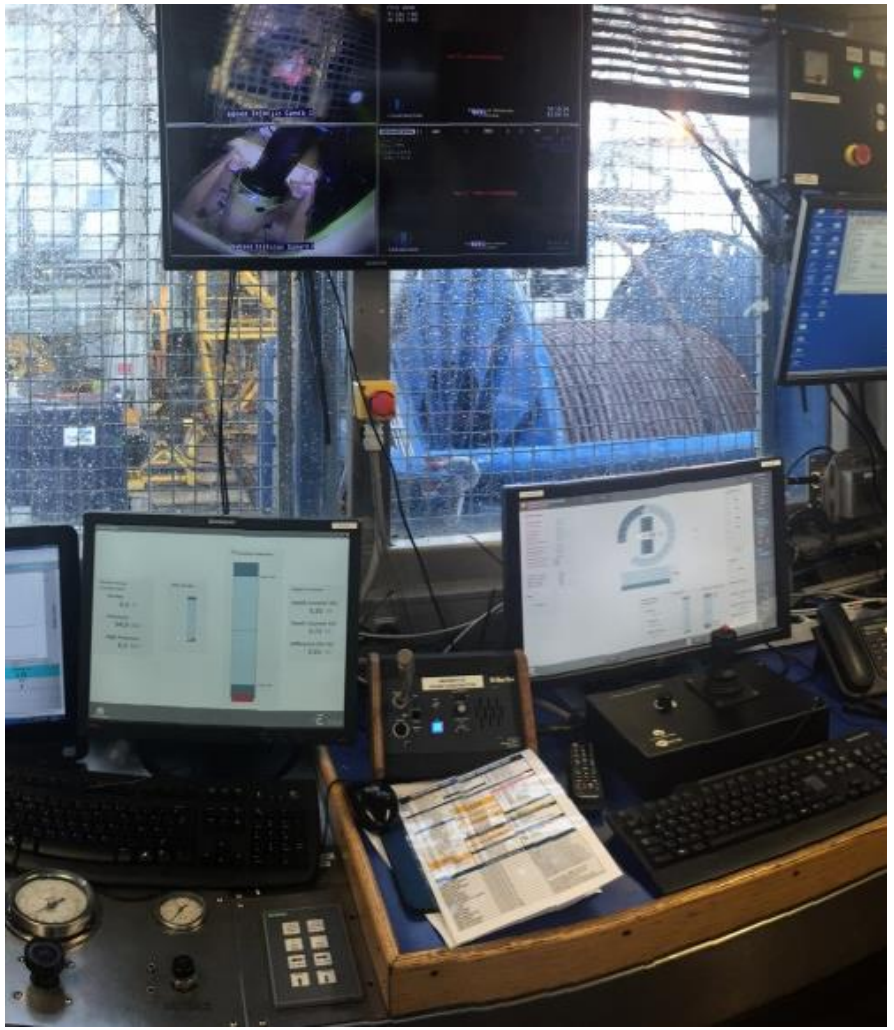
Operator control room





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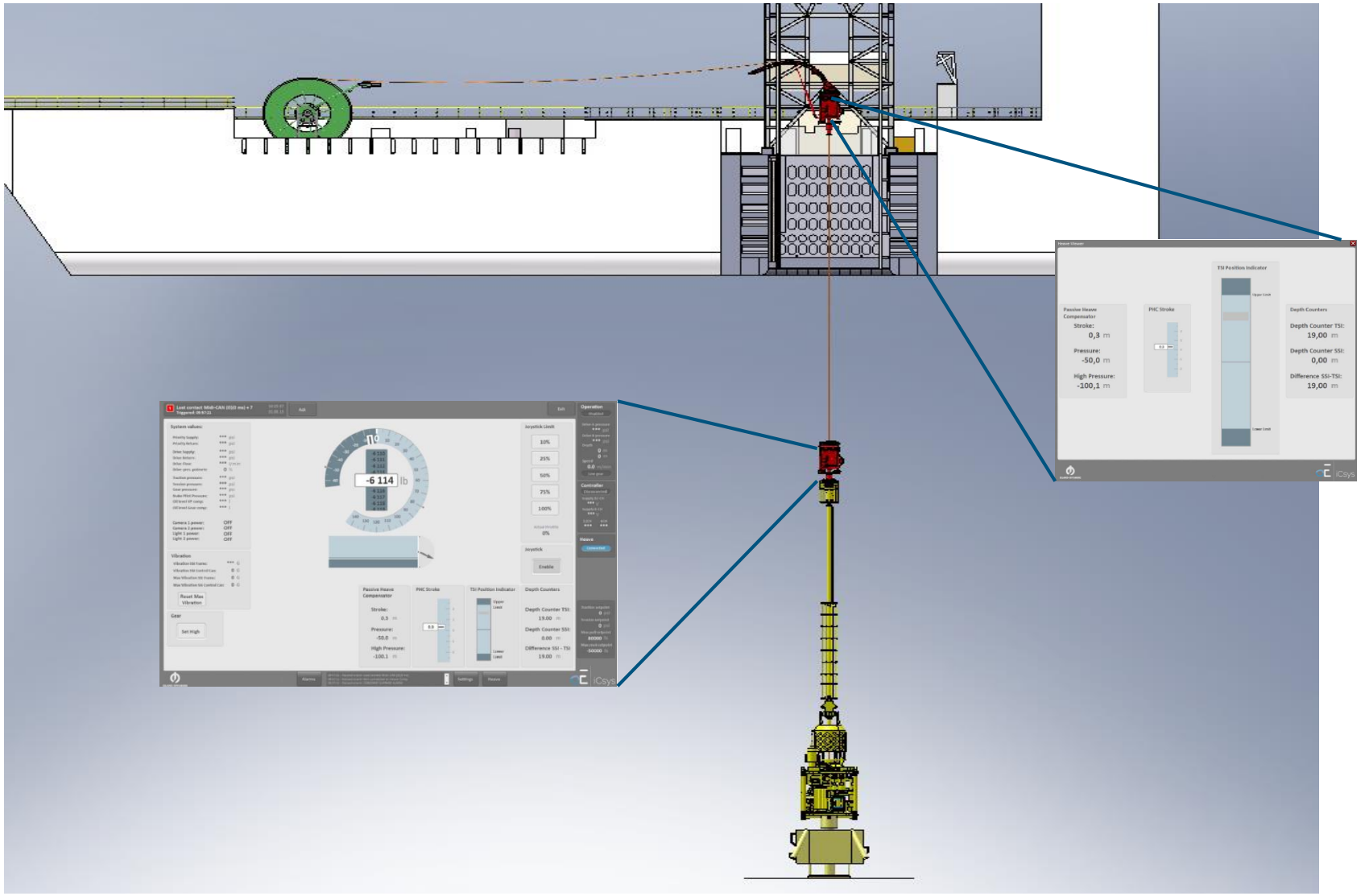
Operation



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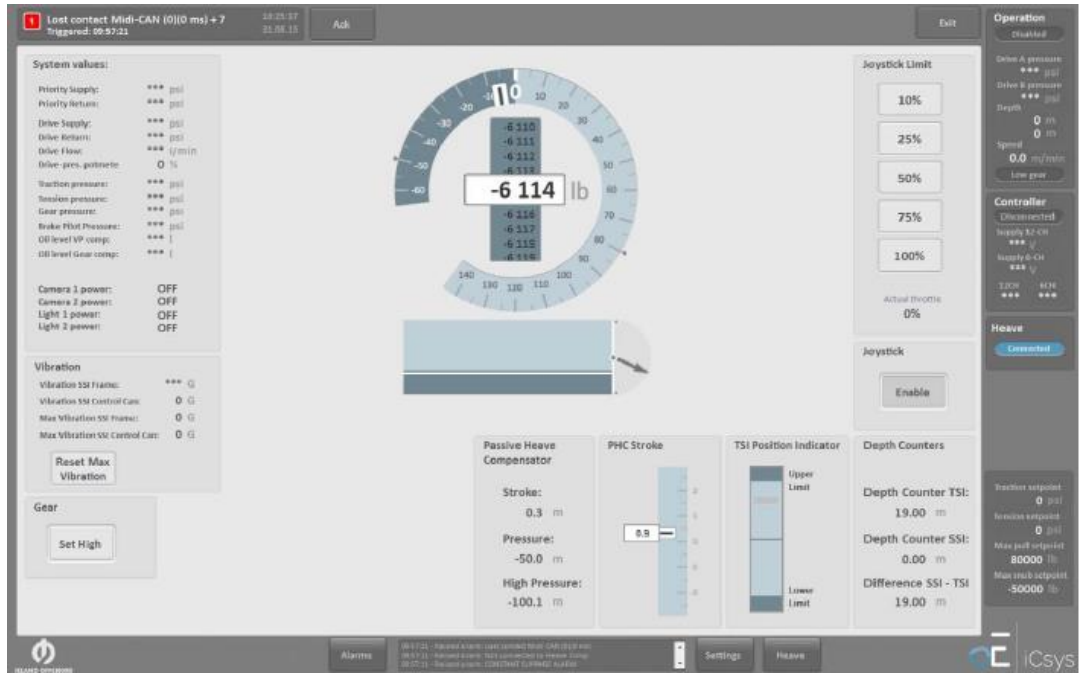
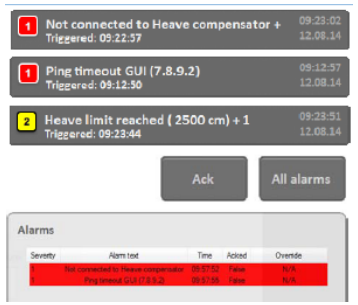
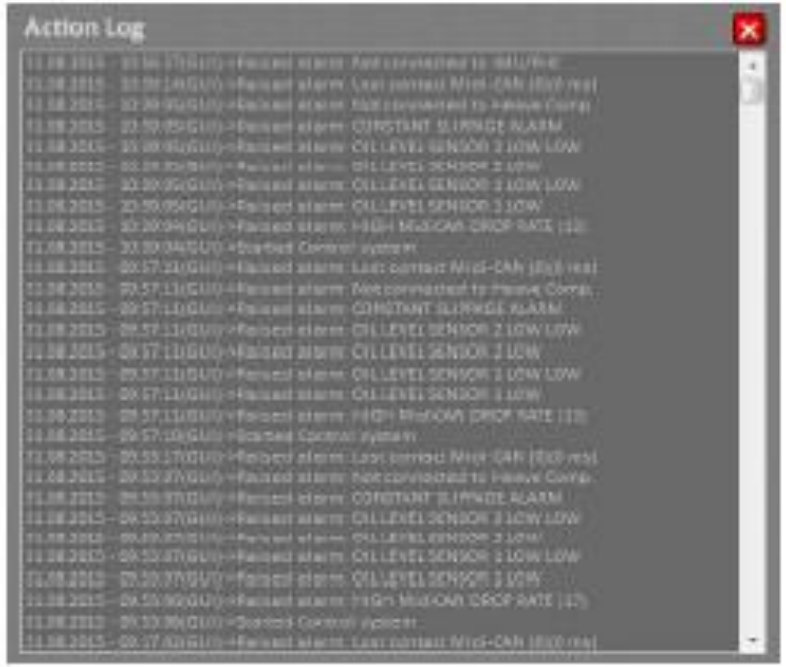
Alarms and log

- Alarm list and warnings visible and logged.
- All states and changes are logged and available for historical trending.
- Risk reducing means: Redundancy, control of startup / default state of all parameters.







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Managing risks

- Managing risk is equally important in control systems
- Redundancy is important, but also wrongly programmed devices can be devistating
- Important to know what to do if the software fails and have control over the default state and startup state
- Increasing risk that industry equipment, such as SCADA systems, being struck by viruses.
  - Germany in 2014: Cyber attack on steel industry company. Massive destructions to the factory.
  - Ukraina in 2015: Hackers hacked into the SCADA systems and turned off the electricity supply for a whole region in Ukraina.

Risk Matrix

HAZARD SEVERITY OUTCOME					PROBABILITY					
People	Environment	Financial	Reputation	Delay	Very unlikely	Unlikely	Possible	Likely	Very likely	
Extensive Fatalities	Global or national effect. Restoration > 10 yr	Cons. cost > NOK 50 mill	International impact negative exposure	Will delay completion	E1 = M	E2 = M	E3 = H	E4 = H	E5 = H	E
Severe Single fatality or serious injury	Restoration time > 1 yr. Restoration cost > NOK 5 mill	Project / Prod cons. Cost > NOK 5 mill	Extensive national impact	Significant delay - likly to delay completion	D1 = L	D2 = M	D3 = M	D4 = H	D5 = H	D
Moderate Injury leading to a lost time incident	Restoration time > 1 md. Restoration cost > NOK 500 K	Project / Prod cons. Cost > NOK 500 K	Limited national impact	Delay, may delay completion	C1 = L	C2 = L	C3 = M	C4 = M	C5 = H	C
Minor Injury requiring first aid treatment	Restoration time < 1 md. Restoration cost < NOK 500 K	Project / Prod cons. Cost < NOK 500 K	Local impact	Small delay, no delay to completion	B1 = L	B2 = L	B3 = L	B4 = M	B5 = M	B
Negligible No specific treatment or loss of work	< 50 l	No cost	No impact		A1 = L	A2 = L	A3 = L	A4 = L	A5 = M	A
					1	2	3	4	5	

High	Actions must be taken to reduce risk to at least the medium level.
Medium	Risk reduction measures must be taken if their respective costs are not disproportionately high as compared to their attained benefits (ALARP principal); actions need to be taken to manage and measure risk.
Low	Monitoring actions required to identify whether the risk rises to medium level.

DET NORSKE VERITAS
Report for Island Offshore Subsea AS
Open Water Coiled Tubing Technology Assessment & Early Phase HAZID

MANAGING RISK

Table 3 Technology Assessment

ID	Components	Functions	New/Critical aspect	Technology			Application			Techn. Class.	Vendor (s)	Comments
				Known	L. hist.	New	Known	L. hist.	New			
A	Topside Equipment											
1	CT power pack & controls	Provide hydraulic power & controls	Increased number of equipment to control	x				x		2	FDS	
2	CT reel	Spool in/out CT		x			x			1	FDS	
3	CT reel feeder for "lazy arc" (Tension injector)	Control lazy arc by communication with reel and topside mini injector	Different than traditional back tension on reel	x			x			1	FDS	
4	Surface injector	-Run subsea injector stack -Feed subsea injector with CT	New function for an injector for subsea	x					x	3	FDS	Previous application has been on land
5	Passive tension	Keeping coil in water in tension	Effects of moving CT	x					x	3	NOV	Moving coil
6	Umbilical reel (compensated)	Spool in/out umbilical	Compensation	x					x	3	FDS	Constant compensation. New design
7	Umbilical reel (with storm loop)	Spool in/out umbilical		x			x			1	FDS	Potentially smaller operation window
B	Subsea lines											
8	CT	-Run subsea injector stack -Traditional services (tension, conduct flow)	Used for running subsea equipment	x					x	3	QT/Tenaris	New model for fatigue life of the coil
9	Umbilical	Transfer energy between power pack and subsea injector		x			x			1	FDS	
10	2" Kill line(s)	Conduct kill fluid		x			x			1	Parker	Same RLWI
11	3 or 4" Return hose	Conduct return flow	Suspension/attachment	x					x	3	Parker	Suspension is not decided on
C	Subsea Equipment											
12	Subsea injector	-Run CT in/out of well -Weight control -Depth control?	Reliability/maintainability of chains, blocks, leaks, etc.			x			x	4	FDS	Primary clamping will be by the injector, secondary by the CT connector
13	Stripper	Dynamic seal for CT	Pressure control/leaks		x			x		3	TOT	Quad strippers to be evaluated. Leak monitoring to be evaluated
14	CT BOP	Functions? -Shear/Blind -Pipe/Grip	Hydrostatic pressure	x				x		2	TOT	CT BOP design for subsea
15	Injector connector	Connect injector stack to lubricator	Trapped volumes, hydrates, flushing			x			x	4	To be decided	Functions need to be determined
16	Lubricator	Enclose BHA	Transfer forces from subsea injector!	x					x	3	FMC	To be covered in detail later
17	WCP	Subsea barrier elements	Not configured for CT	x				x		2	FMC	To be covered in detail later

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ROV based Control system for Subsea Equipment

Subjects for this presentation

- Envirex Group – Short about us
- Internet Of Things (IoT)
- Using Ethernet as main communication
- ROV Technology to control subsea equipment

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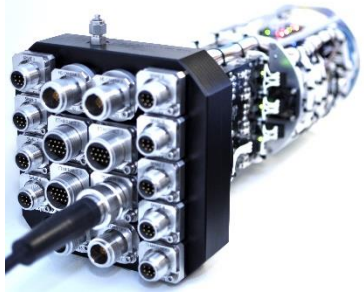
envirex



iCsys

envirent

Short about us

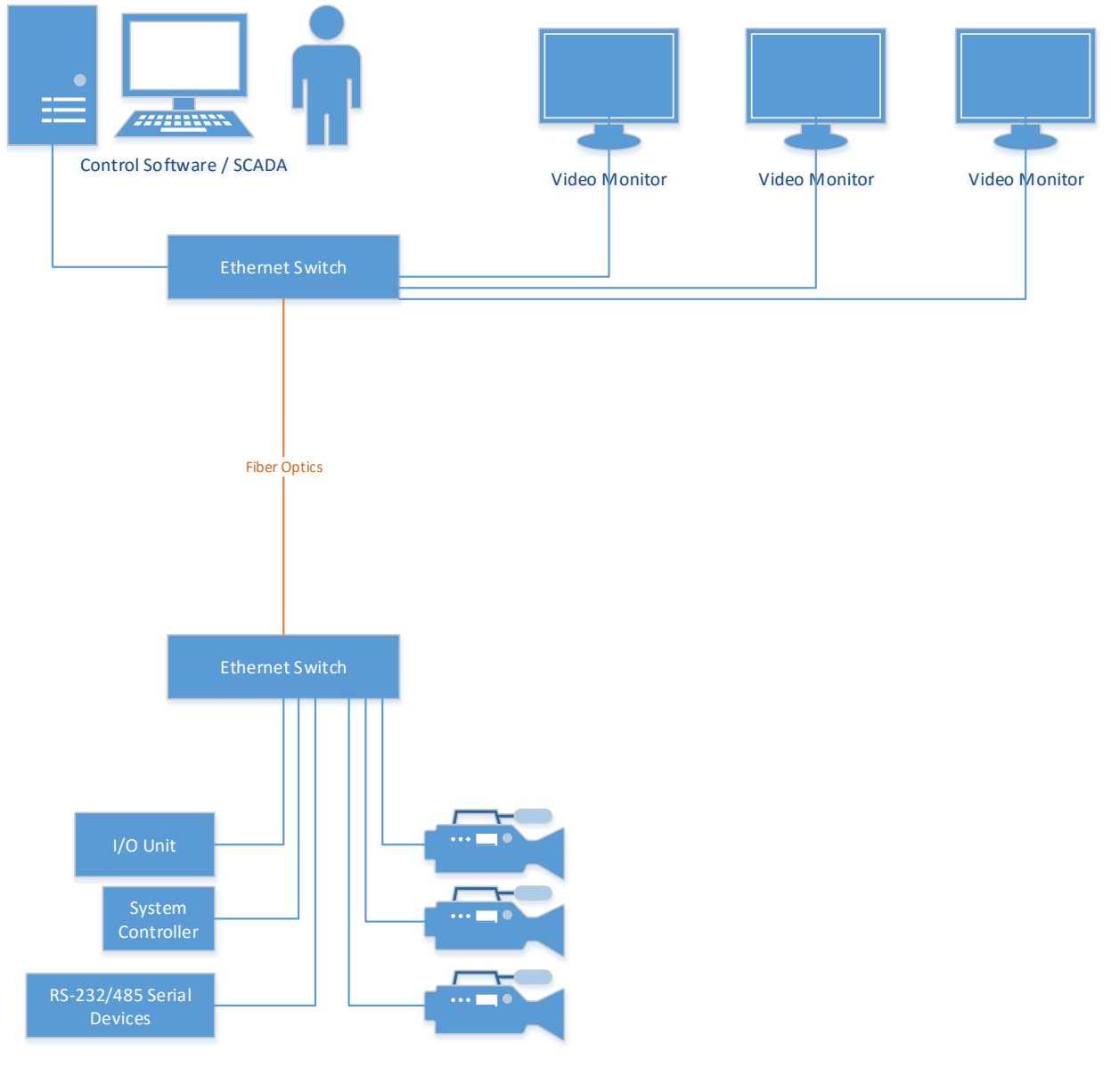
- **Who?**
  iCsys, Envirex and Envirent
- **Where?**
  Rogaland -> Klepp
- **What?**
  Design, Engineering, Production, Maintenance and Rental within Hydraulics, Electronics and Software.
- **Why?**
  Strong focus on quality, cost-reduction, innovation and customer satisfaction within all our fields of expertise.

Internet of Things (IoT)

- What is Internet of Things?
- Big Data?
- Cost benefits?
- How to use this concept Subsea?

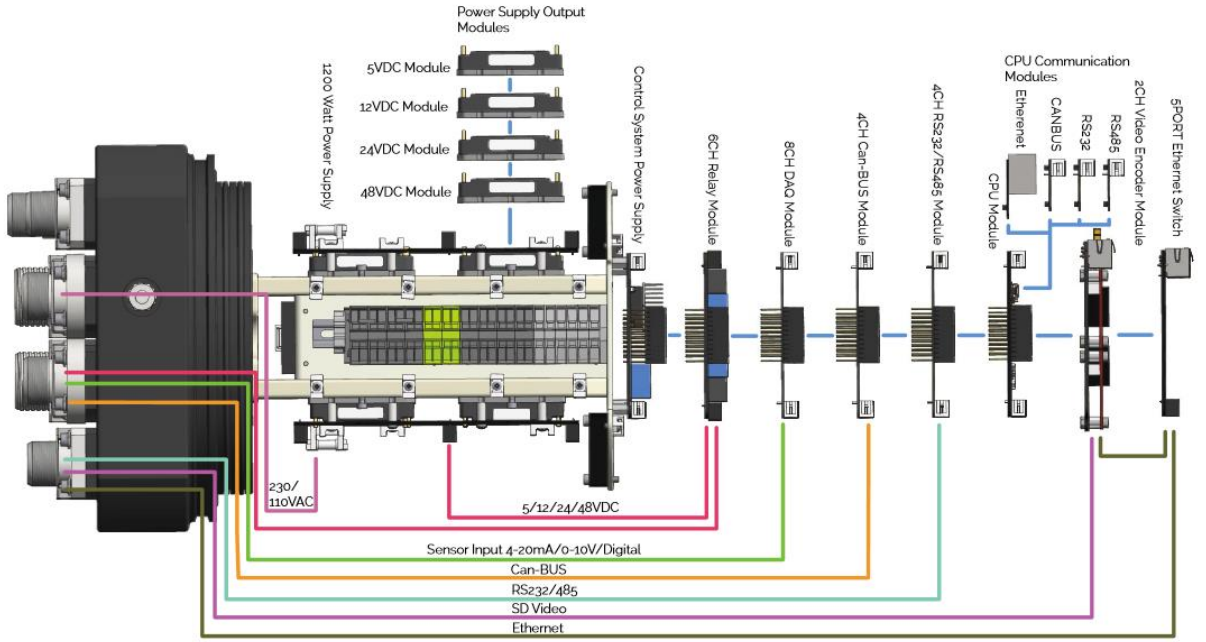
Using Ethernet as main communication

- **No need of expensive MUX**
- **Serial, Video and control signals over the same link**
- **Easy to implement in existing infrastructure**
- **Cost and availability benefits**
- **Easy to provide remote (onshore) support**



ROV Technology to control subsea equipment

- **ROV Technology is adapted to subsea environments**
- **Advanced and flexible options for control applications**
- **Space efficient design**
- **Field tested components**
- **Standard components allow easy spare management and ensures availability**



Island Offshore's new LWI vessel:

Island Navigator

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Island Navigator - size

MAIN DECK SECTION – 169 meter
“ISLAND NAVIGATOR”
UT 777 (2017)

MAIN DECK SECTION – 116 meter
“ISLAND WELLSERVER”
UT 767 CD (Built 2008)

MAIN DECK SECTION – 106 meter
“ISLAND FRONTIER”
UT 737 L (Built 2004)

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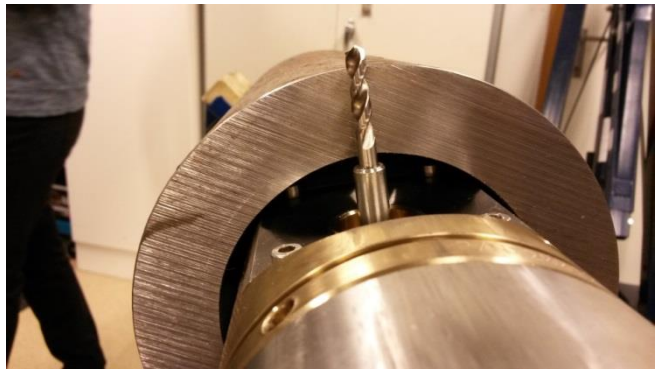
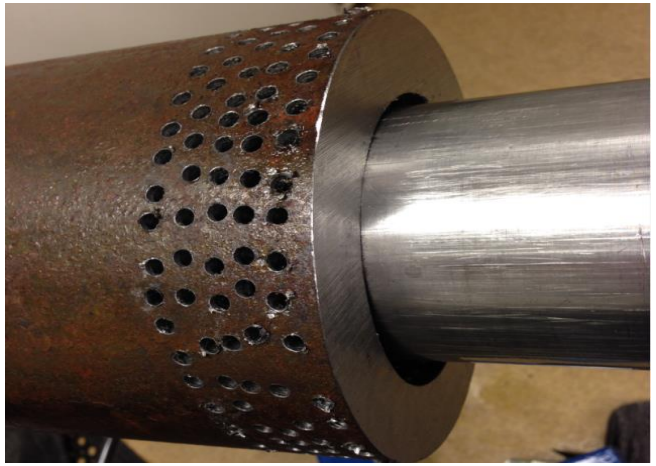
Sister company: Agat Technology

PDT - Perforating Drilling Tool





www.agat.no

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PDT - Perforating Drilling Tool

Conventional Perforation

- Hole diameter and penetration depth may vary (API tests shows more than 66% variance in hole diameter)
- Makes it difficult to calculate pressure & pumping rate for well Stimulation, Fracking, Cement jobs or Leak-off tests
- Creates restrictions in casing and may have sharp edges that may damage packer elements

Hole in casing made by Perforation charge

Perforation Drilling Tool

- Each hole has same diameter and penetration depth
- Makes it easy to calculate pressure & pumping rate for well Stimulation, Fracking, Cement jobs or Leak-off tests
- Burr-free holes in casing and clean passage for packer

Hole in casing made by the Perforation Drilling Tool

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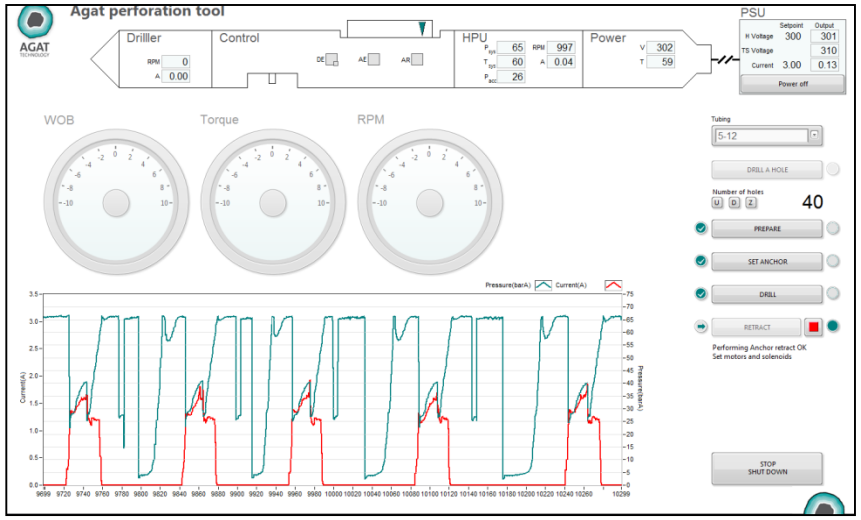
PDT - Perforating Drilling Tool

Control system and Graphical user interface

- Electronic card on the downhole tool
- Real time communication
- Operation sequences will be communicated and monitored
- Verification and documentation of anchor set and retract
- Verification and documentation of drilling operation
- Depth control of PDT is synchronized with wireline depth



Animation:

https://www.youtube.com/watch?v=upevQ566HbU

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Thank you for your attention!

Questions?