Managing Well Integrity in a Cost Driven Net Zero Emissions Energy Industry

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The Cost.

To maintain compliance with regulations well operators are diverting valuable resources and creating emissions by repeatedly inspecting wells where nothing has changed since the last inspection.

Global spend on inspecting subsea wells is +$500m annually.

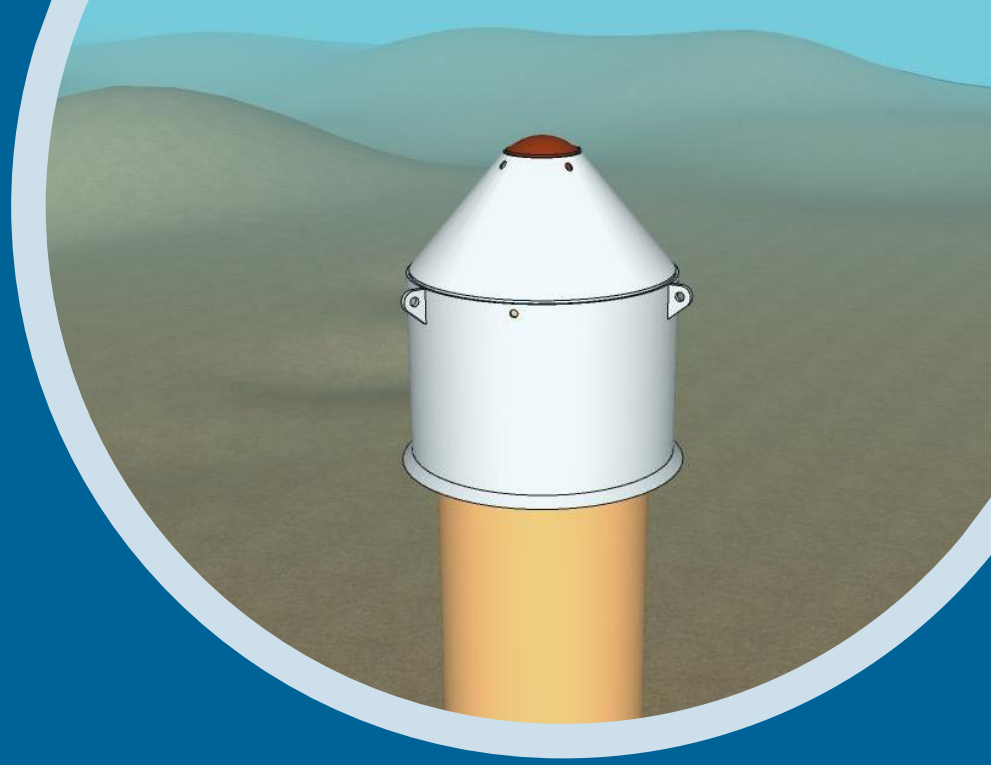
With aging assets and an increasing number of wells reaching the end of production, without innovation this cost will only increase.

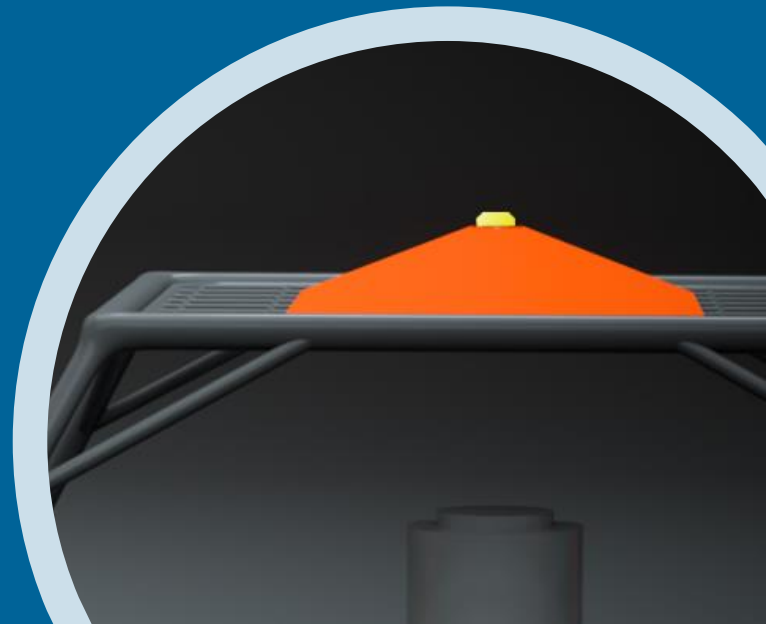
Our Solution.

Sentinel Subsea has developed a range of well monitoring technologies which adopt a unique method for achieving these vital well integrity management activities.

Our low-cost, easy to deploy and environmentally friendly systems can be applied to any well phase, from exploration up to final abandonment.

The technology allows a well operator to comply with regulatory inspection requirements without the need to repeatedly schedule vessel based manual inspection.





How.

Tracer
Detection System

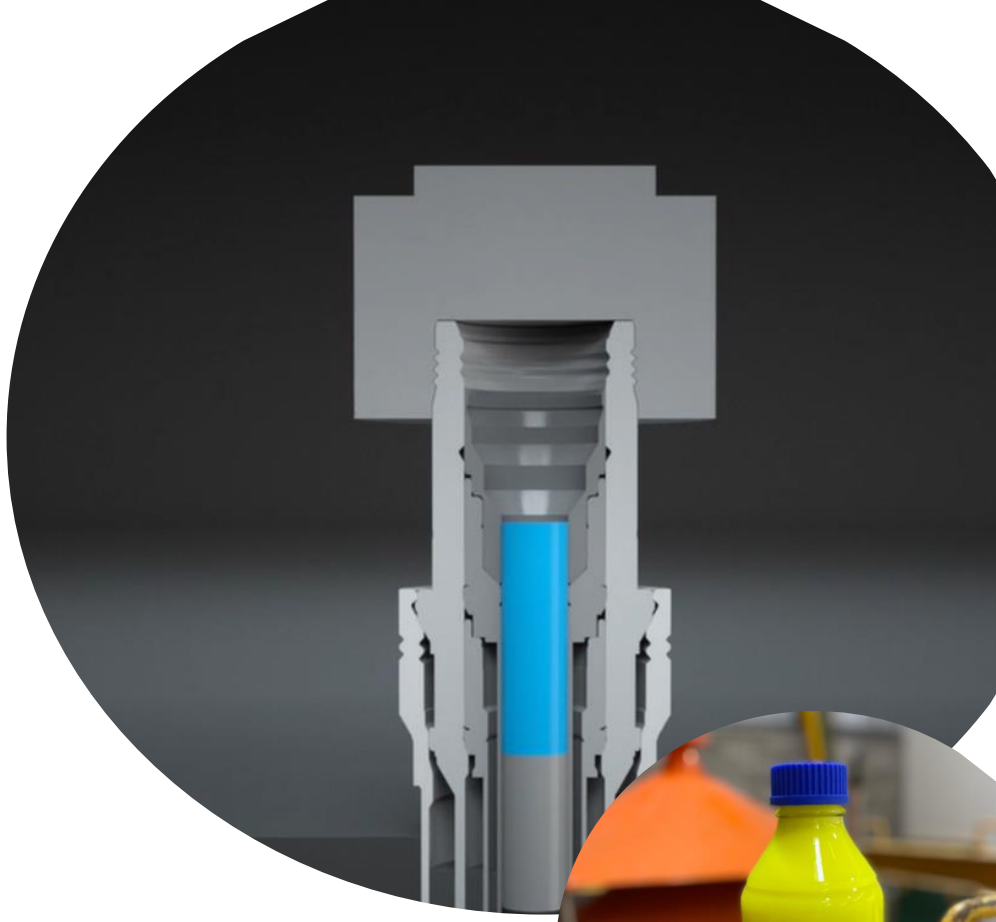
Hydrocarbon
Detection System

Place Tracer.

Our tracer fluid (SWIFT) is sealed into a well during final shut-in/suspension operations. This is done without changing common practices and does not add operational risk.

Our Tracer is;

- ❑ Environmentally friendly
- ❑ Non-invasive (will not react with anything in the well)
- ❑ Same molecular characteristics as methane
- ❑ Unique to the subsea environment
- ❑ Age tested to 100 year minimum
- ❑ Buoyant



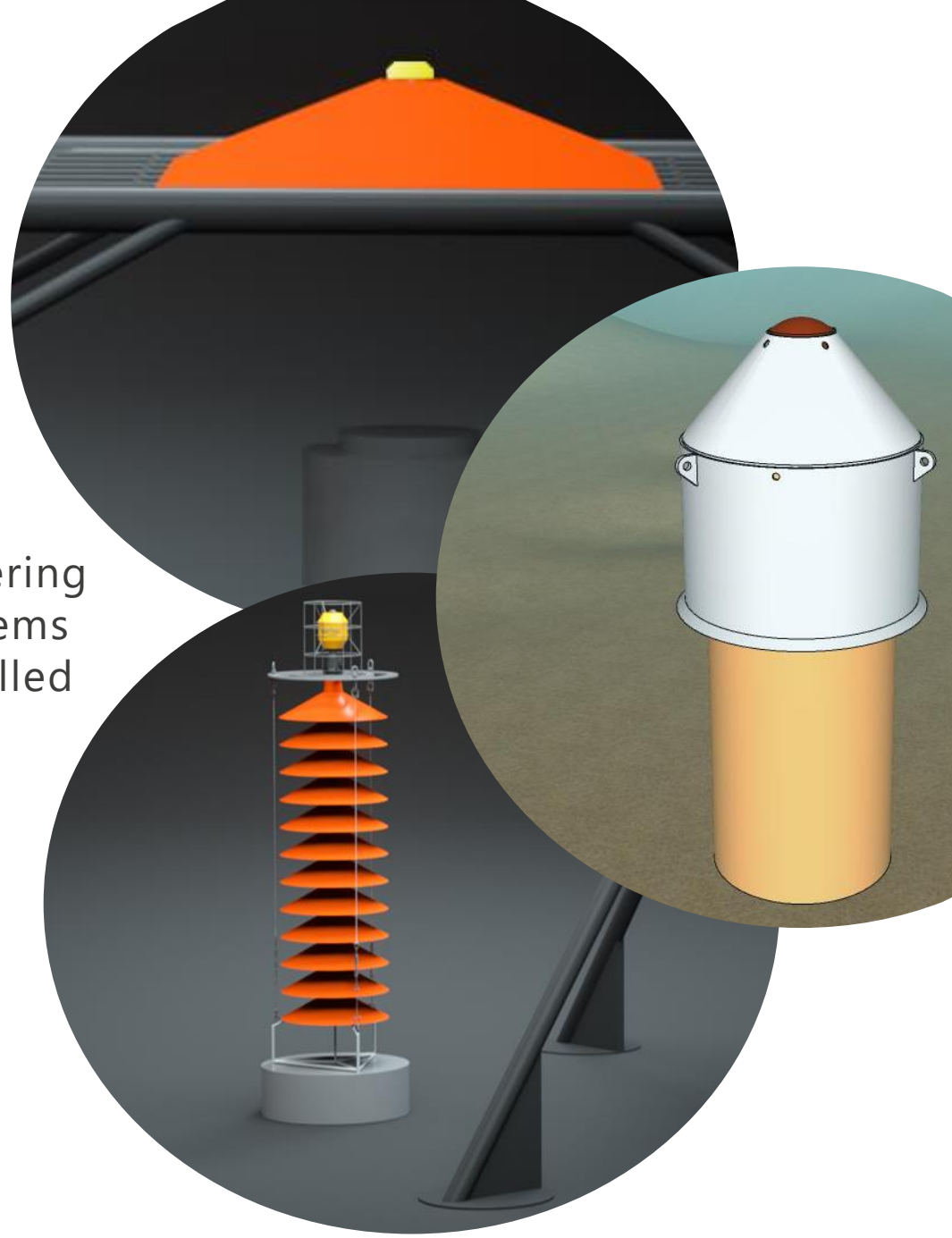
SWIFT Tracer Fluid (10% dilution of selected well volume)

Install System.

Our current range of detection systems are simply installed onto/near subsea key infrastructure in order to capture our SWIFT as it emanates from a subsea well should there be a loss of containment (LoC).

Our detection systems are ;

- ❑ DSV deployable
- ❑ Attached and secured to infrastructure/seabed with a “latch & engage” lock system
- ❑ Marine growth protected
- ❑ Have no requirement for a subsea power source
- ❑ Capable of 20 years subsea without intervention



Gathering Systems Installed

Detect Loss of Containment.

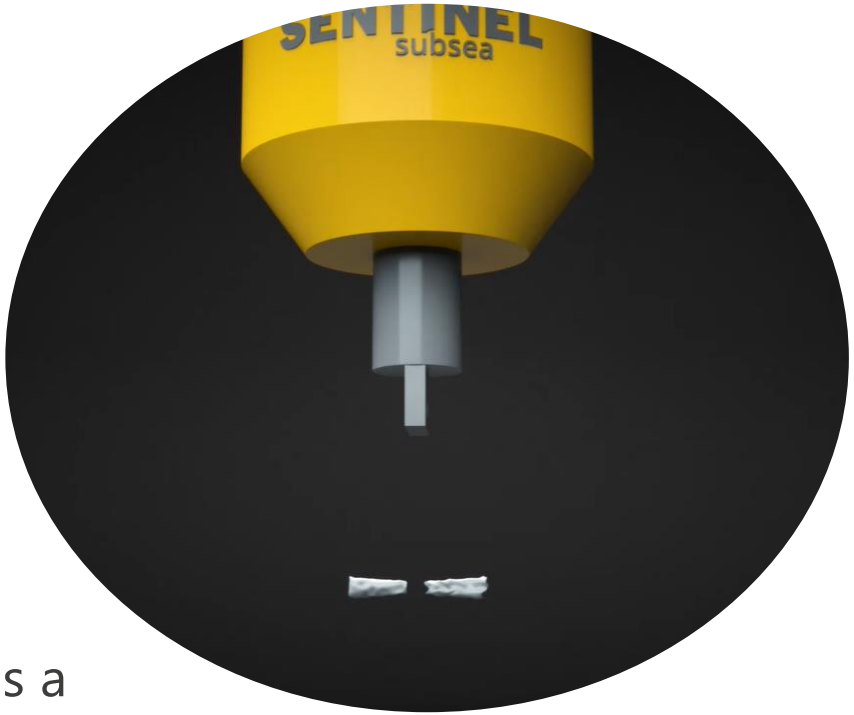
Should there be a unwanted loss of containment our detection system captures a percentage of any escaped well material.

The captured SWIFT pass internally up to a trigger housing where the concentration builds.

Detect Loss of Containment.

Tracer

Exposure



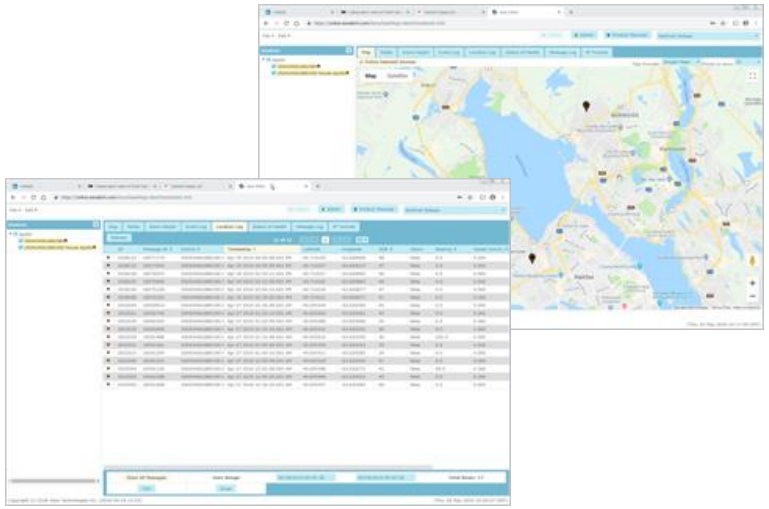
Within the reaction chamber is a locking mechanism that that is holding in place an Alert Beacon.

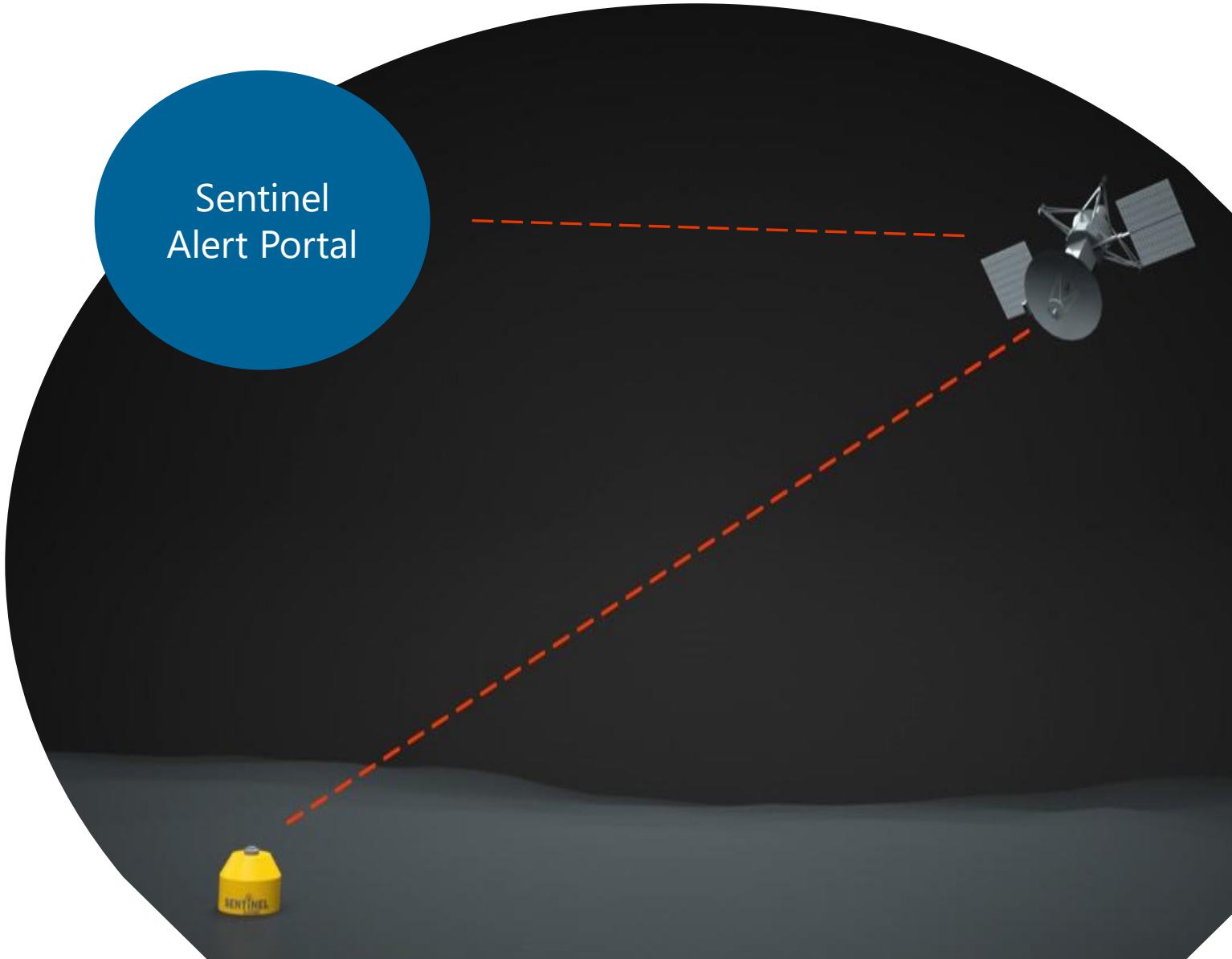
This locking mechanism is only sensitive to tracer and once exposed releases a beacon to surface.

Receiving an Alert.

On reaching the surface the Alert Beacon sends a signal via satellite

Each Alert Beacon is coded to an individual well and Sentinel Subsea immediately alerts the well operator.





Trigger Options.

Our systems are capable of being configured to be sensitive to a range of differing materials. The locking mechanism can be designed in order to react when exposed to the typical gas (C1 –C5) and/or fluid hydrocarbons that originate from the well following a Loss of Containment (LoC).

- ❑ Hydrocarbon Detection System uses the same gathering method and set-up as Tracer Detection Systems
- ❑ Requires no well intervention for installation and deployment
- ❑ Retro fit capability
- ❑ Allows simple Intervention/P&A window extension

Trigger Options.

Well Scenario	SWIFT	Gas Trigger	Oil Trigger	CO2 Trigger

Application.

Exploration Wells

Appraisal Wells

Development Wells

Production Wells

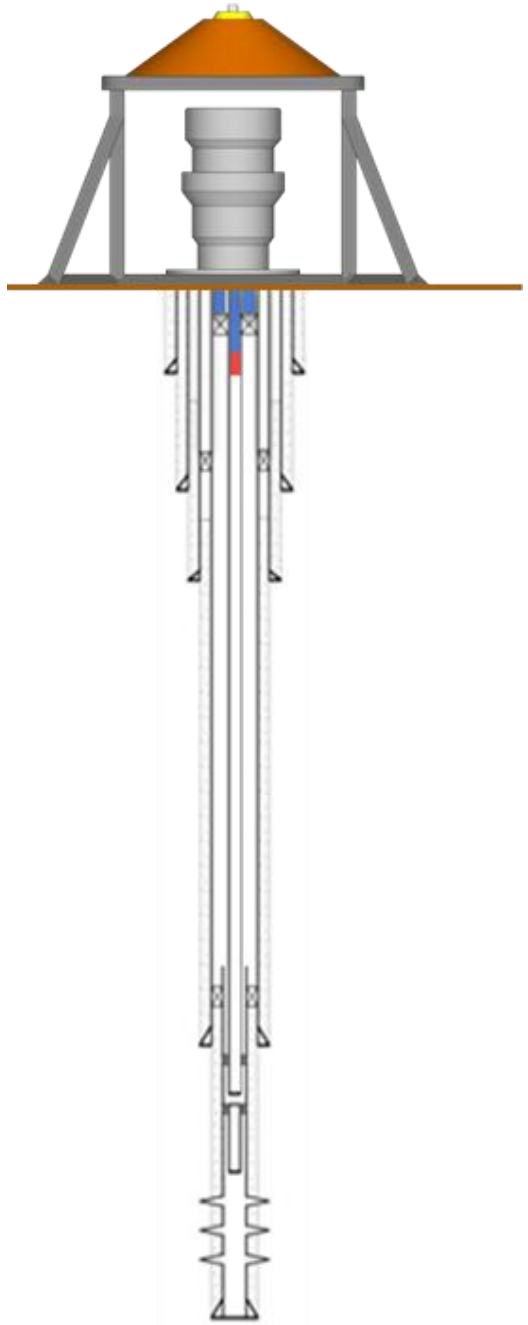
Pre-decommissioned Wells

CCUS wells

Example Deployment 1.

Shut-in Well

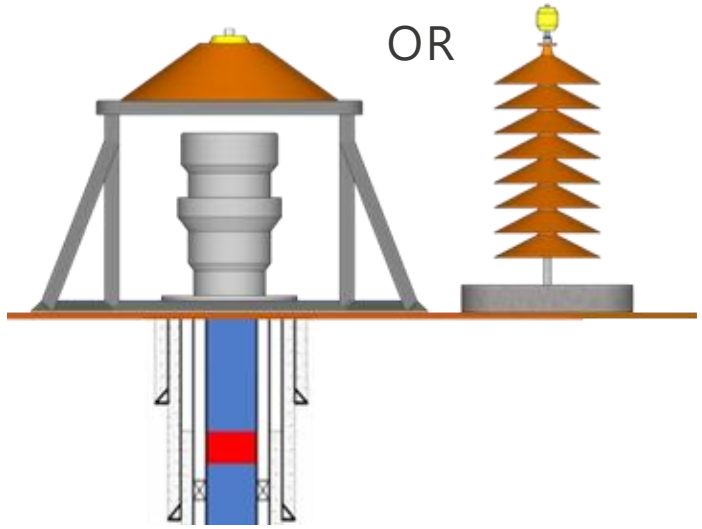
- Ability to remove infrastructure whilst complying with regulatory well inspection requirements
- “Park” appraisal and development wells prior to full field development
- Easy suspension of exploration wells, optimising rig scheduling

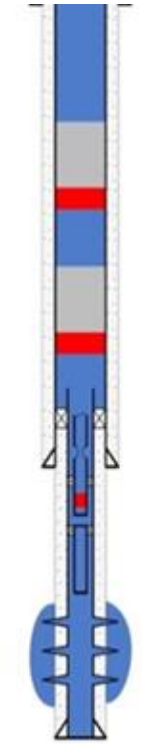


Example Deployment 2.

Suspended Well

- infrastructure whilst complying with regulatory well inspection requirements
- Defer full abandonment operations and conduct as part of wider P&A campaign
- Provide extended validation of new barrier techniques or as part of a CCUS programme





Technical Validation.

- ✓ Extensive verification and testing completed at Heriot-Watt University and Sentinel Subsea Facility
- ✓ Onshore Field Trials completed August 2019
- ✓ 2 week Offshore Field Trial completed October 2019

Technical Validation.

Noble Hans Deul Field Trial

Southern North Sea
Andromeda Well
September – October 2019

- ✓ 6 system deployments and function tests
- ✓ Prove concept of well material capture and varied deployment set-up
- ✓ Verified trigger housing and locking mechanisms ability to work at depth
- ✓ Trigger simulated in real benthic environment with capture rates tested

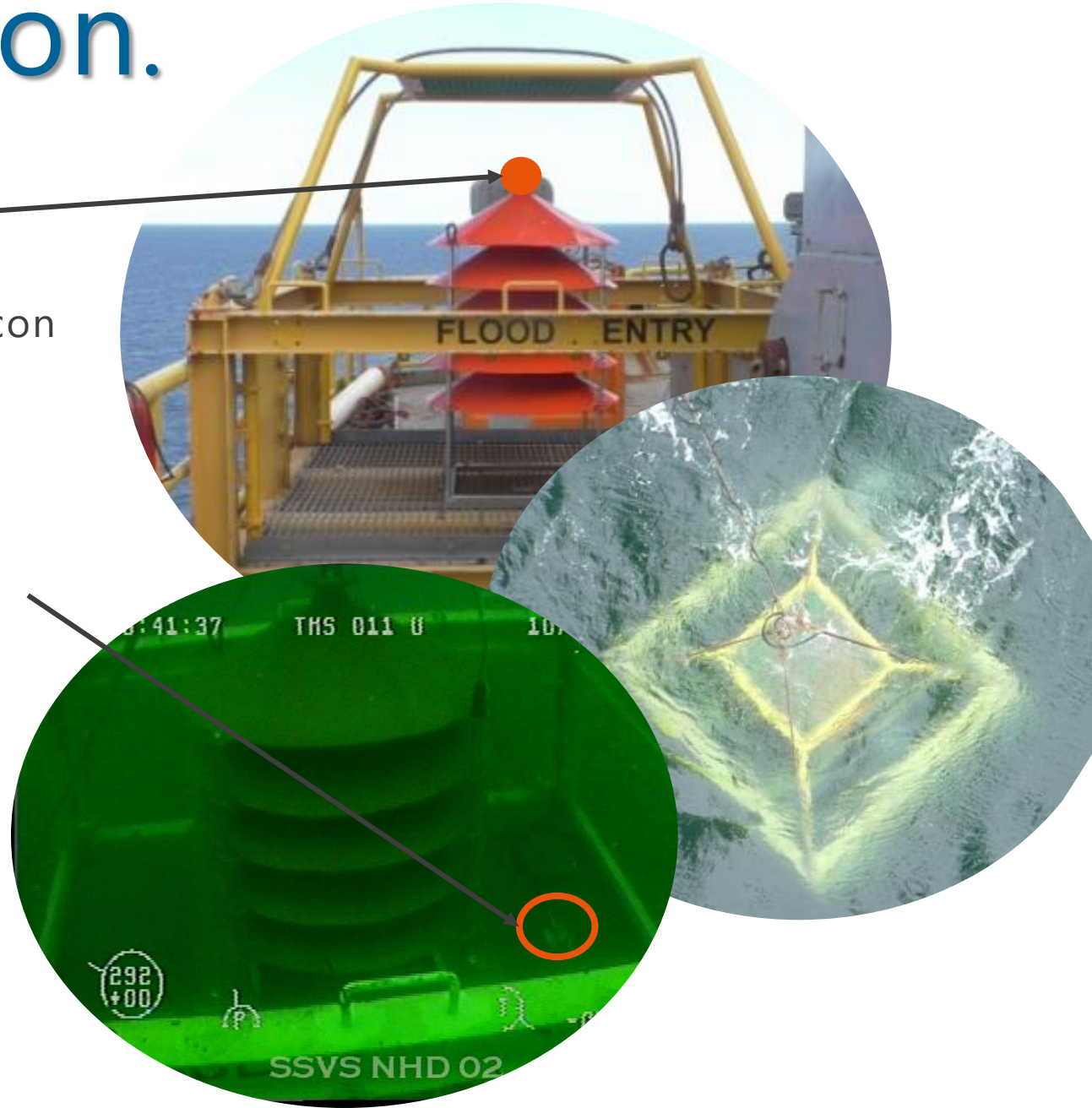
Technical Validation.

Trigger Housing/Locking Mechanism

Trigger material housed within simulated beacon and locking mechanism

Simulated Loss of Containment (LoC) Nozzle

A tank of material on the rig was used to simulate a loss of well containment by pumping directly to the skid and releasing known volumes over measured periods



Technical Validation.

Capture Rate.

1 bbl / day = 159 litres / day

@ 10% SWIFT = 15.9 litres pd

If only captured during slack water (4 hours pd)

If 10% of leak captured at SW,
Σ SWIFT = 265 ml pd

If 1% of leak captured at SW,
Σ SWIFT = 26.5 ml pd

For 40 ml @ 26.5 ml pd
= 1.5 days

Next Operation.

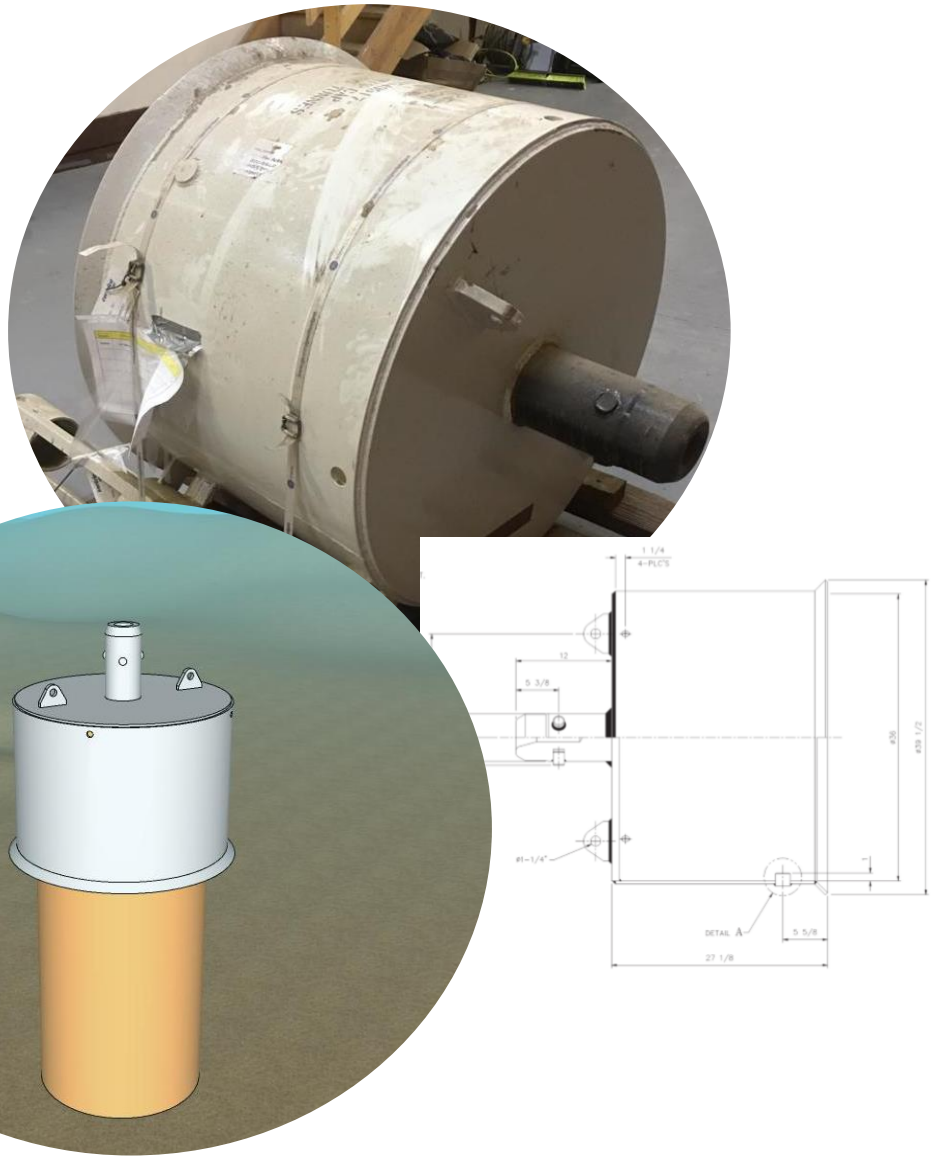
Current Situation

Development Well Suspended for 5 years with 3 Mechanical Plugs, Mudline Suspension System and Temporary Abandonment Cap

Final Development deferred for an undefined period of time.

Options

- ❑ Increased inspection schedule
- ❑ Install additional gauges
- ❑ Install additional barriers
- ❑ Install Modified TA Cap with Sentinel System



Next Operation.

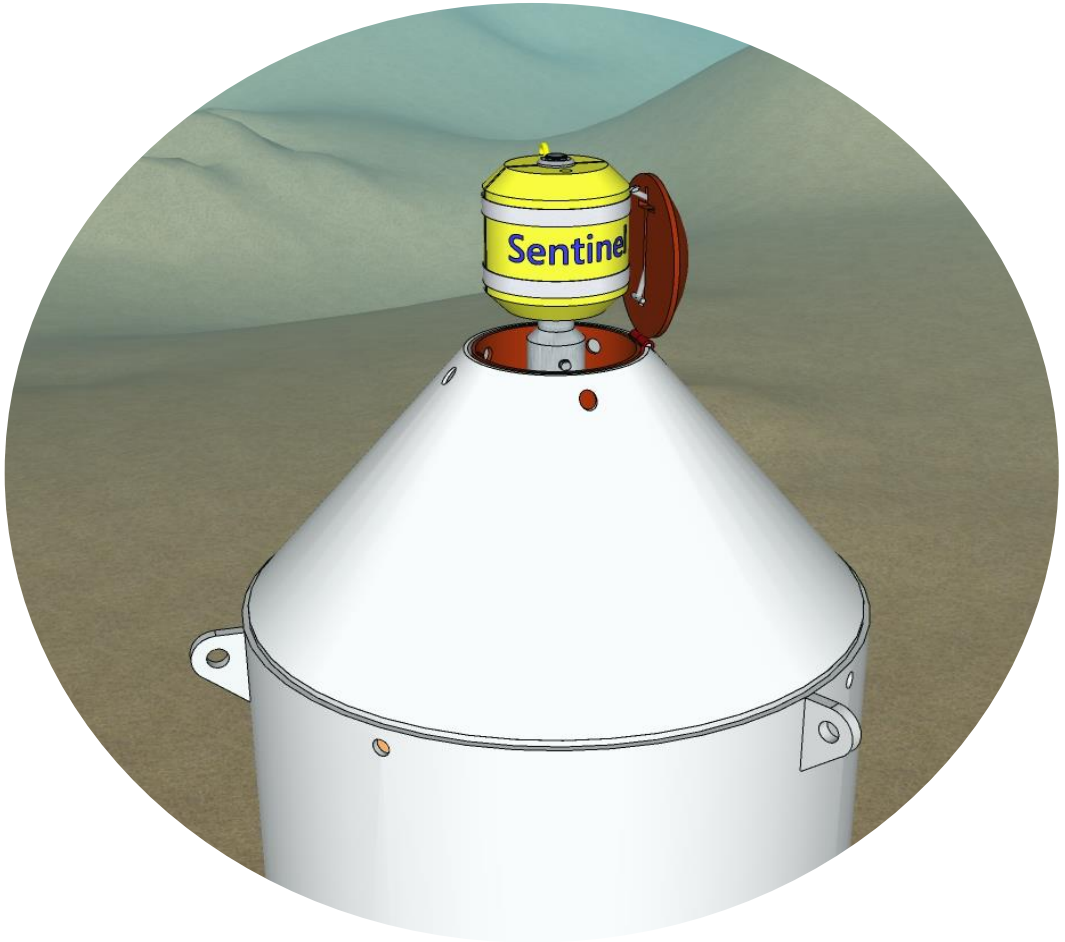
Operator Requirements

- ❑ Simple to deploy through the modification of the existing debris cap
- ❑ Capable of monitoring for hydrocarbon emissions
- ❑ Does not require any intervention in the well to deploy
- ❑ Provides an alert in a timely manner
- ❑ Does not require periodic system checks
- ❑ Capable of gaining all relevant environmental certification

Next Operation.

Deployment Date:

October 2020



Project Plan

Phase 1	Trigger Material Selection, Lab Testing & Finalised
Phase 2	System Engineering & Design System Testing & Validation
Phase 3	System Build & FAT
Phase 4	Offshore Installation

SENTINEL subsea

Reduce Cost.

Manage Risk.

Protect the Environment.