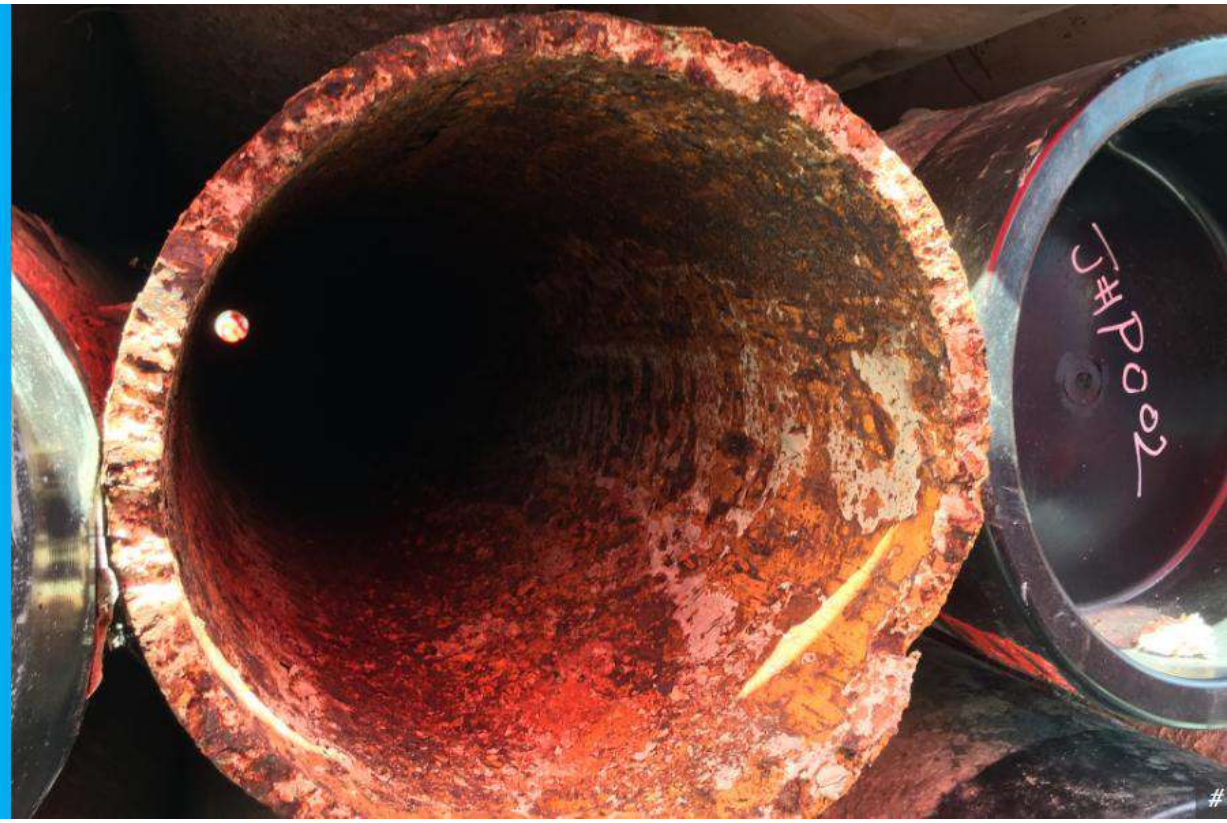
WEBINAR

Mercury from Contaminated Steel in the Oil and Gas Industry: Challenges with Analysis, Waste Treatment, Disposal and Recycling

15 September - 14 October 2026
Online, 13:00 -15:00 CEST



The 1st Webinar: Hg in Steel – The Problem
Tuesday 15 September 2026 - 13:00 -15:00 CEST

A Brief Introduction to Global Mercury Partnership Waste Management Area (GMP-WMA)

Taishi Kawamura
Secretariat, WMA
EX Research Institute Ltd.

Overview of the Waste Management Area (WMA)

Co-Leads

- Dr. Misuzu Asari (Professor, Research Institute for Humanity and Nature, Japan)
- Ministry of the Environment, Japan
  supported by EX Research Institute, Ltd. (WMA Secretariat)

Objective of the WMA

- Promote the environmentally sound management (ESM) of mercury wastes through,
  - Development and dissemination of relevant technical and informational materials
  - Supporting capacity building and awareness raising among stakeholders
  - Providing specific solutions at the global, regional, national, and local level

Activities of the Waste Management Area

- The WMA carries out activities on: (1) the development and dissemination of relevant information materials; (2) capacity building and awareness raising; and (3) the provision of practical, field-based solutions, aiming to promote the sound management of mercury waste at all levels.
- Activities are guided by the Business Plan (annual update).

1



Information materials

- Catalogue of Technologies and Services on Mercury Waste Management
- Factsheets for the ESM of mercury waste
- Case studies on the transboundary movement of mercury waste

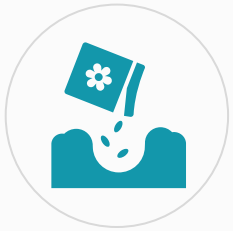
2



Capacity-building

- Webinars on the ESM of specific mercury waste stream
- Webinars to introduce the WMA
- Webinars in collaboration with the Minamata Convention, the Basel Convention and other partnership areas of the GMP

3



Consultation for solution

- Online consultation desk to connect stakeholders facing challenges on mercury waste with WMA partners

Webinars

- WMA organizes thematic webinars on issues relevant to waste management.

Upcoming webinars



- **Hg in Steel – The Problem** (Tuesday 15 September 2026 - 13:00 -15:00 CEST)This webinar will focus on how mercury contamination occurs, its detection and measurement, and associated environmental and occupational concerns.
- **Hg in Steel – Learning from Global Approaches** (Wednesday 14 October 2026 - 13:00 -15:00 CEST)

  This webinar will explore practical experiences and approaches to the treatment, disposal, decontamination and recycling of mercury-contaminated steel from around the world.



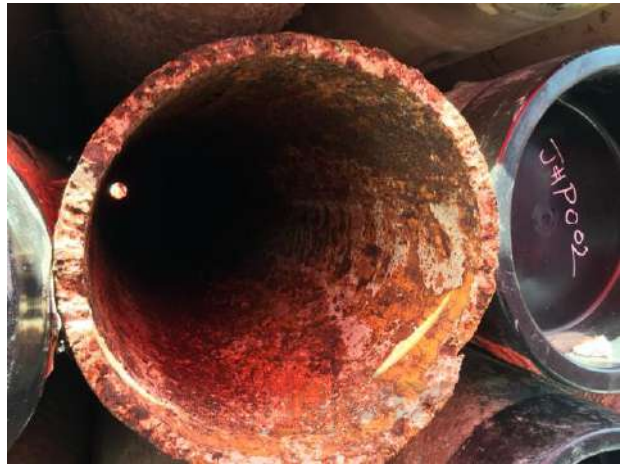
Registration:
https://www.unep.org/globalmercurypartnership/events/webinar/mercury-contaminated-steel-oil-and-gas-industry-challenges-analysis-waste-treatment



Hg in Steel

from the oil and gas decommissioning industry

The problem and why this matters



David Hunter

Hg Ops – The Mercury Specialists



Why is oil and gas decommissioning important to the **Global Mercury Partnership**?

Human health



The objective of the **Minamata Convention** is to protect the **human health** and the **environment** from anthropogenic emissions and releases of mercury and mercury compounds.



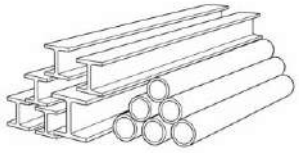
The Environment

Mercury waste and recycling of mercury contaminated steel

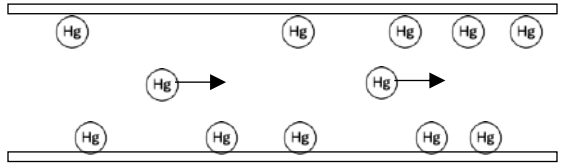
HgOps

GLOBAL MERCURY PARTNERSHIP

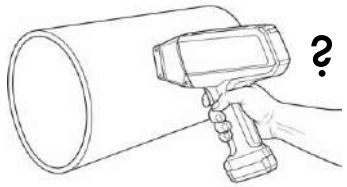
Why is oil and gas decommissioning important to the **Global Mercury Partnership**?



898 million tonnes of steel*



Tiny amounts of Hg can build up over lifetime



Challenges in measurement, understanding & mitigating



Potential for human exposure and local environmental releases

* From 2020-2050. Recycling fossil infrastructure for cleaner energy transitions (Schlesier et al 2026)

HgOps

GLOBAL MERCURY PARTNERSHIP

Why is oil and gas decommissioning important to the **Global Mercury Partnership**?

The issue

Knowledge gaps & lack of transparency

Mercury not priority

High costs

Human exposure potential

Local environmental release potential

Regulatory development slow

Good news

Expertise growing globally

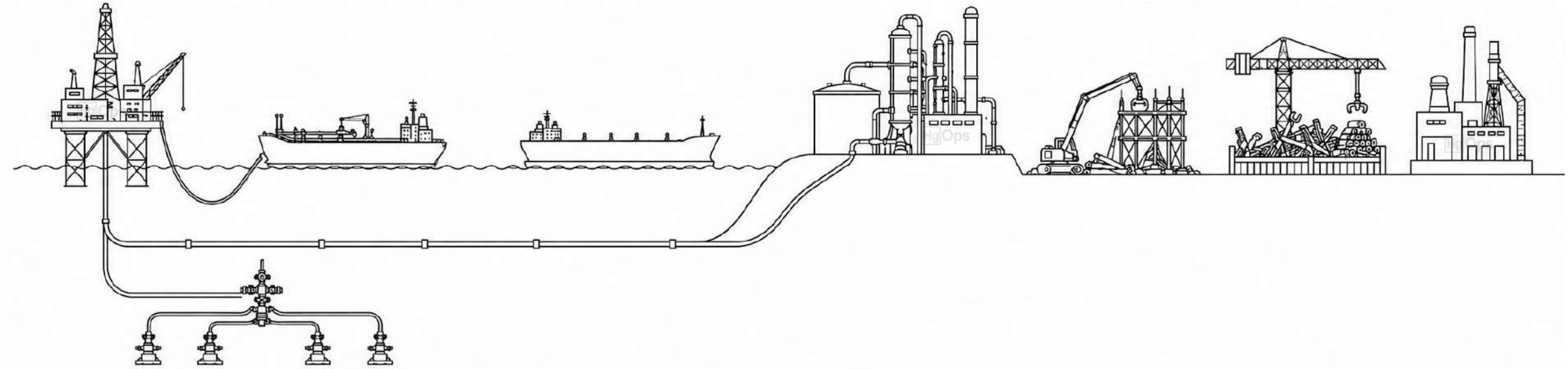
Oil majors improving practice

Industry developing solutions

Awareness raising & Knowledge sharing

Development of mercury waste treatment

Becoming more widely discussed

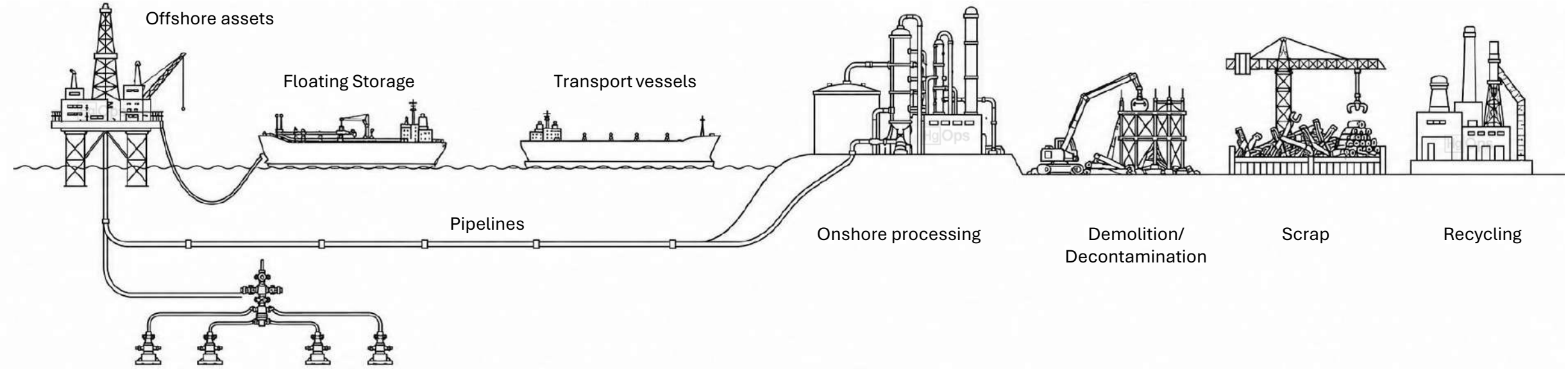




Mercury can be found across the oil and gas value chain

Mercury can be found in all geographic areas

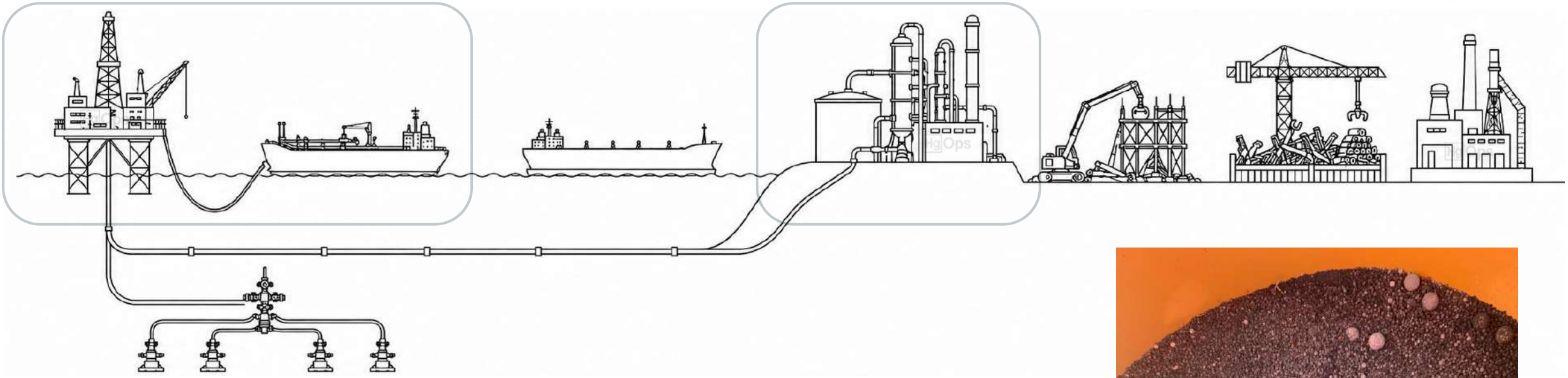
Some wells, fields or geography more concentrated than others



Decommissioning value chain

Potential for exposure and release of Hg

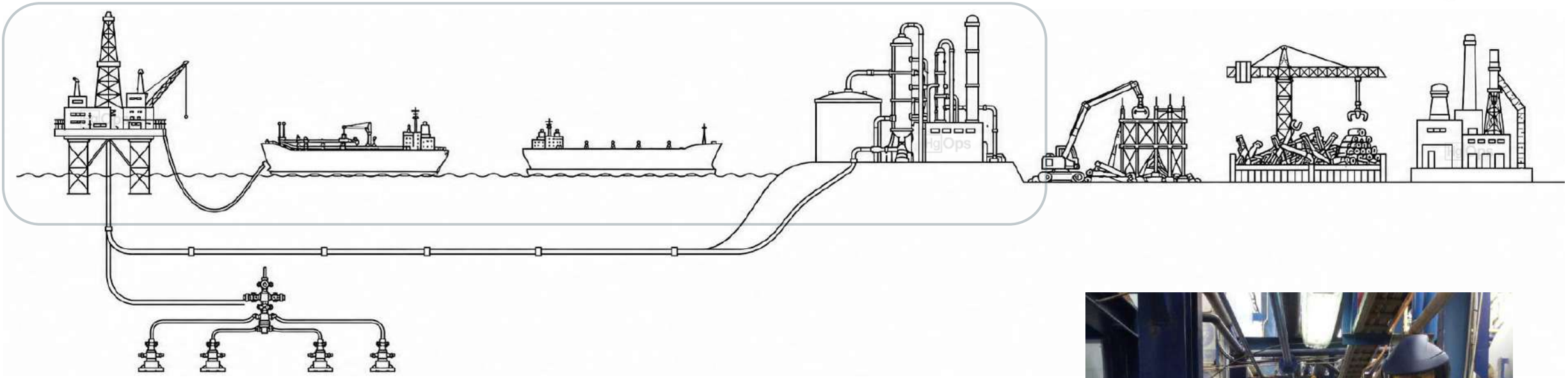
Generation of complex mercury waste streams





Removal of filter media and adsorbants

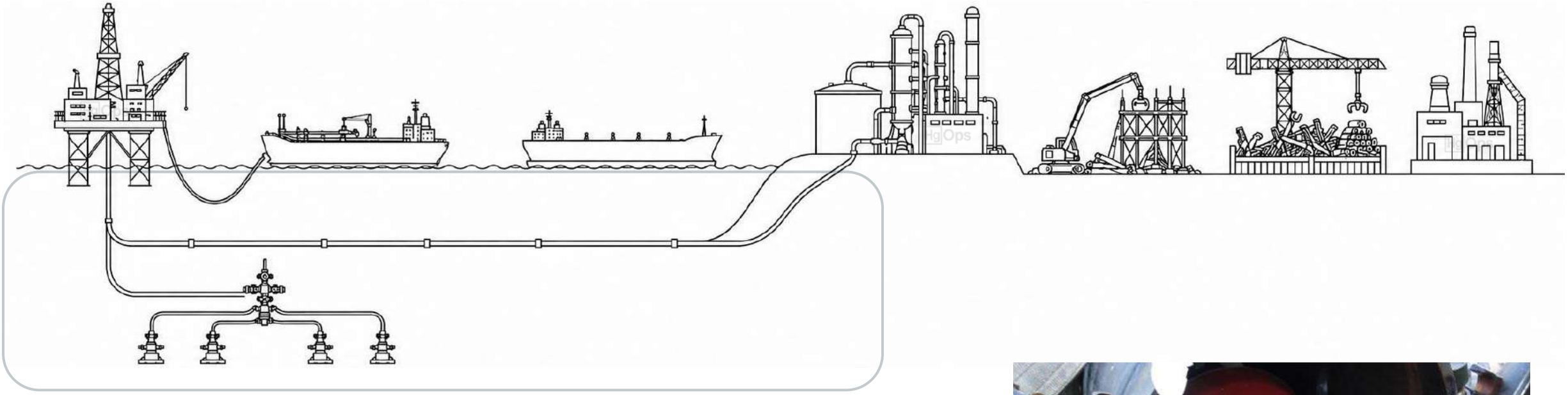
Complex mercury wastes





Initial Cleaning, flushing and decontamination

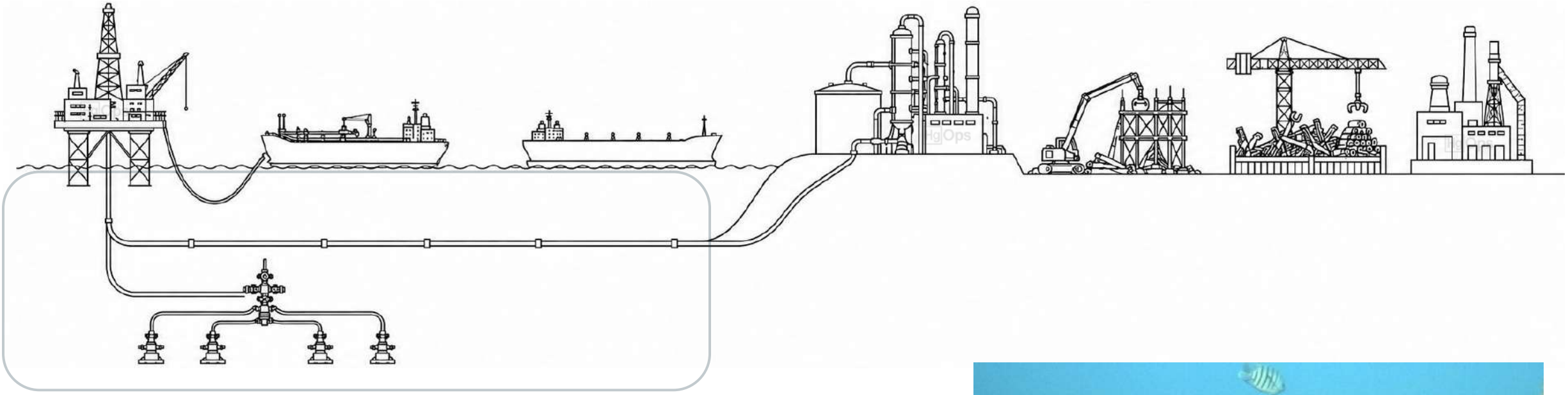
Pockets of liquid mercury, exposure to workers, mercury waste





Pigging of pipelines

Generates sludges which may contain mercury

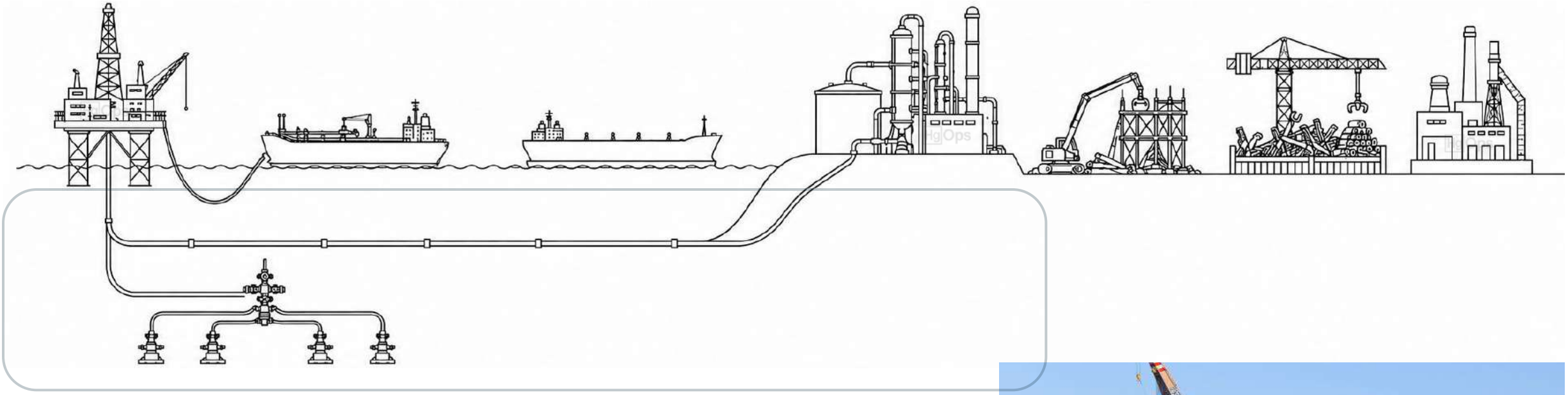




Leaving subsea infrastructure in-situ “Rig-to-reef”

Potential for environmental damage or benefits

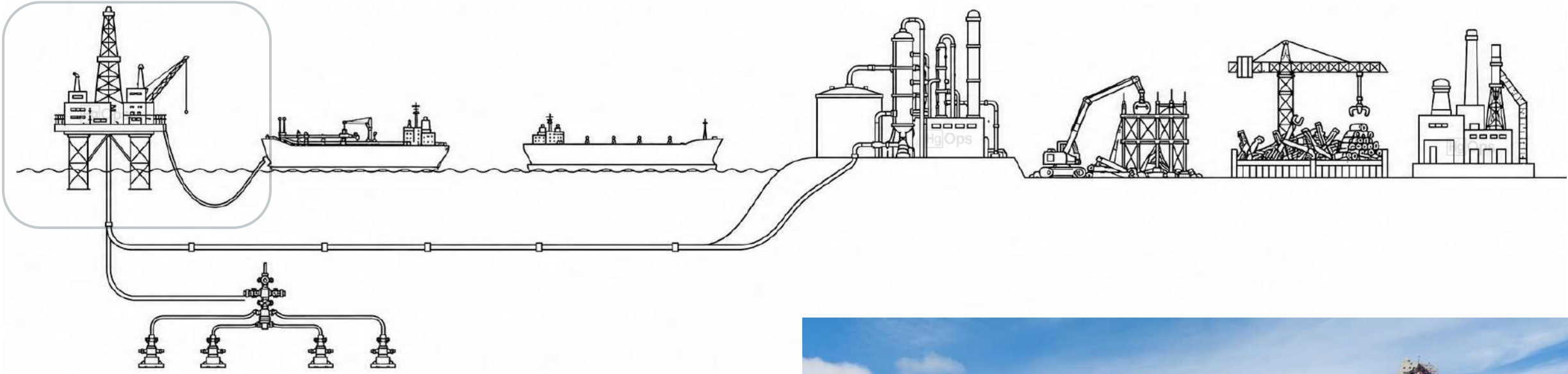
How to assess?



Pipeline and subsea infrastructure removal and cutting

Potential environmental exposure and contamination on vessels

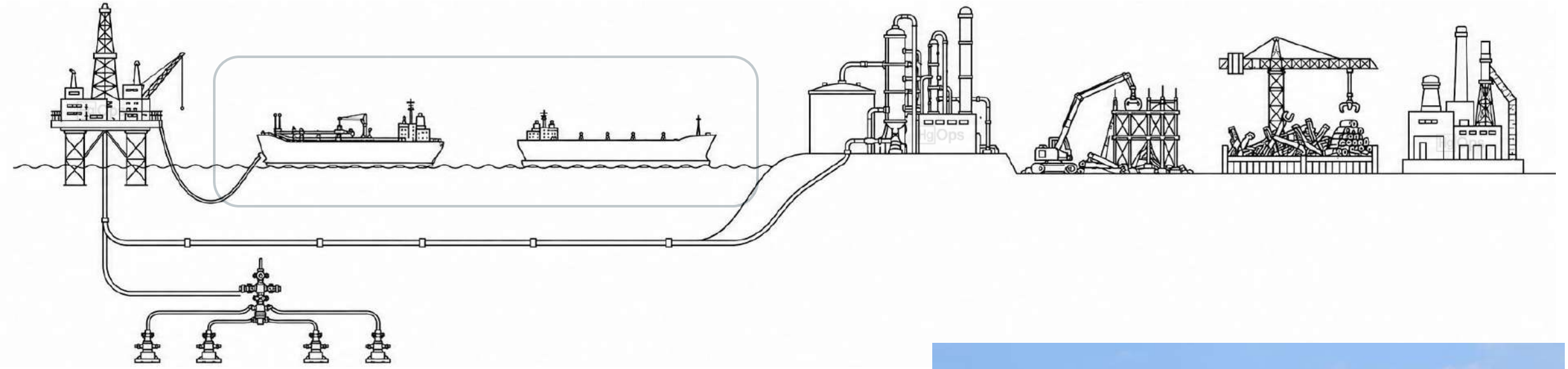




Removal of offshore structures

Human exposure during hot cutting

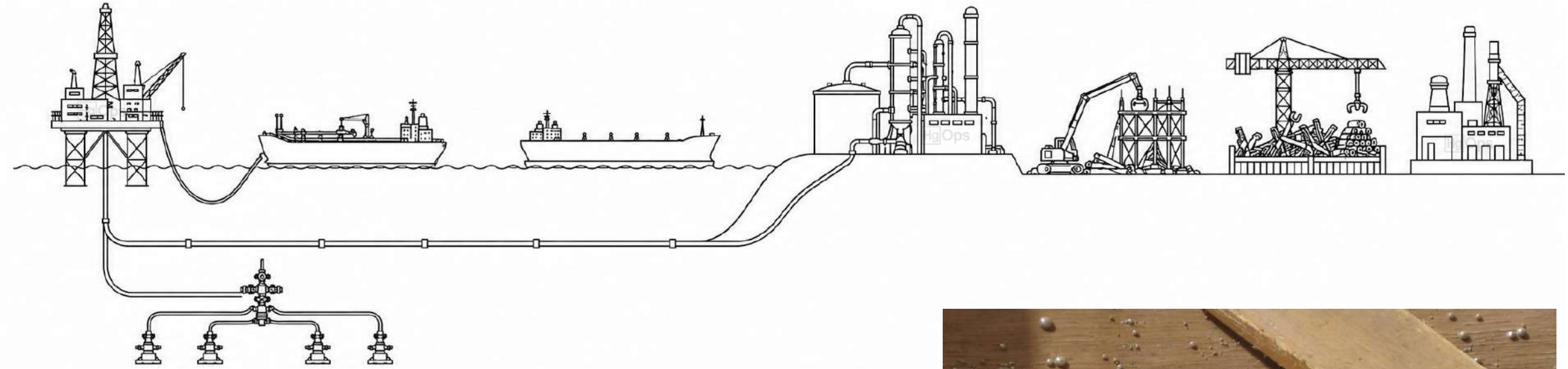




Vessel cleaning and decommissioning

Movement or resale of vessels before scrapping

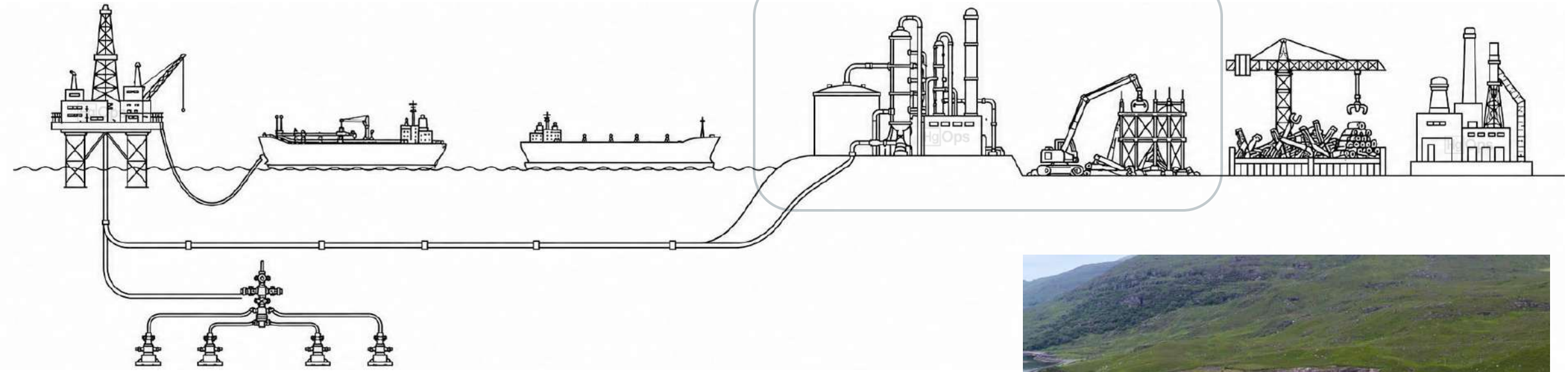




Mercury releases during transport

Contaminated equipment removed to shore



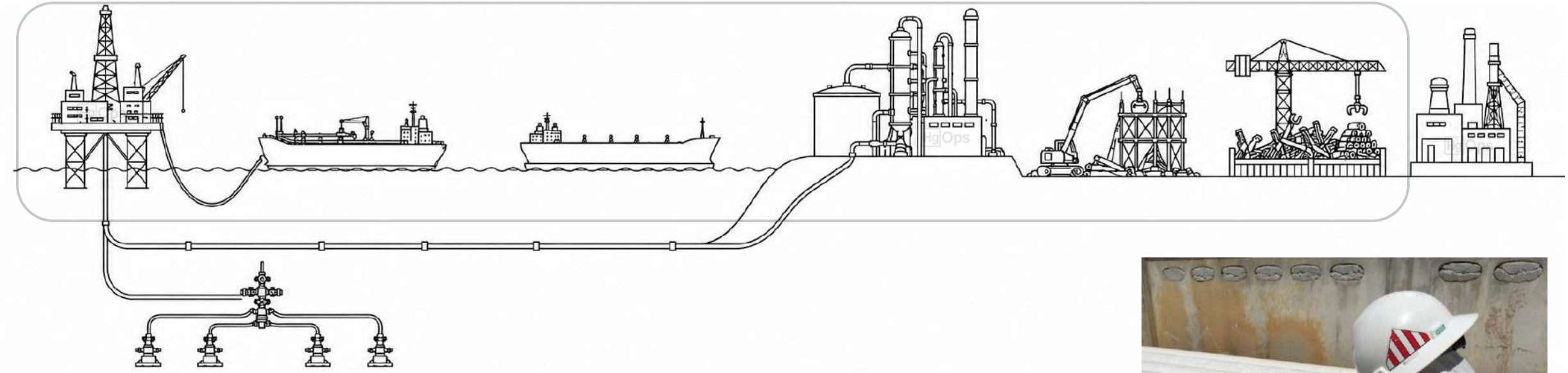


Demolition of assets onshore

Releases of mercury vapour during cutting

How detailed is the mercury survey?



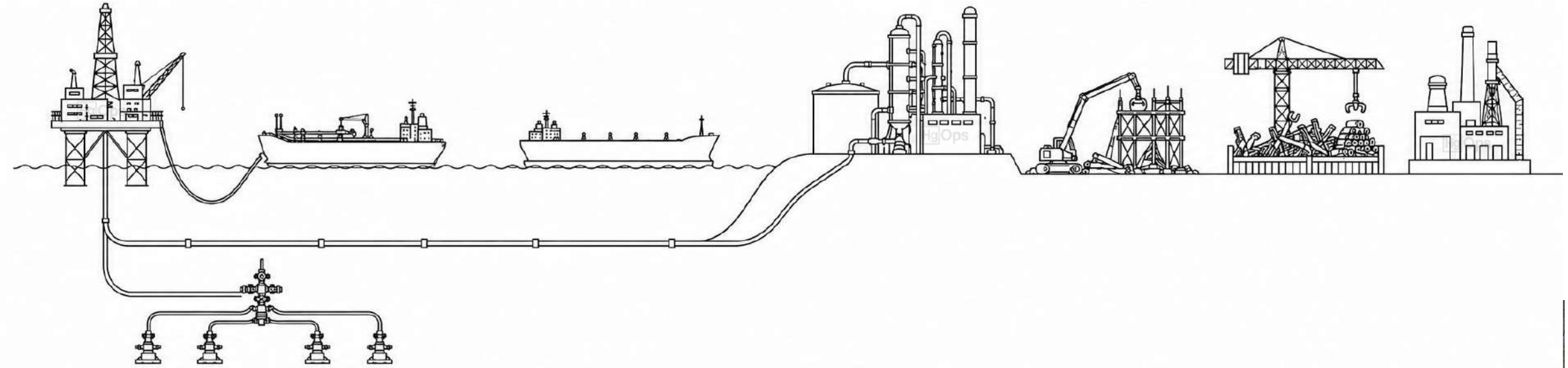




Measurement of Hg

Knowledge gaps and high cost of analysis

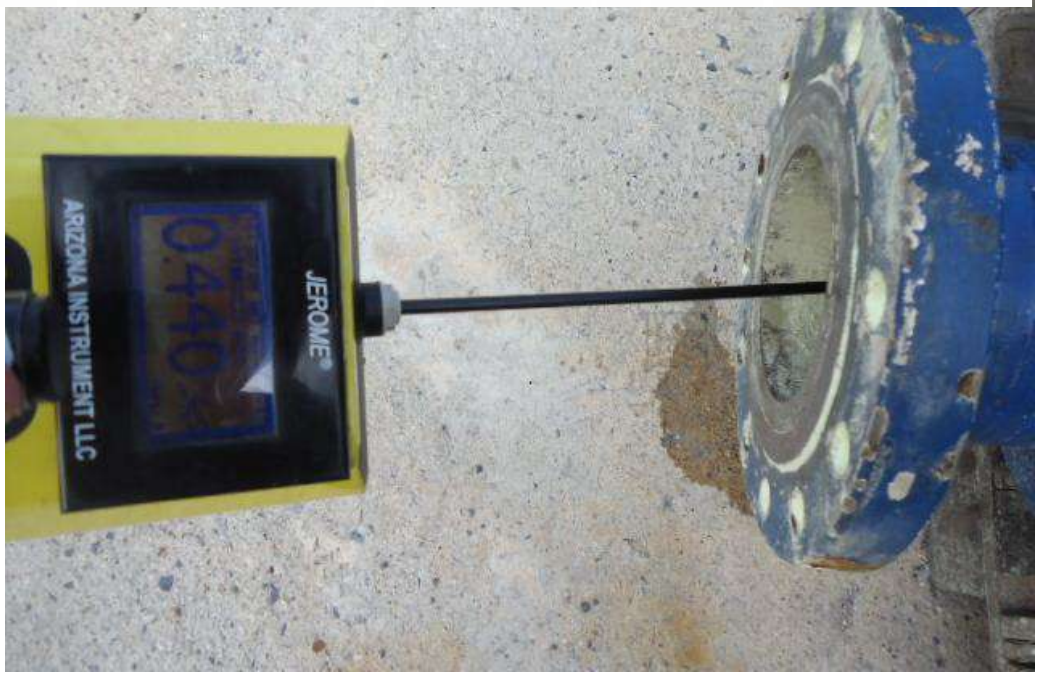
How many measurements to take? Who audits this?

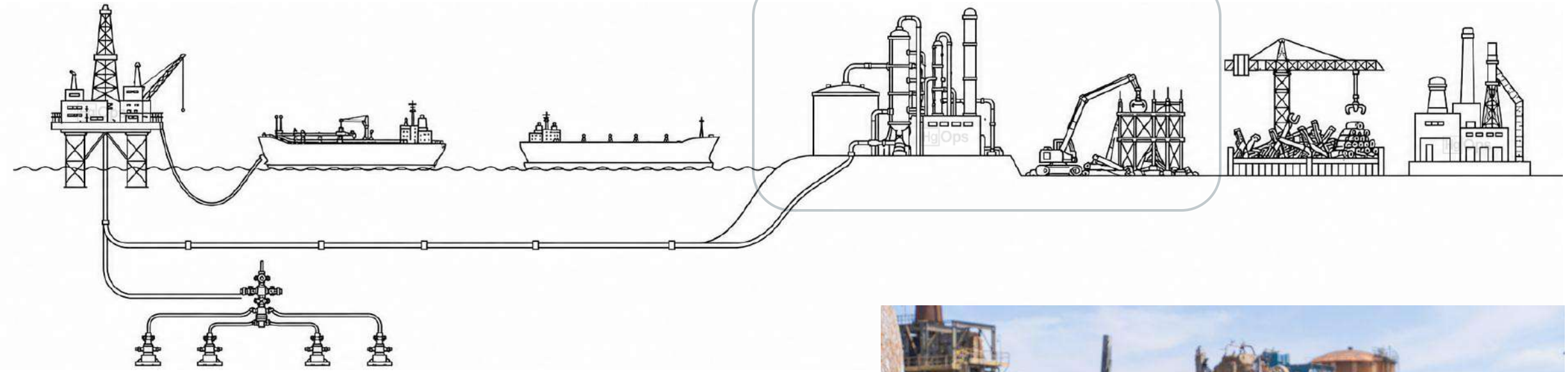


Mercury vapour exposure

Specialist equipment needed

Invisible and no smell



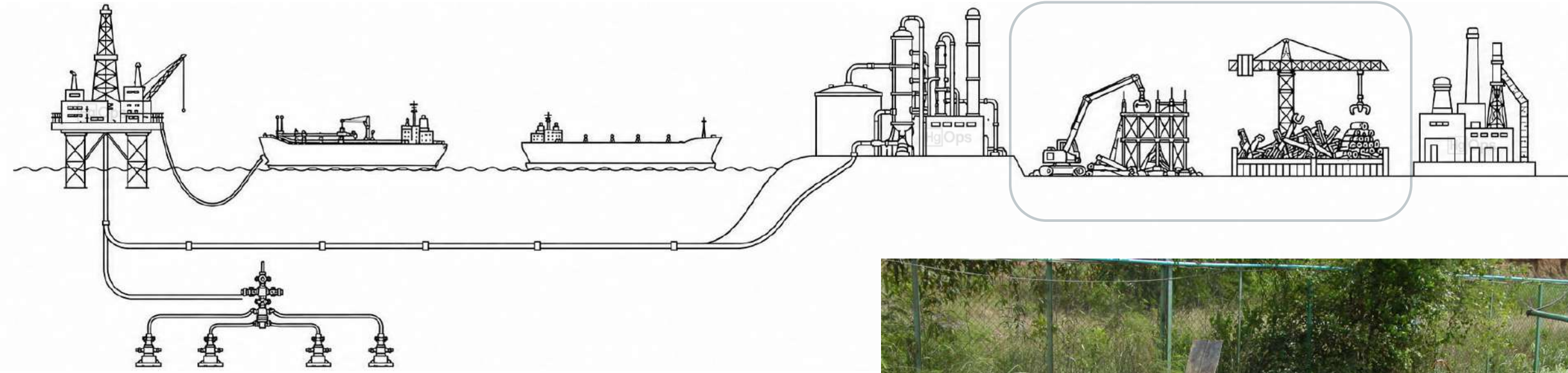


Demolition of assets onshore

Releases of mercury vapour during cutting

Human exposure risk



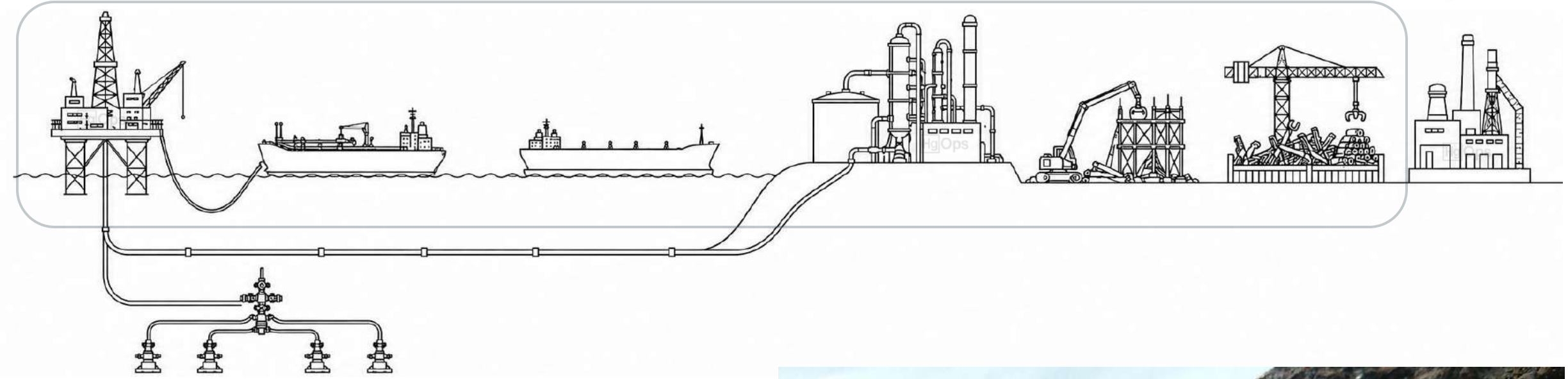


Cutting of steel for recycle

Releases of mercury vapour during cutting

Trapped fluids in complex parts



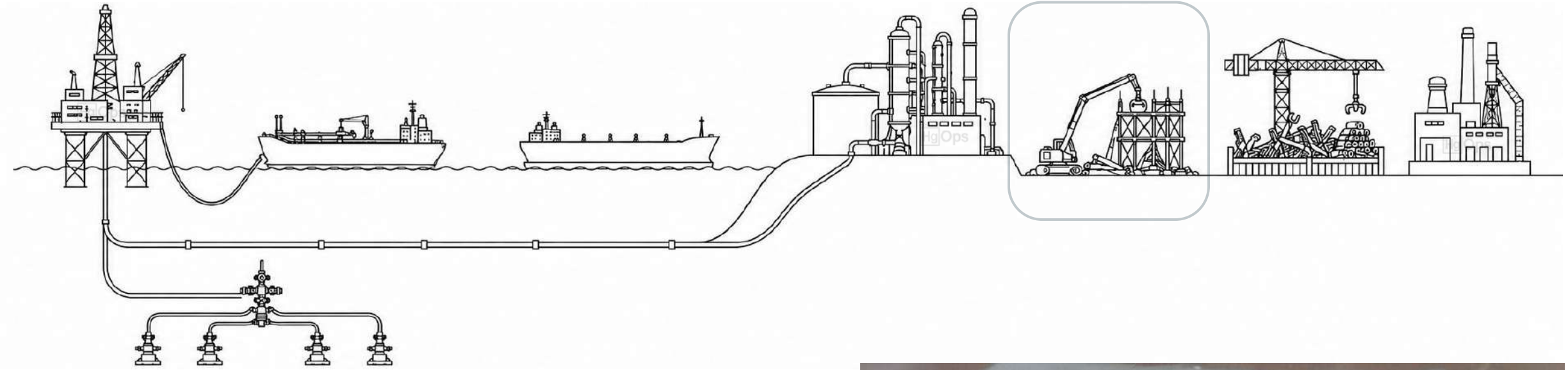


Mercury in steel surfaces

Knowledge gaps and high cost of analysis

Cost and experience in Hg removal



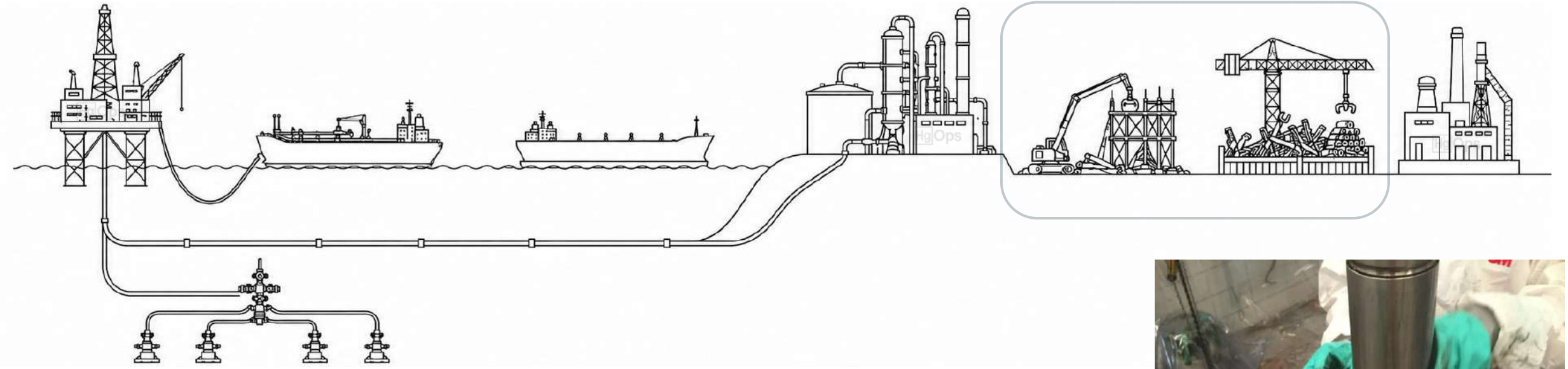


Decontamination of mercury from steel

Knowledge gaps and high cost

Vapour releases and waste generation





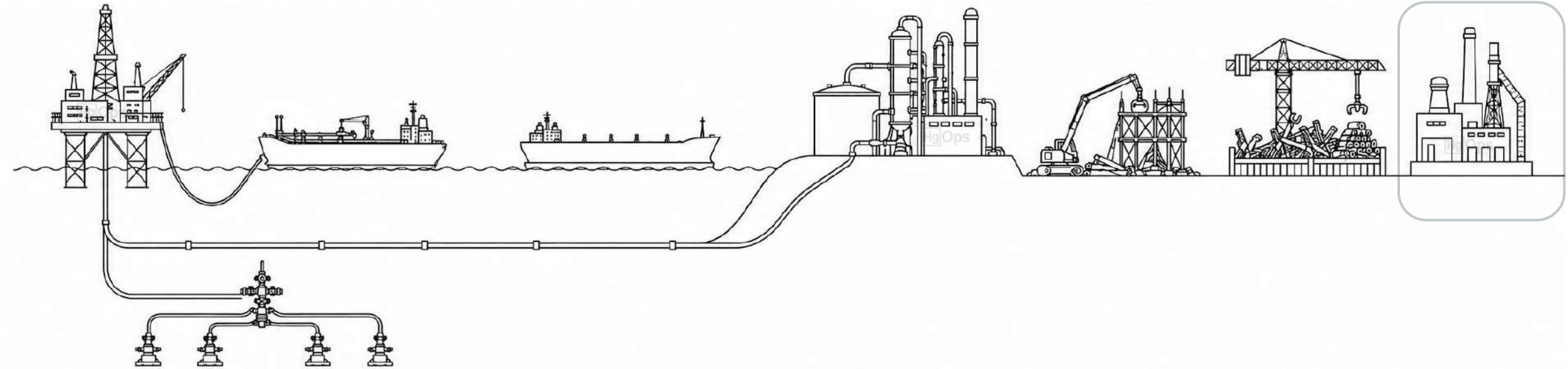
Re-use or re-sale of equipment

Vapour release during refurbishment and maintenance



HgOps

GLOBAL MERCURY PARTNERSHIP



Smelting and recycling

Remaining Hg flash vapourised

1ppm in a 90 t charge = 90 grams

20ppm in a 90 t charge = 1.8 kg





HgOps

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So what can we do?

Share knowledge and experiences

Learn from existing operations

Work with regulators to identify gaps

Human exposure mitigation controls

Assess environmental impact

Mercury management plan for decommissioning

Human health



...protect human health and the environment...



The Environment

Thank you for your attention



Hg Ops – The Mercury Specialists

david.hunter@hgops.com
www.hgops.com





Qa3 On - site Chemistry

Mercury in Steel

how it gets there and how we measure it

GMP Webinar - SEPT 2026

Date
15/09/26

Presented By:
Matt Bower

+ 44 1256 397390

www.qa3.co.uk

GLOBAL MERCURY DISTRIBUTION

Mercury is generally higher in certain regions due to global tectonic activity.

Locations such as Europe are generally lower.

You can get major differences within the same region / field.

MASS VS CONCENTRATION

Maps like these serve as a good illustration of the general distribution of mercury but do have limitations.

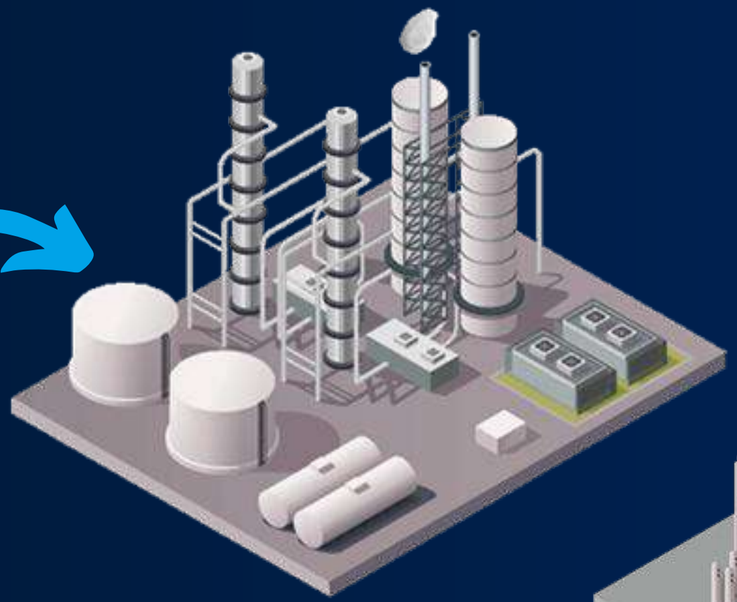
Concentrations are not an appropriate unit and you have to consider production rates and ultimately the total mass of mercury that is being produced.

An onshore field in Saudi could be producing 1000x more than an offshore facility in Thailand.



Mercury Across the Value Chain









EXPLORATION

UPSTREAM PROCESSING

DOWNSTREAM PROCESSING

DECOMMISSIONING

Forms of Mercury in Our Industry

Mercury can exist in a number of forms
Different species cause different issues
Worker exposure routes can be complex
Can exist as a SOLID, GAS, LiQUID elemental or dissolved in LIQUID



Hg^0

HgCl

Hg^+

HgSe

HgS

Hg^{2+}

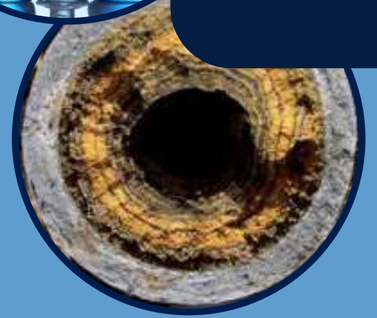
Hg



Hydrocarbon Gases



Hydrocarbon Liquids and Produced Waters



Solids and Sludges

Deposition Mechanisms - Hg0

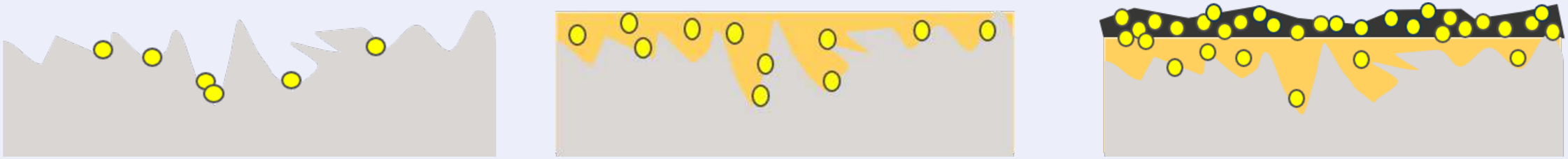
Mercury could be adsorbed onto surfaces via microscopic imperfections in the steel (e.g. cracks or fissures) or onto iron oxide.

Mercury may also permeate (absorb) into an oxide layer eventually contacting the steel surface.

Mercury may be removed from the gas or oil by chemical reaction with other components on the internal surfaces

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

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



STEEL
SUBSTRATE

Deposition Mechanisms - Hg0

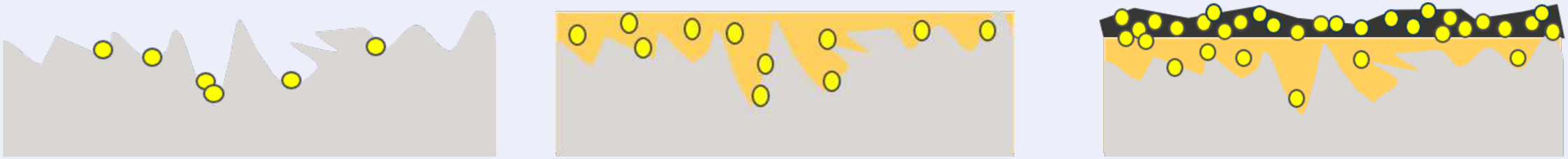
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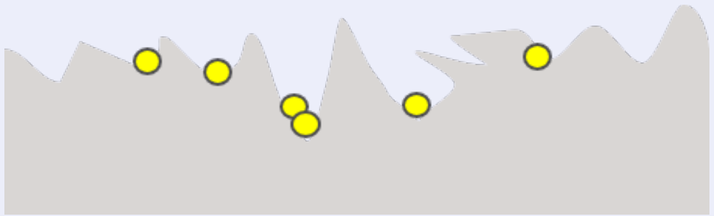
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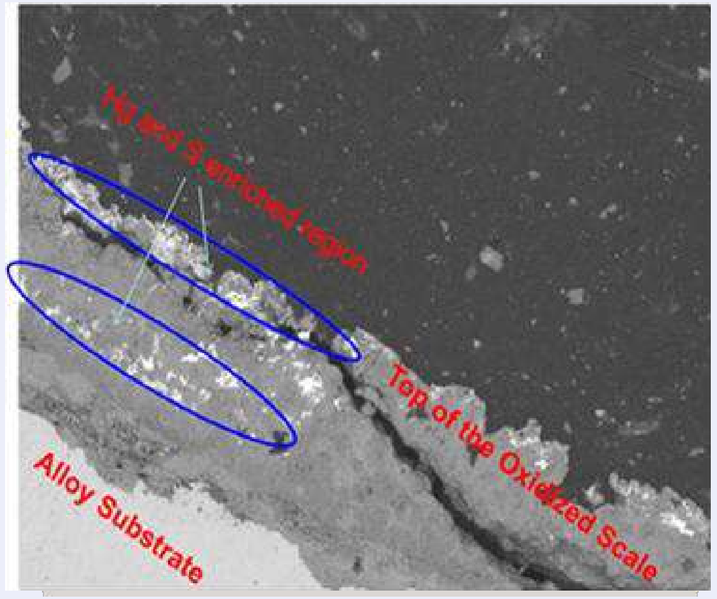


STEEL
SUBSTRATE

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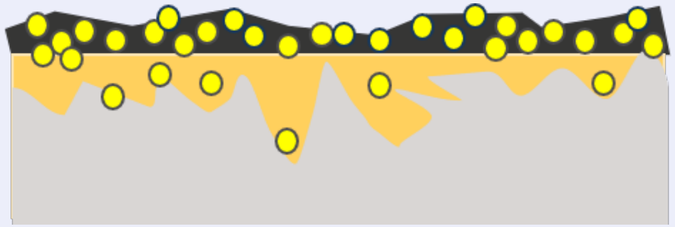




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STEEL
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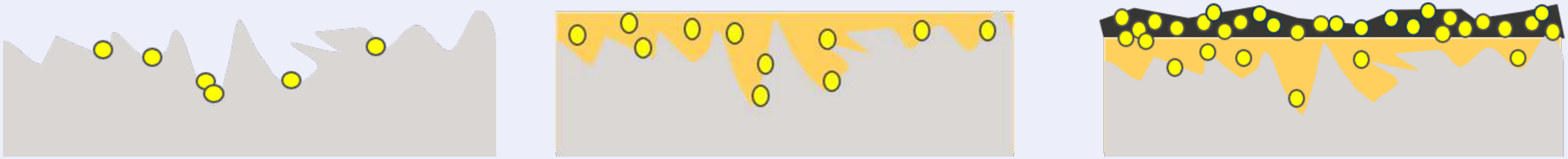
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★

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STEEL
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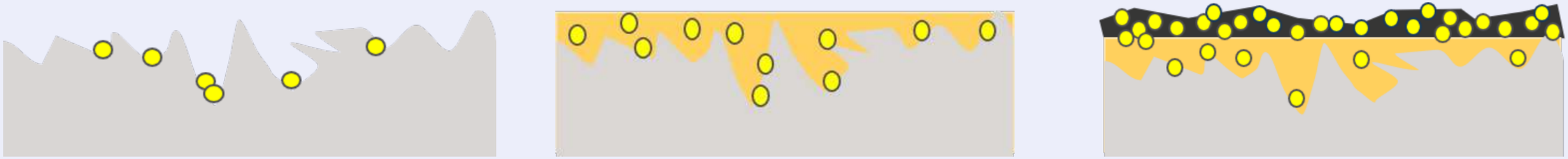
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STEEL
SUBSTRATE

Above proposed deposition mechanisms are supported by speciation analysis and on-site fluid analysis

Mercury Deposition Across a Pipeline

Australia

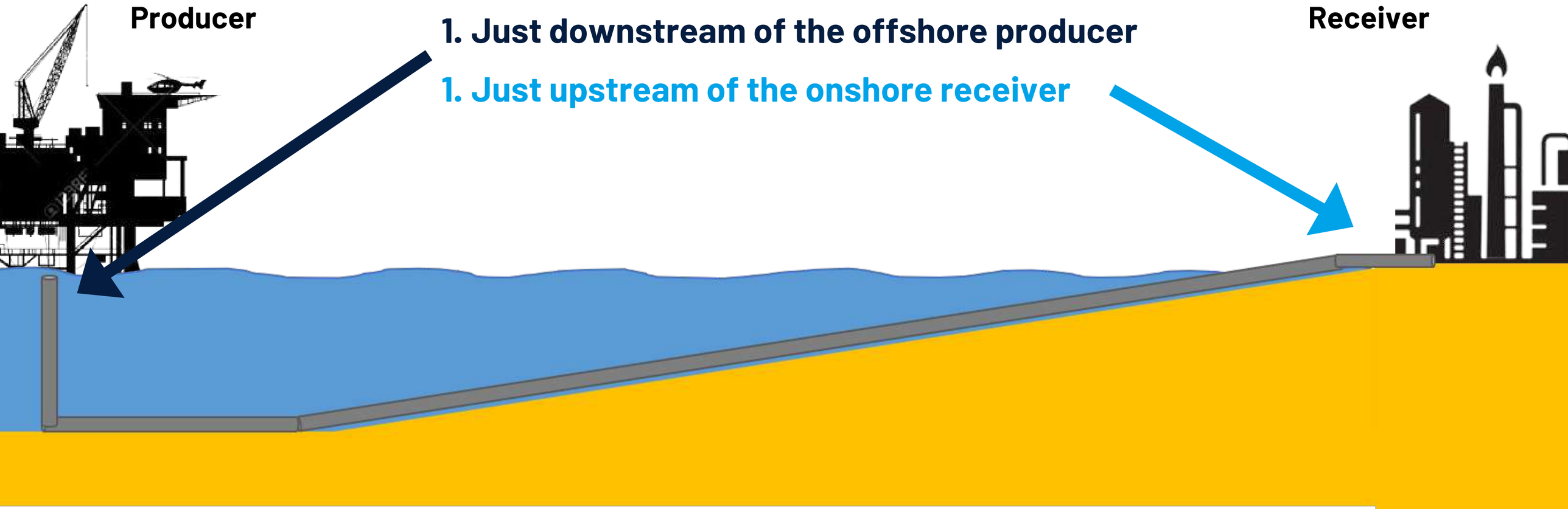
SAMPLING LOCATIONS

Offshore Producer

Onshore Receiver

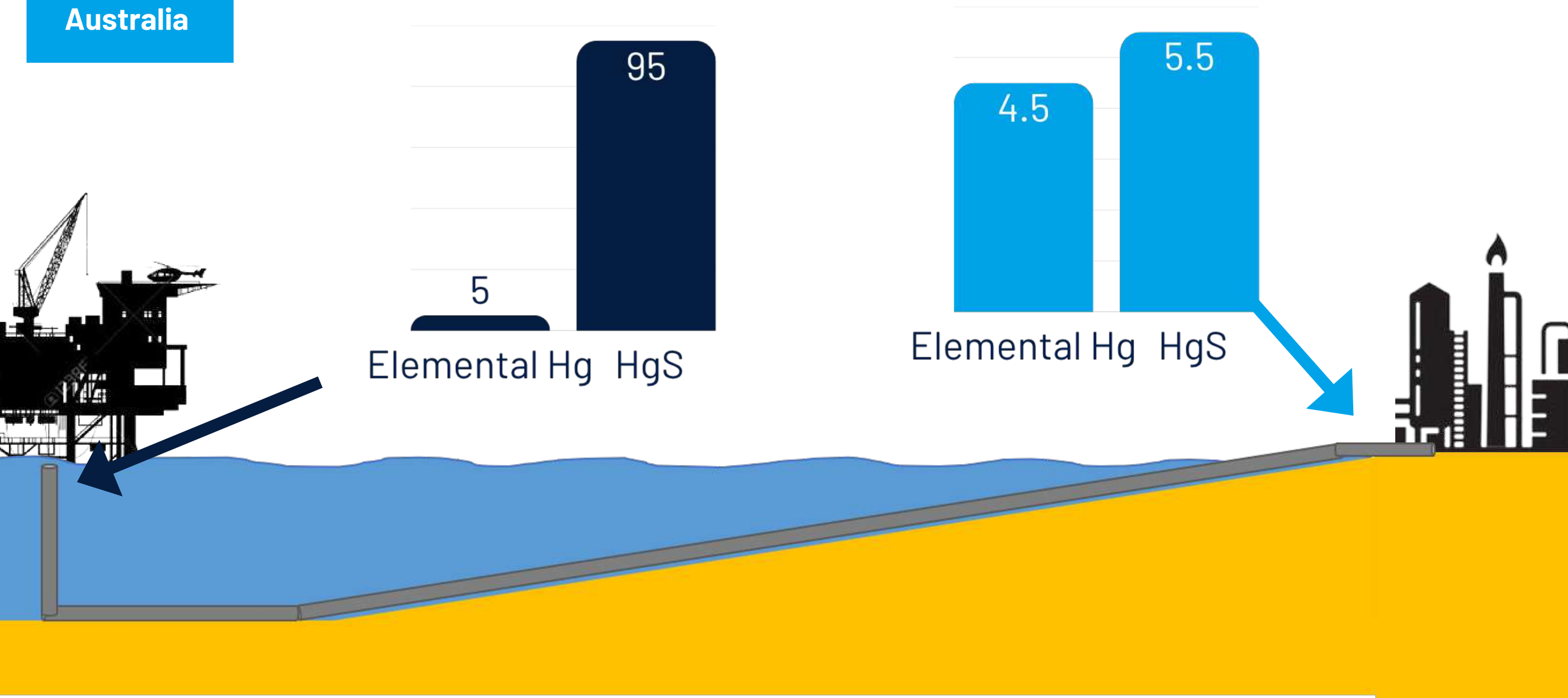
1. Just downstream of the offshore producer

1. Just upstream of the onshore receiver



Mercury Deposition Across a Pipeline

Australia



Mercury Deposition Across a Pipeline

Caribbean

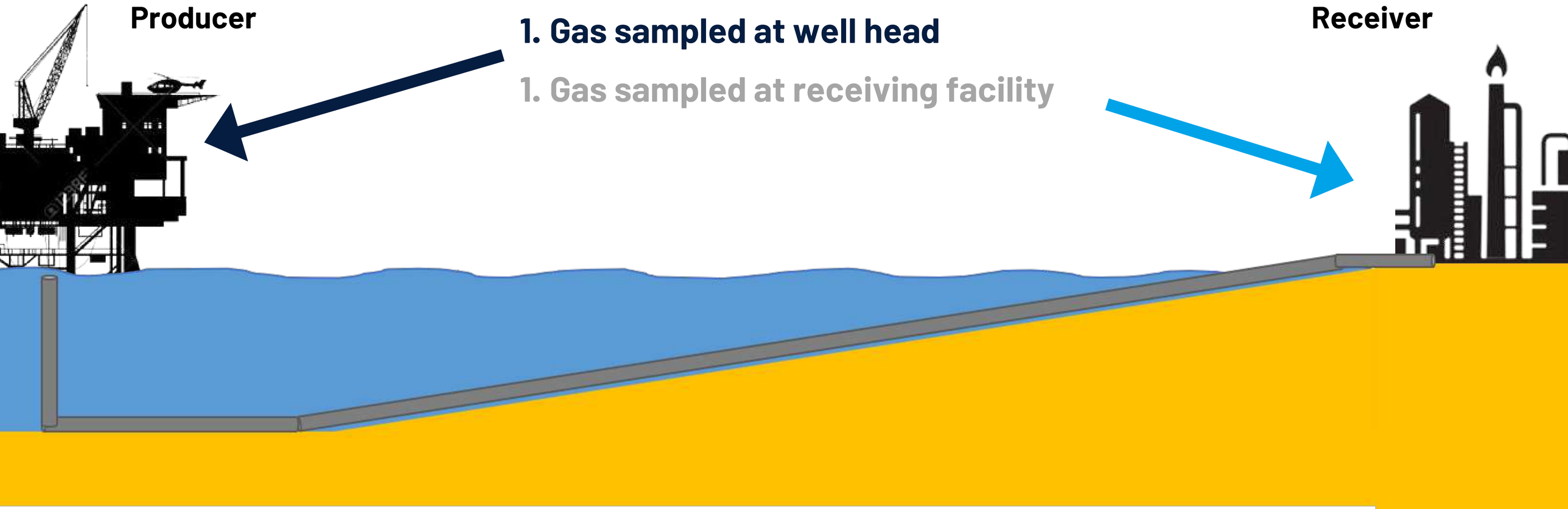
SAMPLING LOCATIONS

Offshore Producer

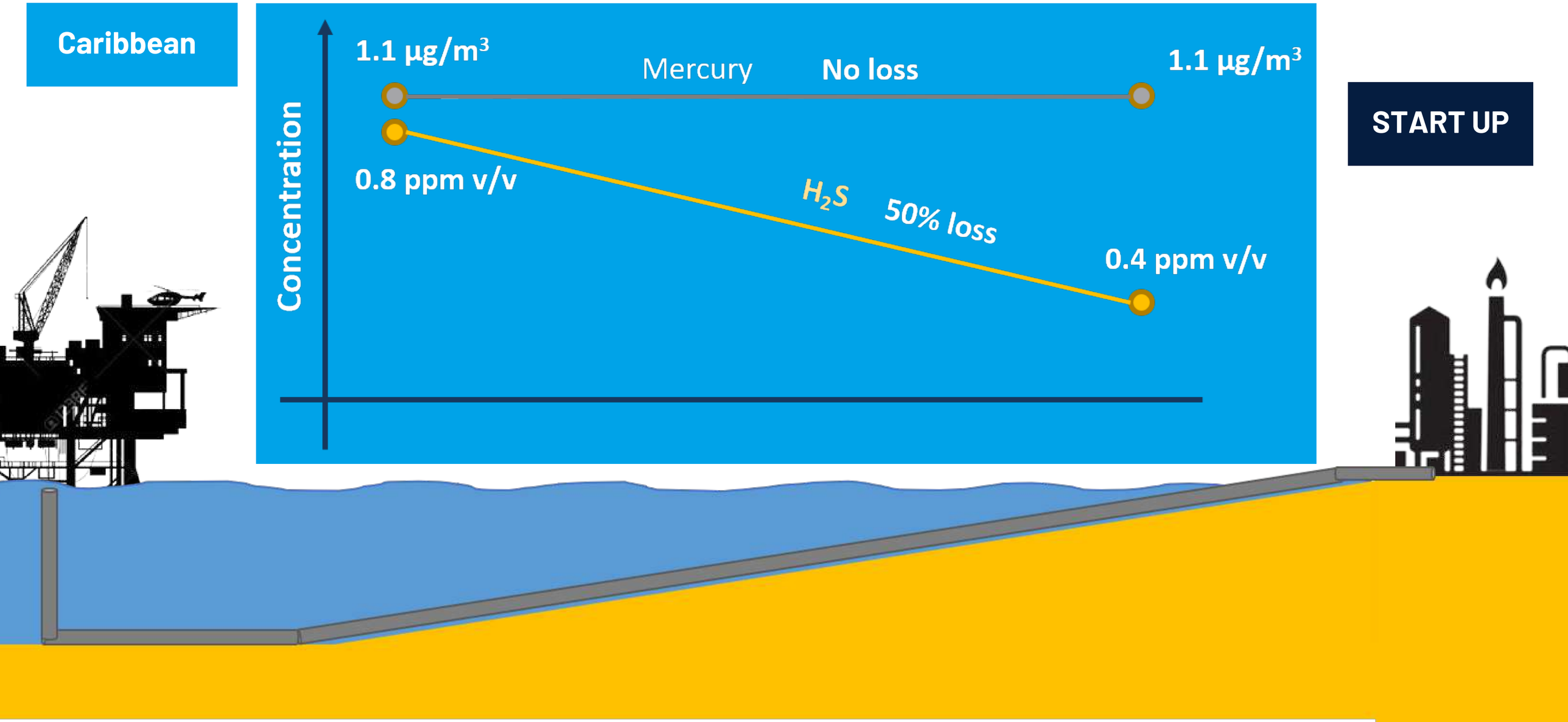
1. Gas sampled at well head

1. Gas sampled at receiving facility

Onshore Receiver

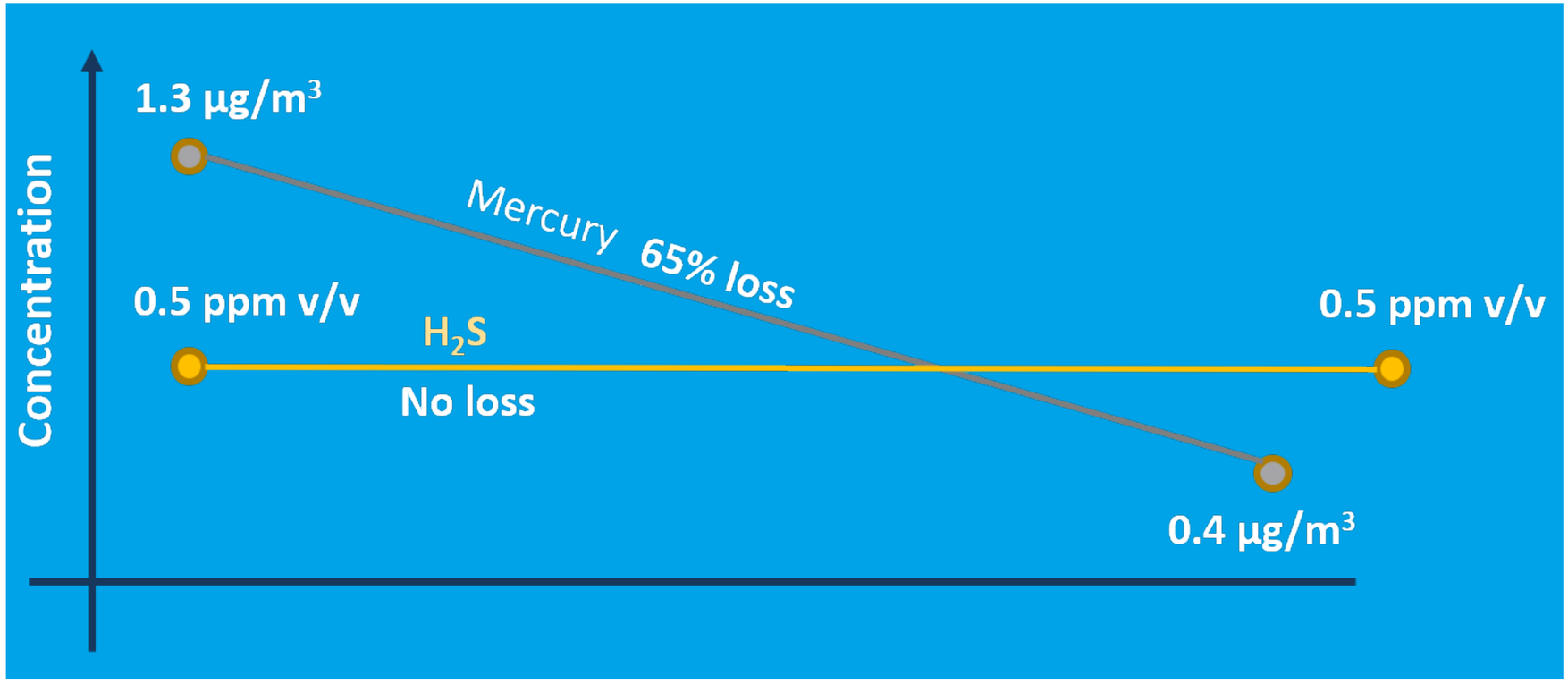


Mercury Deposition Across a Pipeline



Mercury Deposition Across a Pipeline

Caribbean



4 YEAR PRODUCTION





Assessment and Quantification

Pre Cessation of Production

Information on the mercury content of the fluids and identify where mercury is likely to have accumulated across a process.

Post Cessation of Production

Will quantify the concentration of mercury within vessels and on internal surfaces of infrastructure and to determine if a suitable decontamination programme is required.

Post Decontamination

To assess the efficacy of the decontamination treatment

Assessment and Quantification

1

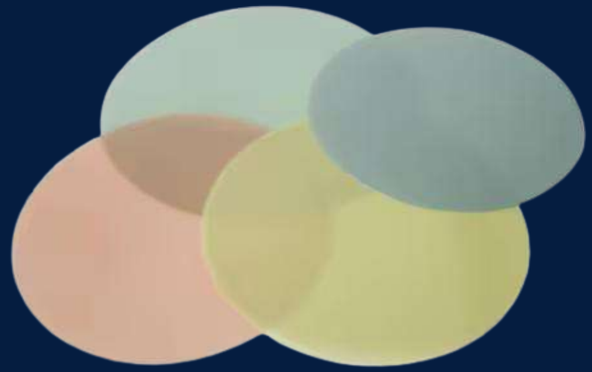
Handheld XRF



Assessment and Quantification

2

Abrasive Rubbings





Assessment and Quantification

3

Pigging Material



Assessment and Quantification

4

Steel Digestion





Quantification Challenges

Pipelines



Quantification Challenges

Pipelines

Robust, rapid field techniques





Quantification Challenges

- Pipelines
- Robust, rapid field techniques
- Lack of Global Alignment on Limits

WHAT IS ACCEPTABLE???
WHAT UNITS???
WHAT TECHNIQUES???
IN WHOLE STEEL ON A PPM MASS / MASS BASIS
VS
MERCURY PER INTERNAL SURFACE AREA??

Qa3 On - site Chemistry

THANK YOU

FOR YOUR ATTENTION AND PARTICIPATION

Questions?



Contact Us:

+44 1256 397390

enquiries@qa3.co.uk

www.qa3.co.uk

Winchester, UK

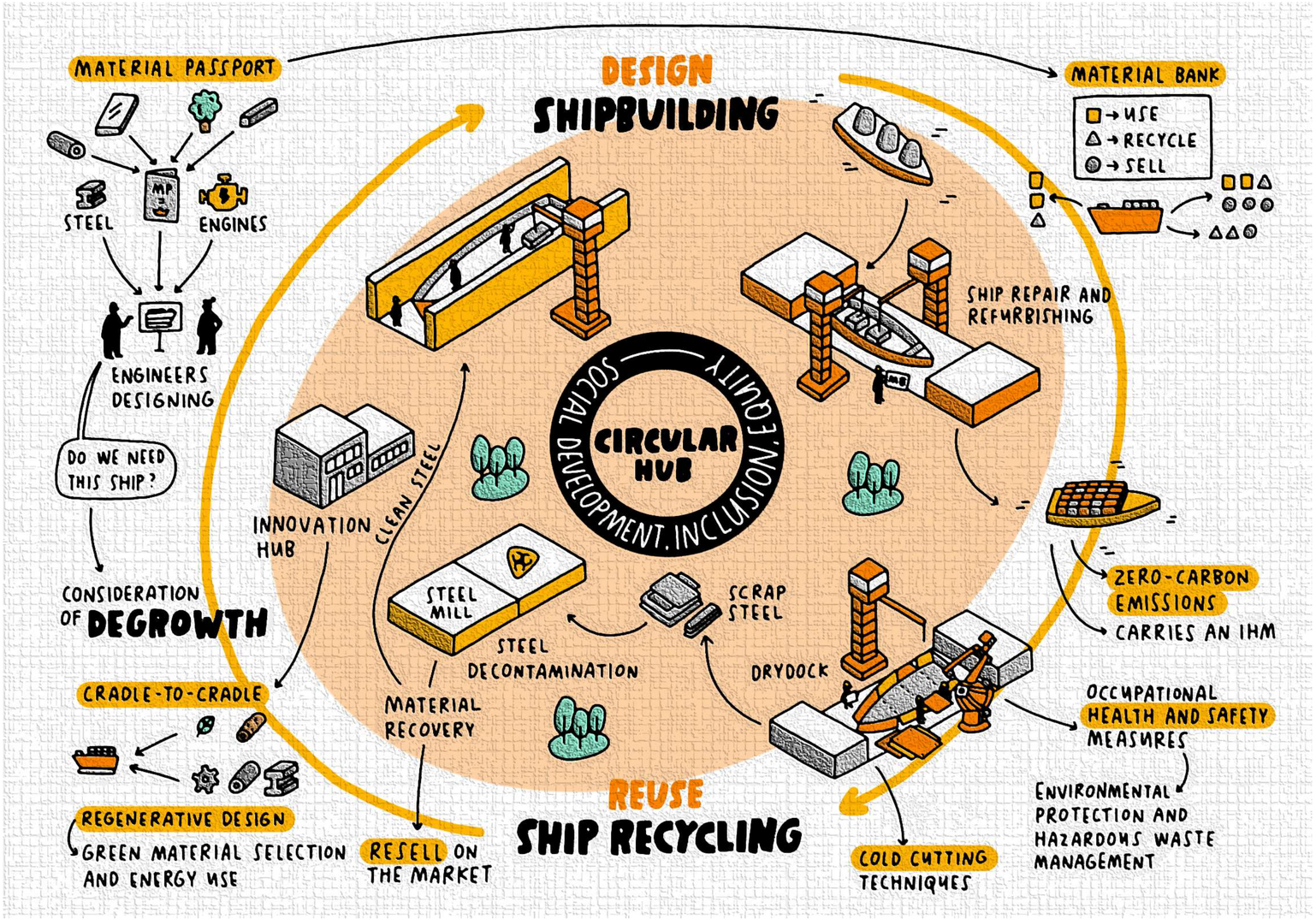
NGO SHIPBREAKING PLATFORM

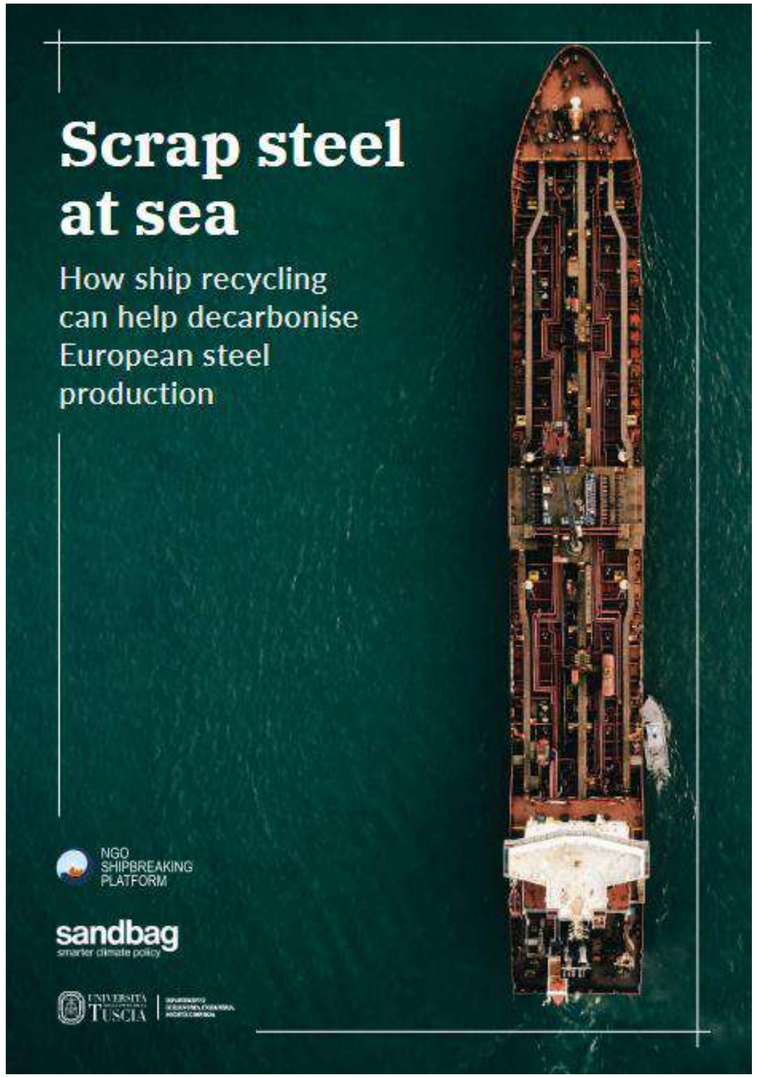
HAZARDOUS SHIPBREAKING
MERCURY CONTAMINATED STEEL AT END-OF-LIFE

INGVILD JENSSEN - NGO SHIPBREAKING PLATFORM

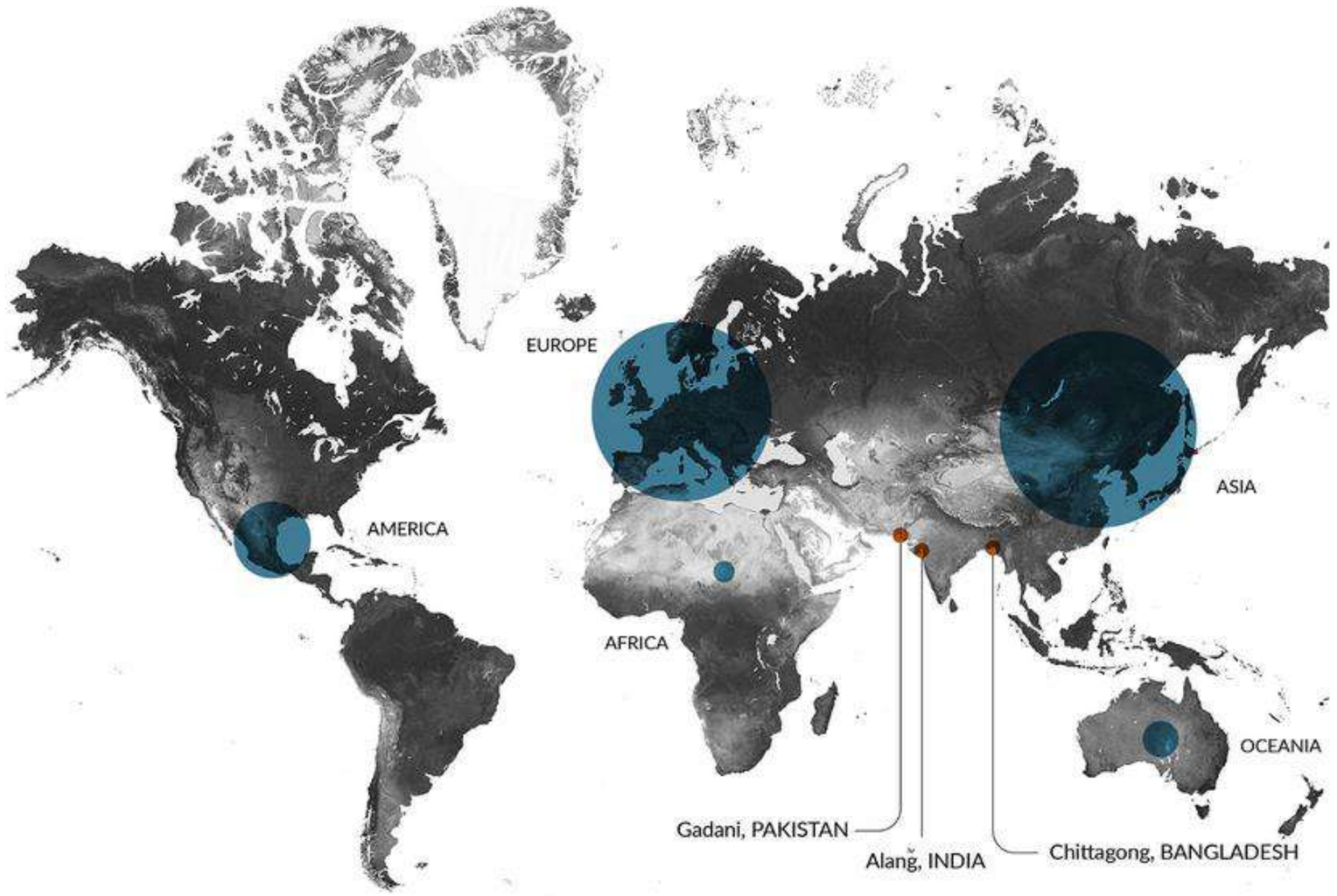
UNEP GMP WMA WEBINAR 15.09.2026

CIRCULAR HUBS FOR OPTIMISED MATERIAL RECOCERY





TOXIC TRADE



● Exporters of toxic ships

Ship owners from East Asia and Europe top the list of dumpers that sell ships for breaking on South Asian beaches.

● Shipbreaking countries

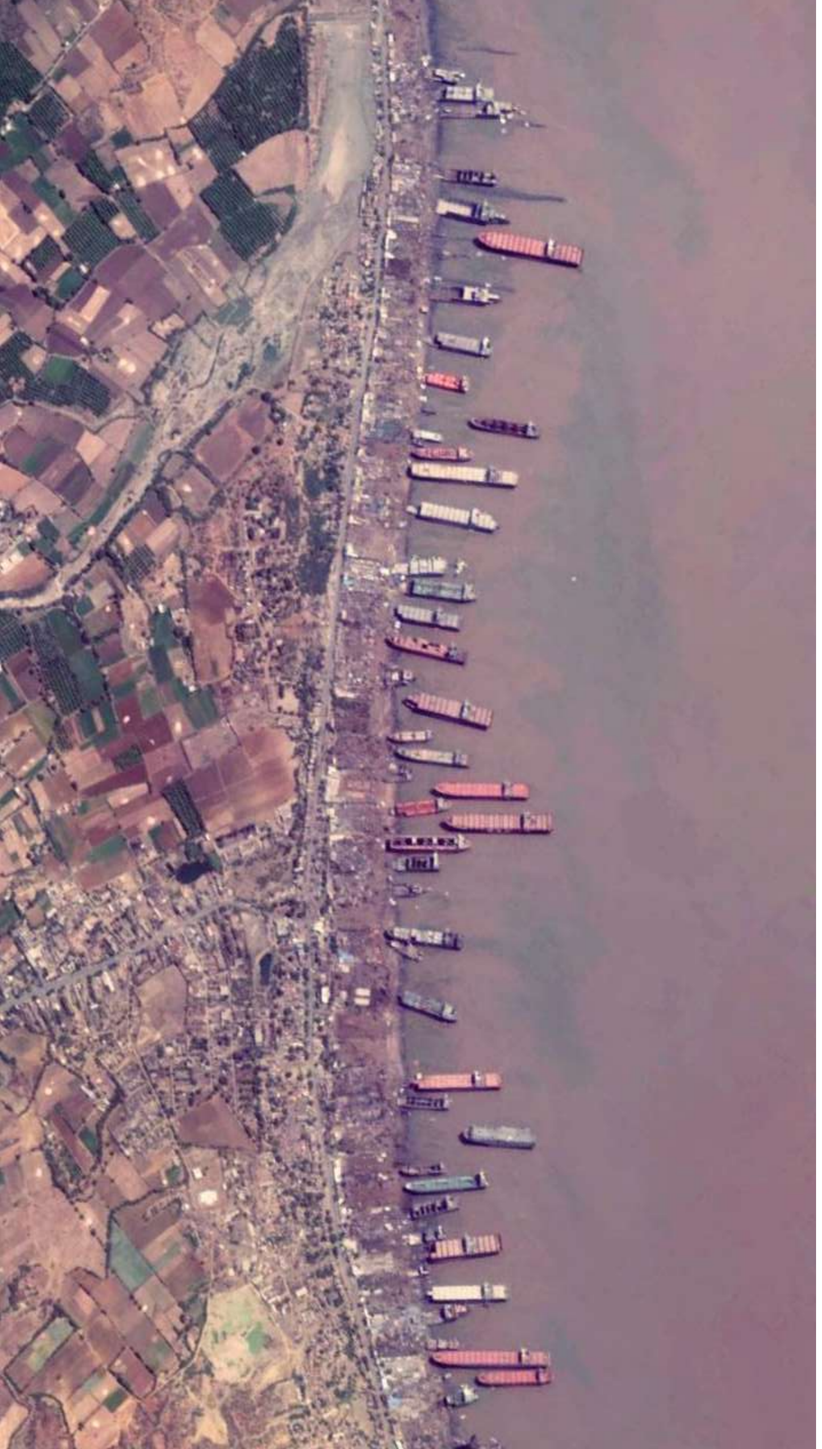
In Bangladesh, India and Pakistan ships are broken apart directly on the beach instead of in an industrial site: a practice known as "beaching".

SINCE 2009:

8078
SHIPS BEACHED

449
DEATHS

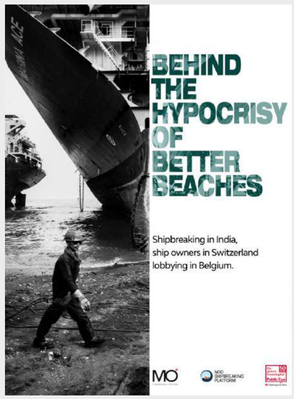
404
INJURIES

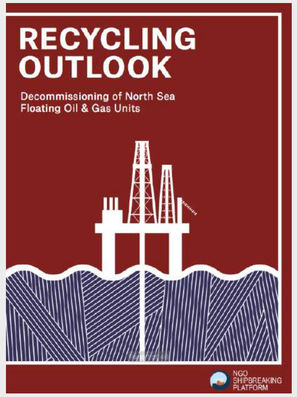


THE PROBLEMS OF BEACHING

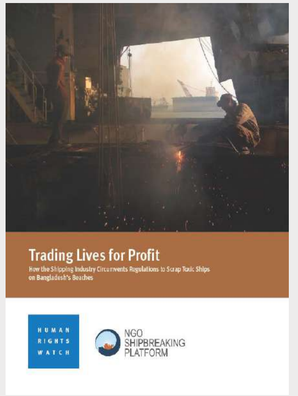
- High risk of accidents and damage to workers' health
- Lack of proper medical and healthcare facilities
- Breach of labour rights, including child labour
- Emissions to water, soil and sediments
- Emissions to air, also at steel re-rolling mills
- Poor or no proper treatment of hazardous wastes
- Poor quality and misleading 3rd party surveys
- Lack of transparency

- Toxics of concern on oil and gas assets: NORM and Mercury







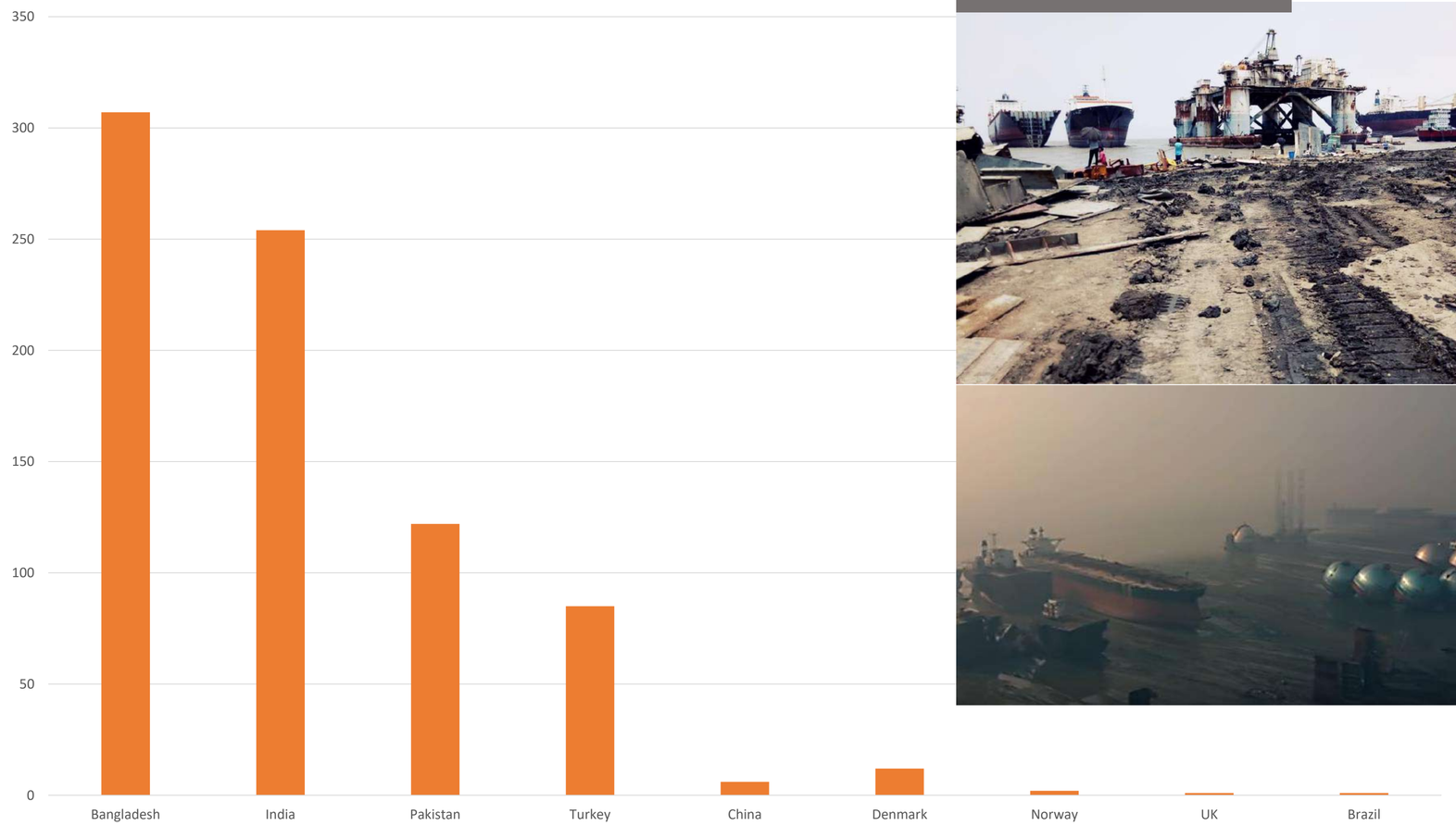




Annual Dumpers List

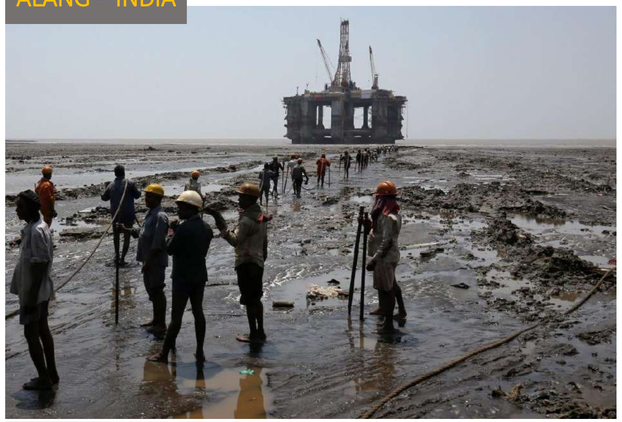
9197351	MAPOCHO	Container Ship												
9105463	JIN HAI XI	Bulk Carrier												
9077288	GUANGZHOU	Container Ship (Fully					China							
9032692	XIN XIANG AN	Bulk Carrier					China							
9413509	FAR EAST CHEER	Container Ship (Fully Cellu	6.253	3.		Leone	Hong Kong	China Un						
9102734	HONG YUAN 01	Container Ship (Fully Cellu	29.181	11.481	1996	Gabon	China	Shanghai Xun						
8981781	HONG YUN YOU 19	Products Tanker	3.856	2.580	1999	Gabon	China	Nanjing Hongyu S						
8223476	LU ZHOU	Products Tanker	1.357	966	1983	Sierra Leone	Palau	Mei Zi Ma						
9094418	XIN RUN 66	Products Tanker	3.807	2.908	2004	Gabon	China	Zhejiang Guomao Grou						
9085572	YAMTA	Bulk Carrier	16.721	6.003	1994	Palau	Hong Kong	Shenzhen Shekou Shpg & T						
9175432	LIAN FENG 6	General Cargo Ship	15.589	6.537	1999	Gabon	China	China COSCO Shipping Corp						
1060007	HONG XI	General Cargo Ship	7.654	3.621	2008	Palau	China	Fangchenggang Zhongxing Shp	China					
9142007	XIN LV BAO SHI	Bulk Carrier	25.933	7.957	1996	Sierra Leone	China	Fujian Xiamen Shipping Co Ltd	China					
1046922	BAO DI LONG 8	General Cargo Ship	7.142	3.133	2006	Sierra Leone	China	Gu QW	China					
9086215	HAN JI 2	Platform Supply Ship	2.961	2.126	1995	Sierra Leone	Unknown	Xingshun Shipping Co Ltd	China	Xingshun Shipping Co Ltd				
8126848	DONG FANG YONG SHI 2	Anchor Handling Tug Supp	1.672	0	1983	Panama		Sinopec Offshore Oilfield Serv	China	Sinopec Offshore Oilfield Serv				
9122306	NAGA 2	Container Ship (Fully Cellu	4.914	2.453	1996	Comoros	Hong Kong	Fujian Xinan Shipping Co Ltd	China	Fujian Xinan Shipping Co Ltd				
9203875	JI HAI ZHONG SHAN	Container Ship (Fully Cellu	3.772	2.175	1998	Gabon	China	SIPG Changjiang Port Logistics	China	Shanghai Jihai Shipping Co L				
1061403	BEI FANG MING ZHU	General Cargo Ship	12.799	5.776	2013	China		Guangxi Evergreen Shipping	China	Guangxi Evergreen Shipping	Guangxi Evergreen Shipp	China	Chittagong	Bangladesh	mai-24
1064467	HAI SHUN FENG 8	General Cargo Ship	6.476	3.402	2004	Gabon	China	Xiamen Haishunfeng Shipping	China	Xiamen Haishunfeng Shippin	Xiamen Haishunfeng Shi	China	Chittagong	Bangladesh	mai-24
1060904	ZHONG HONG DA 1	Container Ship (Fully Cellu	8.911	3.981	2006	Sierra Leone	China	Hainan Zhongda Shipping	China	Hainan Zhongda Shipping	Hainan Zhongda Shippin	China	Chittagong	Bangladesh	mai-24
1066087	XIN HAO JIANG 206	Bulk Carrier	7.719	3.328	2008	Gabon	China	Maoming Haojiang Shipping Co	China	Maoming Haojiang Shipping	Maoming Haojiang Shipp	China	Chittagong	Bangladesh	juin-24
8876431	KAI 1	Container Ship (Fully Cellu	4.879	2.404	1994	China		China Fujian Foreign Trade	China	Fujian Xinan Shipping Co Ltd	Fujian Foreign Trade Cen	China	Chittagong	Bangladesh	juin-24
1067067	YUN TAI LONG 66	General Cargo Ship	4.534	2.091	2005	Gabon	China	Xiamen Yuntailong Shipping Co	China	Xiamen Yuntailong Shipping	Xiamen Yuntailong Shipp	China	Chittagong	Bangladesh	juin-24
9146845	XING TONG 313	LPG Tanker	2.203	1.909	1996	Gabon	China	Shanghai Huachen Shpg Co Ltd	China	Shanghai Huachen Shpg Co L	Shanghai Huachen Shpg	China	Chittagong	Bangladesh	juin-24
1062665	XIANG	Aggregates Carrier	7.006	3.947	2020	St Kitts & Nevis	China	Lin KH	China	Lin KH	Lin KH	China	Chittagong	Bangladesh	juil.-24
9335214	EVER EXPRESS	General Cargo Ship	2.556	1.377	2004	Panama		Sea Carrier Shipping Co Ltd	China	Seivo Express Co Ltd	Seivo Star Co Ltd	Marshall Island	Chittagong	Bangladesh	juil.-24

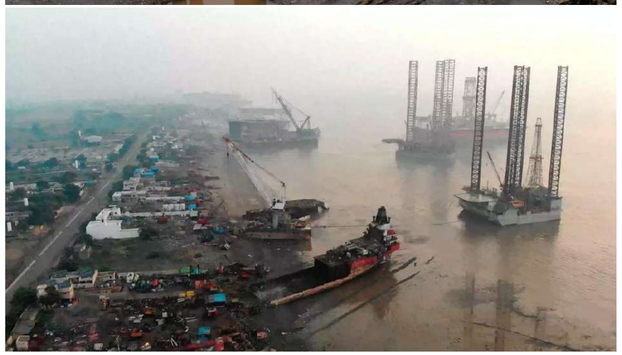
OIL AND GAS ASSETS SCRAPPED 2020-2024



CHATTOGRAM – BANGLADESH

ALANG – INDIA





*Includes: Crude Oil Tankers, Product Tankers, LNG Tankers, LPG Tankers, Shuttle Tanker, FPSOs, FSOs, Drilling Rig (semisubmersible / jack up), Drilling Ship, Offshore Support Ship, Platform Supply Ship, Production Platform (semisubmersible / jack up)

YETAGUN CASE



J.NAT CASE



HONG KONG CONVENTION WILL NOT SOLVE THE PROBLEM



IMO Hong Kong Convention fails to set a benchmark for safe and environmentally sound ship recycling

- Sets low standards
- Ignores downstream waste management
- No independent auditing

UNEP

BASEL CONVENTION is better than the IMO Hong Kong Convention

- Bans the export of hazardous waste to non-OECD countries
- Requires Prior Informed Consent
- Requires financial guarantees for exports
- Illegal exports are criminal acts
- Requires Environmentally Sound Management all the way

SCRAP DEALERS AKA CASH BUYERS

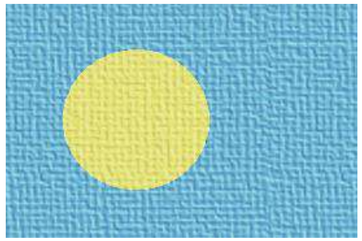
















PRIYA BLUE INDUSTRIES AMONG THE FIRST IN INDIA TO RECEIVE DASR CERTIFICATION



AUTHORIZATION OF SHIP RECYCLING FACILITIES

DOCUMENT OF AUTHORIZATION TO CONDUCT SHIP RECYCLING (DASR) IN ACCORDANCE WITH THE REQUIREMENTS OF THE HONG KONG INTERNATIONAL CONVENTION FOR THE SAFE AND ENVIRONMENTALLY SOUND RECYCLING OF SHIPS, 2009

Issued under the provision of the Hong Kong International Convention for the Safe Environmentally Sound Recycling of Ships, 2009 (hereinafter referred to as "the Convention") under the authority of the Government of India by Gujarat Maritime Board.

Name of Ship Recycling Facility	PRIYA BLUE INDUSTRIES PVT. LTD.
Distinctive Recycling Company Identity No.	Plot No. V-1
Full address of Ship Recycling Facility	Plot No. V-1, Alang Sosiya Ship Recycling Yard, Bhavnagar
Primary contact person	[redacted]
Phone number	[redacted]
E-mail address	[redacted]
Name, address, and contact information of ownership company	[redacted]
Working language(s)	English, Hindi, Gujarati

This is to verify that the Ship Recycling Facility has implemented management systems, procedures and techniques in accordance with Chapter 3 and 4 to the Annex to the Convention.

This authorization is valid up-till 5 years from the date of issuance and is subject to the limitations identified in the attached supplement.

This authorization is subject to amendment, suspension, withdrawal, or periodic renewal in


SOHAR
LNG
PRIYA BLUE



CHATTOGRAM BANGLADESH – JANUARY 2026







Sitakunda shipyard toxic gas death toll rises to 10

Another injured worker dies in a Chattogram hospital

August 20, 2026 The Daily Star

The Daily Star

Green certification alone can't ensure safe ship recycling





UNEP



Europe Regulatory

Hamburg prosecutors raid Erck Rickmers office in ship scrapping investigation

Sam Chambers · August 26, 2021 · 2,052 · Less than a minute



ILLEGAL SHIPBREAKING IS A SERIOUS ENVIRONMENTAL CRIME



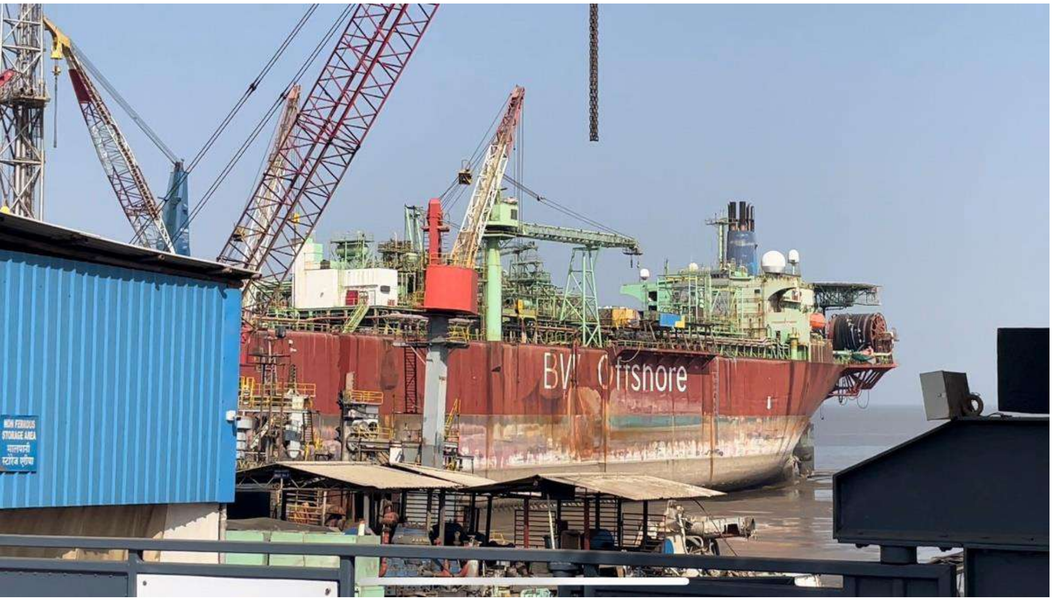




The Hamburg public prosecutor's office raided a number of shipowner offices yesterday including an Alster villa belonging to the Erck Rickmers Group as part of a long running investigation into the beaching of some ships in 2016 and 2017.

Erck Rickmers Group and other entities under suspicion strongly deny that they knew the three ships under investigation – the *Florida 1*, *Alexandra Rickmers* and *ER Hamburg* – were headed for a beach in Pakistan when they sold the ships.

According to European law, ships being sent for recycling are considered hazardous waste that must be properly disposed of at shipyards.





EXTERNALISING COSTS IN ALANG

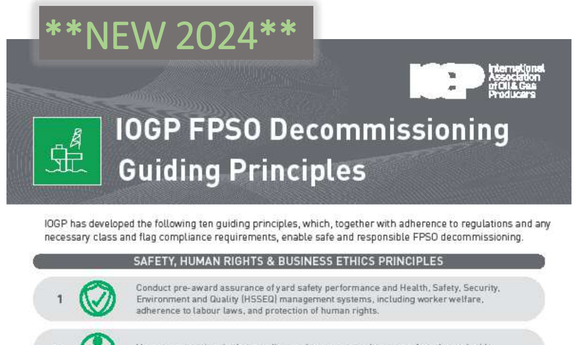
BW OFFSHORE sells FPSOs contaminated by NORM, Mercury

VICE: $ 12,8M

ROAR: $ 13,5M

FATAL ACCIDENT ON VICE

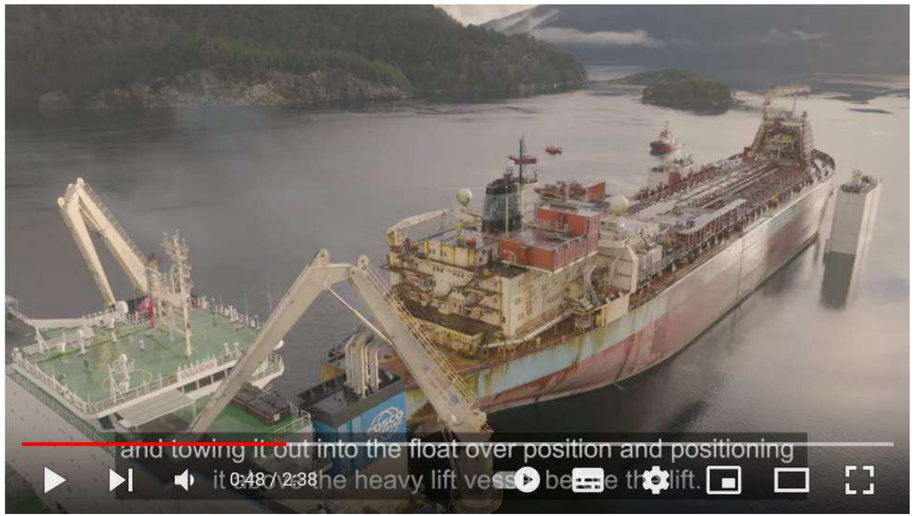
BEST PRACTICE EXAMPLES



SBM Deep Panuke at RJMI, Canada



SHELL Curlew at AF Decom, Norway



DOWNSTREAM : SMALL SCALE STEEL RE-ROLLING MILLS

- Low temperature
- No filters
- Poor quality output

- Toxics of concern with regards to steel originating from oil and gas assets: Mercury





Role of NGOs: from pollution to solution

fact-finding, advocacy, advice, litigation - support our work!

Australian Government | ANSTO | UNI GRAZ | As tesla

Analysis of Hg on steel surfaces: how can we use pXRF?



Lhiam Paton

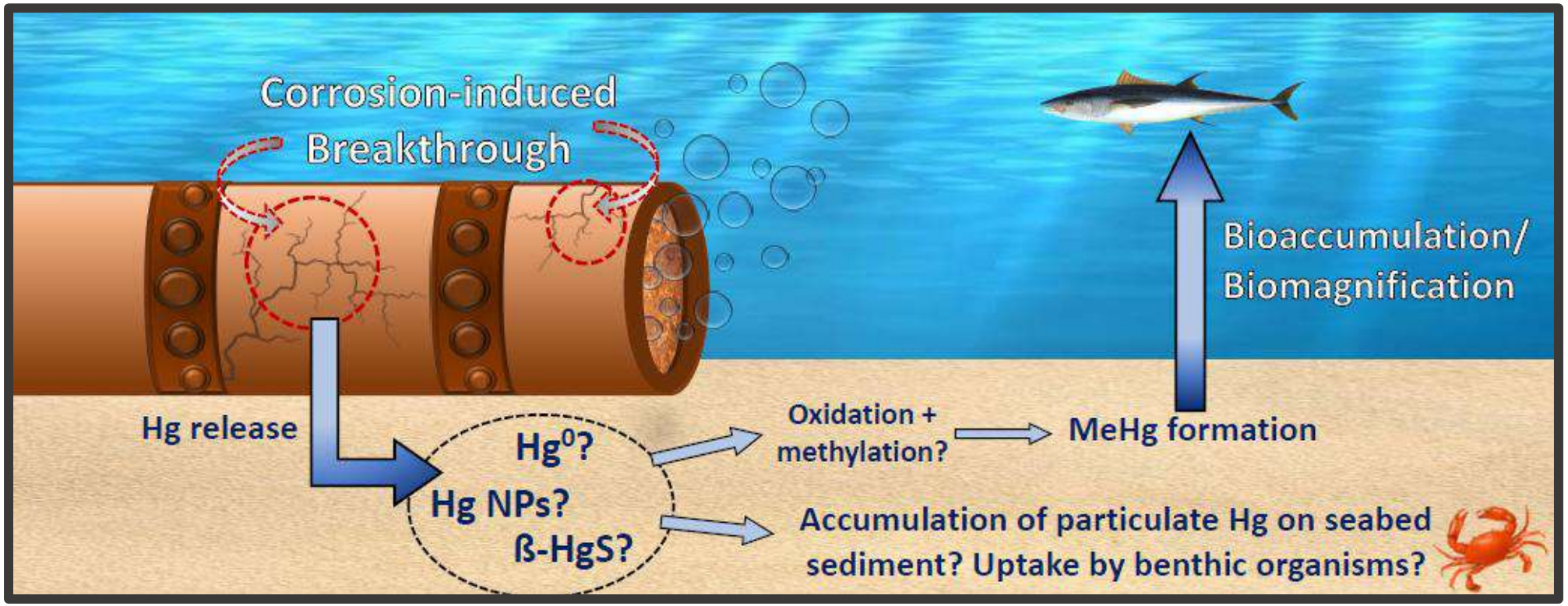
UNEP Global Mercury Partnership Webinar

15/09/26

FWF Austrian Science Fund

Science. Ingenuity. Sustainability.

Overview

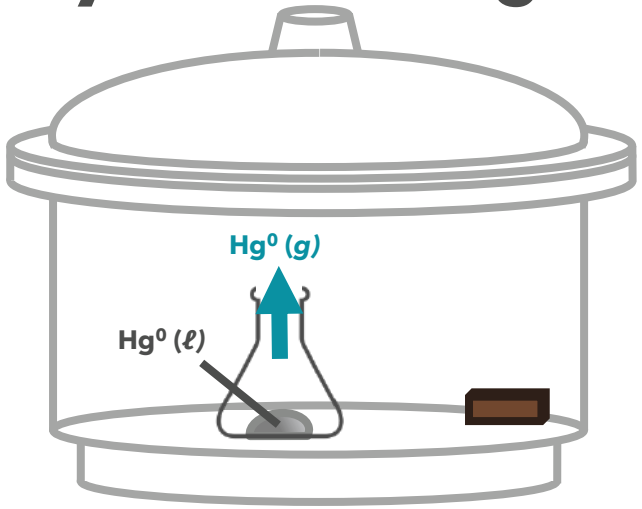


Key questions:

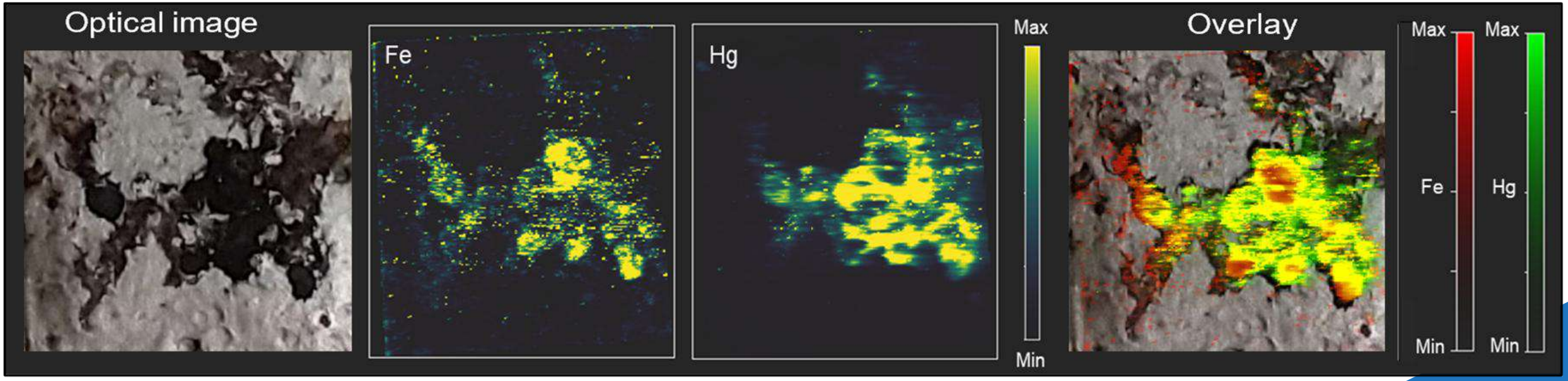
- To what degree could Hg accumulate in pipelines?
- Which species are present?

ANSTO

Analysis of lab-generated samples

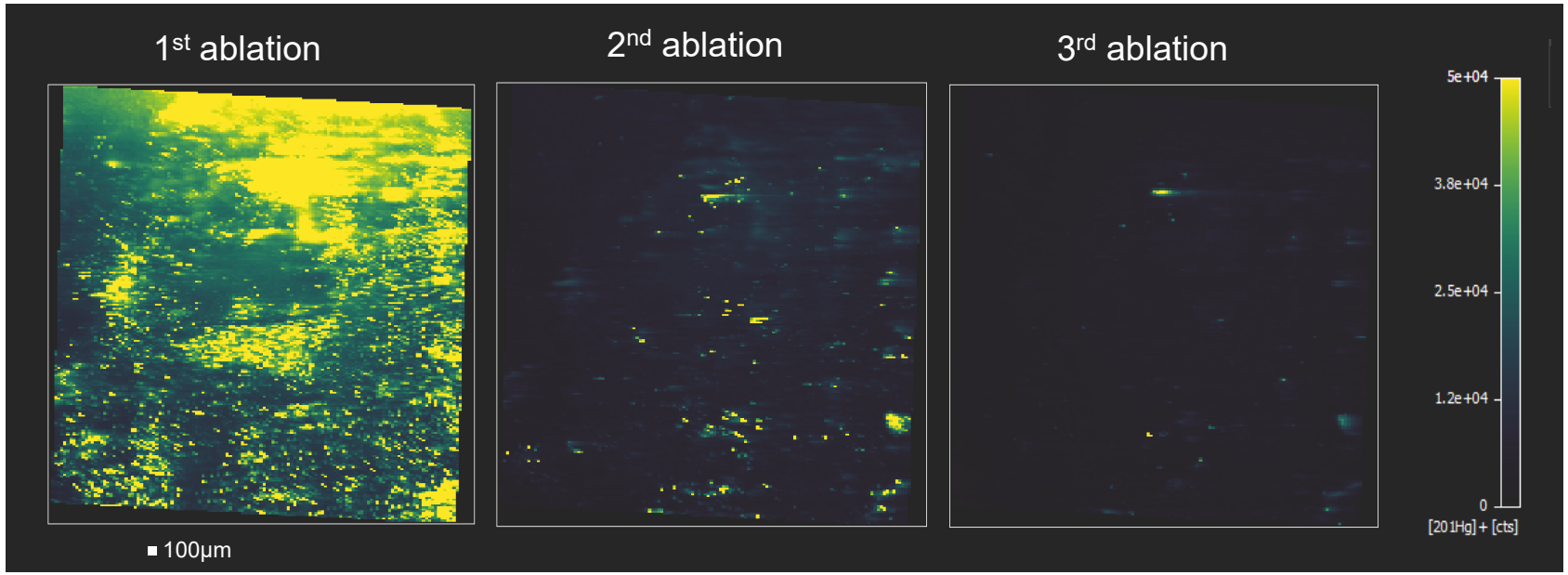


- Total Hg analysis: Hg accumulation varied from 0.01-1 g $Hg \cdot m^{-2}$
- LA-ICP-MS: Hg was most often concentrated on corrosion scale (although not exclusively)



Depth profile analysis

- Hg mostly in the first 1-2 µm.
- Removal of the corrosion layer = substantial removal of Hg.

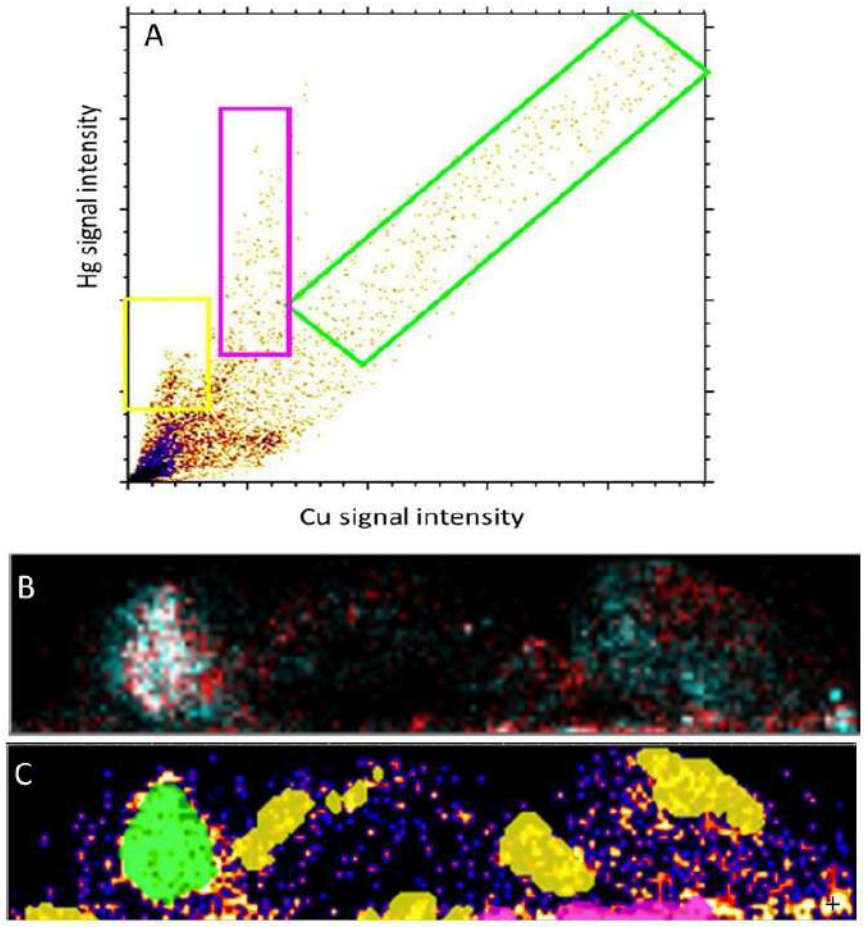


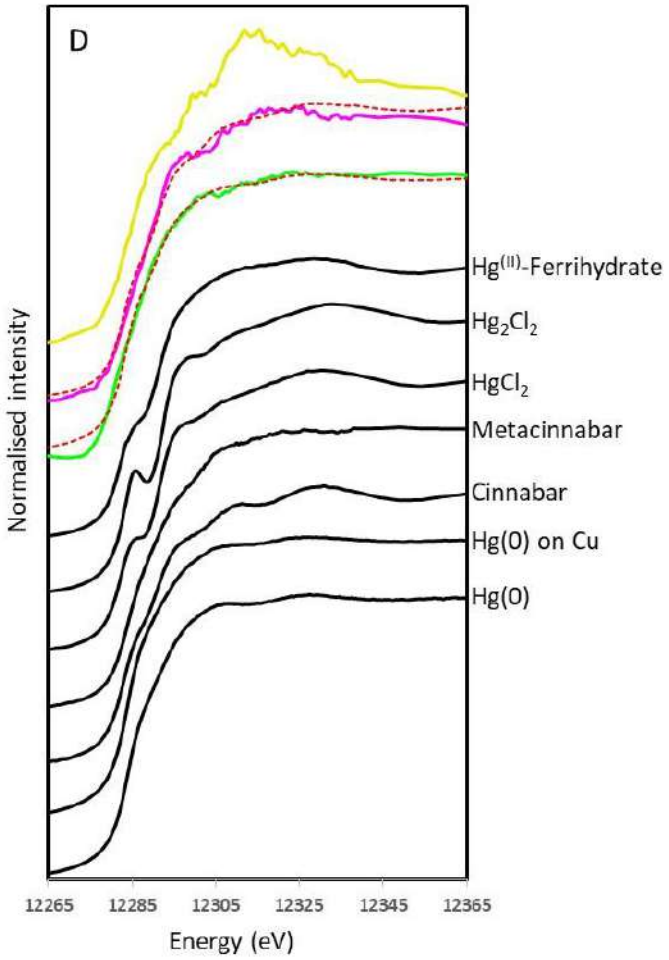
Ablation Number	^{56}Fe counts	^{201}Hg counts
1	1,600,000	37,200
2	454,000	8,800
3	205,000	4,300

ANSTO

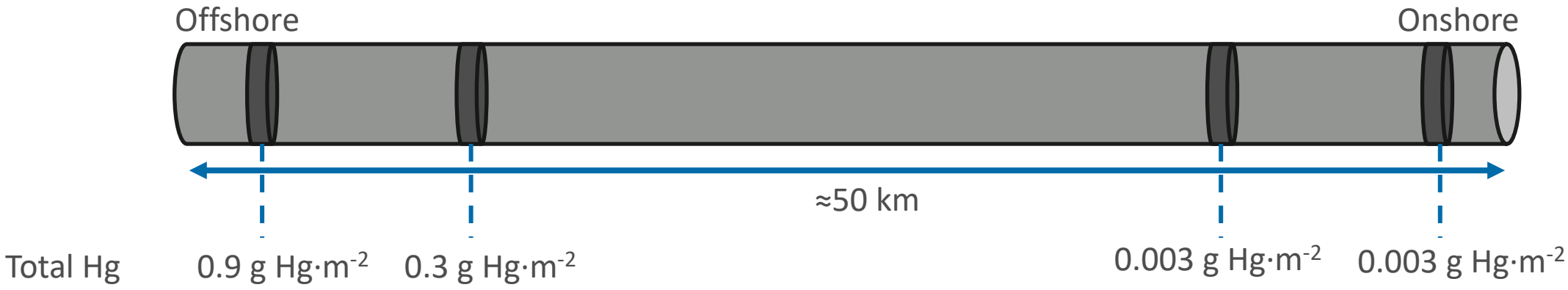
Synchrotron analysis

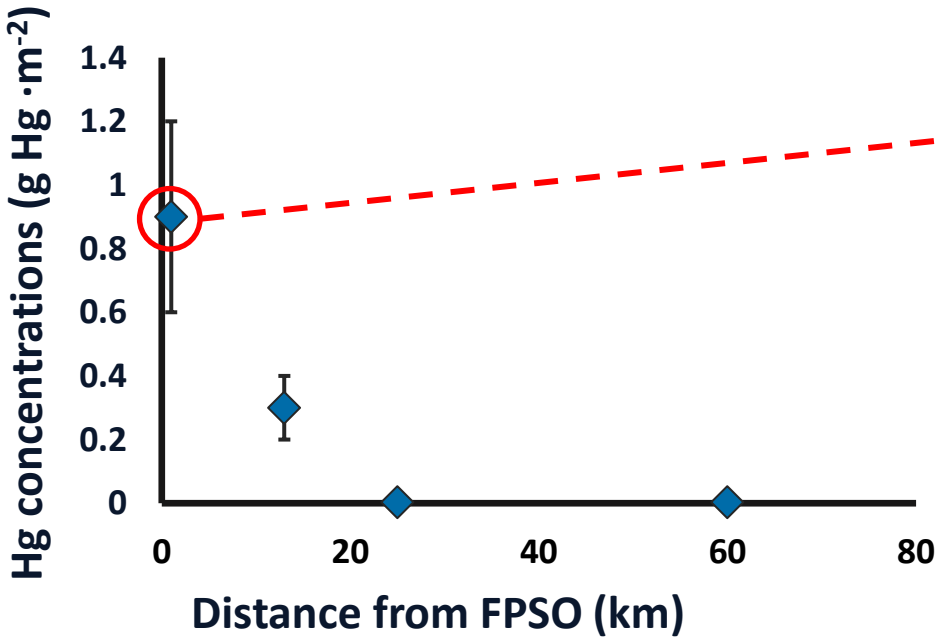
- **Surface speciation**
- High Cu:Hg vs Low Cu:Hg
- Indication of complex speciation in pipelines is possible
- Presence of Cu-Hg co-localization confirmed by LA-ICP-MS -> Potentially Hg^0 present as an amalgam.





How does the lab compare to the field?

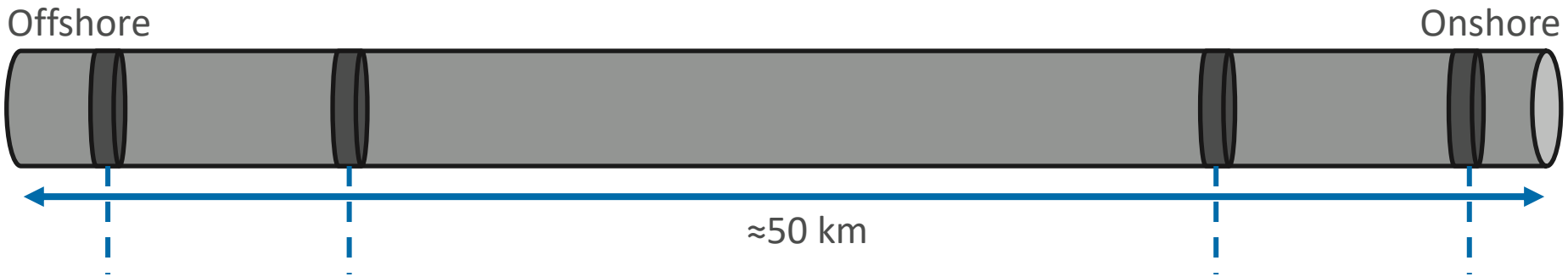


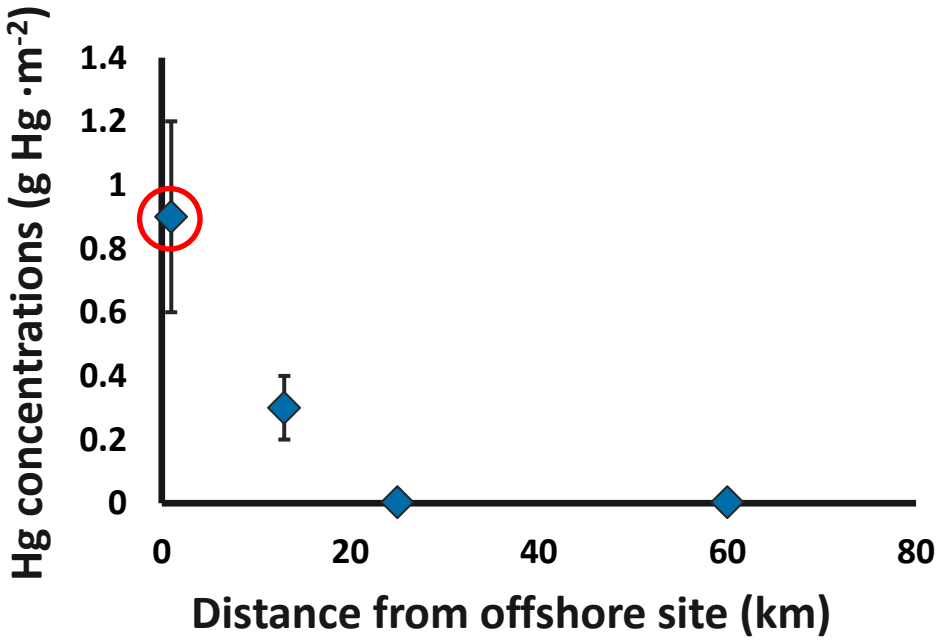


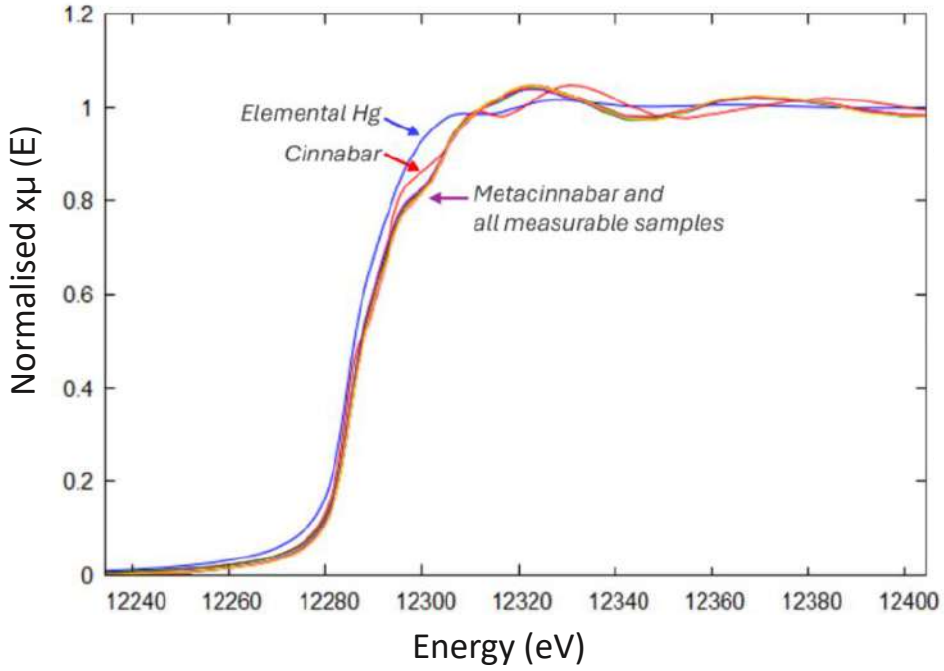
1. **What does this mean?**
   - Heterogeneity across the distance of a pipeline
   - Heterogeneity across centimetres within a pipeline…
2. **Total Hg concentrations compare well to lab-based studies**
3. **How should we handle Hg analysis on the scale of a pipeline?**

ANSTO

How does the lab compare to the field?





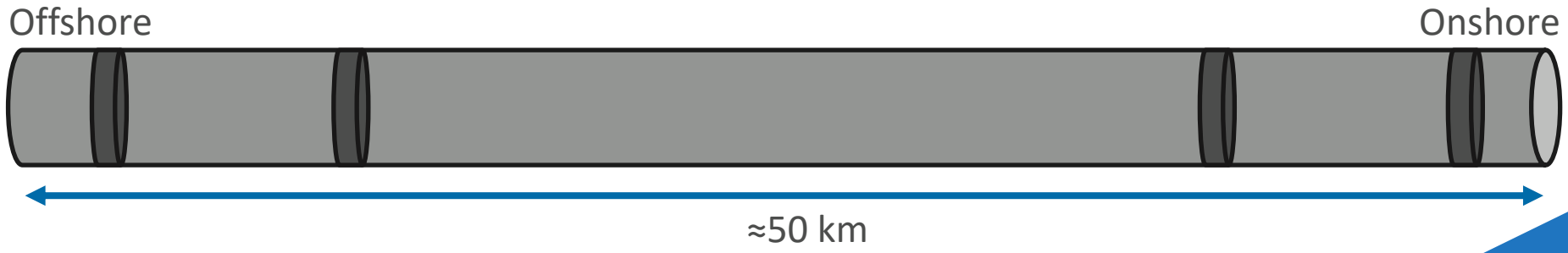


1. β-HgS was the dominant species
2. Although, we did have to pull it out of the ocean…

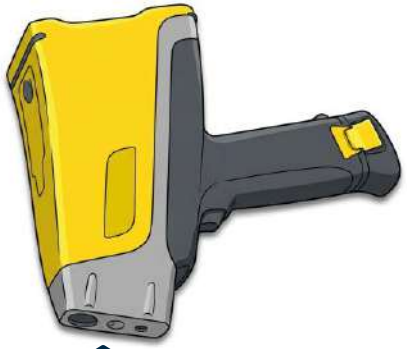
How do we work in the field? Is pXRF a useful tool?

- ICP-MS: expensive and difficult to fit in a car…
- pXRF: fast, cheap and easy to use





Can be pXRF be used for Hg analysis oil and gas infrastructure?

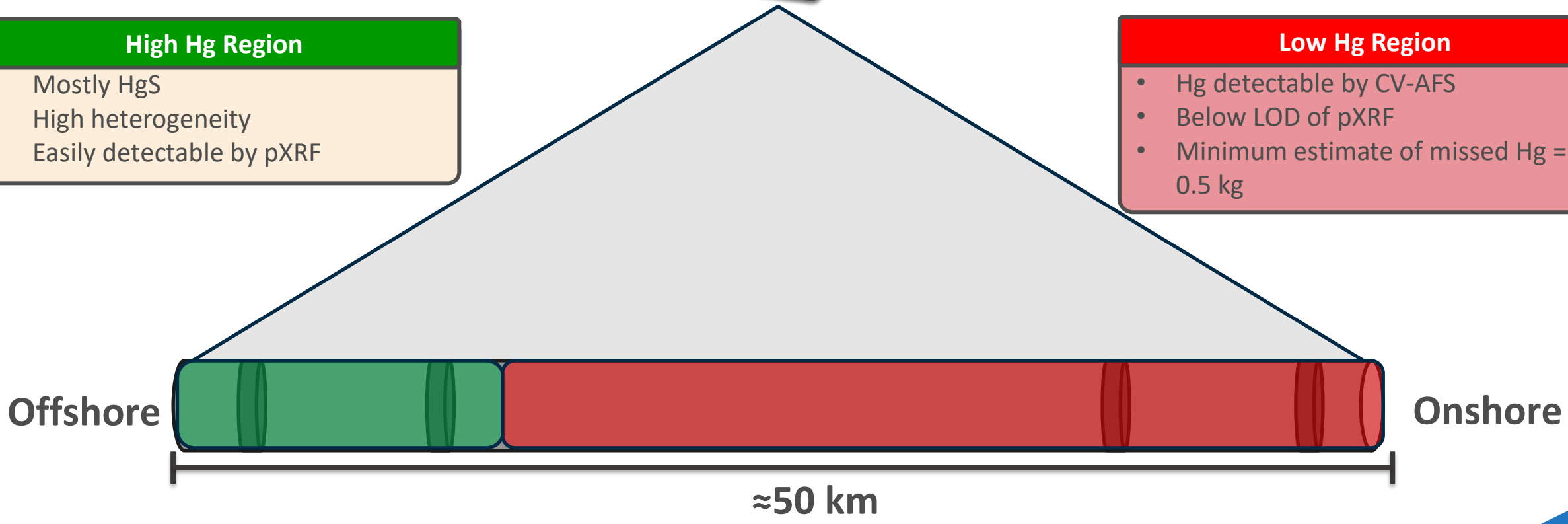


High Hg Region

- Mostly HgS
- High heterogeneity
- Easily detectable by pXRF

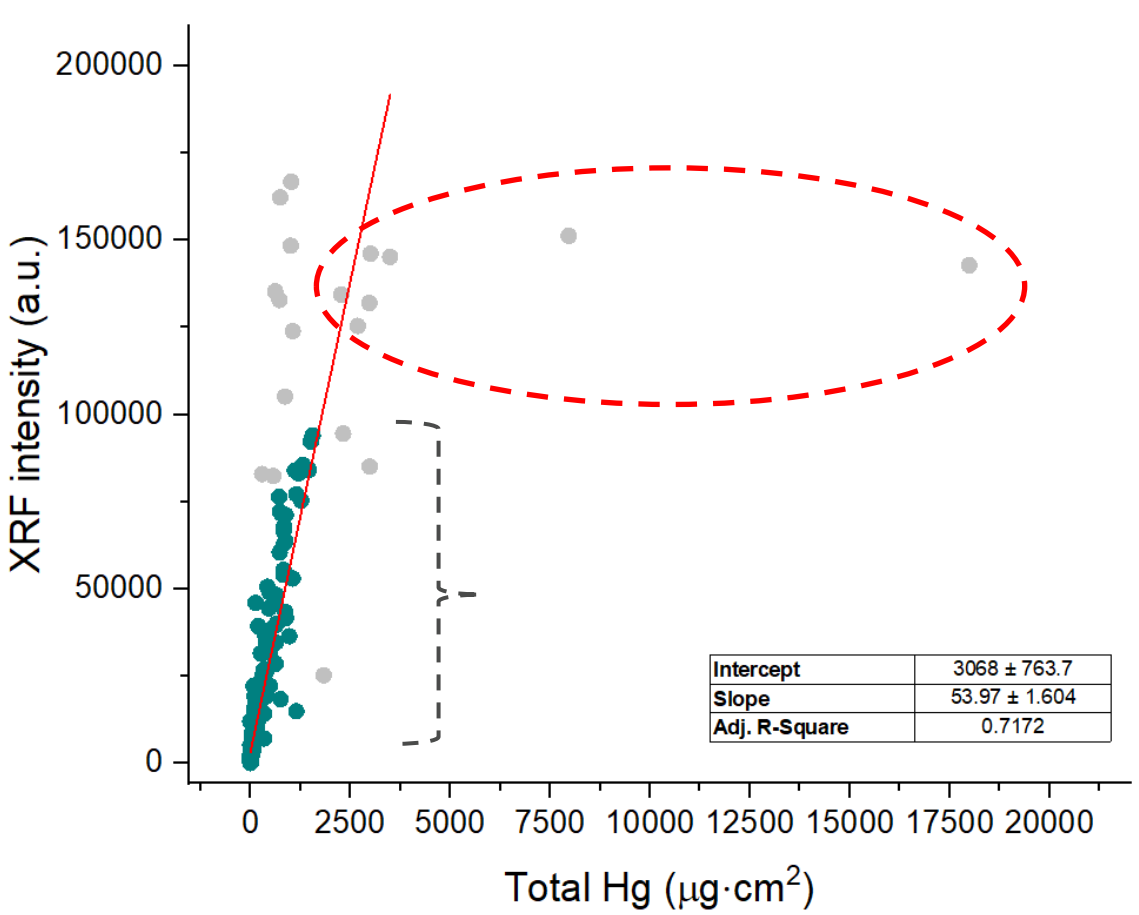
Low Hg Region

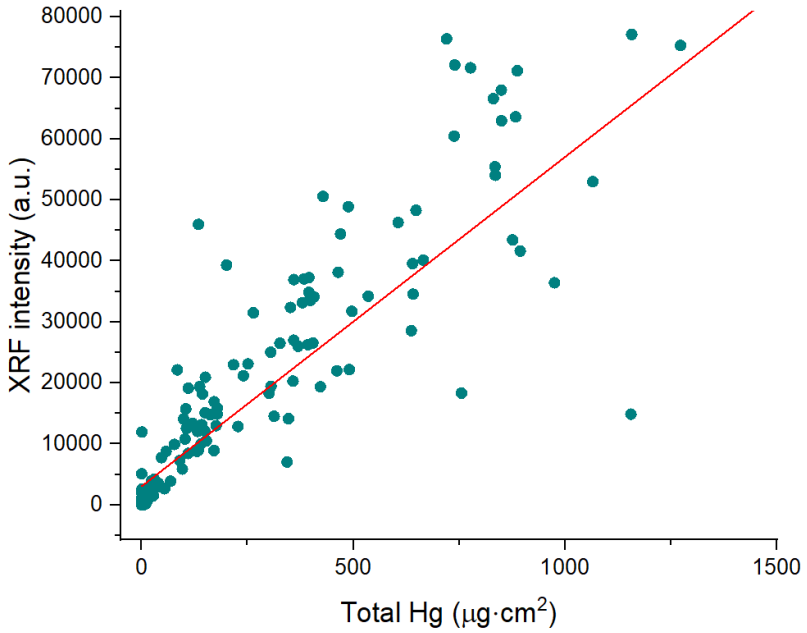
- Hg detectable by CV-AFS
- Below LOD of pXRF
- Minimum estimate of missed Hg = 0.5 kg



ANSTO

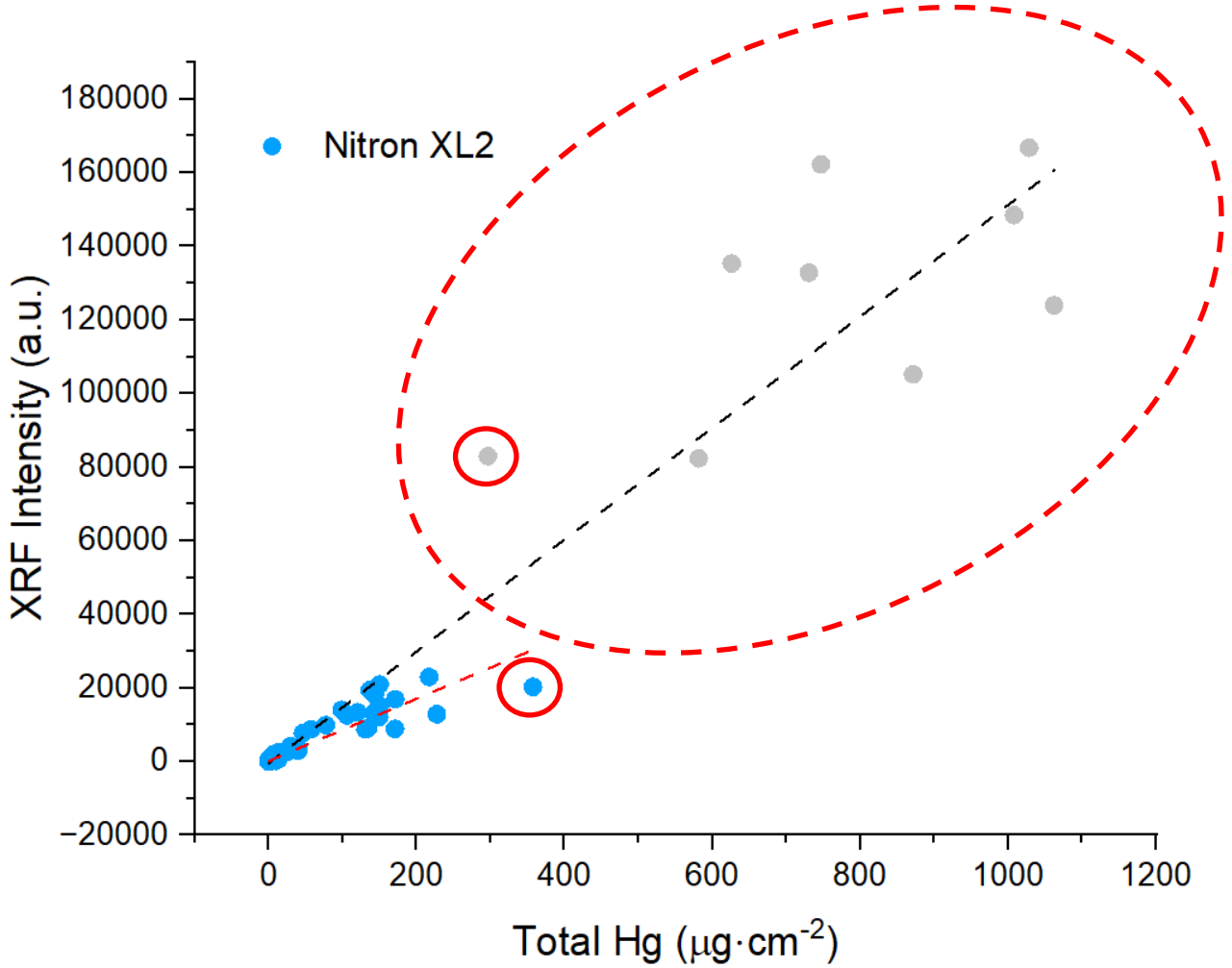
Linearity and variability





- Collaboration between ANSTO and Qa³
- 450 samples analysed by pXRF and AAS
- Evidence of detector saturation above 1500 µg Hg·cm^{-2}
- High variability in instrumental response between samples -> matrix effects

Matrix effects and Hg quantification



- Samples with comparable concentrations but 5x different pXRF response
- Separating the data sees the samples are grouped with coupons taken from the same pipeline
- Presents a significant challenge for calibration and inter-pipeline comparisons

Summary

1. Lab based estimates of total Hg analysis compare well to offshore concentrations.

2. LA-ICP-MS, XFM and XANES point towards complex Hg speciation when Hg^0 interacts with corroded carbon steel.

3. B-HgS is the key species which has been identified from pipeline samples brought onshore.

4. pXRF can be used to screen for Hg and will identify grossly contaminated areas.

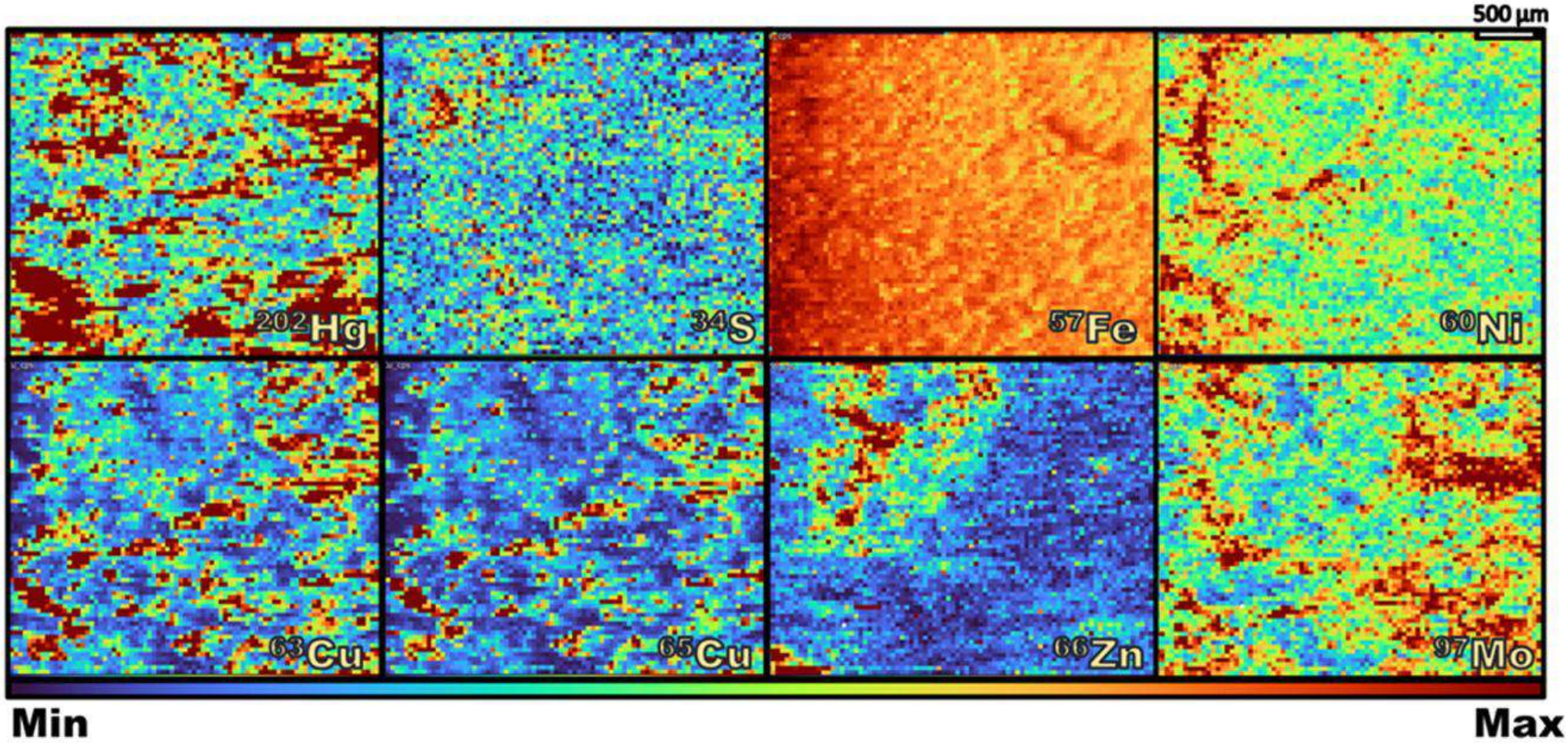
5. Matrix effects (i.e., corrosion scale thickness or composition) pose significant challenges for pXRF quantification strategies.

Thank you for listening!

Contact information: patonl@ansto.gov.au

Australian Government

ANSTO


500 µm
^{202}Hg
^{34}S
^{57}Fe
^{60}Ni
^{63}Cu
^{65}Cu
^{66}Zn
^{97}Mo
Min
Max

Australian Government

ANSTO

Environmental Impact Assessment of in situ decommissioning for offshore oil & gas infrastructure



Dr Tom Cresswell

Principal Research Scientist
Radioecology & Ecotoxicology, ANSTO

UNEP WMA Webinar, 15 September 2026

Science. Ingenuity. Sustainability.



Base case is **complete removal** of infrastructure

Leaving infrastructure **in situ** may be permissible in limited circumstances

ANSTO

Subsea pipelines

Full removal or leave in place?







© Sea Tools



© Theon Ltd

Contaminants

Identified as No. 1 research priority for offshore decommissioning

NORM



Mercury



ANSTO

Mercury in pipelines

Importance of Hg speciation



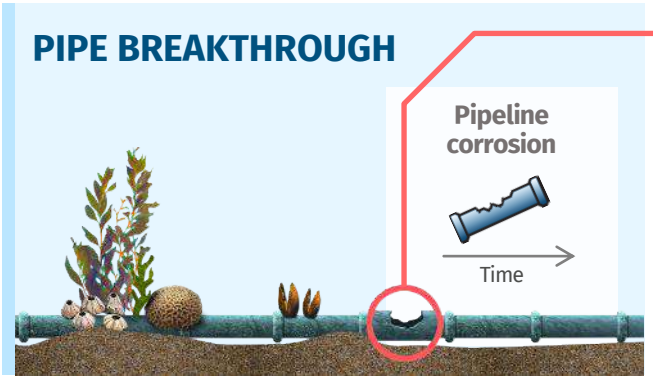


© Amazon Filters

Mercury

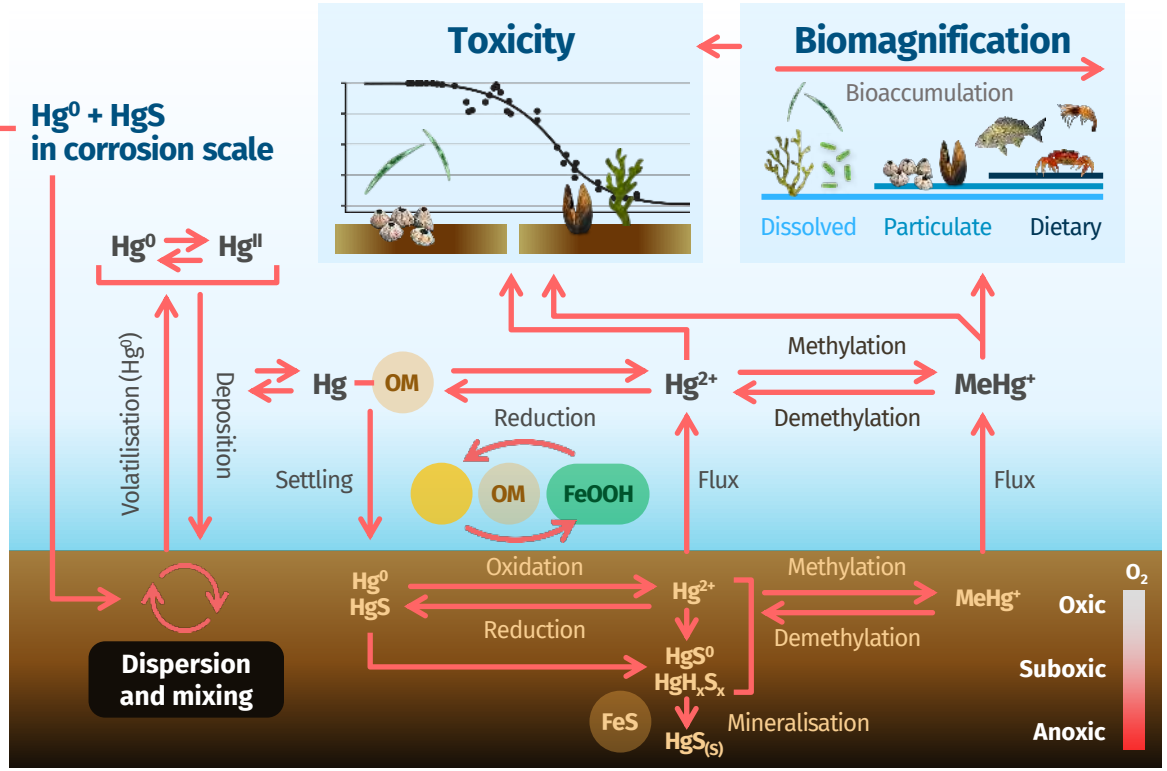
80
Hg
Mercury

Exposure scenario



Relative contribution unknown:



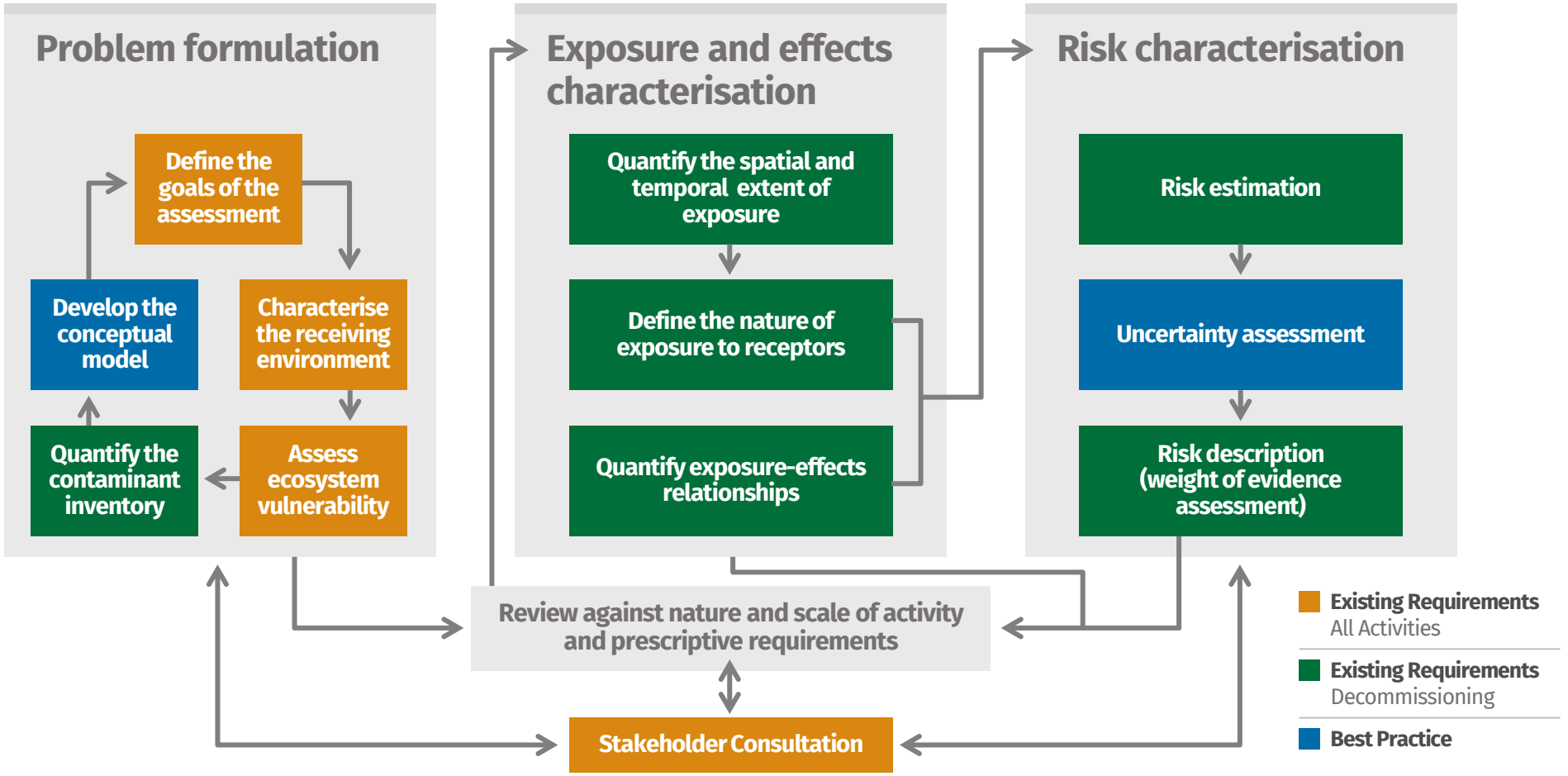


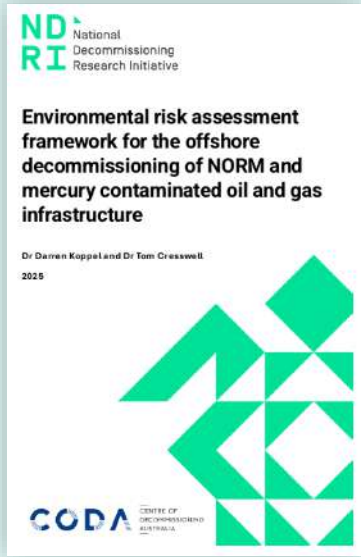
JOURNAL OF HAZARDOUS MATERIALS

Kho et al.
2022

ANSTO

Environmental risk assessment framework



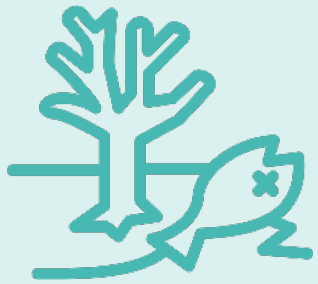


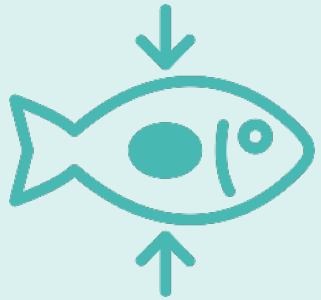
Koppel & Cresswell. 2025

Contaminant risk

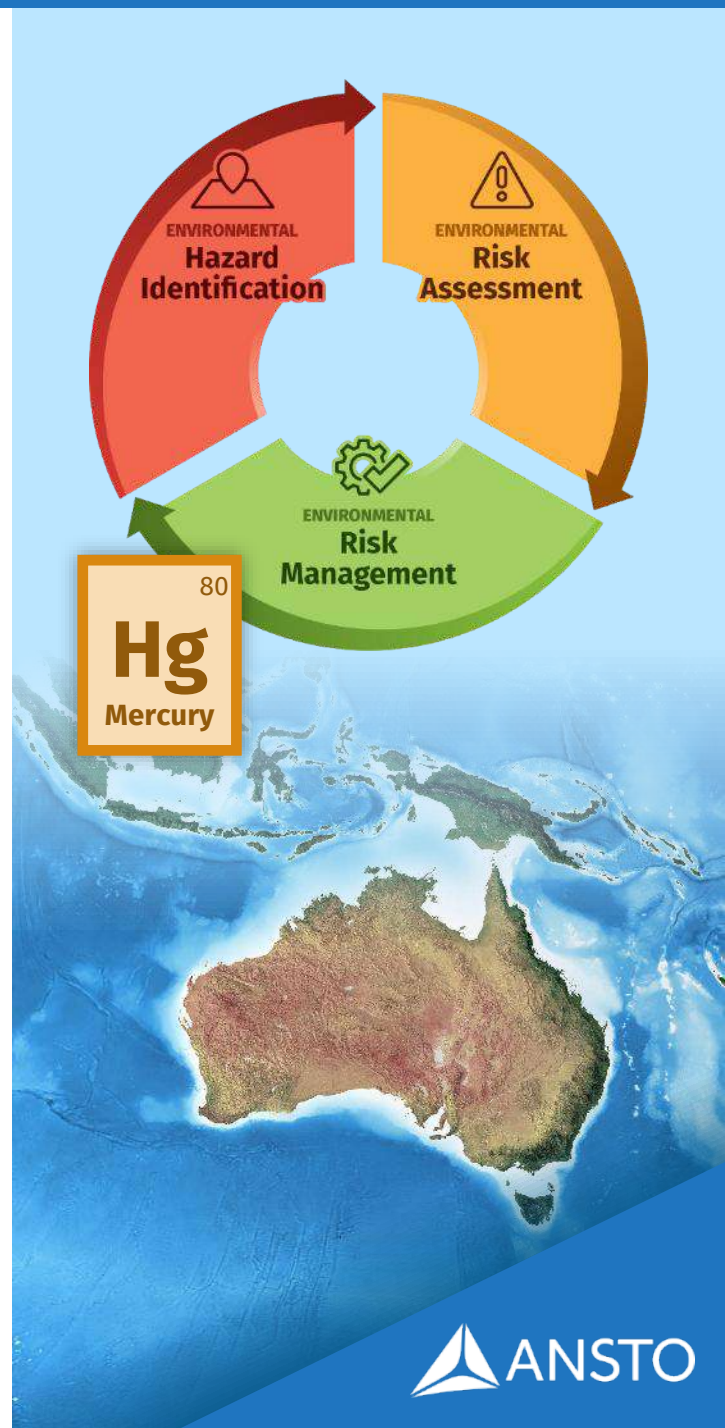
Importance of bioaccumulation

Risk = **Bioaccumulation** + **Toxic**





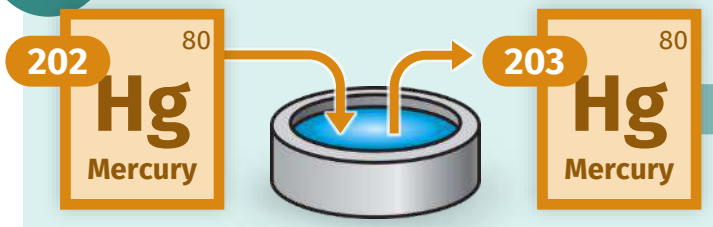




Contaminant risk – bioaccumulation

^{203}Hg live-animal radiotracing

1



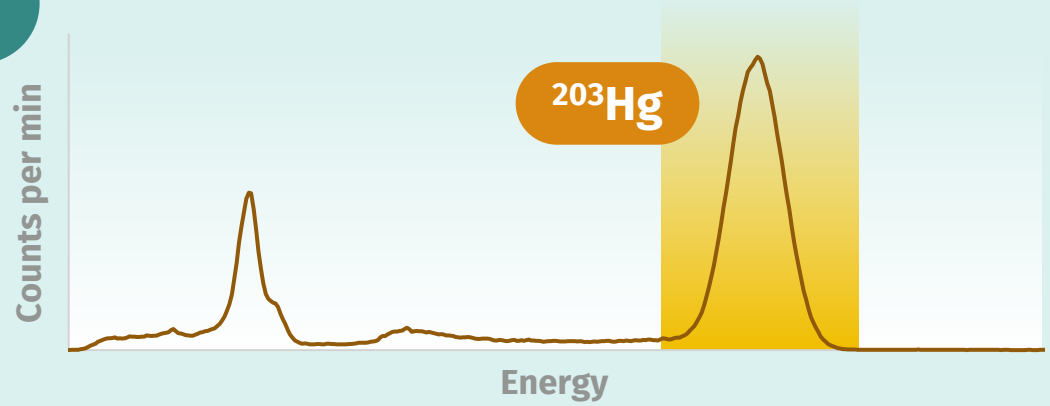
2



3



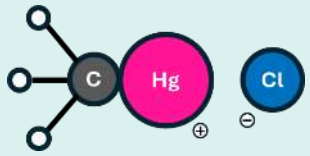
4



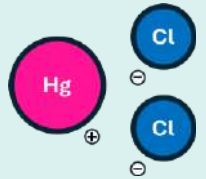
5

Radiolabel different mercury forms (species):

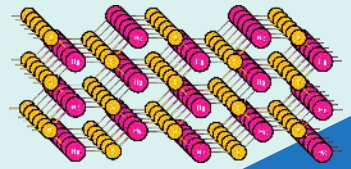
Methyl mercury (MeHg)



Mercury chloride ($HgCl_2$)



Metacinnabar (βHgS)



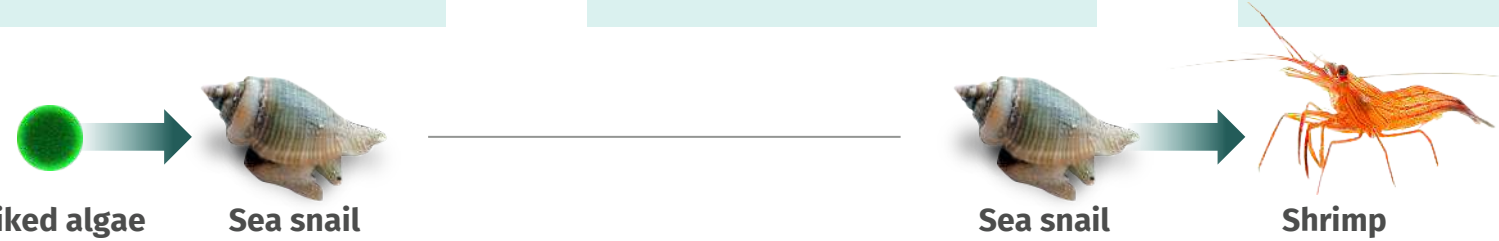
ANSTO

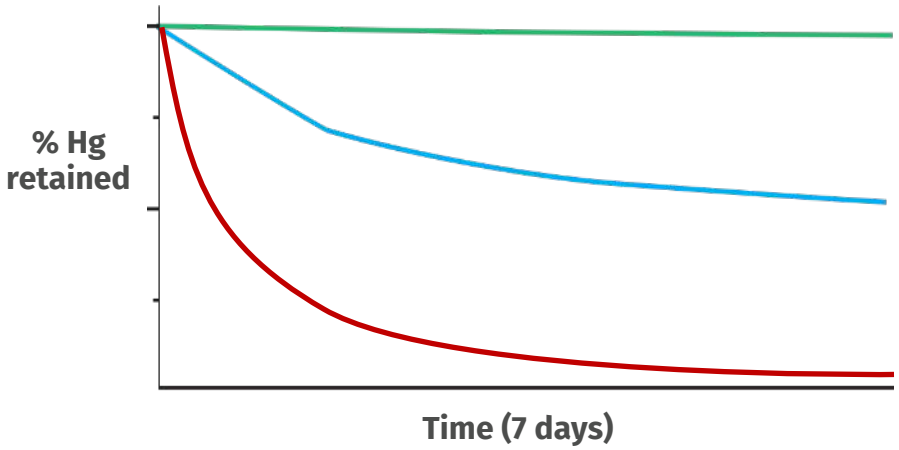
Mercury risk – ingestion

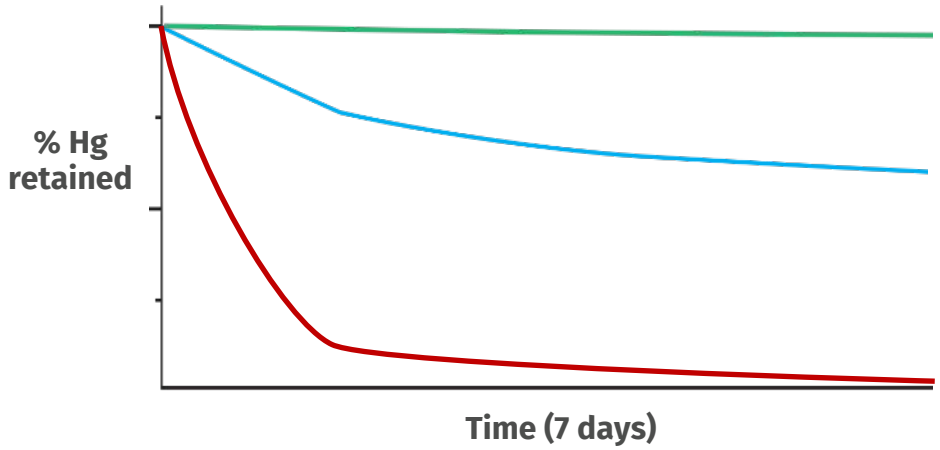
Bioaccumulation of different Hg forms

203 | 80 | Hg | Mercury

Risk = **Bioaccumulation** + **Toxic**



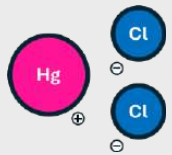




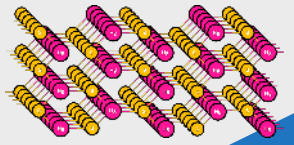
Methyl mercury
(MeHg)



Mercury chloride
($HgCl_2$)



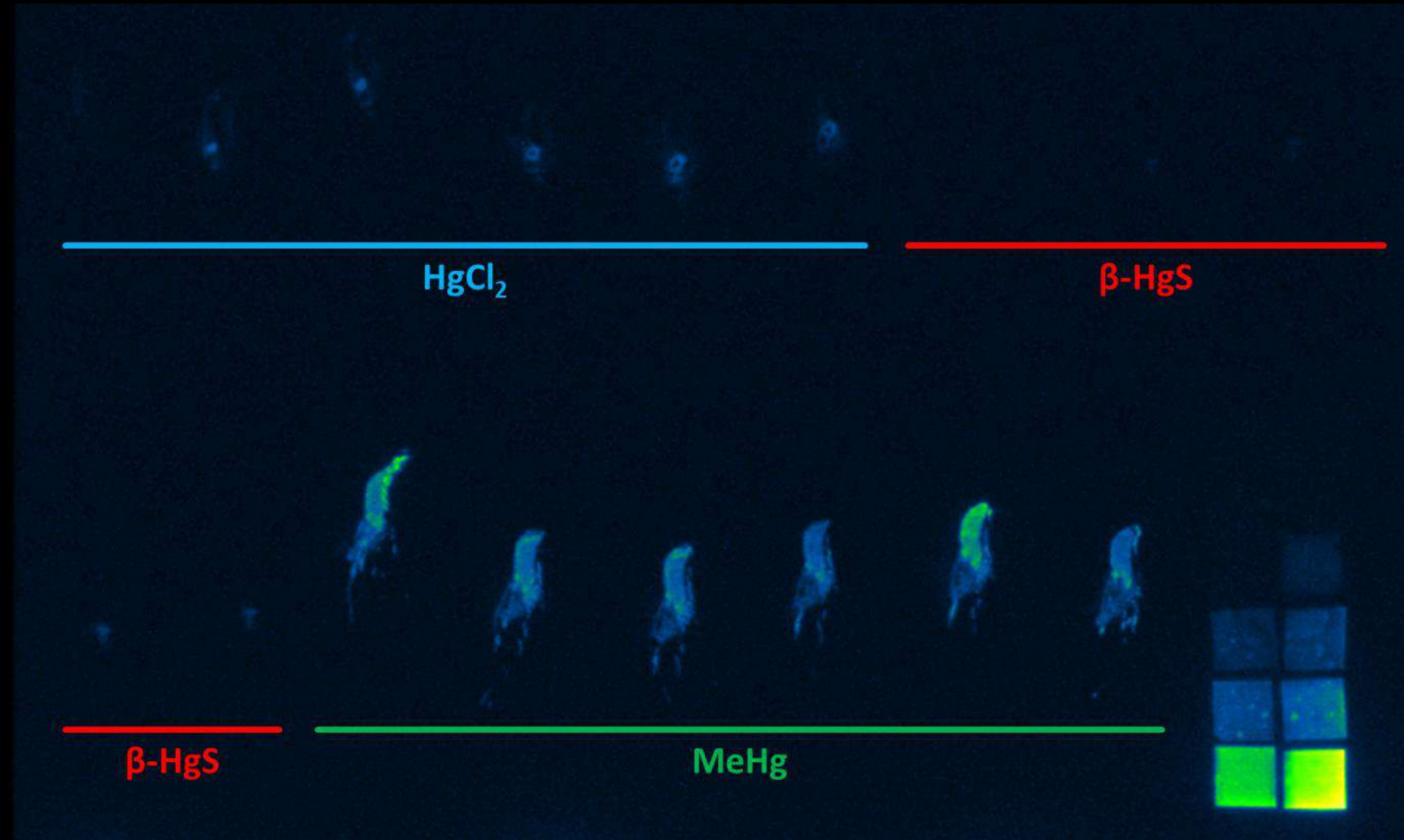
Metacinnabar
(βHgS)

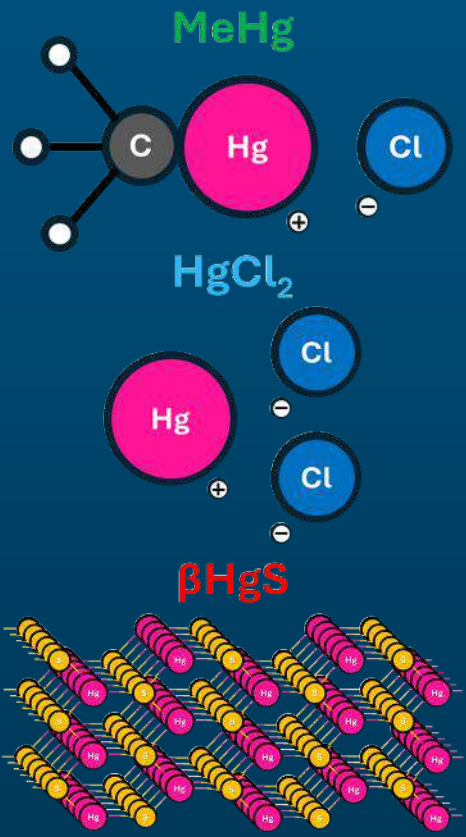


ANSTO

Mercury risk

Biodistribution imaging in shrimp





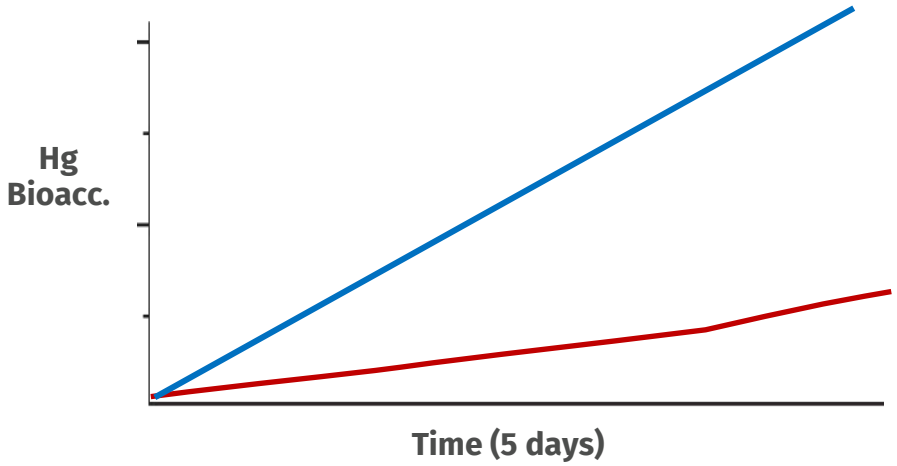
ANSTO

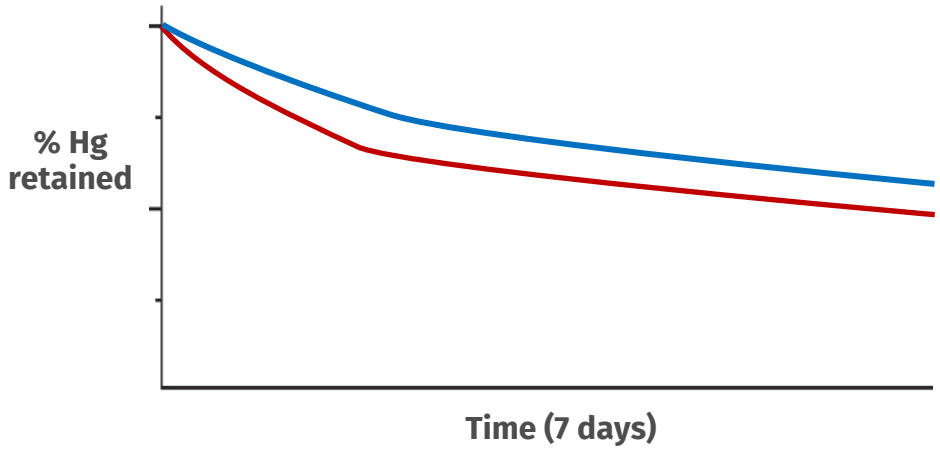
Mercury risk – HgS suspension

Bioaccumulation of nano-HgS

Risk	=	Bioaccumulation	+	Toxic

Exposure to suspended HgS nanoparticles appears to result in measurable bioaccumulation during exposure, and retention during depuration/clearance

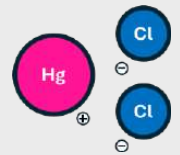




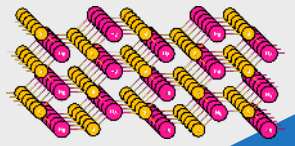
203
80
Hg
Mercury



Mercury chloride
($HgCl_2$)



Metacinnabar
(βHgS)

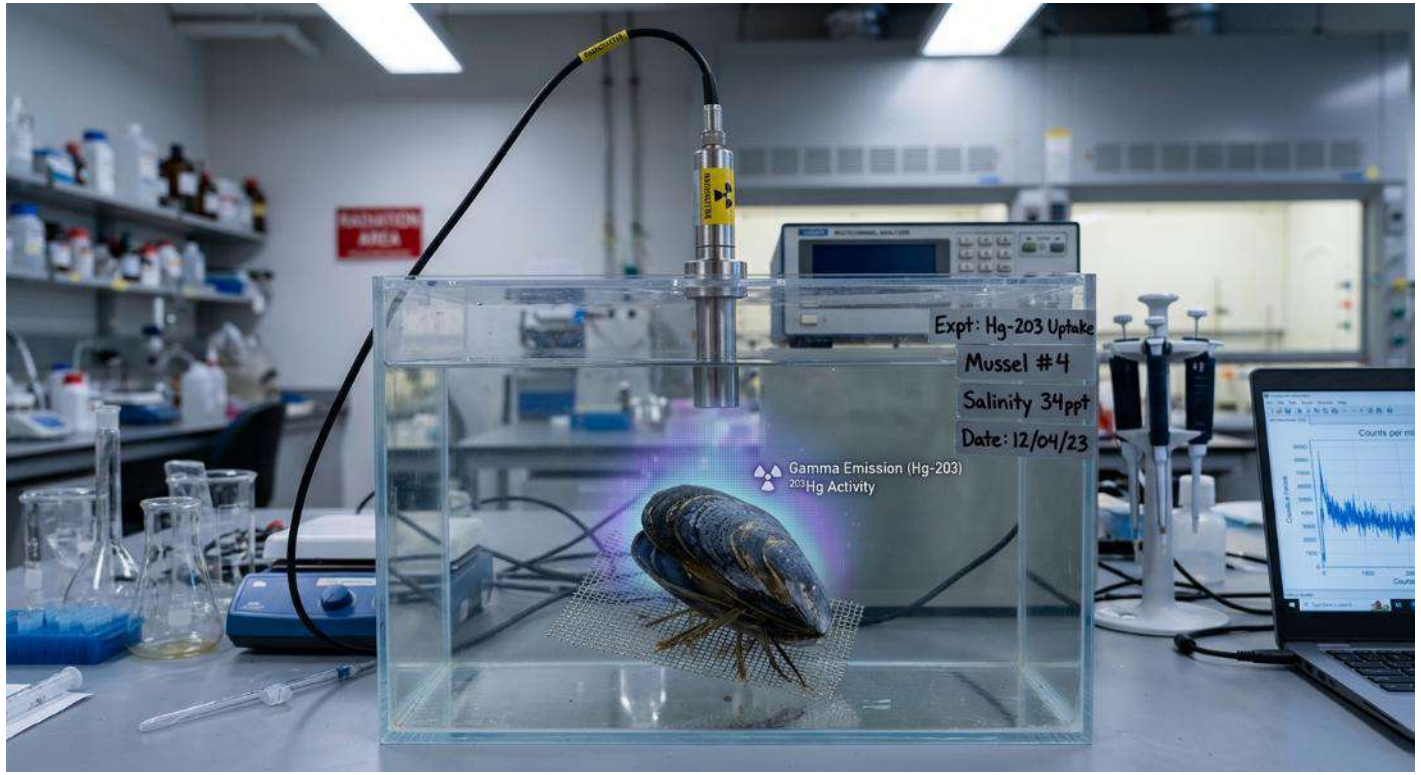


ANSTO

Mercury risk – HgS suspension

Bioaccumulation of nano-HgS

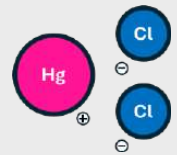
Risk = Bioaccumulation ? + Toxic



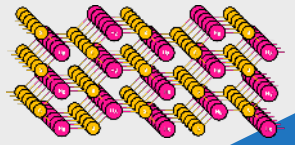
203 80 Hg Mercury



Mercury chloride
($HgCl_2$)



Metacinnabar
(βHgS)



ANSTO

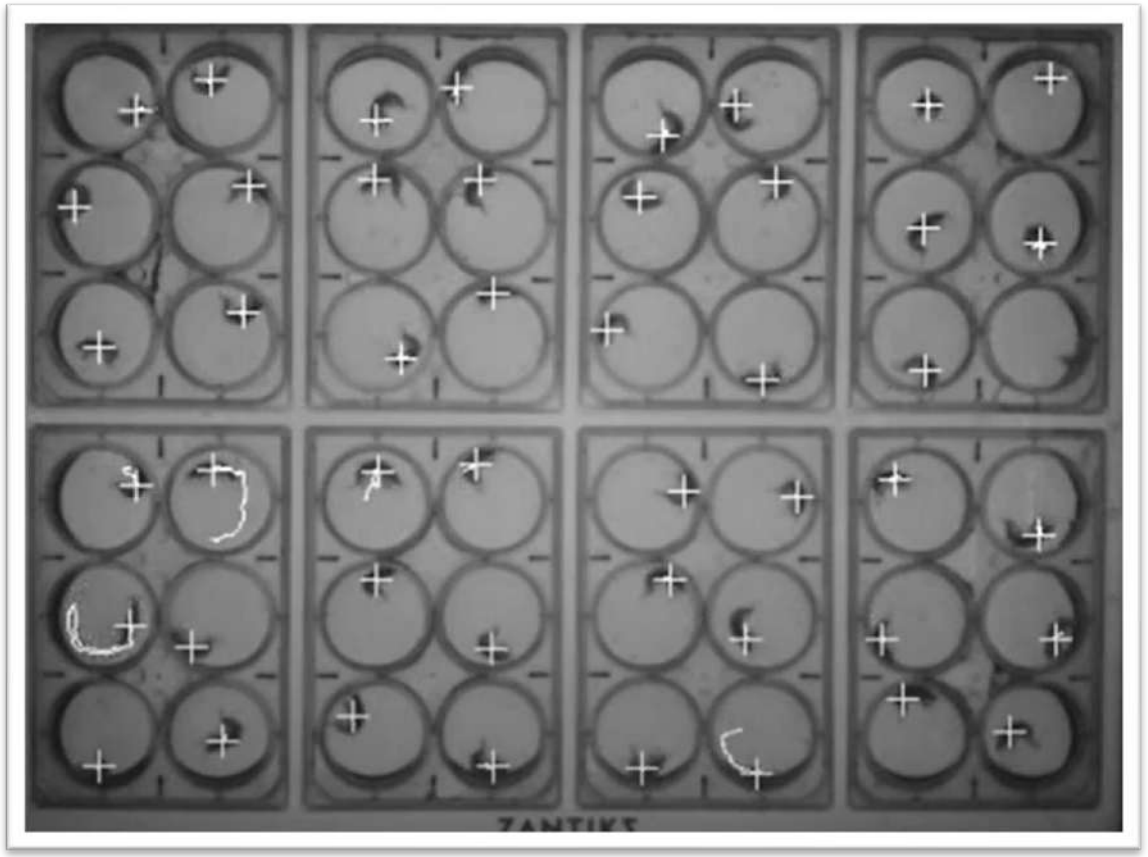
Determine Hg^{2+} conc. that elicits behavioural response



Zantiks LT system

ZANTIKS

behaviour, simply



Amphipod activity monitoring

ANSTO

Mercury research at ANSTO

1.

Understanding the **decomposition** of β-HgS in seawater under different conditions.

Hg Fate

2.

Understanding the potential for **organic transformation** of β-HgS in marine sediments.

Hg Fate

3.

Improve understanding of Hg **transfer** in Australian marine food webs from pipelines as a source.

Hg Fate

4.

Determine links between **bioaccumulated Hg** and **behavioural impacts**.

Hg Risk



Summary

- Mercury speciation is crucial to understand bioavailability
- Future changes to mercury speciation in the marine benthic environment must be investigated
- ANSTO is available to provide advice and conduct detailed research programs in collaboration with industry, academia and governments



Acknowledgments



Dr Francesa GISSI
Ecotoxicologist



Alexandra BOYD
Radioecologist



Dr Darren KOPPEL
Ecotoxicologist and Risk Assessment AIMS



Dr Marie THOMAS
Ecotoxicologist, UTAS



Dr Lhiam PATON
Analytical Chemist



Dr Elisabeth TONDL
Radiochemist

ANSTO

Thank you



Connect with me

Dr Tom Cresswell



Australian Government

ANSTO

NOPSEMA | Australia's offshore energy regulator

Mercury in steel: *an offshore oil and gas regulatory perspective*



nopsema.gov.au

Tarren Reitsema

Garnet Hooper

Minamata Convention



- Came into force in 2022 for Australia.
- Draws particular attention to identifying sources, emissions and discharges of mercury, and how it is managed
- NOPSEMA applies an objective based regulatory approach – onus is on the titleholder to demonstrate how impacts and risks are acceptable and ALARP

Mercury across the Oil & Gas lifecycle

MINAMATA CONVENTION ON MERCURY





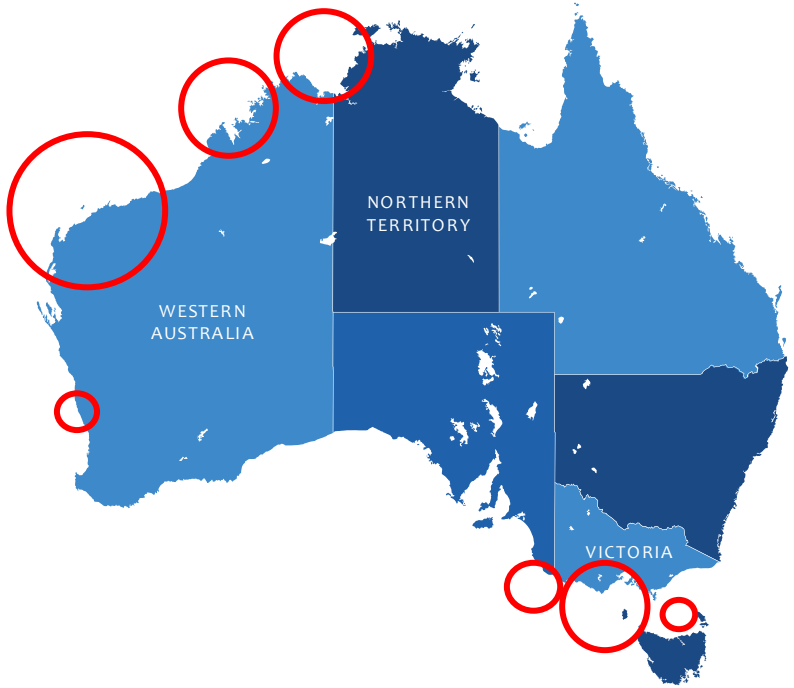


Drilling → Operations/ Production → Decommissioning

DECOMMISSIONING JOURNEY IN AUSTRALIA

WA & NT

- 35 platforms
- 11 Floating facilities
- 6,076 km pipelines and static umbilicals
- 120 flexible risers and dynamic umbilicals
- 483 subsea lifts
- ~548 wells to be plugged and abandoned



Victoria

- 22 platforms
- 2,089km pipelines and umbilicals
- 120 flexible risers and dynamic umbilicals
- 52 subsea lifts
- ~460 wells to be plugged and abandoned

* Wood MacKenzie 2020

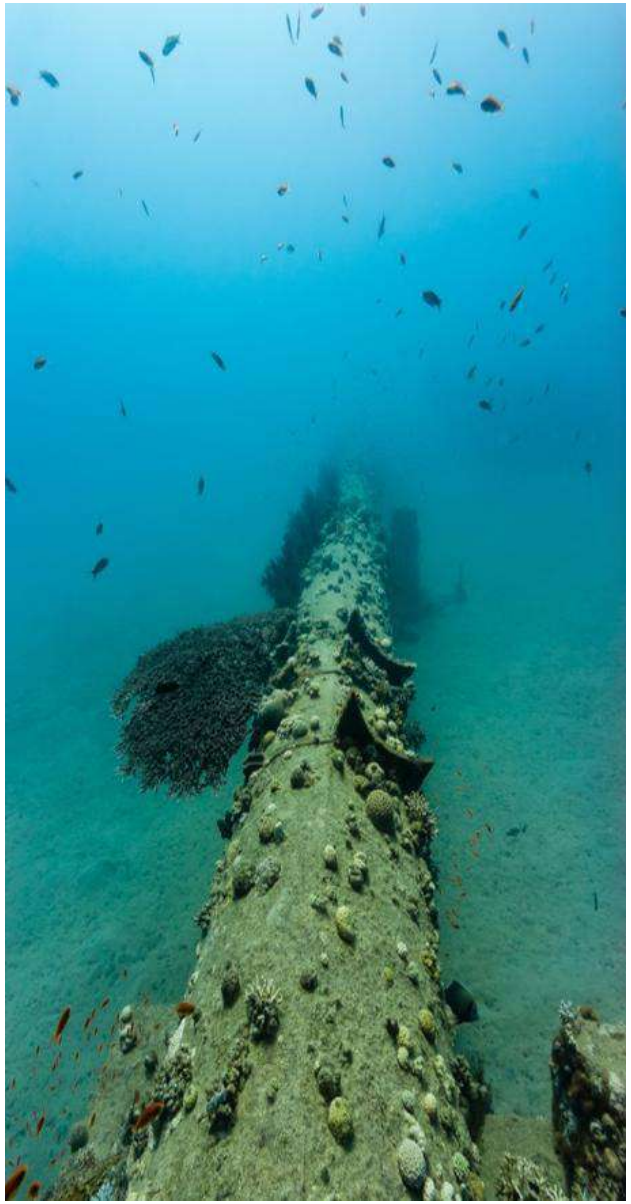
Mercury in Steel

Why It Matters for Decommissioning

- Mercury contamination may remain long after production ceases.
- Decommissioning of contaminated steel can create worker exposure and environmental risks.
- Waste classification:
  - hazardous or asset?
  - Controlled waste requirements for tracking, transport, licensing, disposal

Challenges

- Mercury is difficult to detect visually.
- Contamination is frequently internal and inaccessible.
- Existing sampling and measurement techniques remain an area requiring further research.
- Management of impacts and risks during decommissioning execution and waste management.
- Increased project costs.
- Multiple regulatory jurisdictions.



Decommissioning Controls



Hierarchy of Control

- Mercury contamination may remain long after production ceases.
- Disturbance of contaminated steel during dismantling can create worker exposure and environmental risks.

Control measures

- Mercury risk assessment during decommissioning planning.
- Sampling and contamination mapping.
- Flushing and pigging of pipelines
- Atmospheric mercury monitoring.
- Safety, e.g. cold-cutting techniques, appropriate PPE
- Segregation and controlled disposal of contaminated materials.

Key risks

- Exposure of workers to mercury vapour
- Potential release of mercury-containing wastes to the environment.
- Regulatory and waste-classification challenges.

Implications for Decommissioning

Current Industry Focus

- Accurate mercury detection and quantification.
- Effective decontamination of steel prior to recycling or disposal.
- Verification that exposure controls adequately protect workers.
- Understanding infrastructure degradation and long-term risks associated with infrastructure left in situ:
  - Uncertainty in long-term behaviour (potentially centuries).

Regulatory Considerations

- Mercury contamination may remain long after production ceases.
- Mercury is recognised as a key contaminant requiring assessment during offshore decommissioning programs.
- Demonstration that mercury impacts risks have been reduced to ALARP and acceptable levels.
- The disposal pathway:
  - Recycling, decontamination, disposal, transport, and leave-in-situ decisions can all be affected by mercury contamination levels

Key Takeaway

- Significant decommissioning consideration in offshore oil and gas projects.
- Early identification, robust exposure controls, and effective decontamination strategies are essential to safely manage worker, environmental, and regulatory risks.

NOPSEMA

National Offshore Petroleum Safety and Environmental Management Authority

Level 10 Alluvion, 58 Mounts Bay Rd, Perth WA 6000
GPO Box 2568, PERTH WA 6001 Australia

nopsema.gov.au

