# $Qa^3$

# On - site Chemistry

16th ICMGP Cape Town 2024

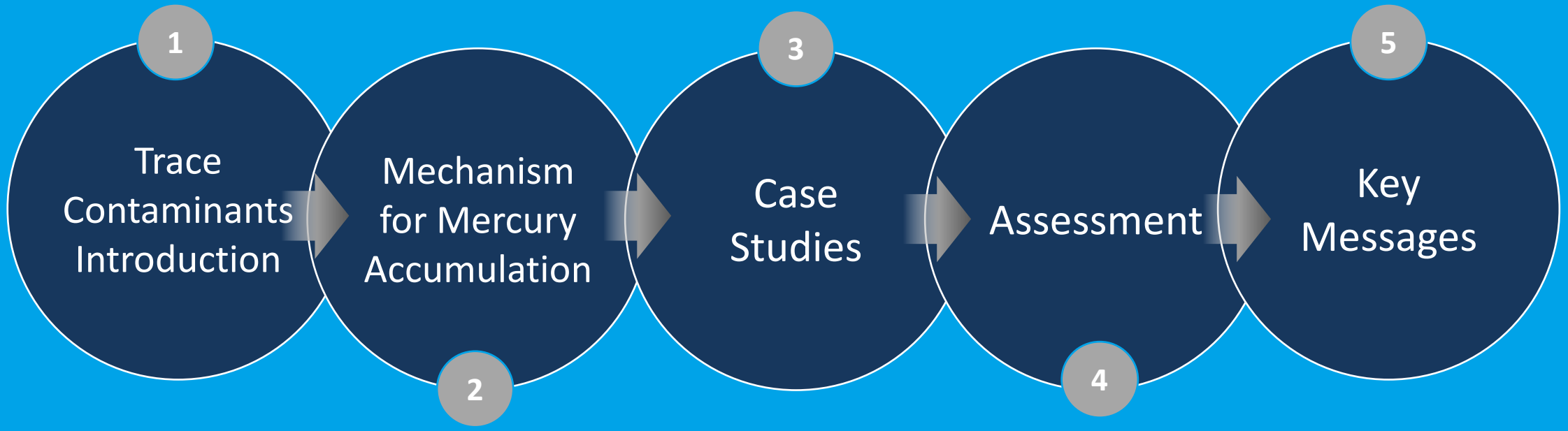
Hg

ICMGP 2024

CAPE TOWN • SOUTH AFRICA • 21 - 26 JULY

***The Assessment and Impact of Mercury on Oil and Gas Asset Decommissioning***

# Content Overview



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# Trace Contaminants Introduction

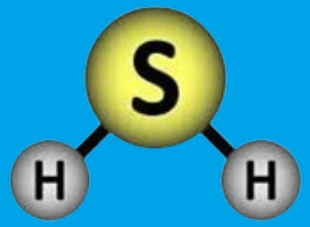
# Introduction to Trace Contaminants in Decommissioning

- One, often overlooked consideration, during decommissioning of assets within the oil and gas industry, is the deposition of toxic, natural contaminants within the scale that builds up on the internal surfaces of pipelines and vessels.

- Environmental and exposure implications if not taken into consideration.

Residual Hydrocarbons

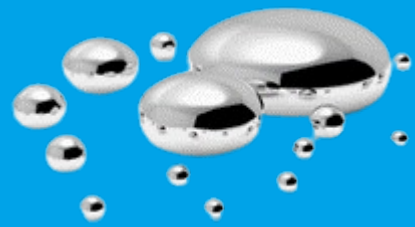
Sulphur





NORM

Arsenic



**Mercury**

- In the UK, where decommissioning has already commenced there is no requirement to assess mercury contamination before either abandonment on seabed or for sending steel onshore for smelting, all that needs to be confirmed is the steel is hydrocarbon and NORM free.

**Australia is in the early stages of decommissioning, but here the issue of mercury has been recognised and discussions with regulators are ongoing.**

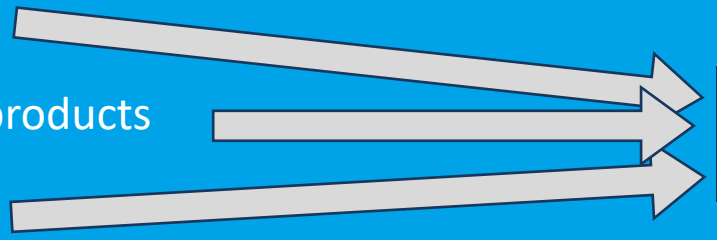
# Mercury During an Asset's Operational Life

- Depending on the export specifications, assets may have historically had mercury determinations undertaken.

If historic mercury concentrations in the products were **HIGH**

If mercury was never determined in products

If historic mercury concentrations in the products were **LOW**



Mercury **must** be addressed during decommissioning

- Even if concentrations in products are considered to be low over the asset's lifetime, this may still lead to significant masses on the internal surfaces of pipelines and vessels. *Example; A gas with 1 µg/m³ mercury and a total lifetime production of 2 trillion cubic metres = ~* ***2 tonnes*** *of mercury produced.*

- This doesn't apply to equipment downstream of any Mercury Removal System installed from start-up (and never saturated).

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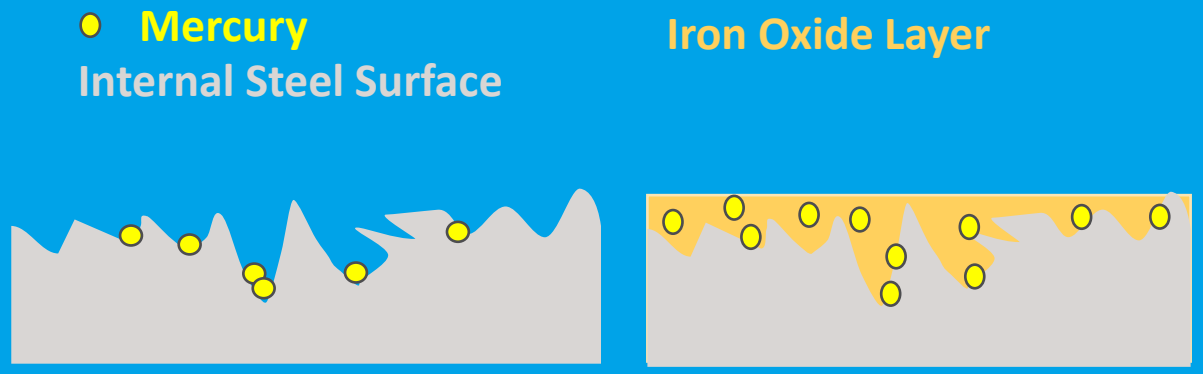
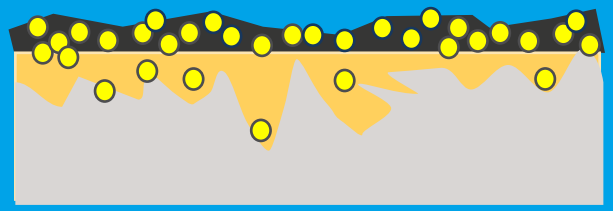
# Mechanism for Mercury Accumulation

# Mechanisms for Loss of Mercury to Pipelines and Infrastructure




**Adsorption onto or Absorption into Steel or Corrosion Product**

Mercury could be adsorbed onto surfaces via microscopic imperfections in the steel (e.g. cracks or fissures) or onto iron oxide. Mercury may also permeate (absorb) into an oxide layer eventually contacting the steel surface.




**Reaction with Other Components / Chemisorption**

Mercury may be removed from the gas or oil by chemical reaction with other components on the internal surfaces (e.g. iron sulphide formed from reaction with $H_2S$ and iron oxide will react with mercury to form stable mercuric sulphide).

$FeO_2 + 2H_2S \Rightarrow FeS_2 + 2H_2O$

$FeS_2 + Hg^0 \Rightarrow HgS$ (bound within the scale layer) + FeS

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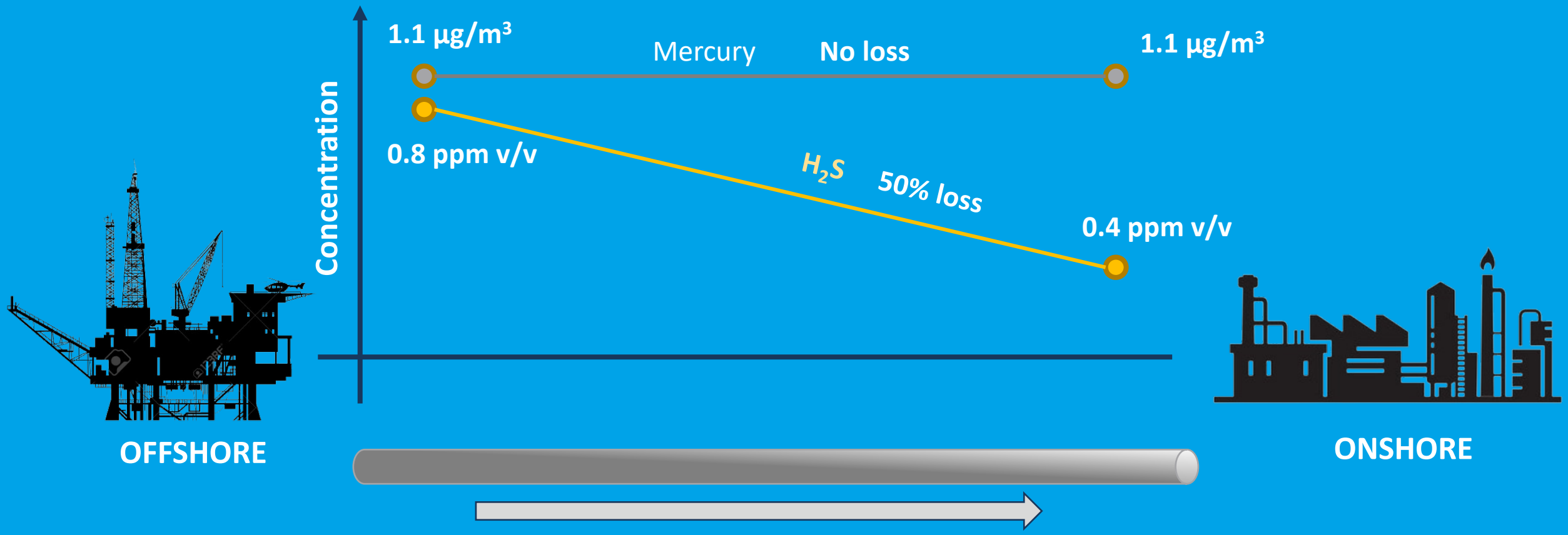
# Case Studies

# Deposition of Mercury with Time

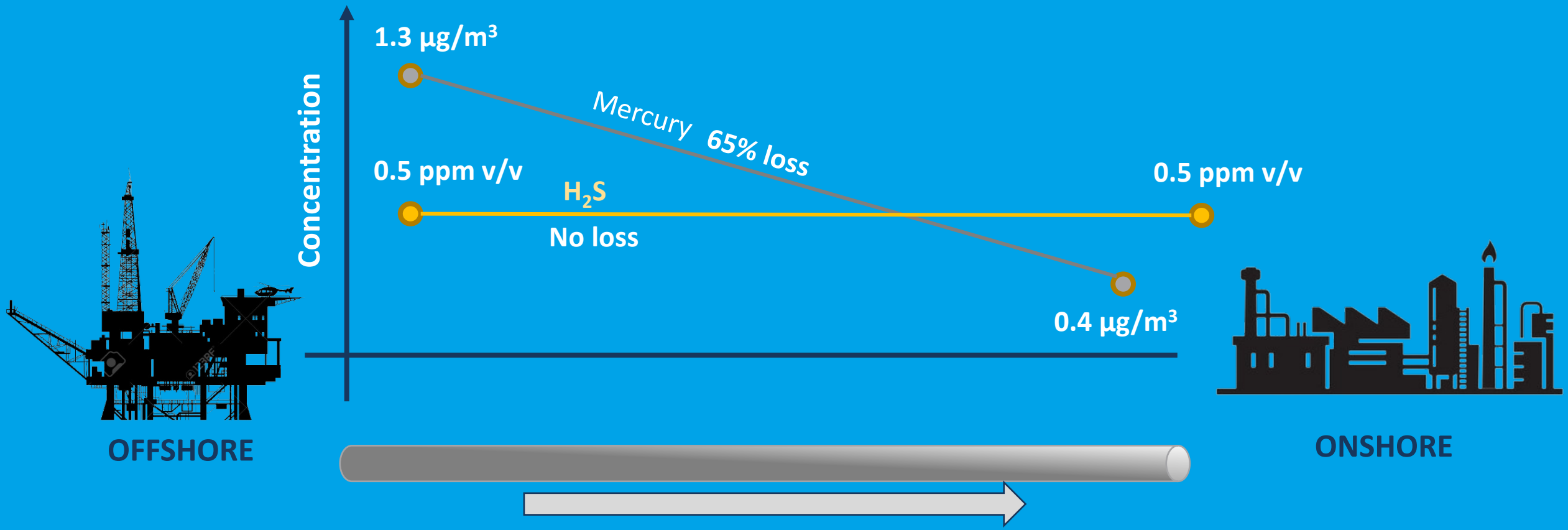
- **CASE STUDY** 1 – Caribbean Gas Producer

**2018 (start up)**



# Deposition of Mercury with Time

- **CASE STUDY** 1 – Caribbean Gas Producer **2022**



# Loss of Mercury Across a Process

- **CASE STUDY** 2 – SE Asia Oil and Gas Producer

# Loss of Mercury Across a Process

- **CASE STUDY** 2 – SE Asia Oil and Gas Producer

458 µg/m³

31 µg/m³

Mercury Removal Unit

Methane /Ethane to Export Pipeline

Gas

Oil and Gas from Wells

Gas Oil and Water Separator

Gas Processing

(Dozens of Vessels and km's of pipeline)

~ 70% Mercury Loss to Process

0.5 Tonne over 20 Years

150 µg/m³

LPG to Fuel Gas /Flare

Water

Oil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Assessment

# Assessment of Mercury

## Pre Cessation of Production

A pre-cessation investigation will provide information on the mercury content of the fluids and identify where mercury is likely to have accumulated across a process.

## Post Cessation of Production

A post cessation study can be undertaken to quantify the concentration of mercury within vessels and on internal surfaces of infrastructure and to determine if a suitable decontamination programme is required.

**Decontamination Not Required**

## Validation of Decontamination

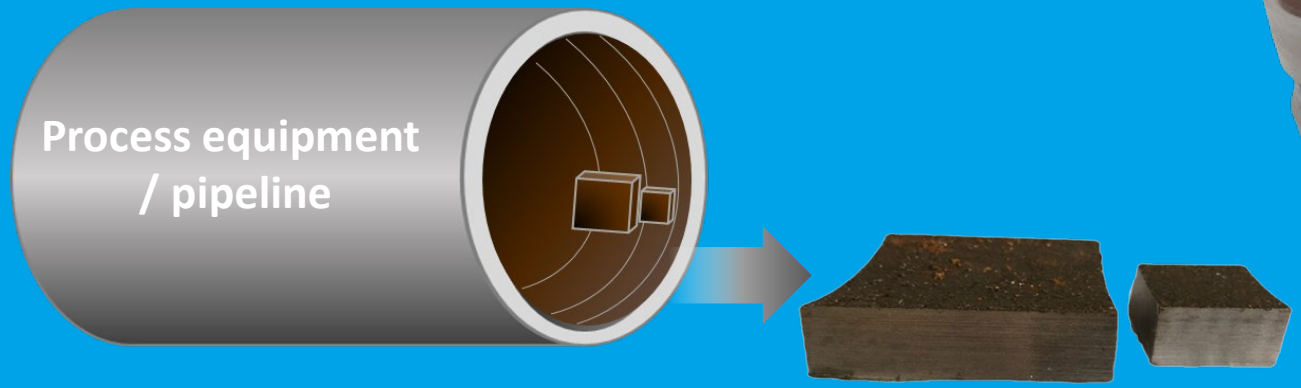
To determine if the decontamination has achieved the required regulatory concentrations

# Quantification of Mercury

## Qualitative / Semi Quantitative Analysis

- pXRF can be a powerful, quick and easy to use tool to determine if you have high or low mercury present
- pXRF cannot be used to give definitive mercury concentrations within your infrastructure


**Mercury in Scale Standards**

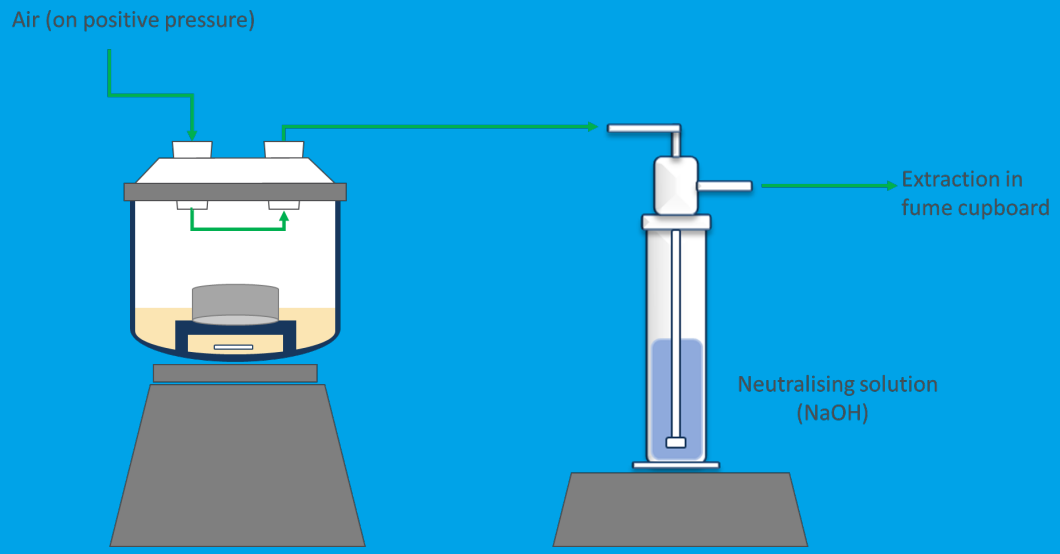



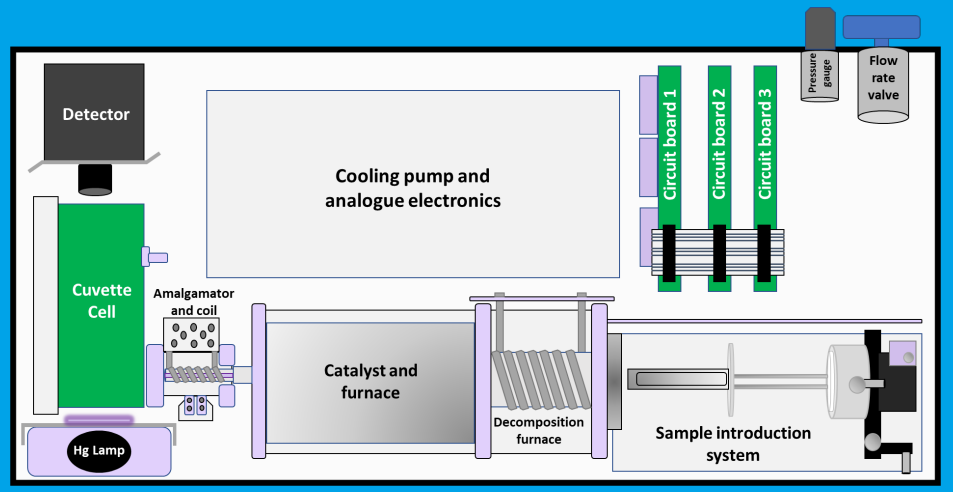

**Coupons cold cut to allow analysis of internal scale layer**

# Quantification of Mercury

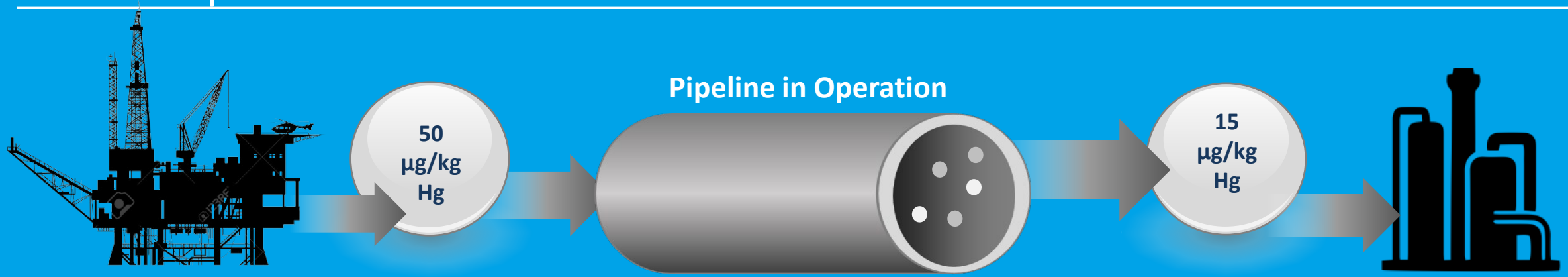
## Quantitative Analysis

- Cold cutting of coupons followed by acid digestion to solubilise all the mercury with subsequent detection of mercury in the digest solution by Atomic Absorption Spectrometry (AAS) provides accurate quantification of mercury present.
- Consideration should be given to the representativeness of the sample and samples should be taken from across a system or pipeline
- Speciation can be undertaken to assess extent of bioavailability (functional / molecular speciation techniques)



# Fate of Pipelines




## Leave in Situ on Sea bed

*(no decontamination)*

Release of mercury into aquatic ecosystems as the pipeline degrades over a long period of time

*(decontamination undertaken)*

Minimal release of mercury. Mercury is removed in decontamination treatment and is safely disposed of

## Lift and Send for Smelting

*(no decontamination)*

Potential release of mercury into the environment and possible worker exposure

*(decontamination undertaken)*

Minimal release of mercury within environmental and exposure limits

# Potential for Release to Atmosphere and Worker Exposure During Smelting

**10 km of Decommissioned Pipeline**
**Mercury Content = 20 mg/kg (ppm)**

**Smelted in Arc Furnace**

**Total Mercury Emitted to the Environment**

**11.4 kg**

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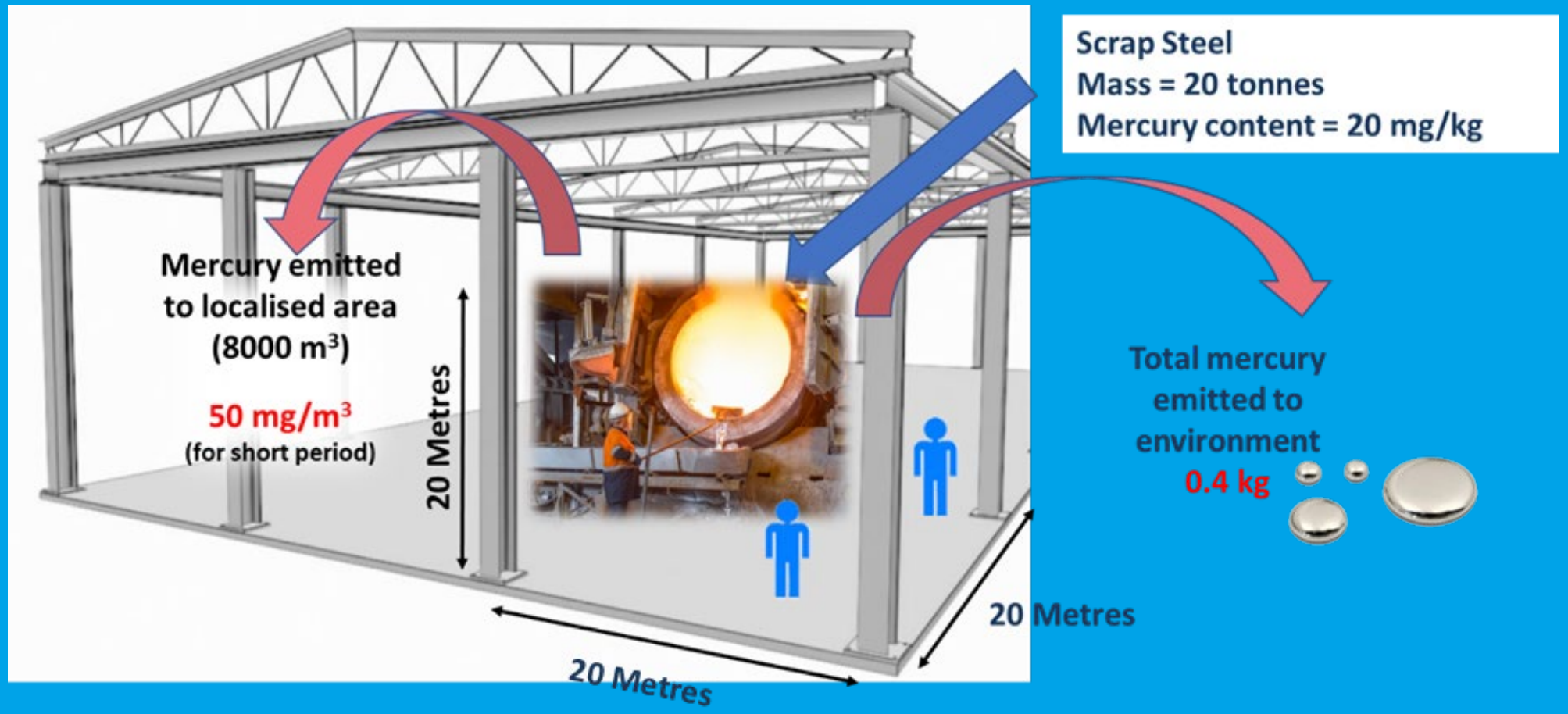
# Potential for Release to Atmosphere and Worker Exposure During Smelting

**Steel contaminated with 20 mg/kg (ppm) smelted as 20 tonne single batch**

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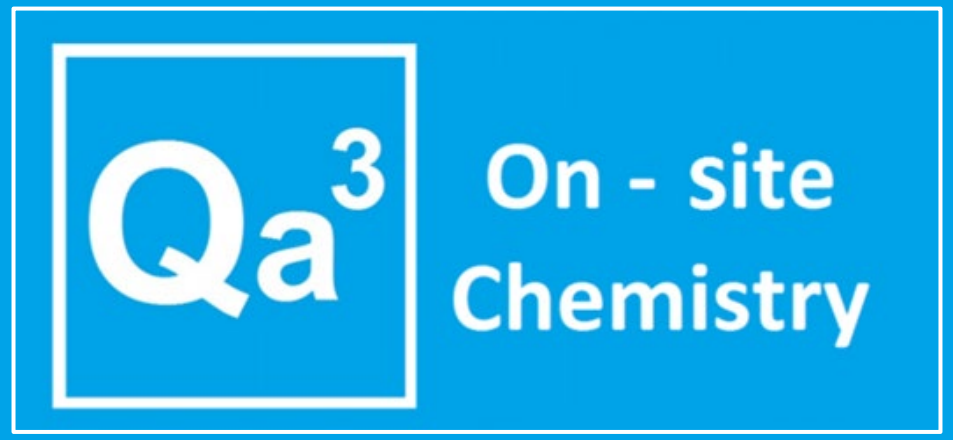
Key Messages

# Summary

- Consideration must be given to mercury (and other trace contaminants) at asset end of life
- Mechanism for accumulation is primarily reaction with iron disulphide to form mercury sulphide which remains bound within scale
- Assessment of mercury can be undertaken pre-cessation, post cessation and after decontamination
- Even at ultra trace concentrations mercury may have built up in aged systems to a significant mass (tonnes)

**The issue of mercury contamination in Oil and Gas infrastructure destined for decommissioning has been largely overlooked and is a global problem that the international industry and regulators need to address with some urgency**




# Thank you for your attention

**Presented by:**

Stuart Baker

On-site Chemist

Email: stuart.baker@qa3.co.uk
Office: +44(0)1256 397390
Mobile: +44(0)7976916622