Tuesday 18 July 2023
13:00 – 15:00 CEST

Managing mercury along the oil and gas value chains: sharing of experiences and best practices

Virtual event

Agenda

Opening remarks (1:00 pm – 1:20 pm)

- Lilian Corra, *International Society of Doctors for the Environment, lead author of the Global Mercury Partnership Study report on mercury from oil and gas*
- Eisaku Toda, *Secretariat of the Minamata Convention on Mercury*

Session 1 - Managing mercury emissions and releases along the life cycle in the oil and gas sector (1:20 pm – 2:10 pm), facilitated by Misuzu Azari, Kyoto University (Japan), Co-lead of the Mercury Waste Management Partnership Area

- Global mercury hotspots along the oil and gas value chain: current knowledge and experience by Matt Bower, Qa3
- Mercury Management in petroleum refining, by Yamile Julio Castillo, IPIECA
- Managing mercury waste from the oil and gas sector, by David Hunter, Batrec
- Environmentally sound management of mercury waste generated from the oil and gas sector, by Hiroki Iwase, Nomura Kohsan

Questions and Answers

Session 2 - Experiences, lessons learned and challenges from countries (2:10 pm – 2:50 pm), facilitated by Judith Torres, Ministry of Housing, Territorial Planning and Environment of Uruguay, Co-lead of the Mercury Supply and Storage Partnership Area

- Experience in managing mercury along the oil and gas supply chain in Thailand, by Narongsak Chaiyasit, Synergy Plus Co., Ltd., Thailand
- Challenges in the Latin America Region for the management of mercury from the oil and gas sector by Alberto Santos Capra, BCRC Argentina
- Treating mercury waste generated by the production of oil and gas in Ghana, by Sam Adu-Kumi, consultant and national expert in the sound management of chemicals and waste for the Environmental Protection Agency, Ghana

Questions and Answers

Closing remarks (2:50 pm – 3:00 pm)

- Rodges Ankrah, *Environmental Protection Agency of the United States, Chair of the Partnership Advisory Group*

Managing mercury along the oil and gas value chains: sharing of experience and best practices

Lilian Corra

International Society of Doctors for the Environment, lead author of the Partnership technical study report on mercury from oil and gas

Managing mercury along the oil and gas value chains: sharing of experience and best practices

Eisaku Toda

Secretariat of the Minamata Convention on Mercury

Managing mercury along the oil and gas value chains: sharing of experience and best practices

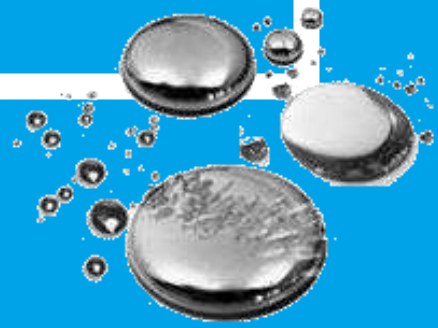
Session 1 - Managing mercury emissions and releases along the life cycle in the oil and gas sector

facilitated by Misuzu Azari, Kyoto University (Japan), Co-lead of the Mercury Waste Management Partnership Area

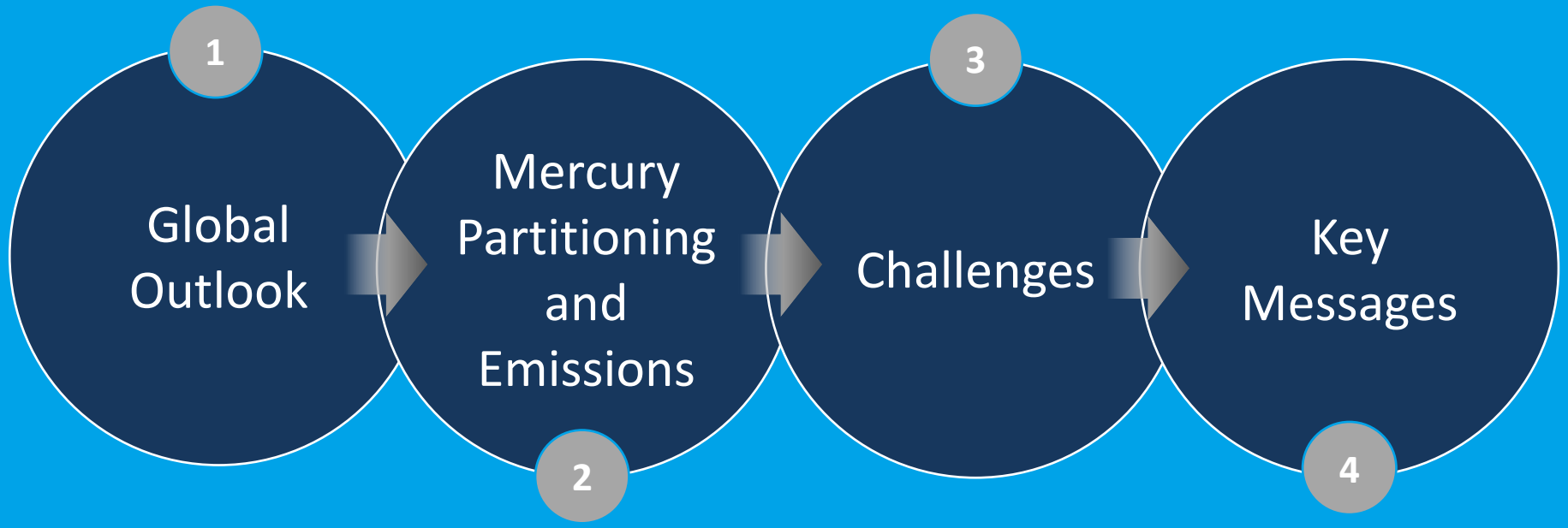
Qa³

On - site Chemistry

Global Mercury Hotspots Along the Oil and Gas Value Chain - Current Knowledge and Experience

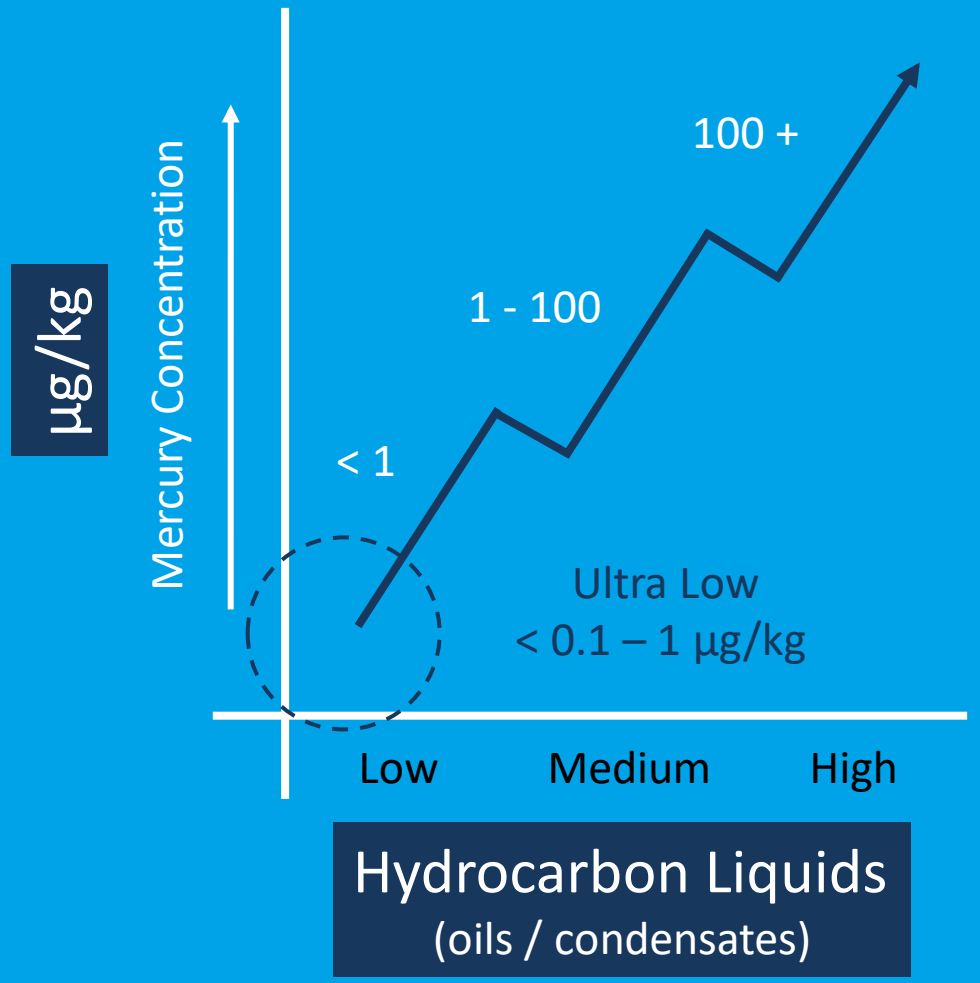


Content Overview

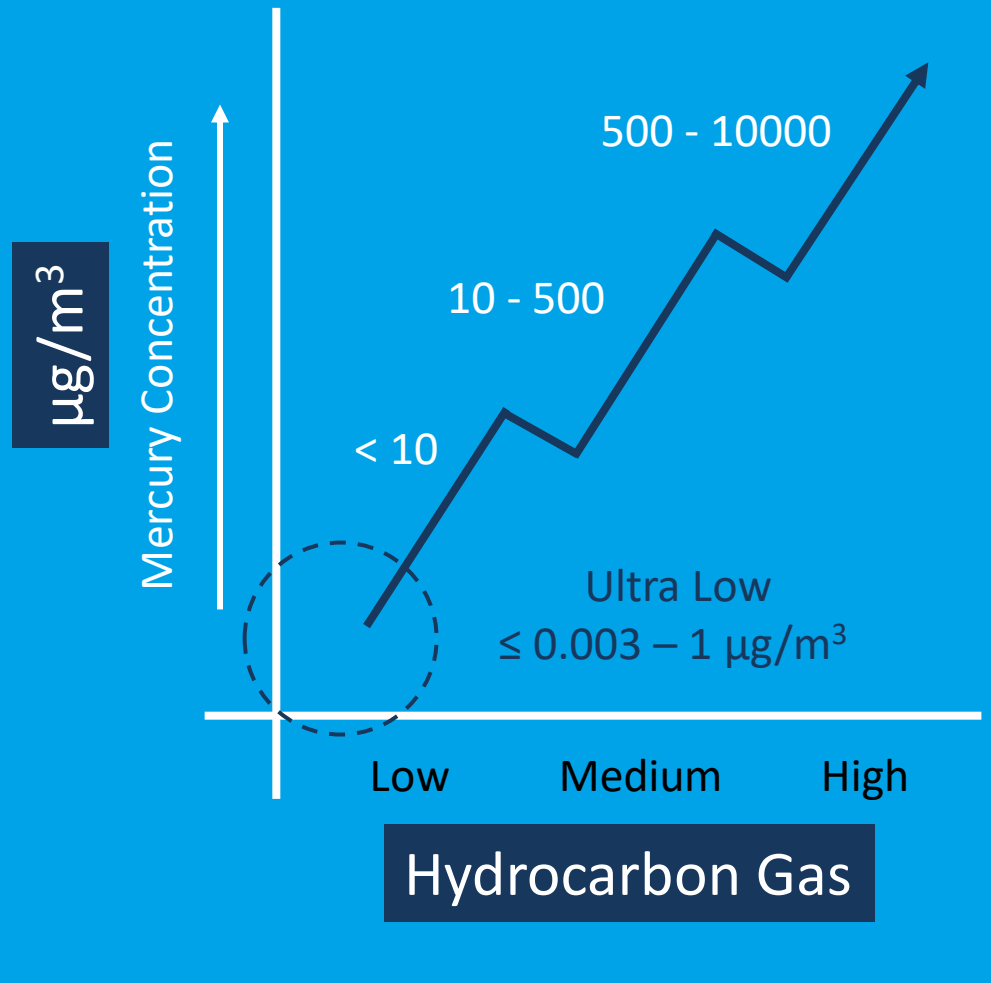



1
Global
Outlook

Mercury Concentrations in the Oil and Gas Industry



Hydrocarbon Liquids
(oils / condensates)



Hydrocarbon Gas

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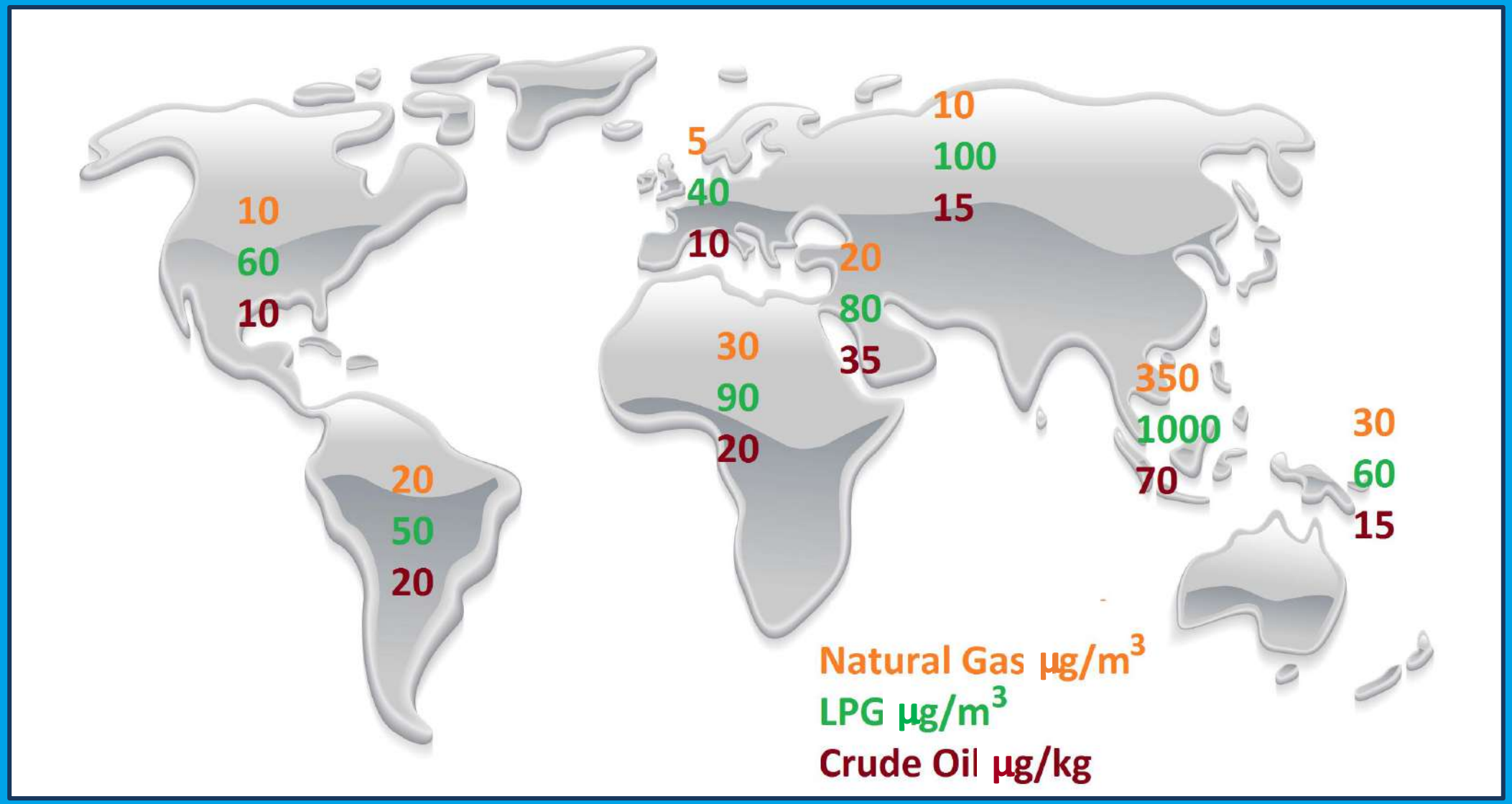
Global Mercury Distribution



Global Mercury Distribution

Gas:	**< 0.01 µg/m³**
Oil:	**< 1 µg/kg**

Within 100 Km

Gas:	**120 µg/m³**
Condensate:	**80 µg/kg**

In what form will you find mercury in our industry?

Hydrocarbon Gas

Only Hg^0 (elemental mercury)

Concentrations observed from

< 0.003 – 12000 µg/m³

Hydrocarbon Liquids and Produced Waters

Associated and dissolved Hg^0

Insoluble species (predominantly HgS)

Soluble ionic mercury (Hg^{2+})

Soluble non-ionic / organic mercury

Hydrocarbon liquid concentrations observed from < 0.5 µg/kg – 8000 mg/kg

Solids and Sludges

Including corrosion product, pigging debris, tank sludges, pipeline scales, filter solids

Predominantly HgS but can include other species such as $HgCl_2$ and HgSe

% concentrations often observed 40% highest observed by Qa³

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2

Mercury Partitioning and Emissions

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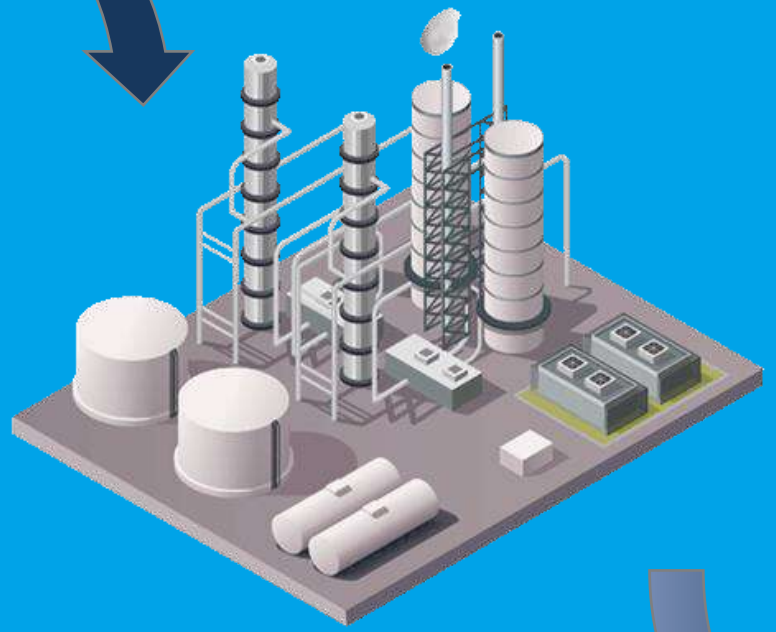
Oil and Gas Value Chain Overview

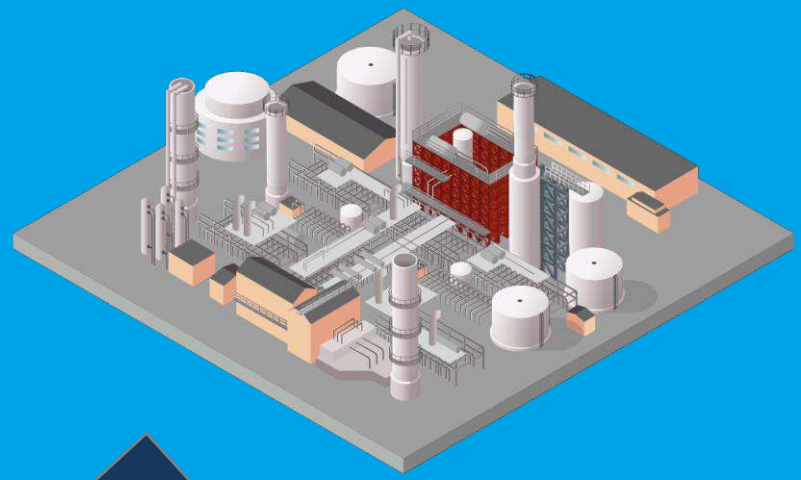
Upstream

Exploration and Initial Production



Midstream

Refining and Storage



Downstream

Petrochemical and Distribution

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Summary of Unconsidered Emissions

Emission Source	Observed / Estimated % Removal	Common Emission Route
Dehydration - (Glycol Contactor)	OBSERVED 10 – 60%	Venting direct to atmosphere
Dehydration - (Mol Sieve)	OBSERVED 10 – 99%	Via water and possible flaring
Acid Gas Removal - (Amine Contactor)	OBSERVED 10 – 60%	Flaring or contaminated sulphur
Pipework and Equipment	OBSERVED 10 - 99%	Smelting at end of life
Waste Solids and Sludges	OBSERVED 10 – 60%	Hydrocarbon waste disposal routes
Flaring	OBSERVED 1 – 80%	Direct to atmosphere
CO_2 and N_2 Removal	ESTIMATED 1 – 5%	Vent to atmosphere
Effluent Water	OBSERVED 0.1 – 2%	Directly into sea / waterway
Venting of Cargo Tanks	ESTIMATED 1 – 2%	Direct to atmosphere

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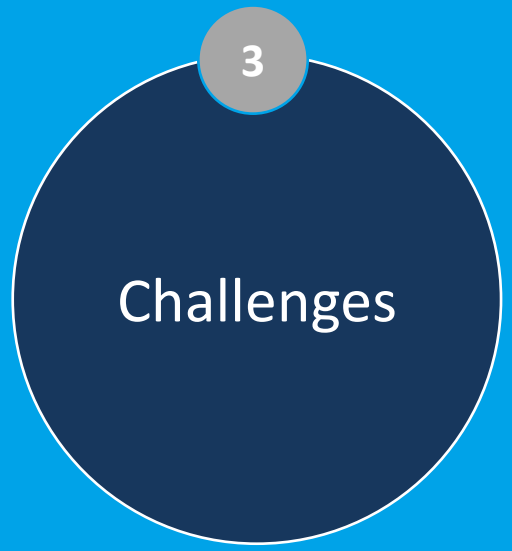
Summary of Unconsidered Emissions

Continent / Region	Annual Production*			Estimated Average Mercury Concentration#			Estimated Annual Mass of Mercury Produced (tonnes)	Estimated Annual Mercury Emission *(tonnes)*	
	NG (Bm^3)	CO (Mt)	LPG (Mt)	NG ($\mu g/m^3$)	CO (µg/kg)	LPG (µg/kg)		20% Loss	50% Loss
Europe	236	149	13	6	12	60	4.0	0.8	2.0
North America	1128	927	188	15	15	90	48	10	23.9
Latin America	174	289	11	25	20	120	11	2	5.7
CIS	847	711	10	15	10	100	21	4	10.3
Asia Pacific	672	350	19	140	110	1000	152	30	76.0
Africa	238	394	15	30	25	150	19	4	9.6
Middle East	695	1321	119	20	15	90	44	9	22.2
TOTALS	***3989***	***4141***	***377***	-	-	-	***300***	***60 - 150 tonnes***	

* *Based upon data collated by* ***BP*** *- 'Statistical Review of World Energy 2020 | 69th edition'*

\# *Based upon Qa3 project experience and observations*

NG - Natural Gas, CO - Crude Oil, LPG - Liquefied Petroleum Gas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Challenges

Current Challenges

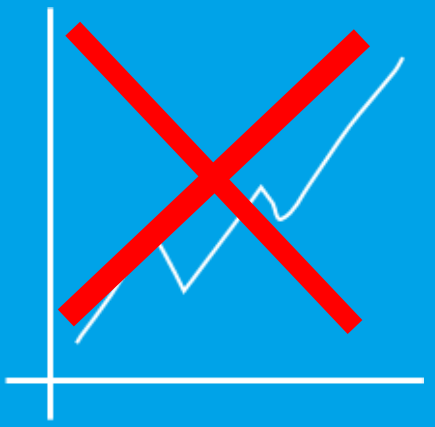
Challenges in the determination of production and emission from the industry

Historical Data

- *Limited availability as operators were often reluctant to share*
- *Incorrect data – Incorrect sampling techniques due to limited understanding at the time*

On-going

- *Industry plagued by old procedures and methodologies (1970/80s)*
- *Complexities of gaining truly representative samples*
- *Lack of oversight when it comes to mercury*
- *Driven by process issues and product value rather than emission monitoring*



Current Challenges

Additional Challenges

End of life considerations

- *End of life considerations – recovery and smelting, or leaving in situ*

Personnel safety / exposure concerns

- *Lack of understanding around the behaviour of mercury*
- *Hot work / breaking containment / confined entry / blasting or cleaning*


4
Key
Messages

CONCLUDING COMMENTS

- **Don’t ever assume mercury concentrations will be low based on geographical location.**
- **It is very important to consider production rates of each product stream along side mercury concentrations.**
- **Oil and gas is a unique, multi-faceted system making estimates on total production and emissions complicated.**
- **Mercury in the oil and gas industry exists in a number of different chemical forms.**
- **Qa³ have estimated unconsidered emissions from the industry to fall in the range 60 – 150 tonnes per year.**
- **Historical data cannot be relied upon. International guidelines on best mercury sampling and analysis practises should be published and adhered to. Gaining truly representative samples is very complex.**
- **The industry needs to be further educated about the dangers (or not) of mercury and its various forms.**
- **End of life considerations – decommissioning is growing into its own industry. Impact of contaminated infrastructure. Ecological impacts of equipment disposal / smelting impacts.**

Qa3 On - site Chemistry

Thank you for your attention

Presented by:
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UNEP Global Mercury Partnership

Mercury management in petroleum refining

18 July 2023

Yamile Julio Castillo

Advancing environmental and social performance across the energy transition

www.ipieca.org

Ipieca

Founded in 1974 at the request of the UN Environment Programme

Our vision

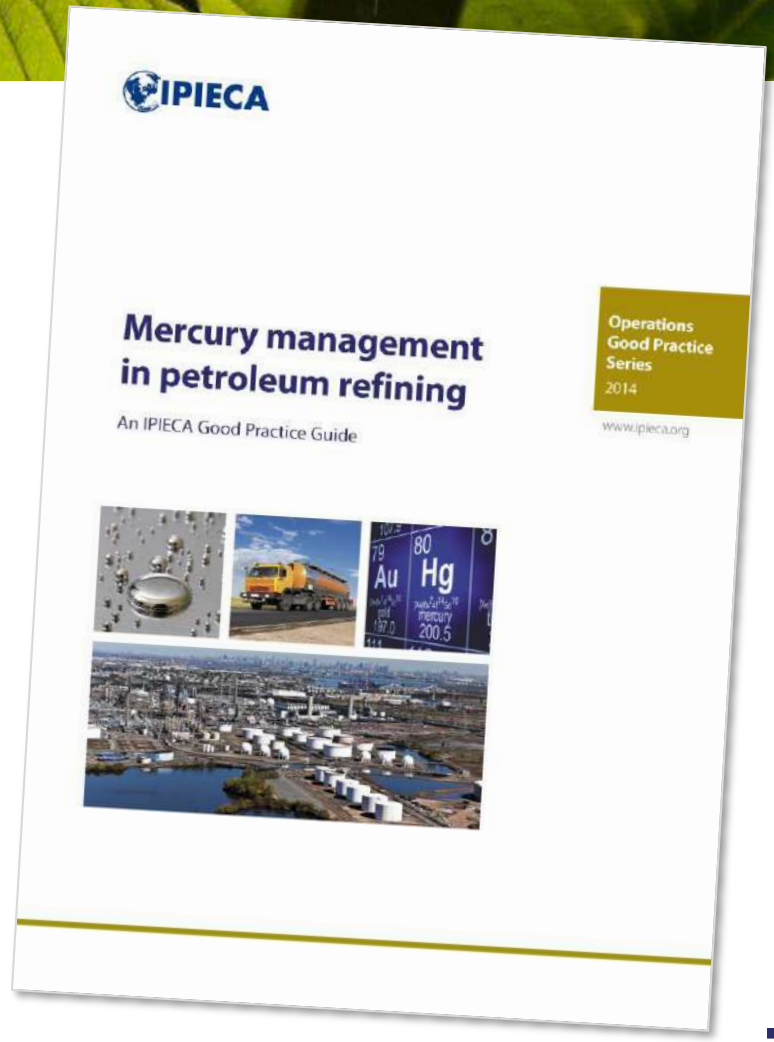
To advance the oil and gas industry's environmental and social performance and contribution to the energy transition in the context of sustainable development

Our strategic pillars

Mercury management in petroleum refining

Overview

- Introduction and background
- Forms of mercury
- Analytical methods and challenges
- Mercury concentrations in crude oils and condensates
- Mercury fate in refining
- Worker health and safety
- Process safety
- Environment considerations
- Product stewardship
- Mercury removal technologies
- Conclusion



Mercury management in petroleum refining

Introduction and background

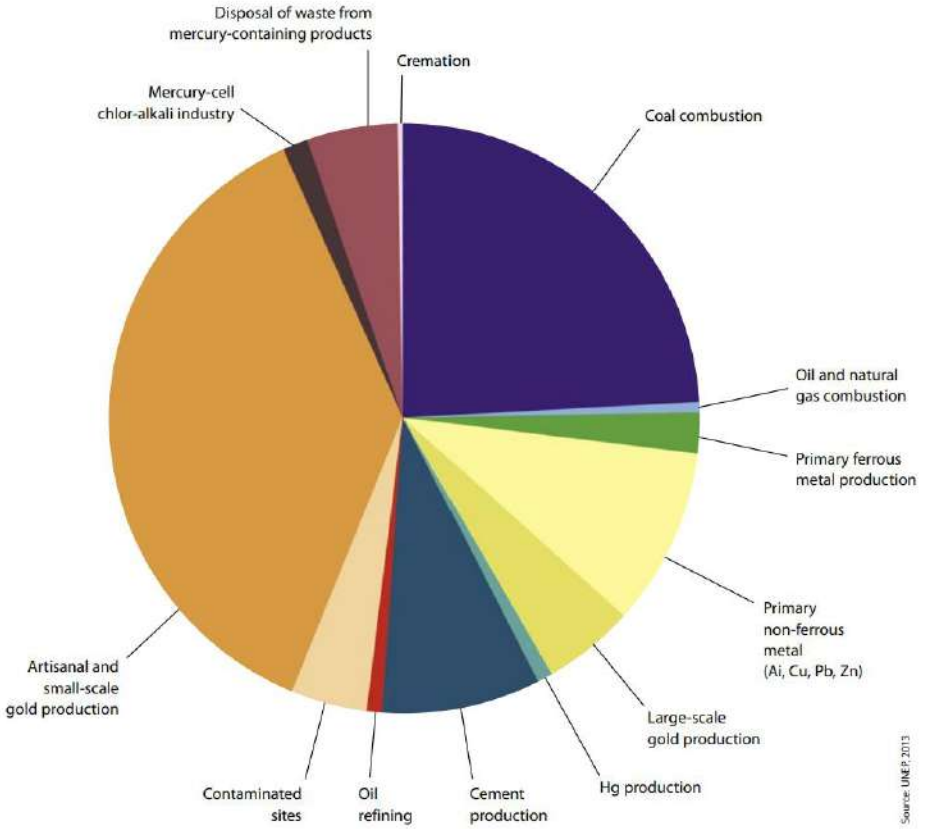
Contributors to Mercury in the biosphere:

- Volcanic activity
- Gold mining
- Industrialization
- Coal burning

Two sources of emissions related to O&G (UNEP):

- Direct combustion
- Refining (each less than 1% total anthropogenic emissions)

Figure 3 *Relative contributions to estimated emissions to air from anthropogenic sources in 2010*



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Mercury management in petroleum refining

Forms of mercury

Elementary Mercury (Hg0)

- Unstable in presence of sulphur & sulphur compounds, can form mercury sulphide
- Liquid at room temperature and has a measurable vapour pressure, does not evaporate quickly

Mercury Sulphide (HgS)

- Solid, low solubility in water, high affinity for sulphur, it will decompose and liberate elemental mercury if heated
- Predominant form of mercury leaving the refineries

Mercury Sulphate (HgSO4) No available data to indicate that exist in refineries

Organic mercury (R-Hg-R or R-Hg-X)3 Most toxic, never observed in refinery products

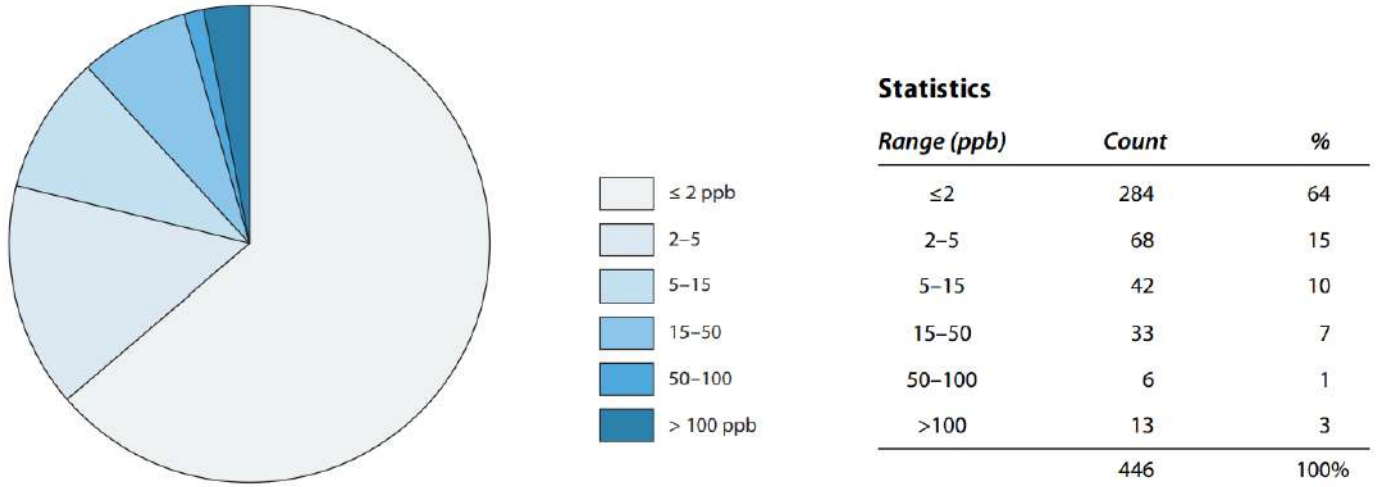
Mercury Mercaptides (RS-Hg-SR) Unstable to be present in refinery products or waste streams

Mercury Chloride (Cl-Hg-Cl) Soluble in water and somewhat in hydrocarbons, volatile. Ipieca is not aware of data in refineries

Mercury management in petroleum refining

Mercury concentrations in crude oils and condensates

Figure 5 *Range of mercury levels in global crude grades (summarized from the IPIECA dataset, which includes 446 crude assays)*



Statistics

Range (ppb)	*Count*	*%*
≤2	284	64
2–5	68	15
5–15	42	10
15–50	33	7
50–100	6	1
>100	13	3
	446	100%

Table 2 *Regional breakdown of mercury in crude*

Crude region	Count	Median Hg level (ppb)	Percentage of crudes and condensates containing specific ranges of mercury (ppb of mercury)					
			≤2 ppb	2–5 ppb	5–15 ppb	15–50 ppb	50–100 ppb	>100 ppb
Africa	90	1.0	72%	15%	9%	3%	1%	-
Eurasia	95	1.2	74%	10%	6%	4%	1%	5%
Middle East	34	1.0	79%	18%	3%	-	-	-
North America	95	1.2	64%	21%	9%	6%	-	-
Pacific and Indian Ocean	93	3.0	41%	13%	16%	18%	4%	8%
South America	39	1.4	69%	12%	8%	8%	-	3%

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Mercury management in petroleum refining

Mercury fate in refining & best practice

Knowing the mercury content of crudes entering refinery

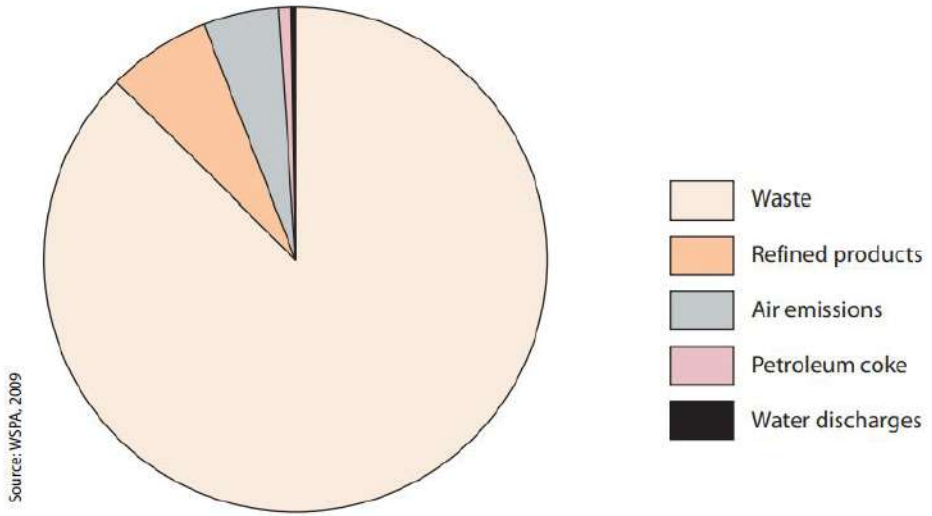
- Establishing an approved ‘mercury operating envelope’ = applying acceptance criteria to limit the intake of mercury into refinery

Crude assays/ SDS used for purchasing decisions could include Hg as one of the properties

Periodic measurements of crude to confirm that the refinery is within its operating envelope

Frequent measurements on any crude known to contain an elevated level of mercury (e.g. 100ppb)

Figure 6 *Example of a mercury mass balance for five refineries in the San Francisco region*



Mercury management in petroleum refining

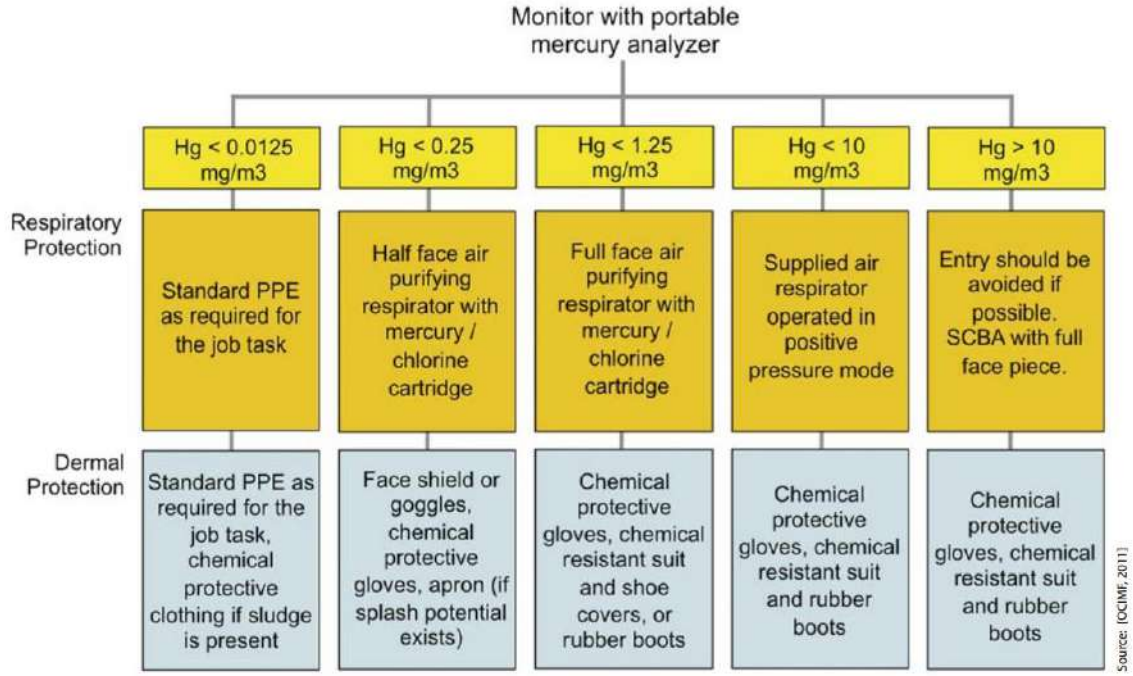
Worker health and safety

- **Exposure risk:**
- **Inhalation elementary mercury vapour:**
  - Confined space entry
  - Hot work
  - Opening/ draining of equipment
- **Exposure control measures:**
  - Acceptance criteria for crude intake
  - Design and engineering controls
  - Procedural controls: designated areas
  - Worker protection: Monitoring exposure, PPE, Hazard communication and training, Medical surveillance
  - Decontamination

Table 5 *Examples of occupational exposure limits for mercury*

UK WEL (Workplace Exposure Limits)	DFG MAK (German Research Foundation)	The Netherlands	US ACGIH (American Conference of Governmental Industrial Hygienists)	US OSHA (Occupational Safety and Health Administration
Elemental and inorganic mercury 0.02 mg/m^3 (8 hours)	Elemental and inorganic mercury 0.02 mg/m^3 (8 hours)	Elemental and inorganic mercury 0.02 mg/m^3 (8 hours)	Elemental and inorganic mercury 0.025 mg/m^3 (8 hours)	Elemental and inorganic mercury 0.1 mg/m^3 (8 hours)

Figure 9 *Example of an action-level matrix for PPE*



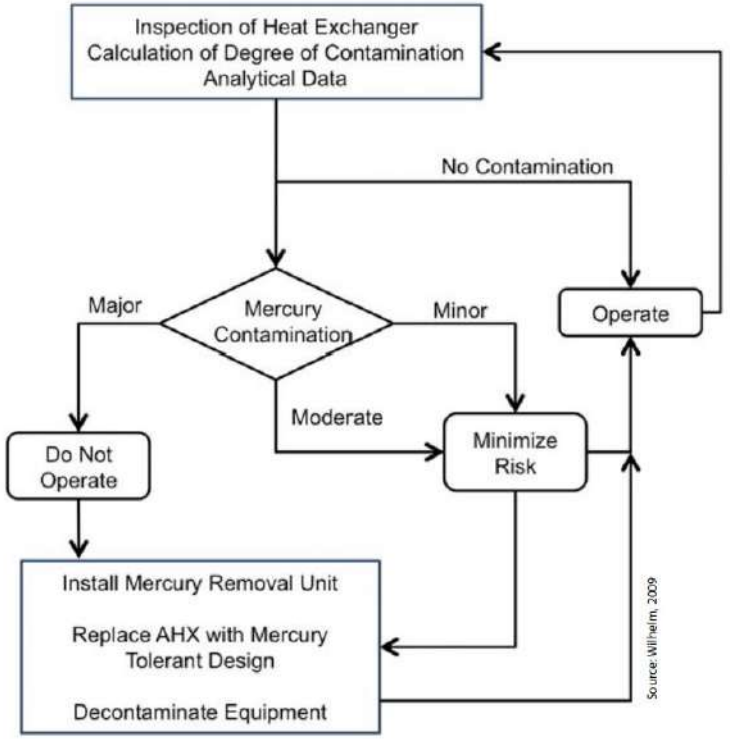
Mercury management in petroleum refining

Process safety

Figure 12 *Metallurgical failure caused by liquid mercury*

Source: Humphreys, 2009

Figure 13 *Example of a decision tree for equipment risk minimization*



Liquid metal embrittlement (LME)

Happens when aluminium equipment is exposed to liquid elemental mercury

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Mercury management in petroleum refining

Environment Considerations

Wastewater treatment

- Very low mercury concentrations in wastewater treatments (less than 0.01%)
- Most of the mercury that enters the refinery will be removed as solid waste (87%)
- Additives can assist in the process of controlling mercury levels in wastewater

Solid waste:

- Needs to be identified, labelled, stored, and disposed according to country regulations.
- Segregate waste streams
- 3rd parties must be appropriately qualified
- Incineration may not be appropriate if the third-party facility doesn’t control mercury in its waste gases
- Develop a Mercury Waste Management Procedure into their existing Waste Management Procedure
- Sample pieces of equipment: ND: 1. X-ray fluorescence analysis (XRF, HXRF), 2. using cotton swabs or mercury check surface sampling or D: 3. analysis in a laboratory

Mercury management in petroleum refining

Conclusions

- **Ipieca data show that the majority of the world's crudes are low in mercury**
- **On a global basis Ipieca estimates that weighted average mercury content of the global crude supply is 7.5 wt ppb of mercury**
- **Best practices for managing mercury in the refining industry:**
  - Know mercury content of crude oil entering the refining facilities
  - Safe workplace, assuring worker protection via proper training
  - Appropriate use of personal protective equipment
  - Precautions during operation and maintenance
  - Use of Mercury Removal Units (MRU's)
  - Proper waste management procedures
  - Having fit-for-purpose constraints on mercury in products and intermediates, and
  - Assuring Process safety via awareness of mercury's potential impact on equipment

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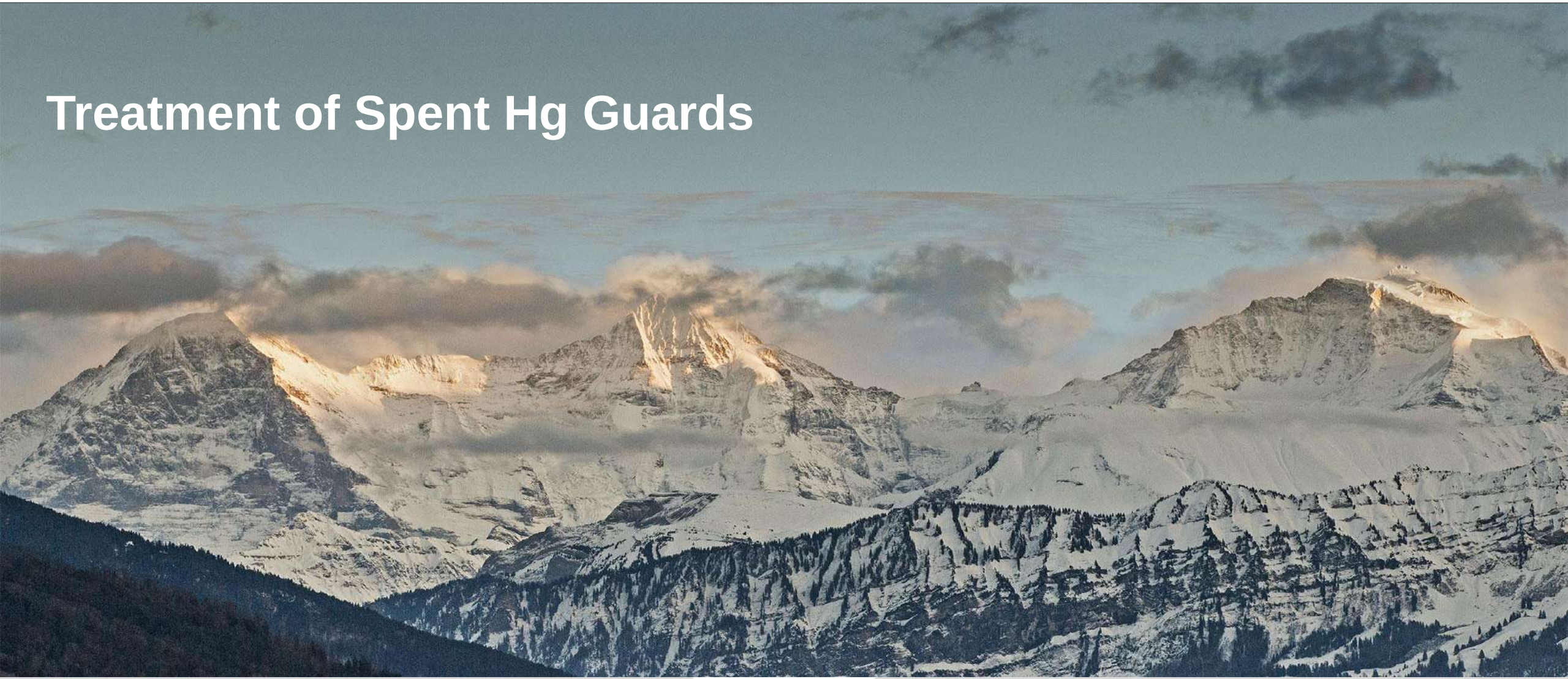
Treatment of Spent Hg Guards



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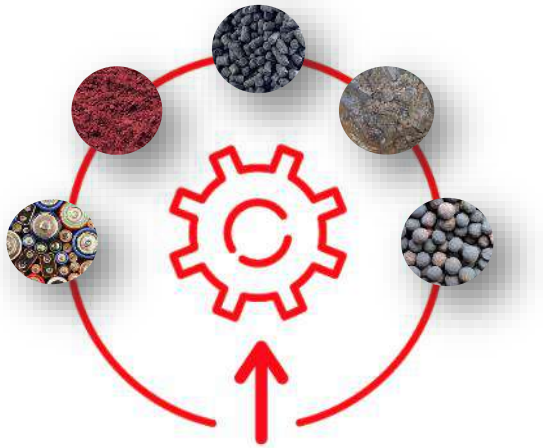

Liquid Mercury Stabilisation
Activated Carbon reactivation
Mercury wastes treatment
Mercury adsorbents recycling
Battery recycling

5 CORE SPECIALITIES

The process in short:

BATREC
Swiss quality recycling solutions

Batrec provides a unique process able to decontaminate mercury from Hg Guards or Activated Carbon

The Mercury is stabilized as HgS

Mix metal sulfides are sent to smelters for Cu and Zn recovery

Activated Carbon is reactivated

Spent Hg Guards

BATREC
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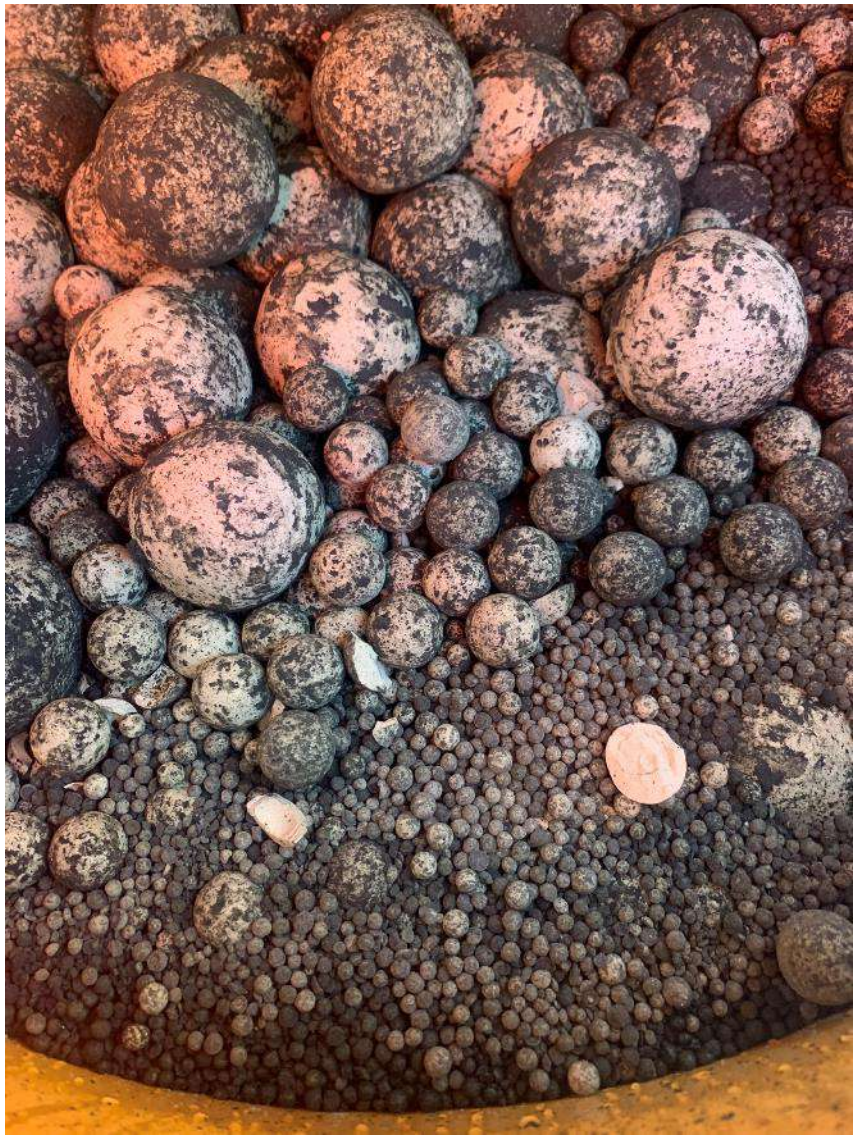

Spent Hg Guards – Typical analysis

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N° Analysis	Al	S	Cu	Zn	As	Br	Hg	Pb
	%	%	%	%	%	%	%	%
1	42.87	5.76	9.35	0.17	0.011	0.006	9.22	0.029
2	60.48	4.00	9.31	0.12	0.008	0.005	5.86	0.019
3	38.02	4.73	8.43	0.13	0.008	0.034	6.04	0.022
4	1.60	27.76	44.74	0.41	0.0004	0.0002	0.13	0.012
5	27.46	9.26	16.13	0.11	0.0019	0.0078	1.98	0.009
6	7.41	19.84	24.51	12.40	0.0026	0.0094	2.85	0.009
7	18.26	14.49	20.46	5.98	0.0020	0.0093	1.96	0.008
8	18.64	12.36	18.70	4.74	0.0022	0.0087	2.34	0.009

BATREC: Hg Guard treatment – whats the process

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1

Identify the material

You deliver **information** about how and when the Hg Guards are ready

We produce 1st draft of the **technical-sales offer**

2

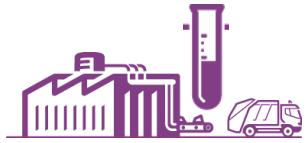
You provide **samples, or at least indicative analysis**

We carry out a **treatment test** in the lab

Together we agree on the technical-sales offer produced in Step 1

3

We prepare the Transfrontier Dossier
+
Send the Hg Guards to BATREC



Hg Guard Treatment

Hg Removed for Stabilisation
+
Separation, analysis, repacking

The treated Hg Guards are sent for recycling
+
Inert materials are sent for final disposal

BATREC's action

Customer's action

Treatment of Hg Guards in the CRP at Batrec

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Treatment Process - Detail

1 THERMAL TREATMENT

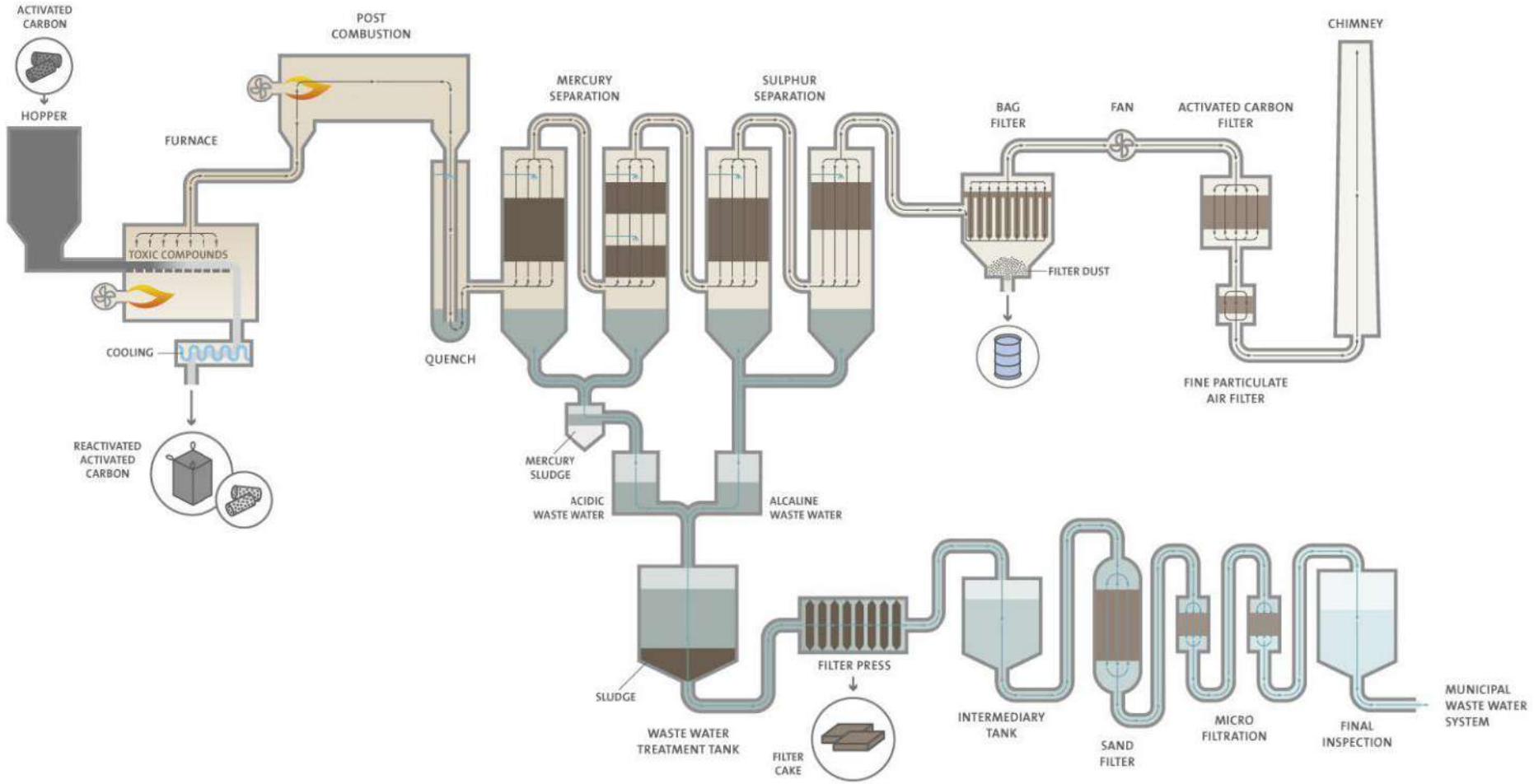
- desorption of the pollutants at 750 – 850°C
- destruction of the organic pollutants in the post-combustion chamber

2 WASTE GAS WET CLEANING

- condensation of Mercury
- removal of Sulfur

3 WASTE GAS DRY CLEANING

- removal of trace level Mercury
- removal of other pollutants and fine dust removal HEPA Filter



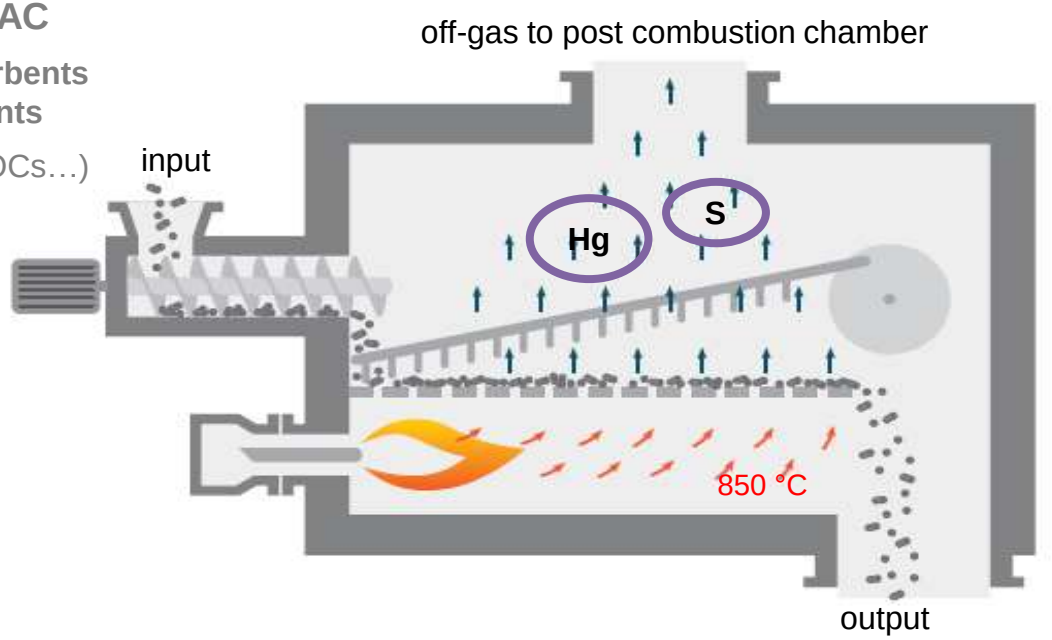
Treatment Process

Decontamination Furnace

Spent AC

With **adsorbents pollutants**

(S, Hg, VOCs…)



Treated Hg Guards

Oxidised and all VOCs removed, no longer pyrophoric.

Hg <20ppm

- **Mercury** (Hg) without limit
- **Sulphur** (S) up to 20%
- **VOCs**

Treatment Process

Decontamination Furnace

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Treatment Process

Post-combustion chamber

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Treatment of Mercury

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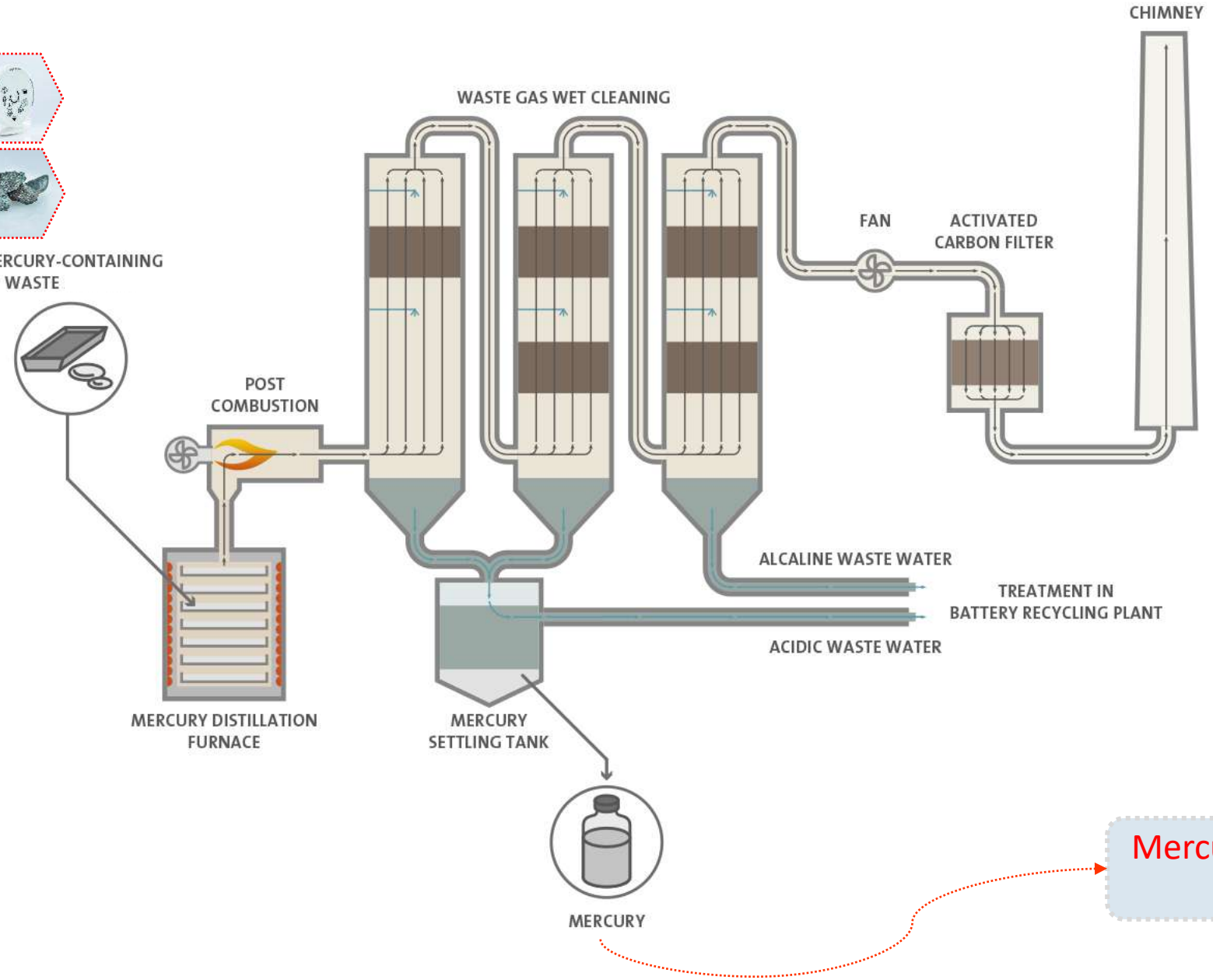
Mercury Distillation – Process



Mercury Stabilisation
Hg → HgS

Mercury Operations

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Why Stabilise Mercury? - Global Context

Global evolution of environmental legislation

EU Export Ban
Regulation (EC) N° 2017/852

UNEP
Minamata Convention on Mercury

US Export Ban
Mercury Export Ban Act 2008

Creates a demand for
safe, sustainable treatment through stabilisation

Mercury does not re-enter the market

Example industries:

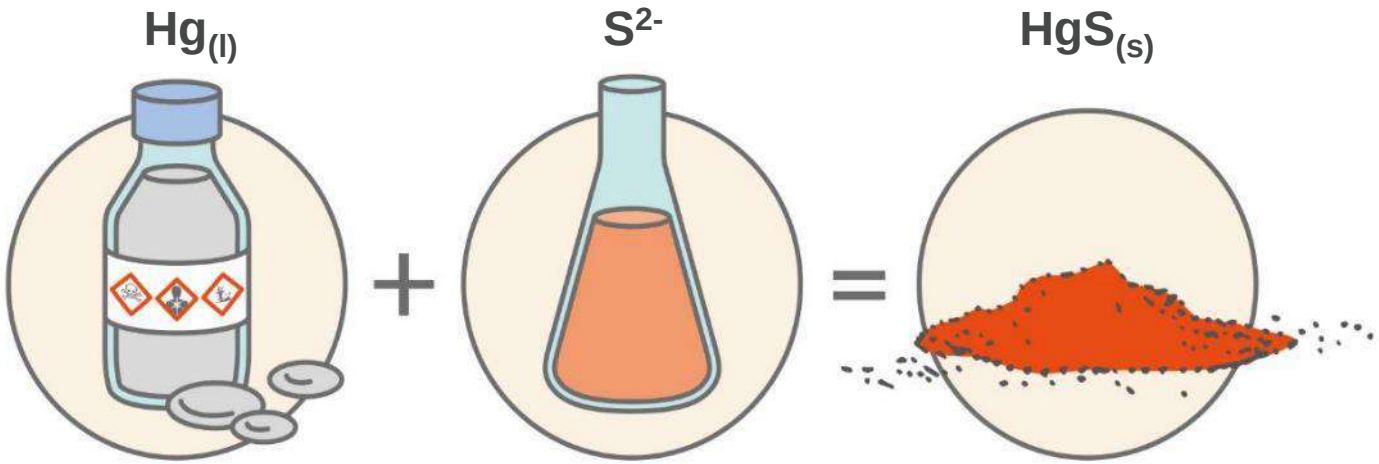
- Natural gas production
- Cl-Alkali industry
- nonferrous mining industry (e.g. gold mining)
- nonferrous metallurgy (Cu- & Zn-smelters)

Mercury Stabilisation – Process

BATREC's approach

Transform highly toxic Hg into non-toxic HgS

Controlled reaction at ambient temperature and pressure ➔ low risk, high conversion and consistent product

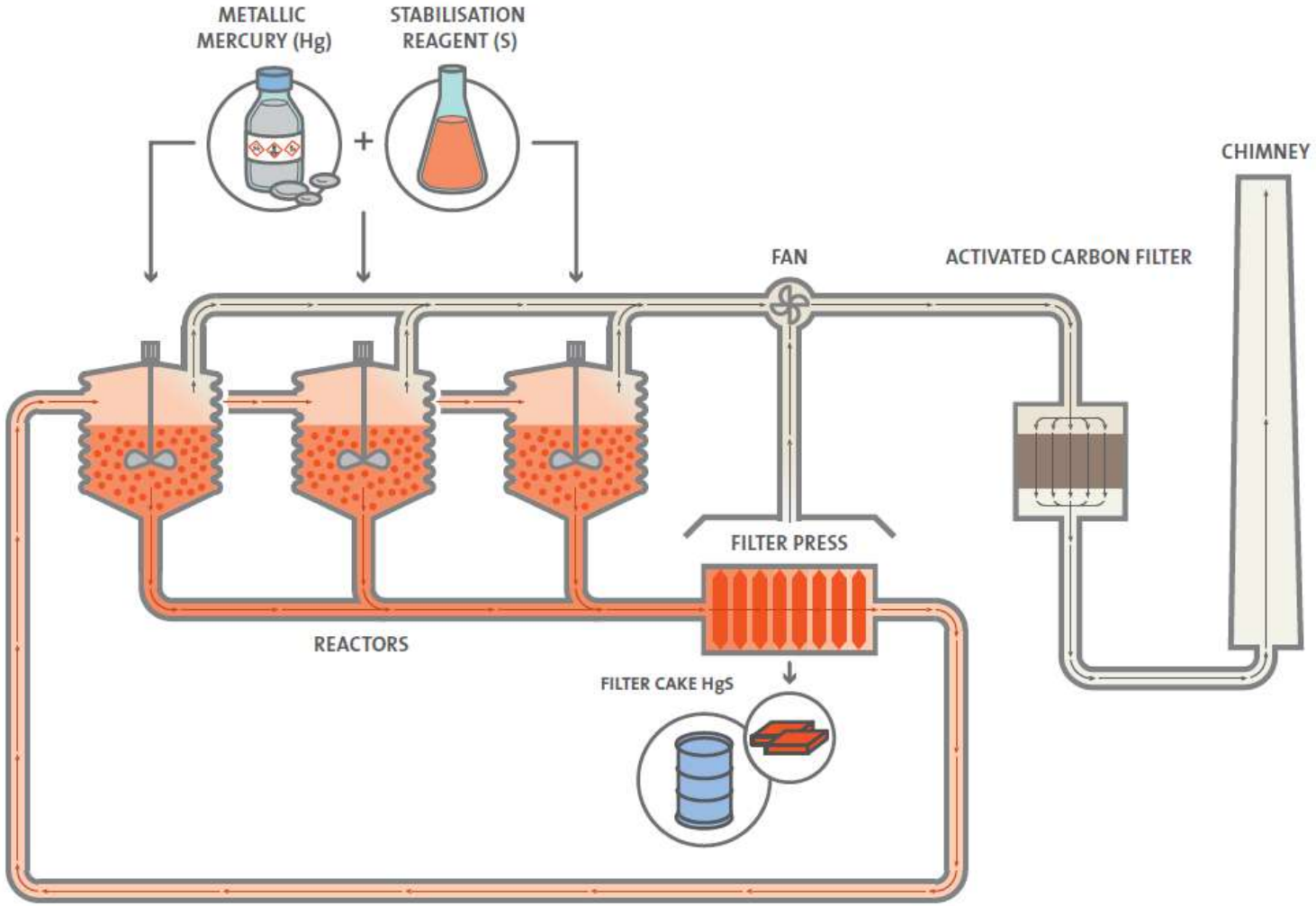


Metallic mercury | Stabilisation reagent | Final product

- HgS is **least toxic** Hg compound
- HgS is the **most stable** Hg compound
- HgS is the **most insoluble** Hg compound
- HgS is the natural mineral form [cinnabar] of Hg

Mercury Stabilisation – Process

Capacity: 1.200 t/year



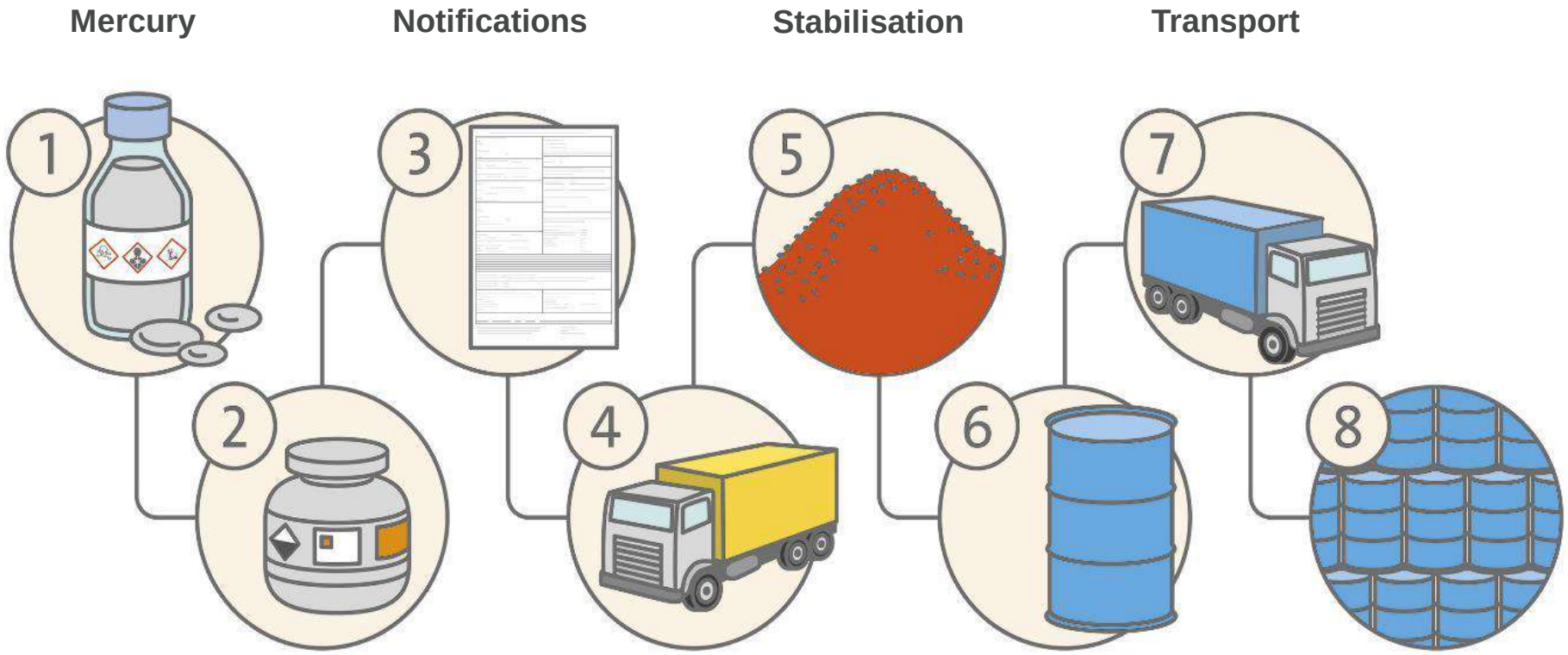
Process characteristics

- ✓ batch process
- ✓ wet process at low temperatures in a closed circuit limits the risk of Hg emissions
- ✓ no gaseous Hg in the process
- ✓ stabilisation solution is regenerated
  → *zero effluents produced*
- ✓ simple reactants

Mercury Stabilisation – Process

BATREC
Swiss quality recycling solutions

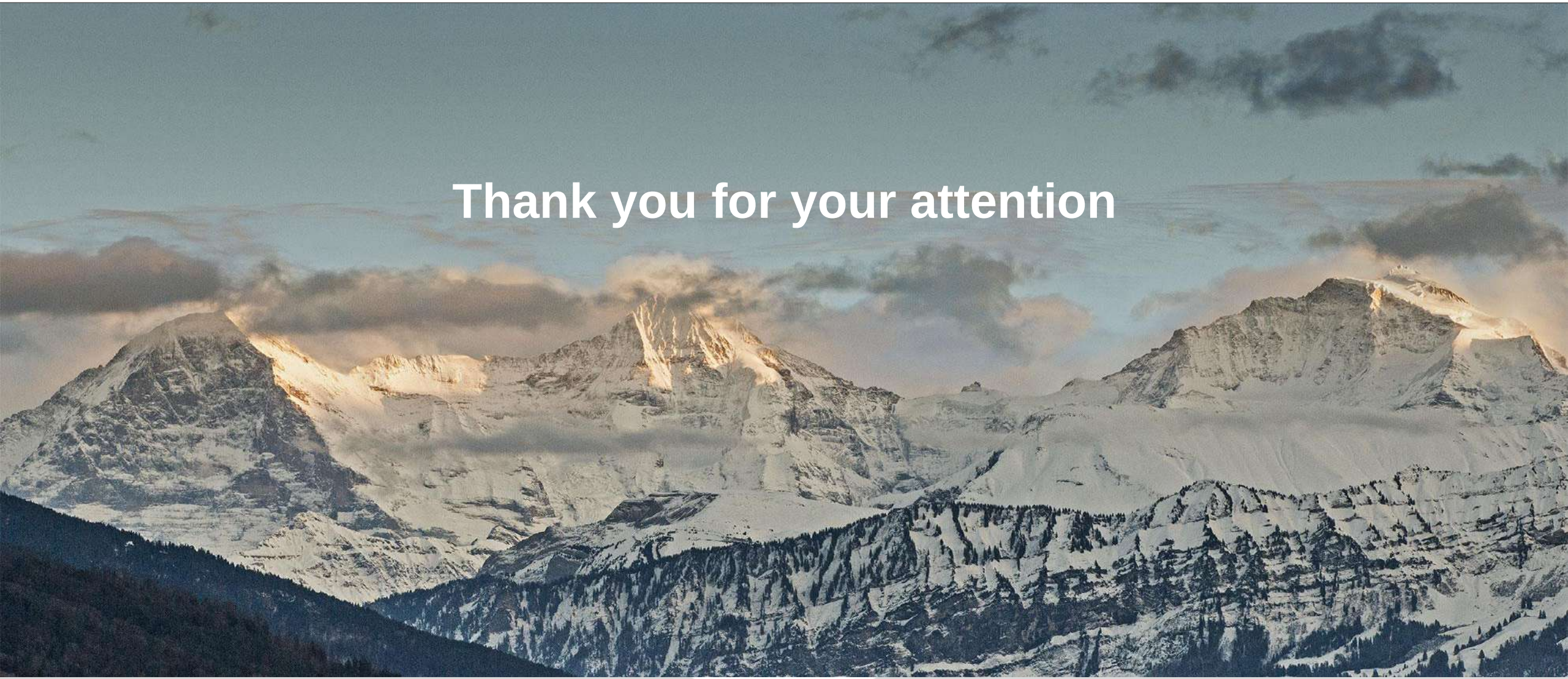
BATREC – Value Proposition



BATREC takes care of the whole process “cradle to grave”

BATREC
Swiss quality recycling solutions

Thank you for your attention



SARPI VEOLIA

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18 July 2023

Environmentally sound management of mercury waste generated from oil and gas sector

Nomura Kohsan Co., Ltd.

Contents

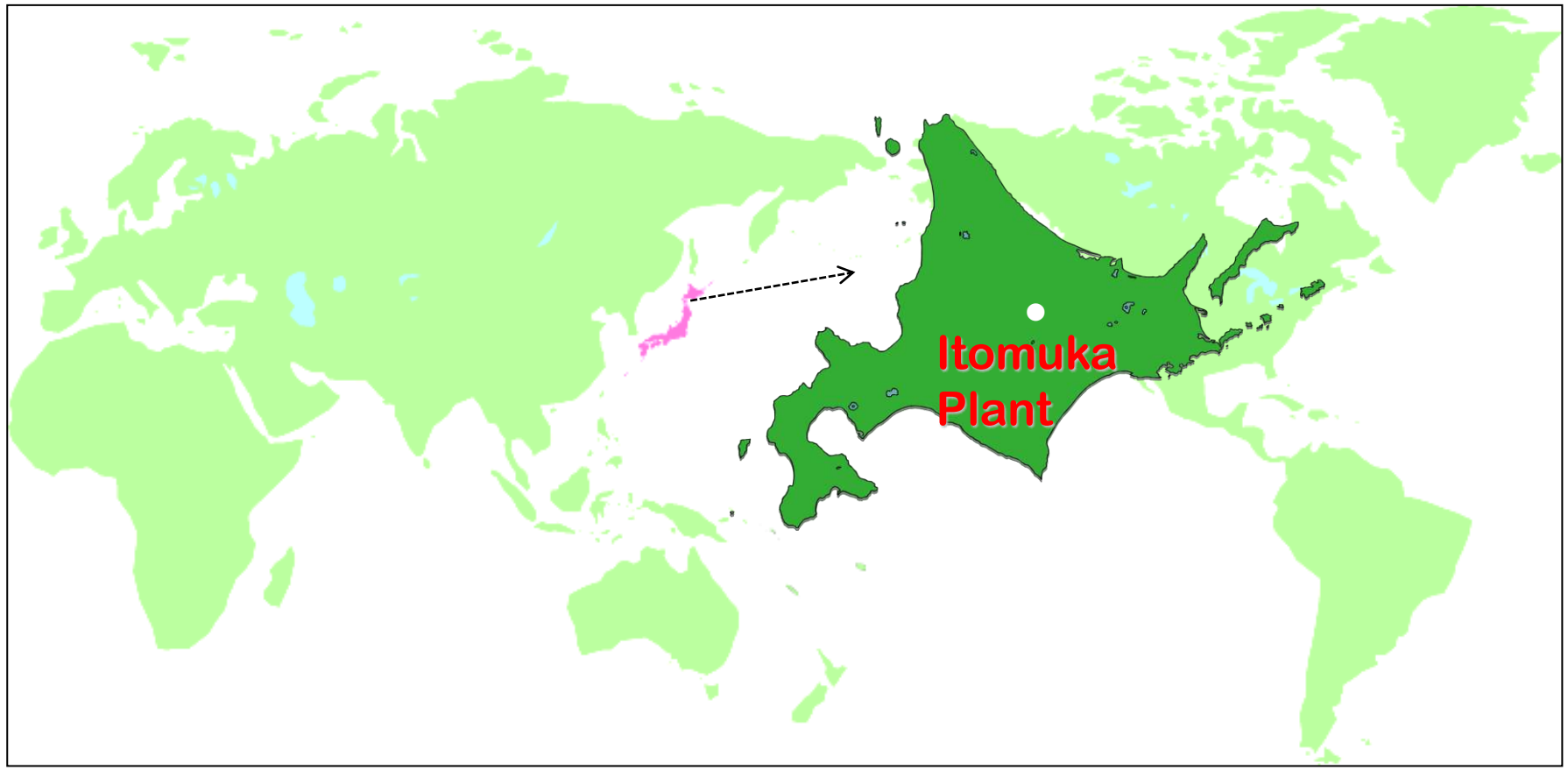
1. Overview of Nomura Kohsan

2. Treatment Process of mercury waste

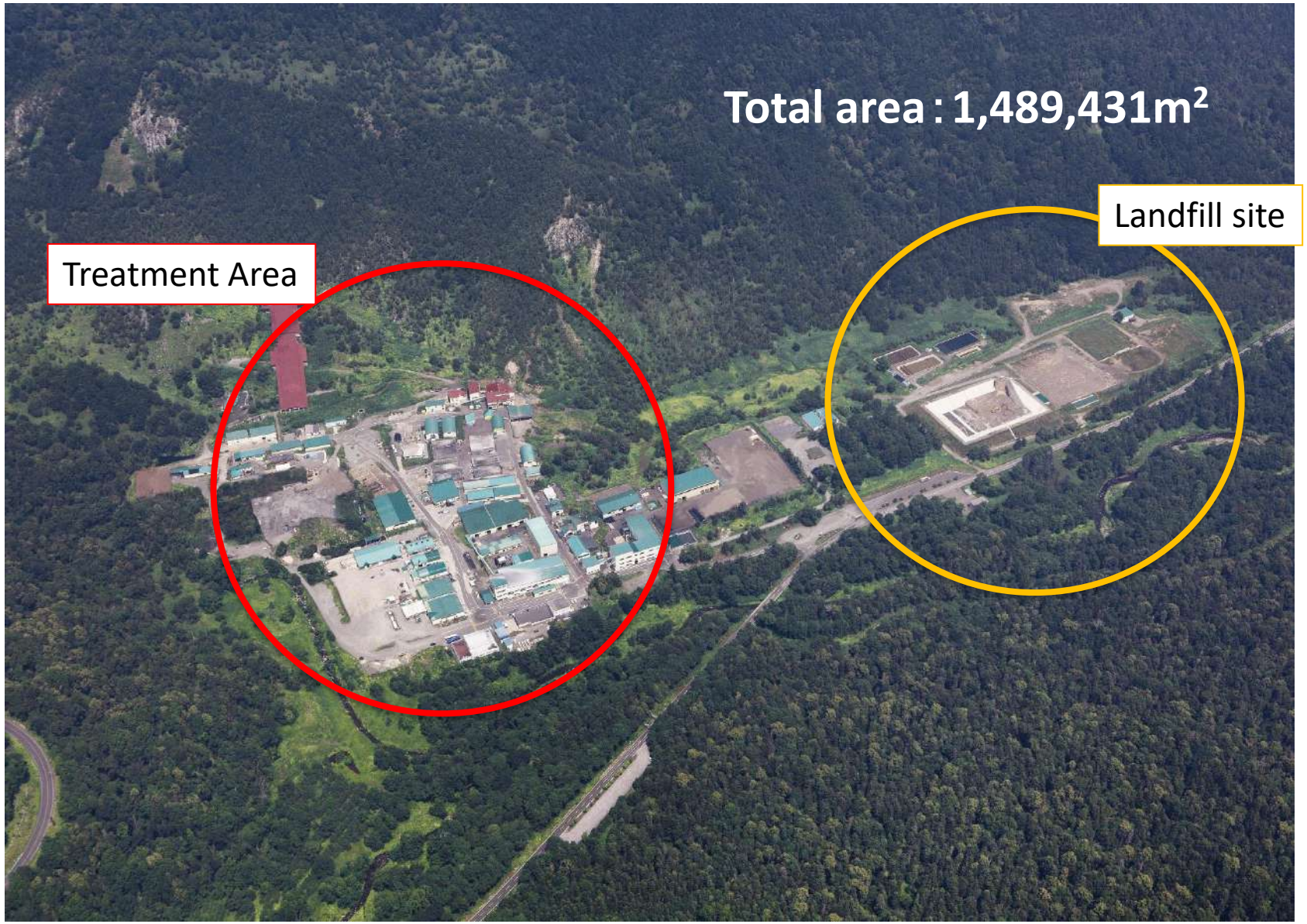
3. Management of mercury waste generated from oil and gas sector

1. Overview of Nomura Kohsan

Overview of Nomura Kohsan



Overview of Nomura Kohsan



History

1936	Itomuka mine was discovered
Apr. 1939	Nomura Mining Co., Ltd. began operations
Dec. 1973	Nomura Kohsan Co., Ltd. established
Apr. 1974	Itomuka Mine was closed
Jul. 1974	Nomura Kohsan took over all of Nomura Mining's plants and technology. Started management business of industrial wastes and municipal wastes
Jul. 1985	Demonstration plant for recycling mercury containing wastes constructed (mainly used dry cell batteries)
Aug. 1993	Waste fluorescent lamps recycling plant constructed
Mar. 2004	Kansai Plant completed
Feb. 2014	Nomura Kohsan joined two areas of UNEP GMP
Apr. 2014	Nomura Kohsan signed a MoU with UNIDO
Apr. 2018	Nomura Kohsan and UNIDO renew the MOU

ANY and ALL types of mercury wastes

TREATMENT

- Wastes consisting of mercury/mercury compounds
  - Metal mercury

- Wastes containing mercury/mercury compounds
  - Fluorescent lamps
  - Batteries
  - Measuring devices

- Wastes contaminated with mercury/ mercury compounds
  - Sludge
  - Catalyst
  - Activated Carbon

… and more!

Overview of Nomura Kohsan

We treat a total of **31,700** tons of mercury waste in 2022

-**17,900** tons of dry-cell batteries

-**8,000** tons of fluorescent lamps

-**5,800** tons of other types of waste
(i.e. measuring devices, etc.)

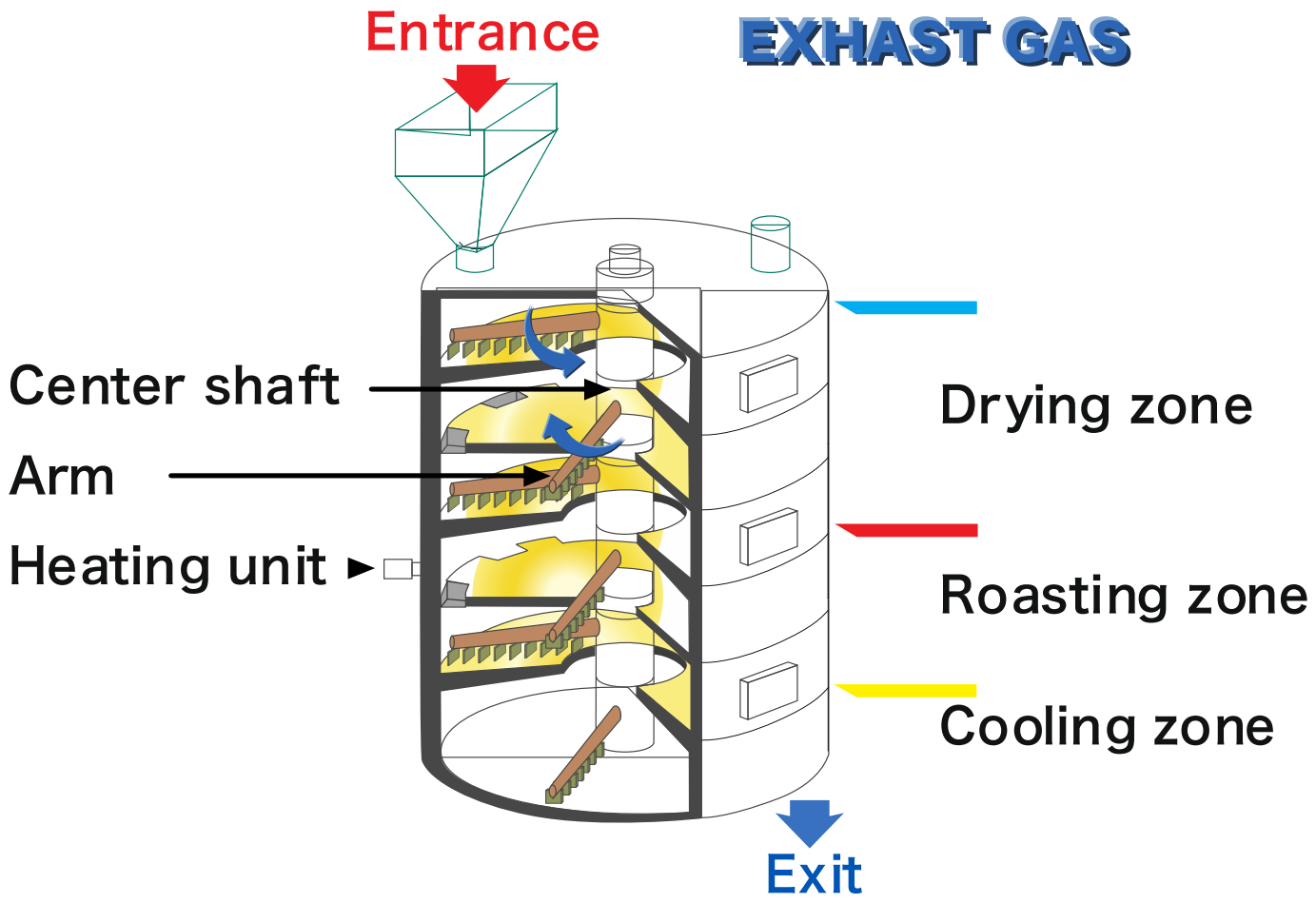
2. Treatment Process

Roasting process

- Waste is heated at a temperature between 600℃ to 800℃
- The mercury evaporates, which is then collected through a cooling process.

Roasting process

Herreshoff furnace



Mercury recovery system

Mercury sludge

Pretreatment

Flue gas
(Mercury stream)

Scrubbing dust collector

Cooling tower

Scrubber

Electrostatic precipitator

Adsorption tower

Stack

Blower

Dust collecter

Multiple hearth furnace
(Heresshoff furnace)

Heating unit

Mercury

Dissolution test

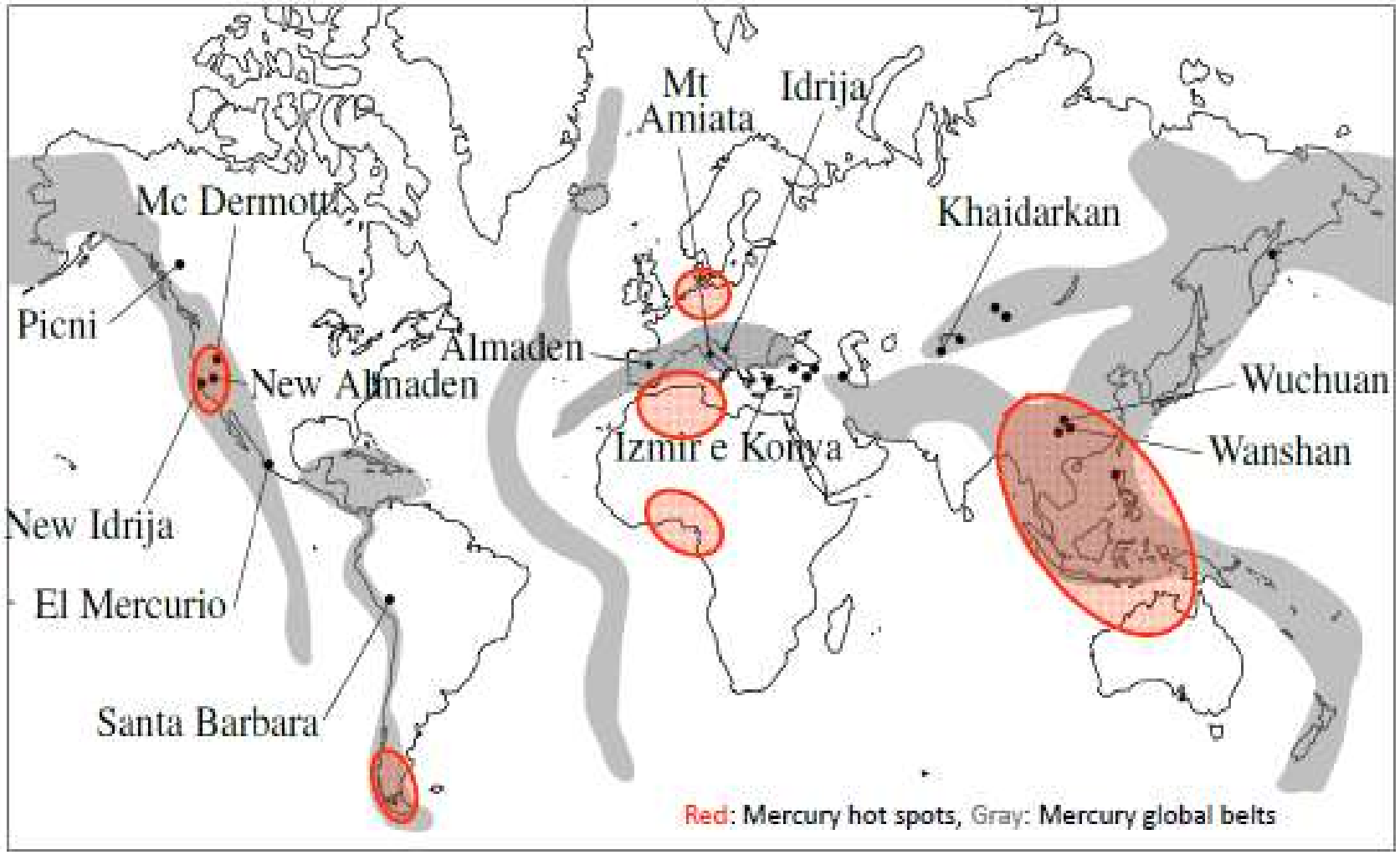
Landfill site for waste

Leachate-controlled Landfill Site

- Double water-sealing structure
- Reinforced concrete on the premises
- Only residues below the acceptance standard
  (Under the Japanese Leaching Test ≦ o.oo5mg/L)
- Discharged water and groundwater regularly analyzed

3. Management of mercury waste generated from oil and gas sector

The map of mercury global belts and hot spots.



The source：Giulia Pattelli et al., Effects of the November 2012 Flood Event on the Mobilization of Hg from the Mount Amiata Mining District to the Sediments of the Paglia River Basin, Minerals 2014, 4, 241-256 Partial modification by JOE

Mercury wastes generated from oil and gas sector

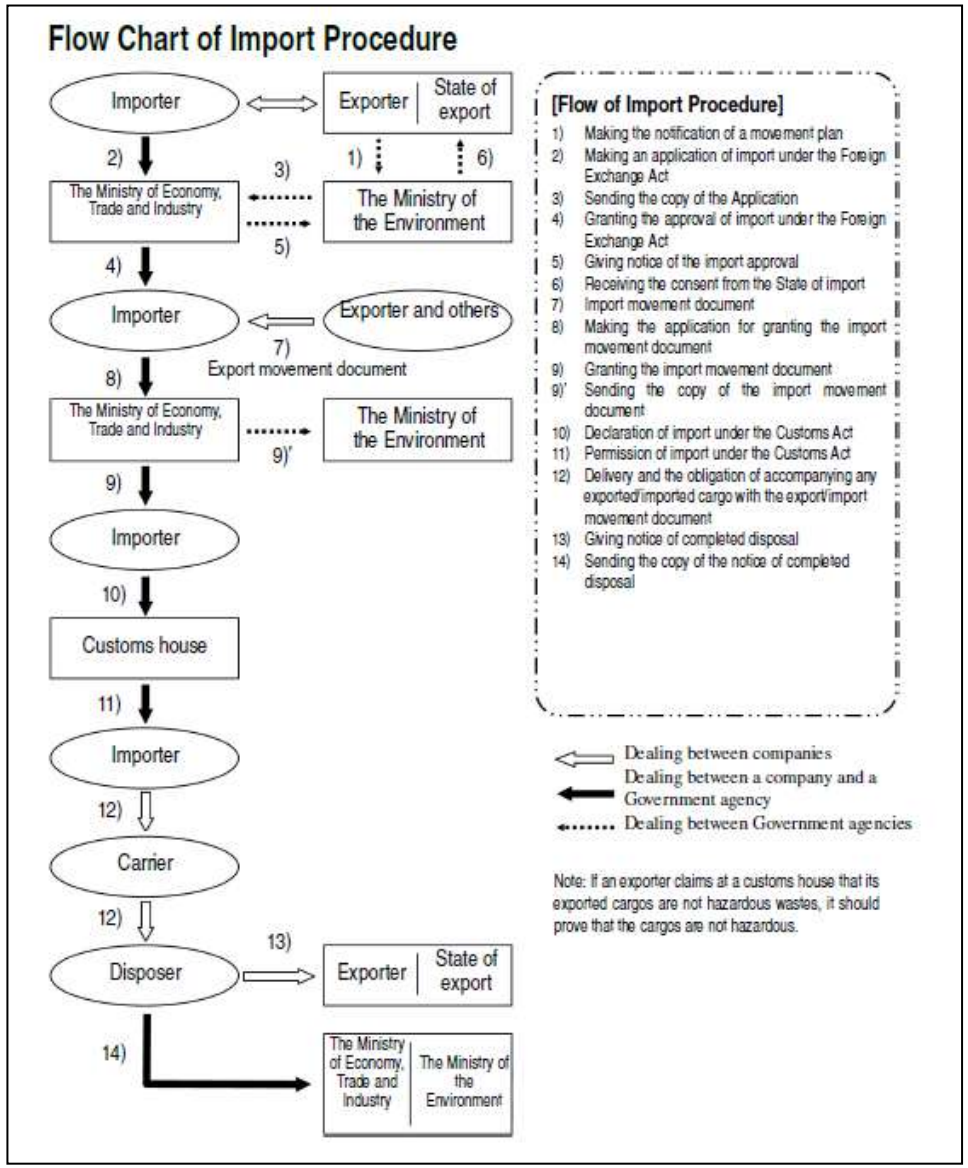
Oil sludge

Filters

Catalysts

- We treat mercury waste abroad in accordance with the Basel Convention.
- We have imported and treated mercury waste from oil gas companies in Indonesia and Thailand.

Basel Convention Procedure



The source https://www.env.go.jp/en/recycle/basel_conv/Legal_Framework_in_Japan/import_by_japan.html

In Japan, Ministry of the Environment, Japan (MOEJ) and Ministry of Economy, Trade and Industry (METI) have jurisdiction over the import procedure for hazardous wastes and other wastes.

Nomura Kohsan has the Certification of Pre-consented Facility and Importer.

Some procedures for importing hazardous wastes are exempted or streamlined in case that the wastes are imported by the pre-consented facilities or pre-consented importers.

Transportation of mercury waste

Import records of mercury wastes

Import records from Indonesia and Thailand

Year	2016	2017	2018	2019	2020	2021
Indonesia	370t	65t	32t	69t	89t	47t
Thailand				831t	570t	406t

For more information,
please contact: iwase@nomurakohsan.co.jp
Or visit our website at: www. nkcl.jp

Managing mercury along the oil and gas value chains: sharing of experience and best practices

Session 2 - Experiences, lessons learned and challenges from countries

facilitated by Judith Torres, Ministry of Housing, Territorial Planning and Environment of Uruguay, Co-lead of the Mercury Supply and Storage Partnership Area

Experience in managing mercury along the oil and gas supply chain and in the decommissioning activity in Thailand

Dr. Narongsak Chaiyasit

Synergy Plus Co., Ltd.

Thailand

July 2023

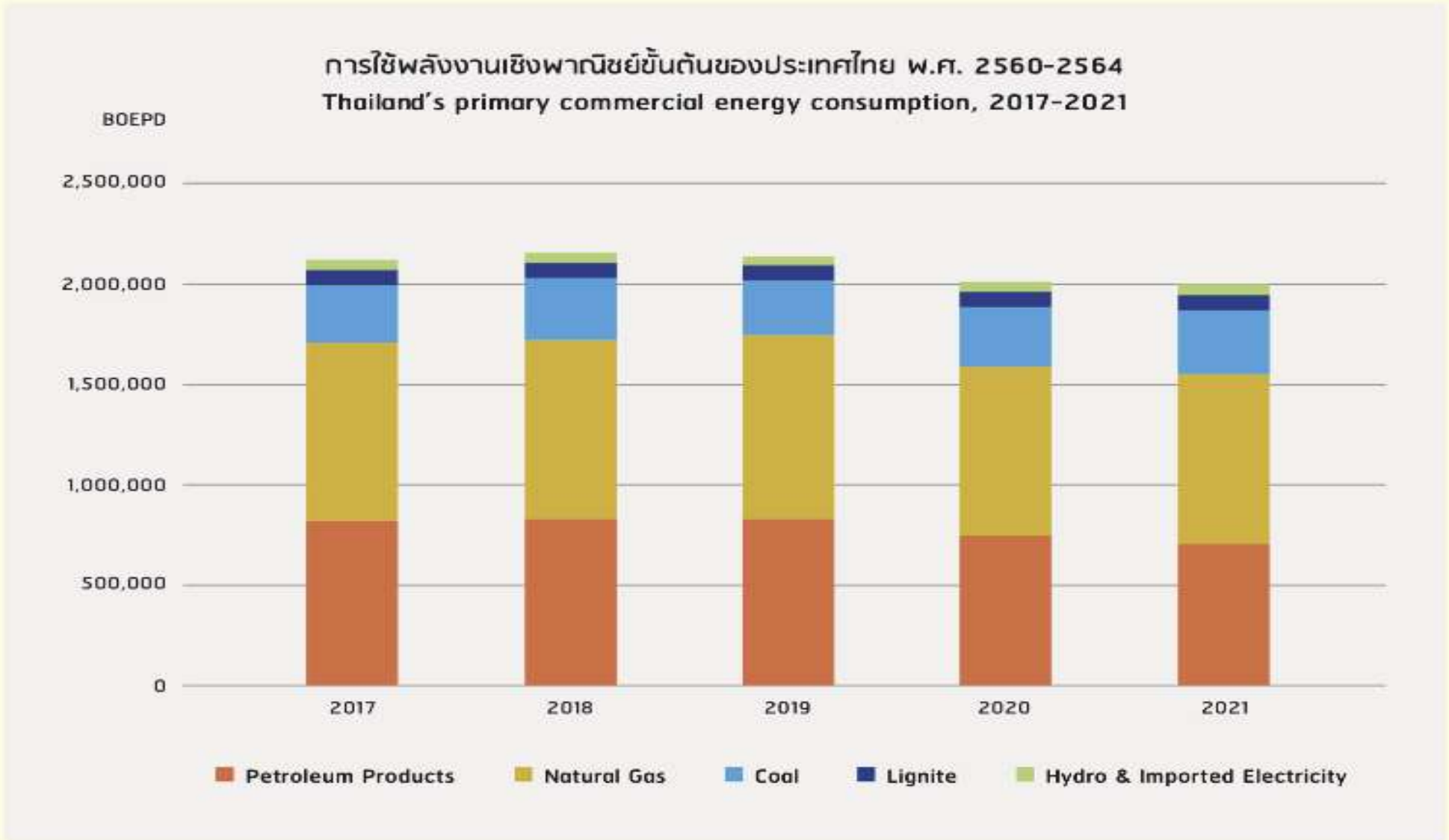
Dr. Narognsak Chaiyasit

Education

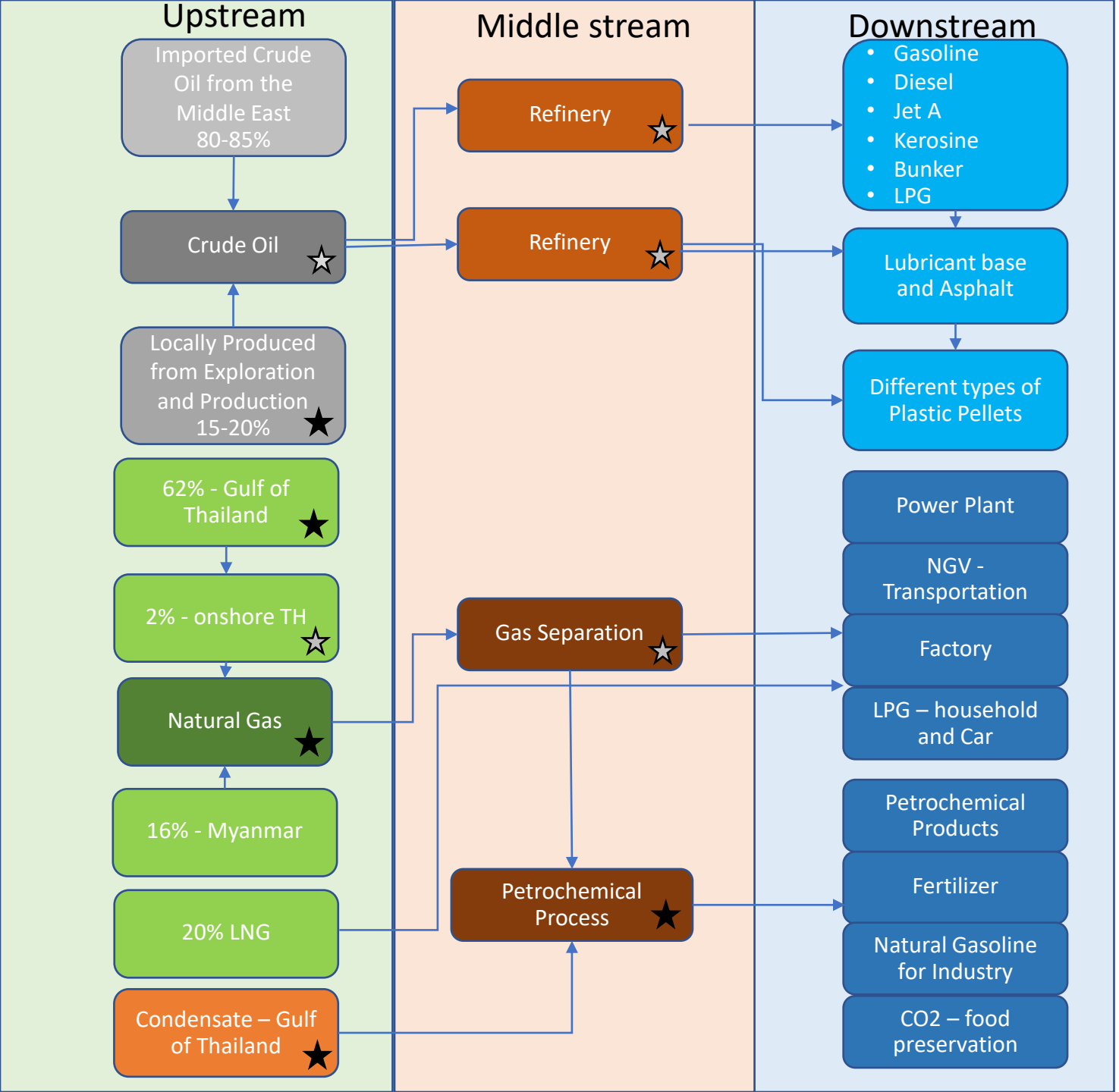
- B.Sc Biotechnology (Honors); KMUTL
- M.Sc. Environmental Engineering, AIT
- Ph.D. Interdisciplinary Environmental Science, Chulalongkorn University

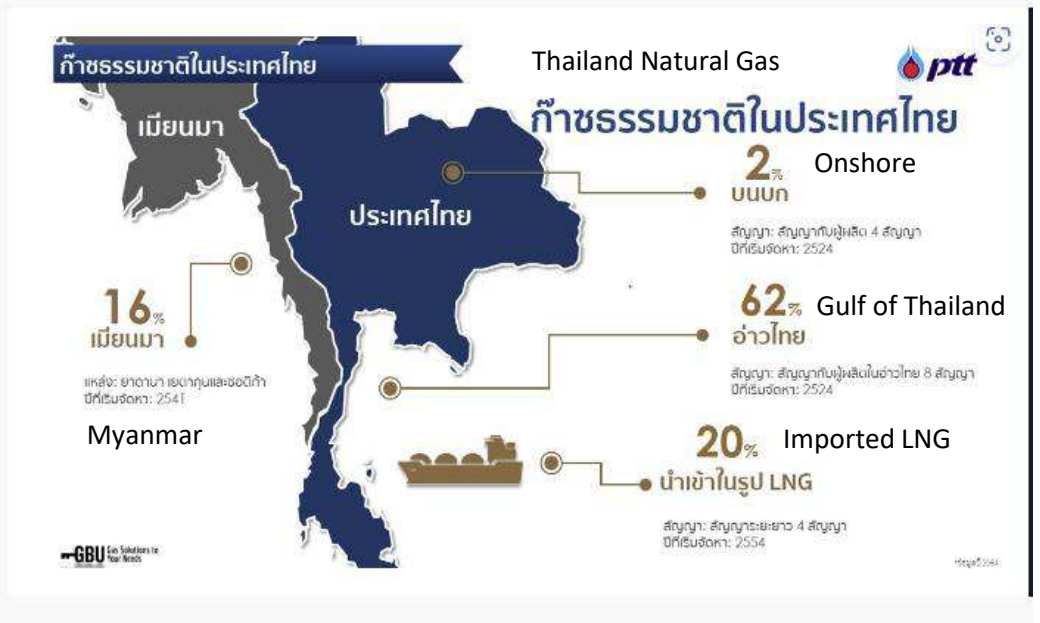
Working Experiences

- ERM Siam – EIA, Waste, Env Audit (5 years)
- Unocal Thailand – Waste Management, ISO14001, EIA (6 years)
- Chevron Thailand – SHE, Hg Waste, Hg Decont (6 years)
- BMTP Thailand – Hg treatment and Hg Decont (3 years)
- Synergy Plus – SHE Consultancy, Hg Training , Hg Study (7 Years)



ที่มา : สำนักนโยบายและแผนพลังงาน (สนพ.)
Source : Energy Policy & Planning Office, EPPO





Thailand Oil & Gas Downstream Market Size

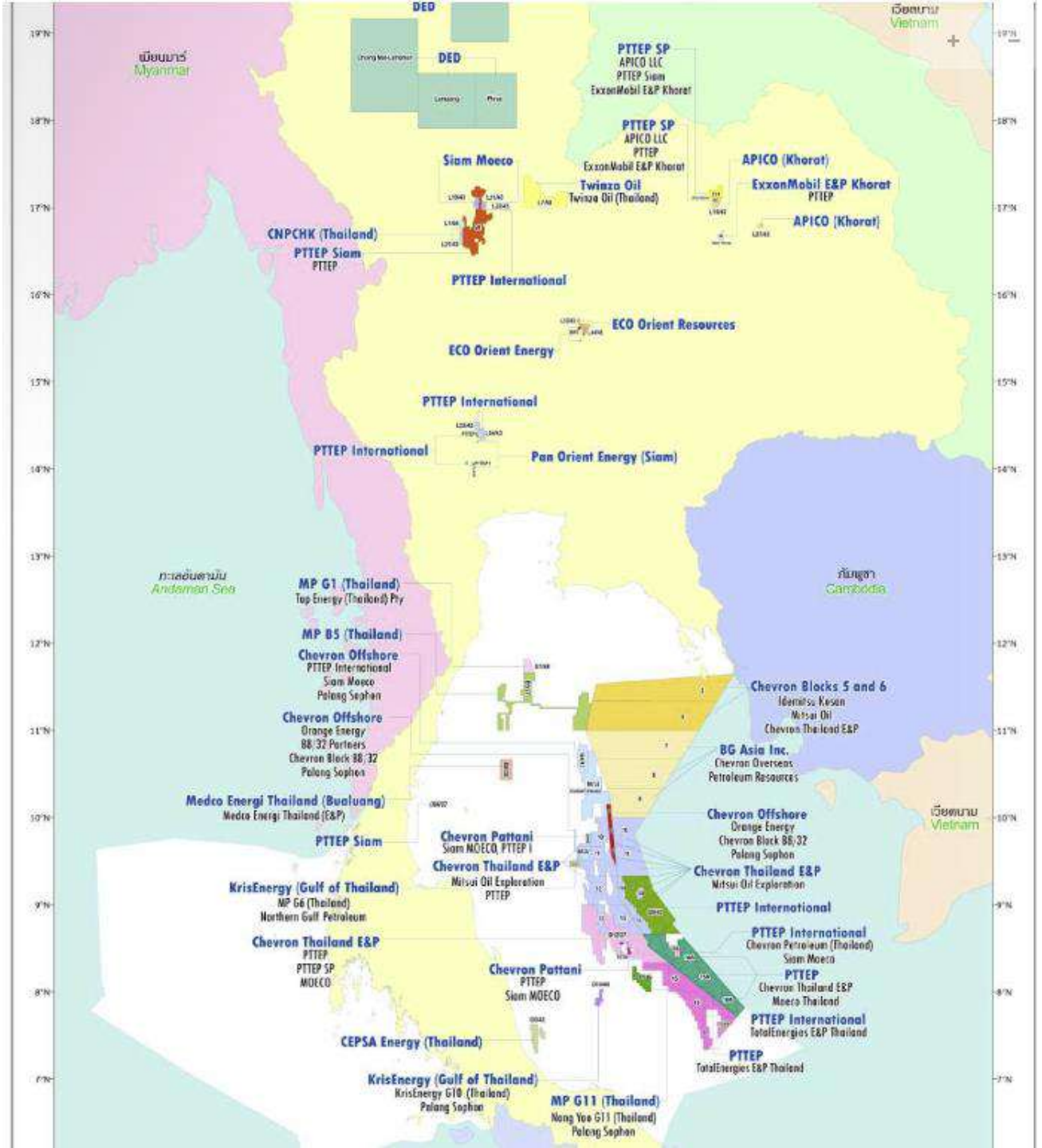
Mercury Management in Exploration and Production Oil and Gas Industries – Thailand Case Study

Narongsak Chaiyasit, Ph.D.

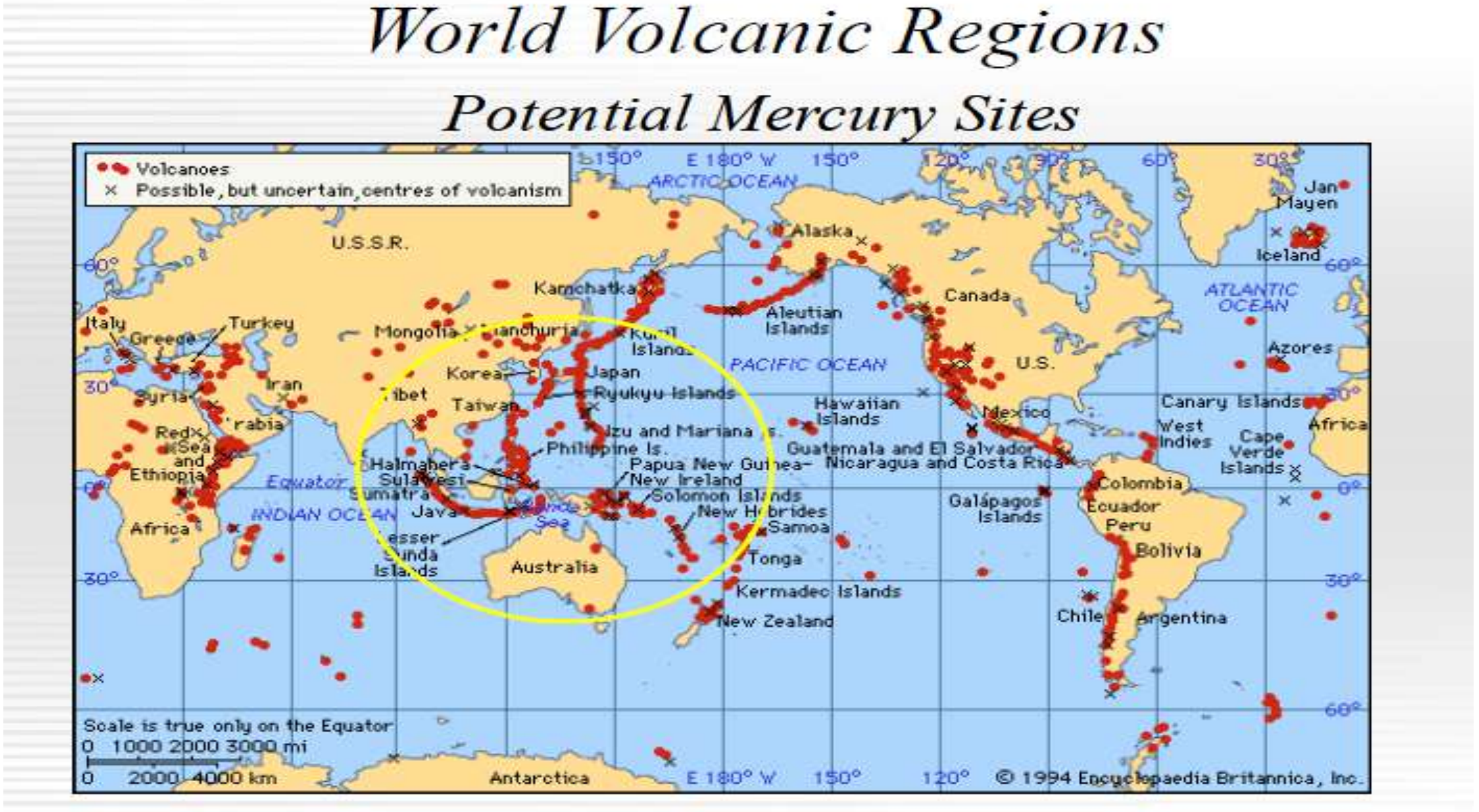
Synergy Plus Co., Ltd.

Thailand

Thailand Petroleum Production Areas



Potential Mercury Sites



Distribution of Mercury presence in hydrocarbon production streams in the region

Thailand
- Pattani (~1000ppb) 35mbd
- Erawan (~ 1000ppb) 55mbd
- Tantawan (200-400ppb) 5-7mbd
- Jasmine (200-700ppb) 10mbd
- Benchamas (~400ppb) 50mbd

Indonesia
- Arun Field 180-300 µg/Nm3

Indonesia
- Wright 2005
- Multiple other occurrences

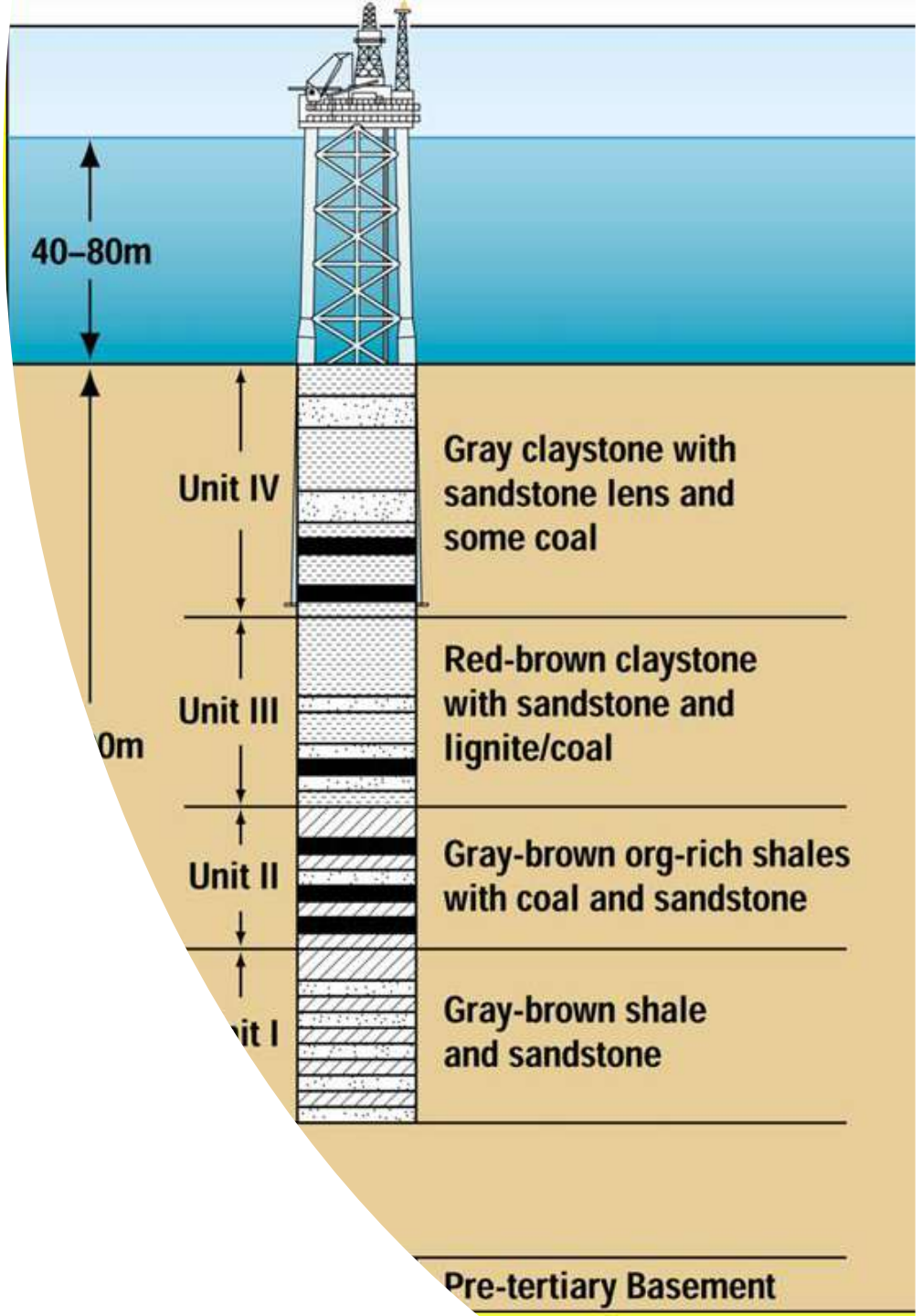
Vietnam
- Bach Ho <50ppb
- Rang Dong ~40-60ppb
- Bunga Kekwa ~85ppb

Philippines
- Malampaya Condensate (~100ppb)15mbd

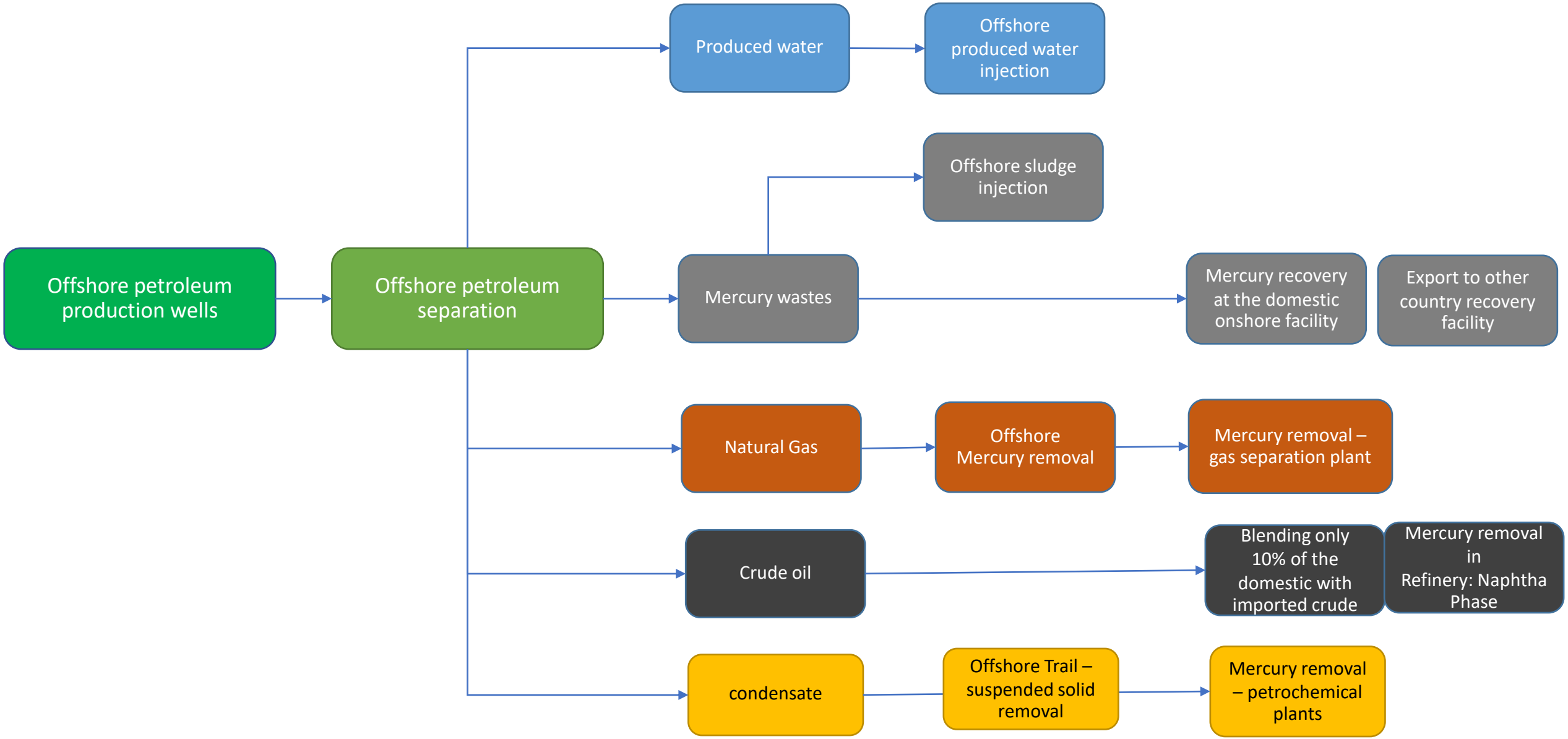
Australia
- North West Shelf (110mbd) – 10 to 30 ppb
- Bayu Undan (70mbd) – 19 to 30 ppb

History of Mercury in the Gulf of Thailand

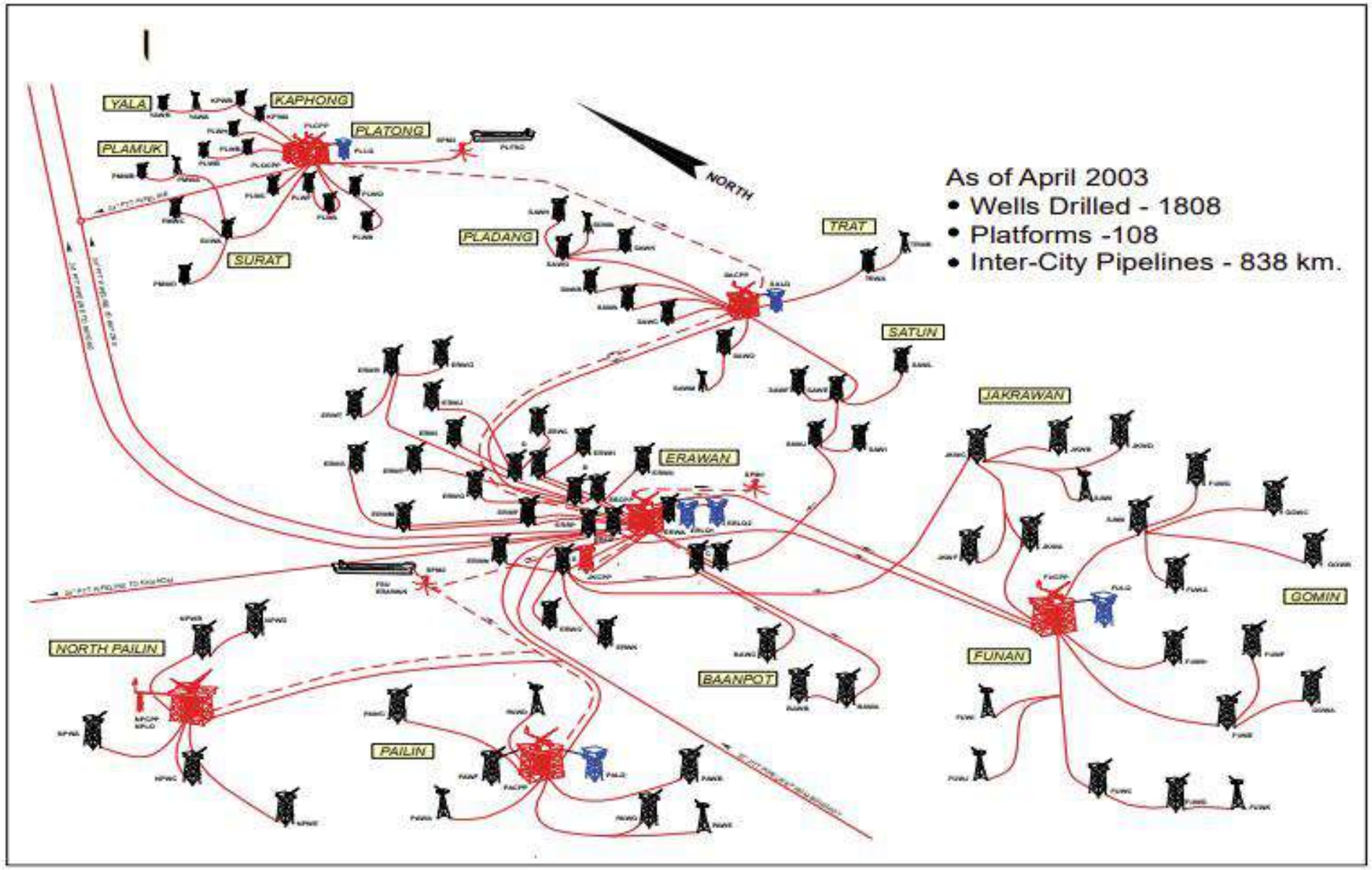
- A natural by-product of oil and gas production
- Discovered in 1985 -- a new experience in Unocal Thailand operations
- Management Policies initiated

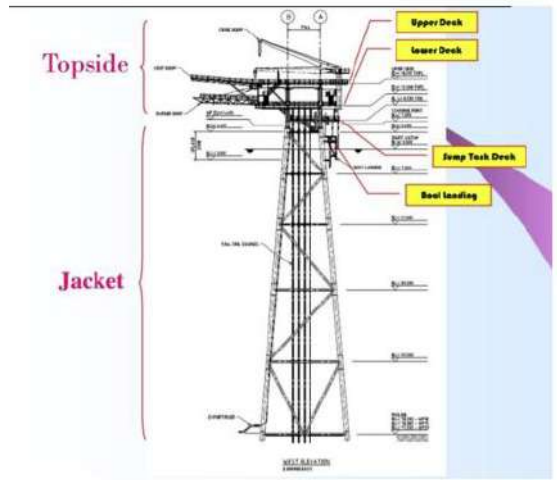


Mercury management in upstream and middle stream – oil and gas supply chain: Thailand case study

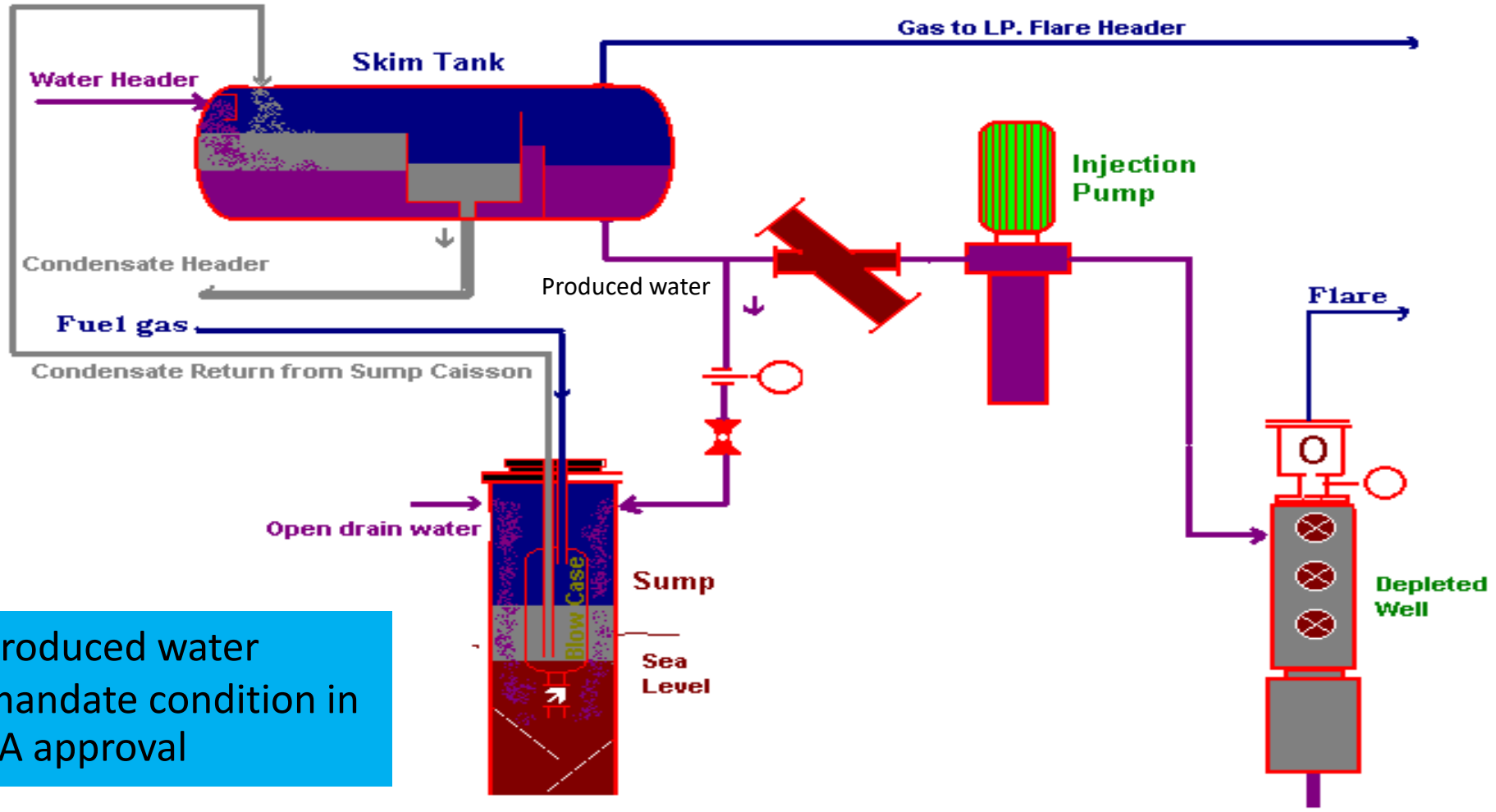


Offshore Oil and Gas Production Installation – Gulf of Thailand





Produced Water Reinjection into the Depleted Petroleum Reservoirs



At the present, produced water Reinjection is a mandate condition in In E&P Project EIA approval

5.1

โครงการตรวจเฝ้าระวังผลกระทบด้านสิ่งแวดล้อมจากการประกอบกิจการปิโตรเลียมในอ่าวไทย

ENVIRONMENTAL MONITORING PROGRAM IN PETROLEUM OPERATIONS IN THE GULF OF THAILAND

1. Monitoring program of mercury and arsenic compound contaminations in seawater in petroleum operations areas in the Gulf.

The study revealed that the average level of mercury compounds in seawater around all fields in the Gulf does not exceed 0.1 microgram per liter or the standard quality of seawater in Thai Territorial Waters Category 1 and the standard quality of seawater for natural resource conservation, stipulated in the Announcement of the National Environment Board No. 27 B.E. 2549 (2006) on seawater quality standard. The average level of arsenic compounds in seawater in the same areas does not exceed 10 micrograms per liter, using the same standards mentioned above. The study does not foresee a statistical rising tendency over the period of 2013-2021.

2. Monitoring program of mercury and arsenic compound contamination in tissues of benthic fish in petroleum operations areas in the Gulf.

The report also revealed that the average concentration of mercury and arsenic compounds in tissues of benthic fish from every field does not exceed the standard quality stipulated in the announcement of the Ministry of Public Health No. 414, issued under the Food Act B.E. 2563 on Standards for Contaminants in Food: 0.5 milligram per kilogram for mercury and 2 milligrams per kilogram for arsenic, respectively.

Offshore E&P Hg Waste Management Process

Remote Platform

Hg Cont. Sludge

Disposal by Deep well injection

Hg Wastes

Hg Wastes

Jetty & Onshore Warehouse

Onshore Facilities e.g. Workshop, Lab

Offshore Processing Platforms and Tankers

Domestic Hg Recovery Facility

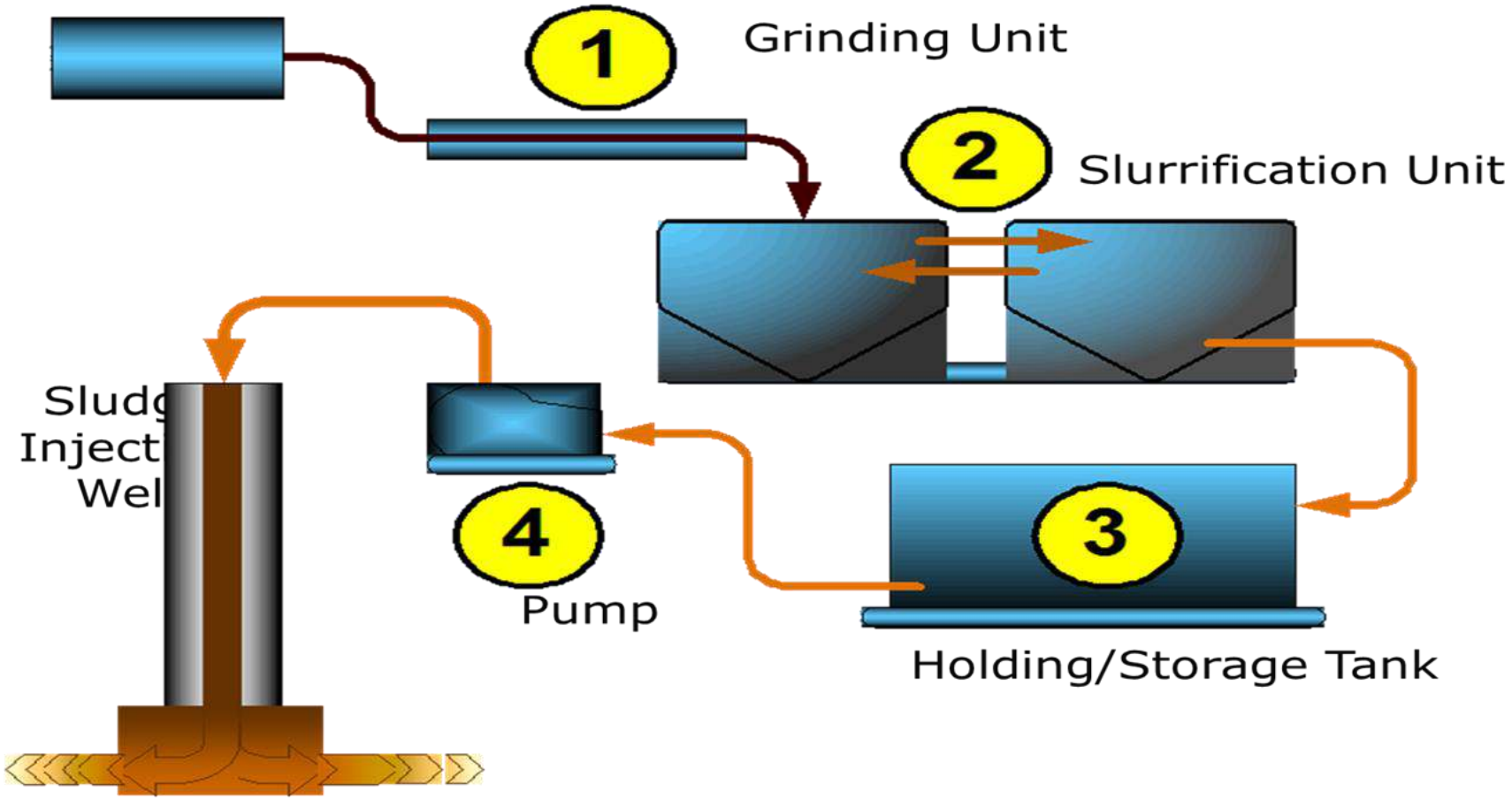
Residue Waste Disposal
a) Metal recovery
b) Cement Kiln
c) Hazardous Waste Incinerator

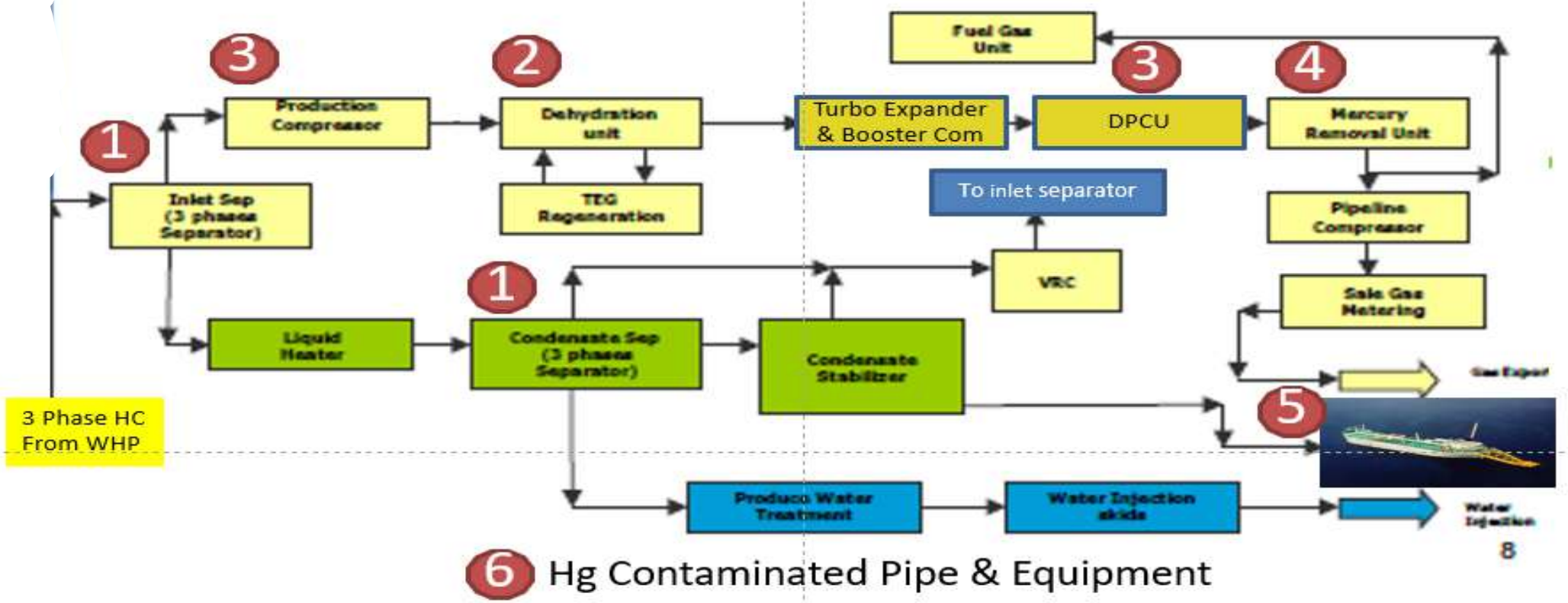
Pure Hg
Sold to Industry with allowed uses
e.g. thermometer, sphygmomanometer

Mercury sludge Deep Well Injection

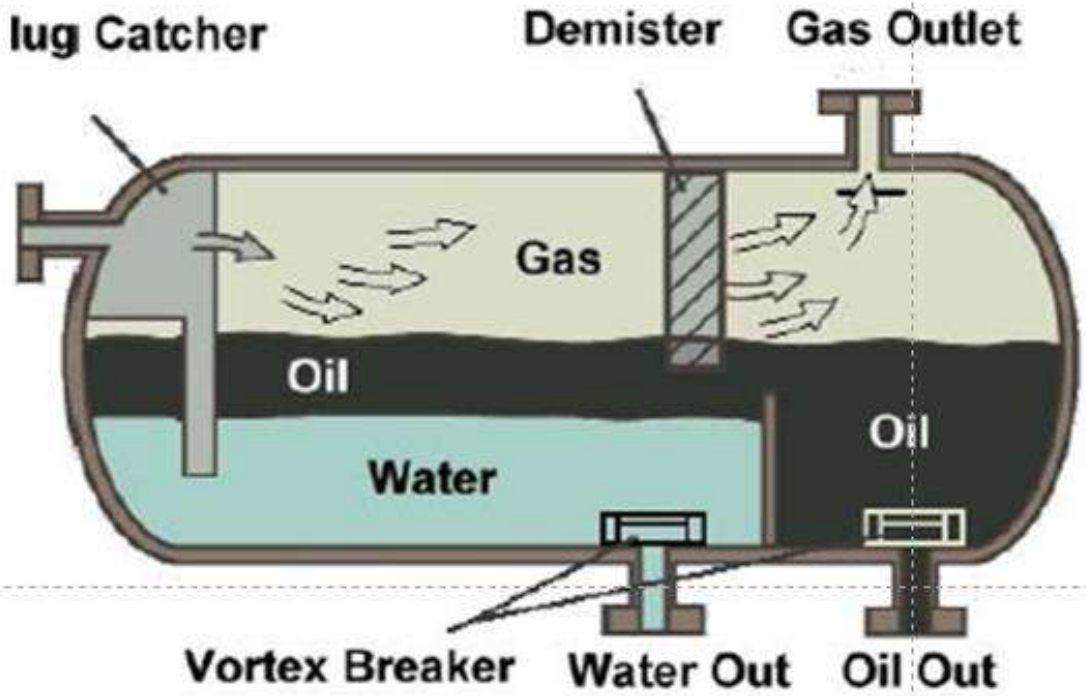
- Former practice for Hg contaminated sludge disposal
- Need to get approval from DMF
- Well should have suitable formation such that it will not get clogged
- Sludge drums are transferred to designated WHP for sludge injection

Mercury Sludge Preparation and Reinjection into Depleted Wells



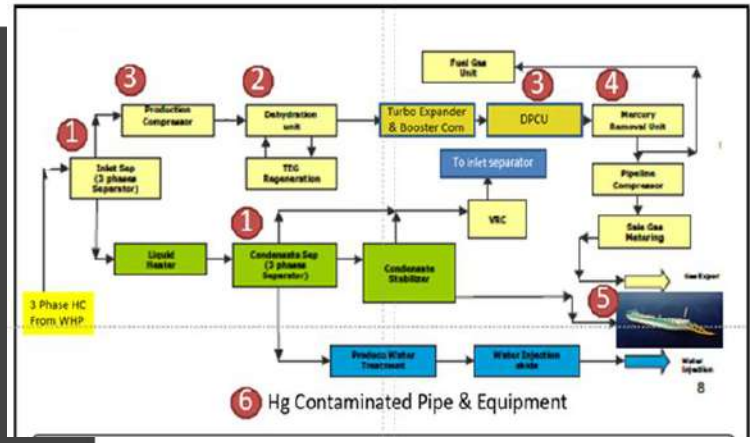


Where Hg Wastes are Generated?



Mercury Contaminated Sludge:

- Gas Field – Liquid Sludge
- Oil Field – Waxy Sludge



1 Separators

2 Dehydration

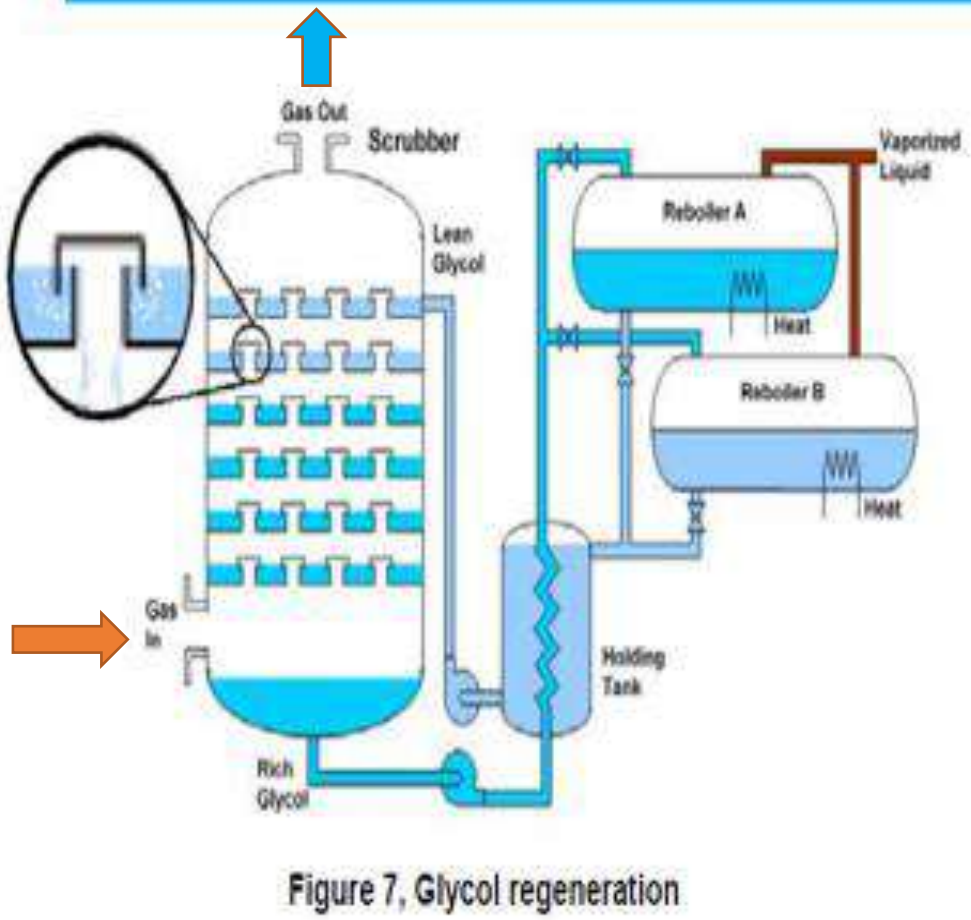
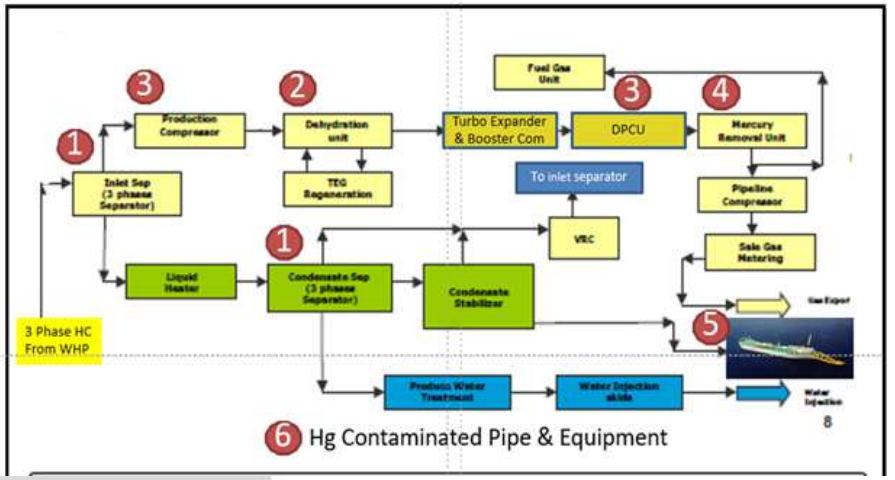


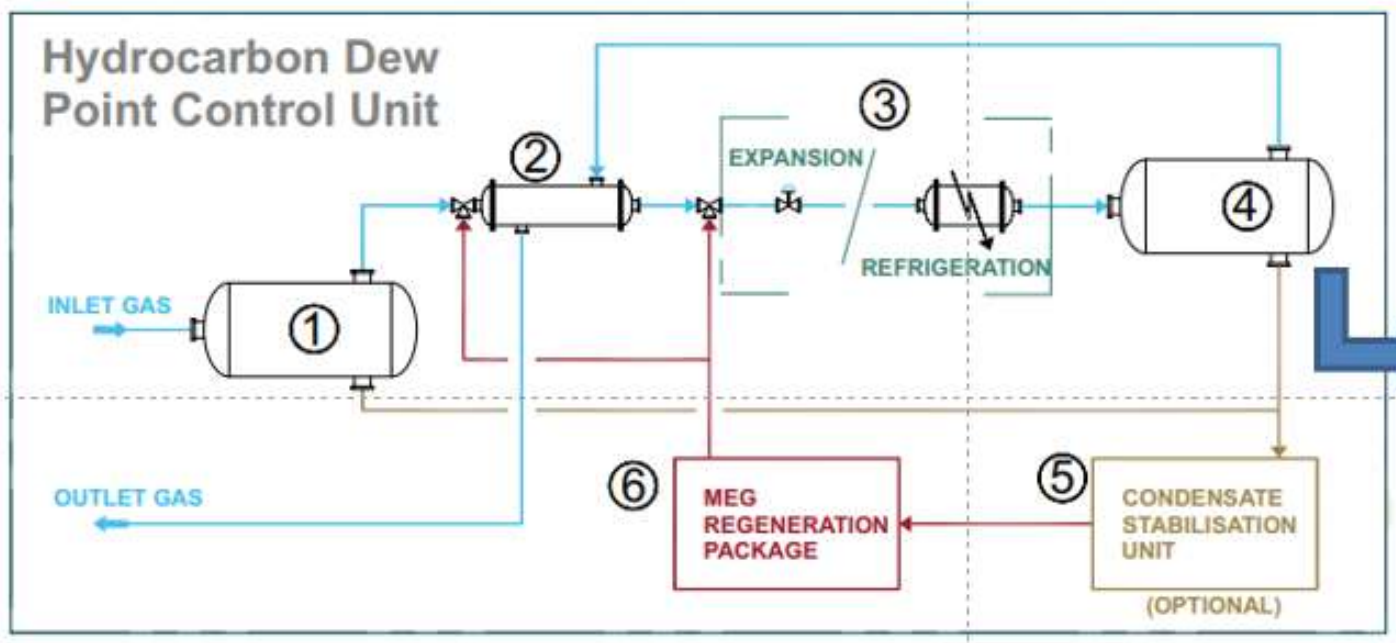
Figure 7. Glycol regeneration

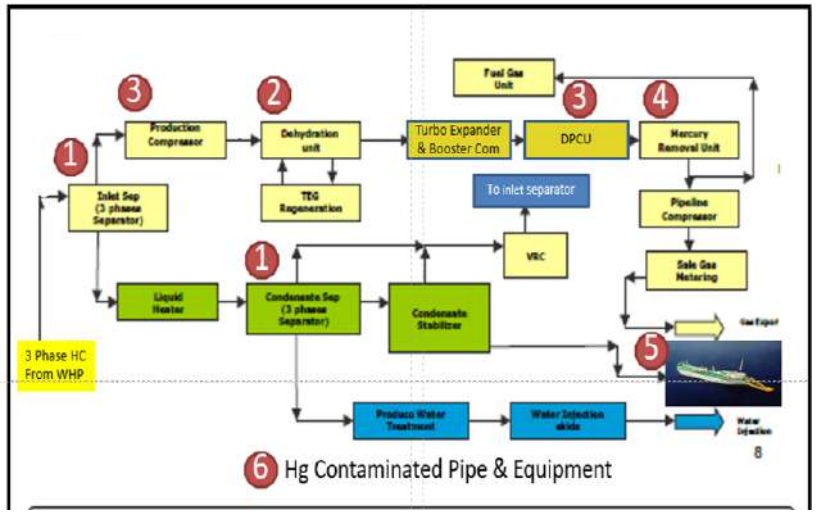


- Glycol sludge
- Glycol filters

Synergy Plus

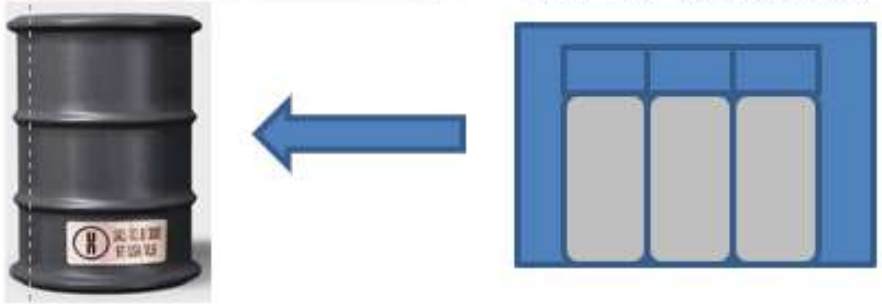
3 Dew Point Control Unit(DPCU)



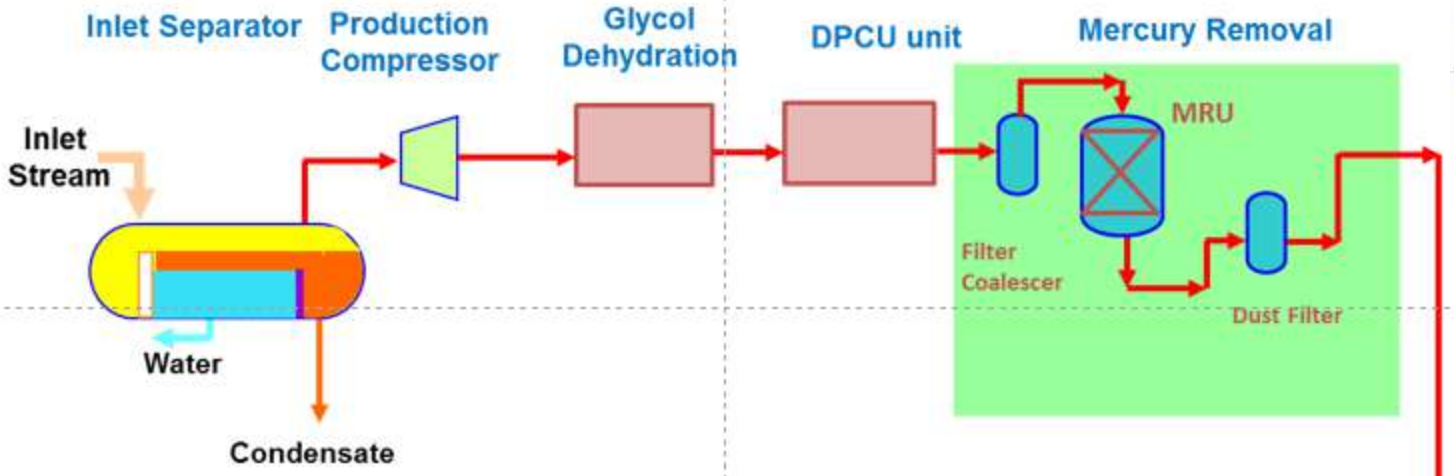


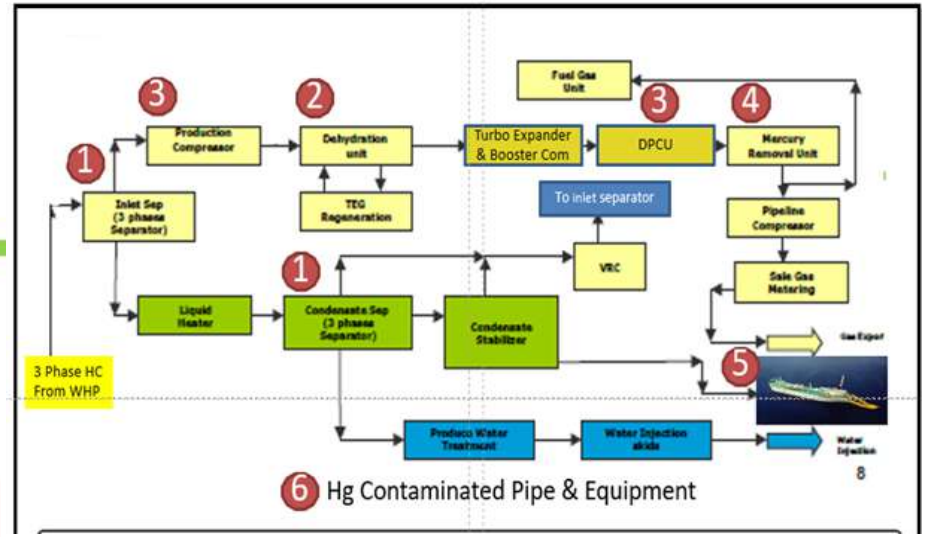
Liquid Elemental Mercury

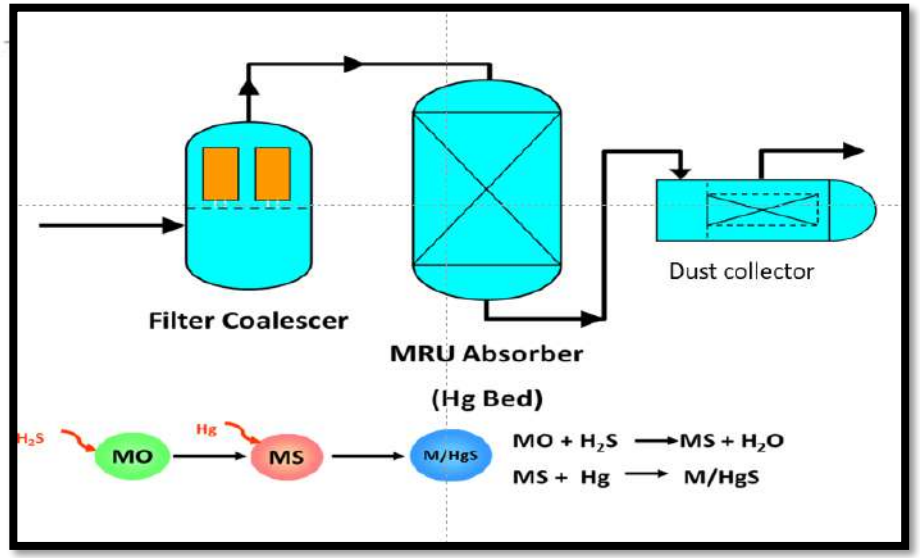
HDPE + Steel Box



4 Mercury Removal Units







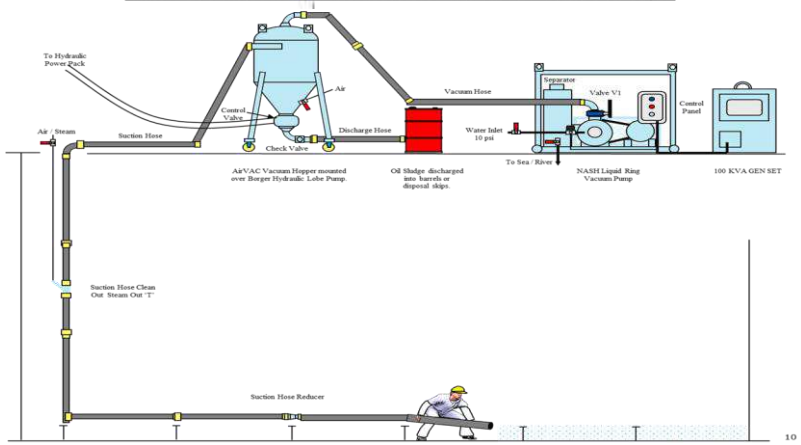

Spent MRU Catalyst

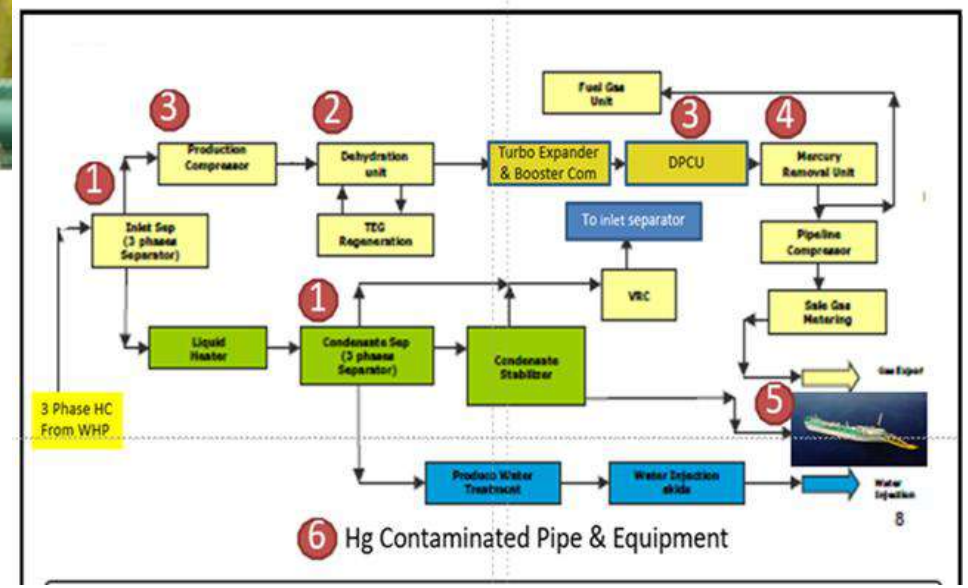

Ceramic Ball

Membrane Element

5 Vessel Tank Bottom Sludge

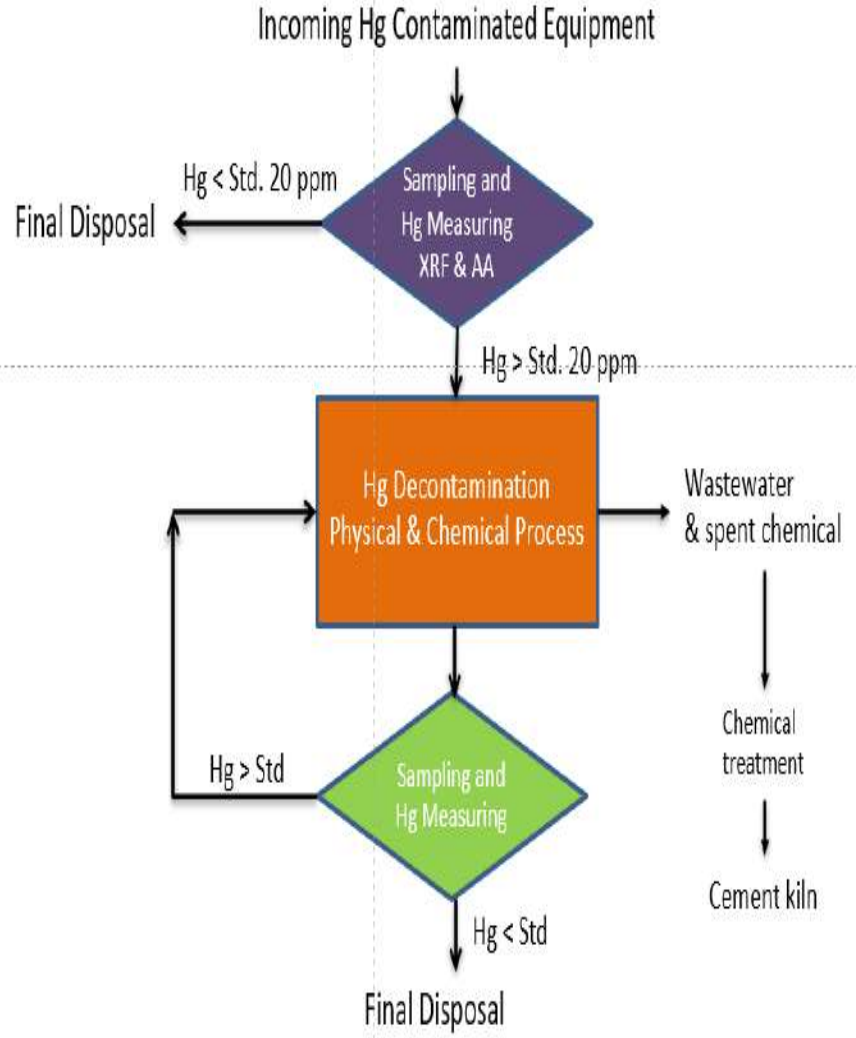
AirVAC – NASH VACUUM PUMP/VACUUM HOPPER SLUDGE LIFTING TECHNIQUE

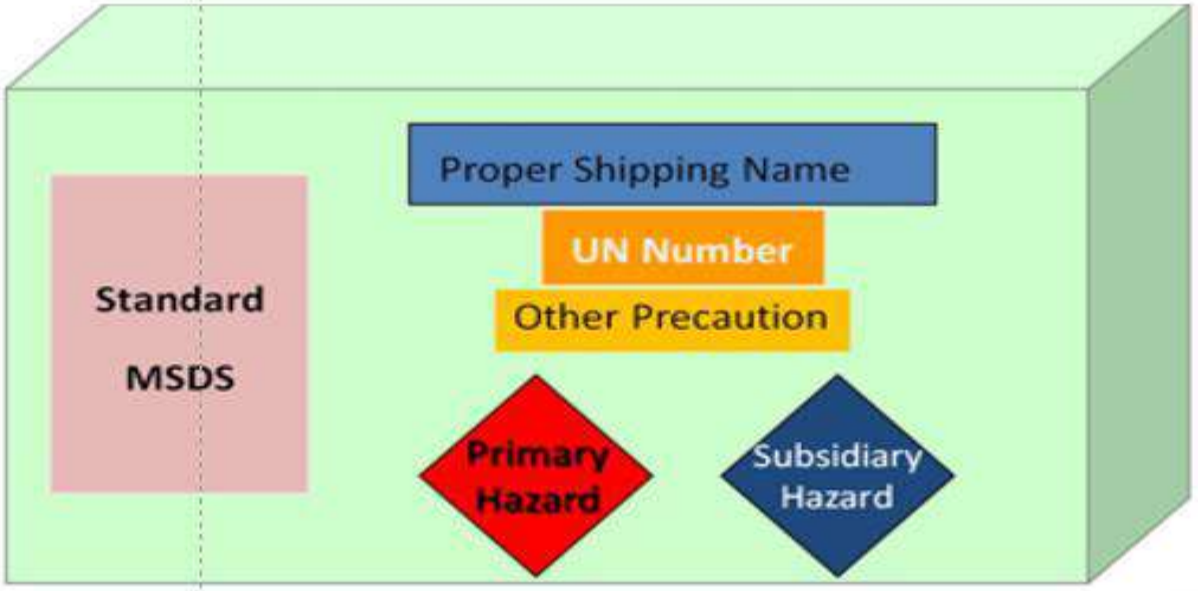




6 Hg Contaminated Equipment

Mercury decontamination Facility – supporting maintenance activities of oil and gas installation and equipment

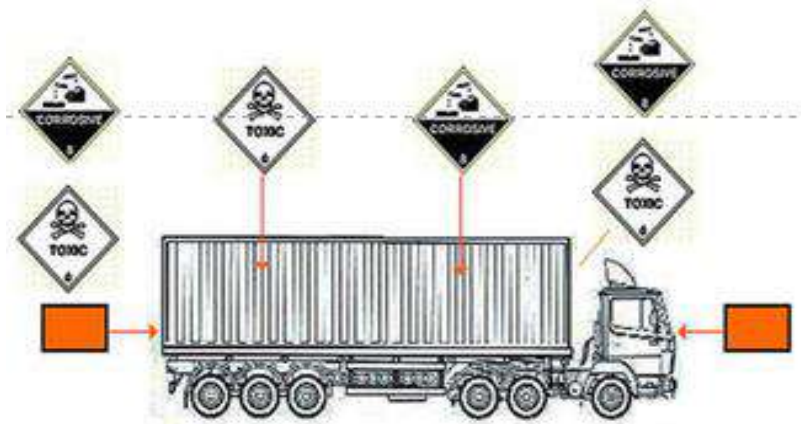




Packaging, Labelling and Securing

Hg Waste Transportations

- Marine Transport – in compliance with IMDG
- Road Transport – local regulations on transportation of hazardous wastes



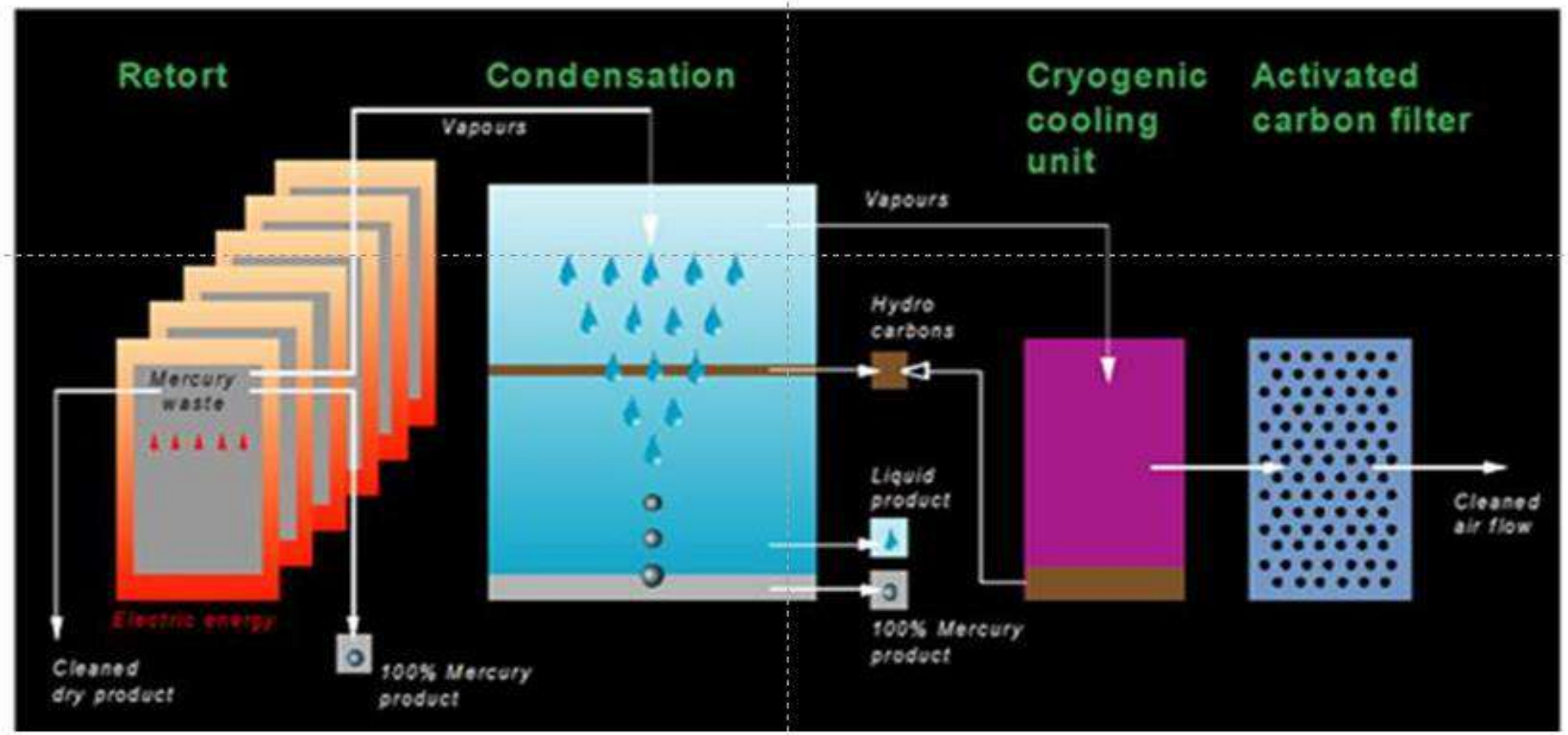
- Licensed Truck & Driver
- Install with GPS
- Restricted Routes for DG
- Warning sign provided
- Use Shipment Manifest

- Fire extinguisher
- Spill response equipment
- Emergency Response Plan
- 30 Million THB insurance

- Alcohol & Substance Abuse Examination
- Advanced Defensive Driving Training
- Not allow to drive over 6 hours

Hg Waste Treatment – Mercury Recovery

Thermal Desorption and Vacuum Distillation



Hg Waste Treatment – Mercury Recovery

Hg Waste Storage

- Epoxy coated floor
- In rack fire springer
- Fire resistance wall
- Hg and HC detections

Waste Filling into Retort

- Full PPEs
- Conducted in extraction hood
- With assistance of pneumatic arm

Hg Recovery Area

- Isolated and Totally enclosed
- Negative Pressure
- Epoxy coated floor
- Controlled temp at 25 ^{0}C

Hg Waste Treatment – Mercury Recovery

Thermal Desorption

- Undertaken at 550 ^{0}C for 30-40 hrs
- Heating is done under vacuum to prevent explosion for waste with HCs
- Residues after treatment – catalyst (metal recovery), others (hazardous waste incinerator or cement kiln

Vacuum Distillation

- To separate Hg, HC and Condensed Water
- HC & condensed water – finally disposed of in Haz Incinerator
- Elemental Hg – sold for further uses in allowed product

Gas Treatment

- Gas is treated through
- Cryogenic – to condense HC
- Wet Scrubber – to treat H2S
- Hg and HC Catalyst – to remove HC and Hg

Final Disposal of Hg Treated Wastes

Cement kiln

- Solid residue from retort (Hg < 20 ppm, As < 500 ppm)
- Liquid residue (Hg < 20 ppm, As < 500 ppm, high flash point)

Hazardous Waste Incinerator

- Solid residue from retort (Hg < 20 ppm As > 500 ppm)
- Liquid residue (Hg < 20 ppm, As > 500 ppm, low flash point)

Copper Smelter

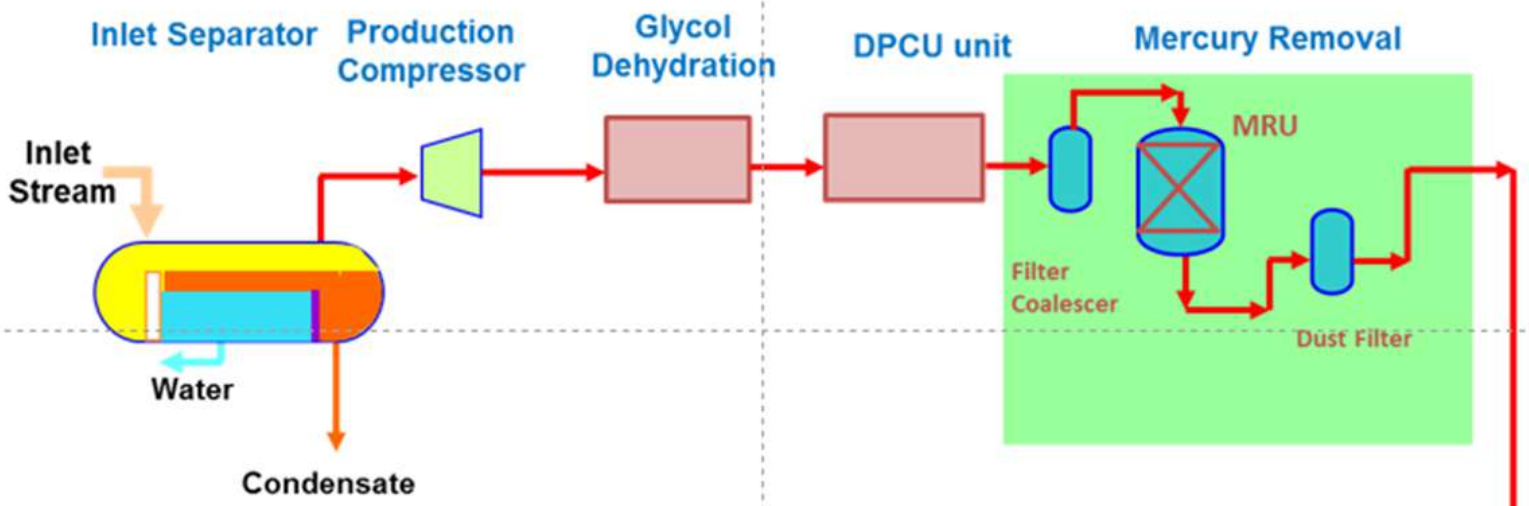
- Copper based catalyst

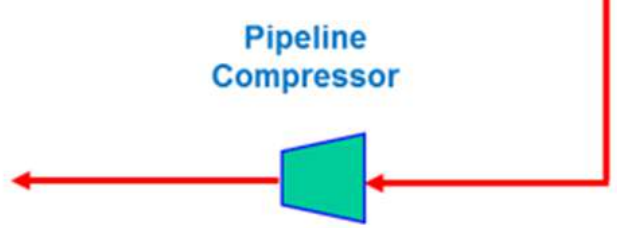
Natural Gas
Mercury removal

- Offshore process
- Separated offshore Platform dedicated For MRU
- Some MRU installed on the existing production platforms

Synergy Plus

4 Mercury Removal Units





Stipulation of gas specification Which include mercury and the Penalty charge

Mercury removal Platform – Erawan Field: Gulf of Thailand

Mercury Management in Oil and Gas middle stream and downstream – Thailand Case Study

Narongsak Chaiyasit, Ph.D.

Synergy Plus Co., Ltd.

Thailand

Mercury management in the oil and gas middle stream process

- Gas – Install MRU to reduce Hg < 10 ug/m3

- Crude Oil
  - No Proven Hg Removal Technology for crude oil offshore
  - Refinery has now installed the Mercury Removal Unit (MRU) at naphtha phase of the refinery

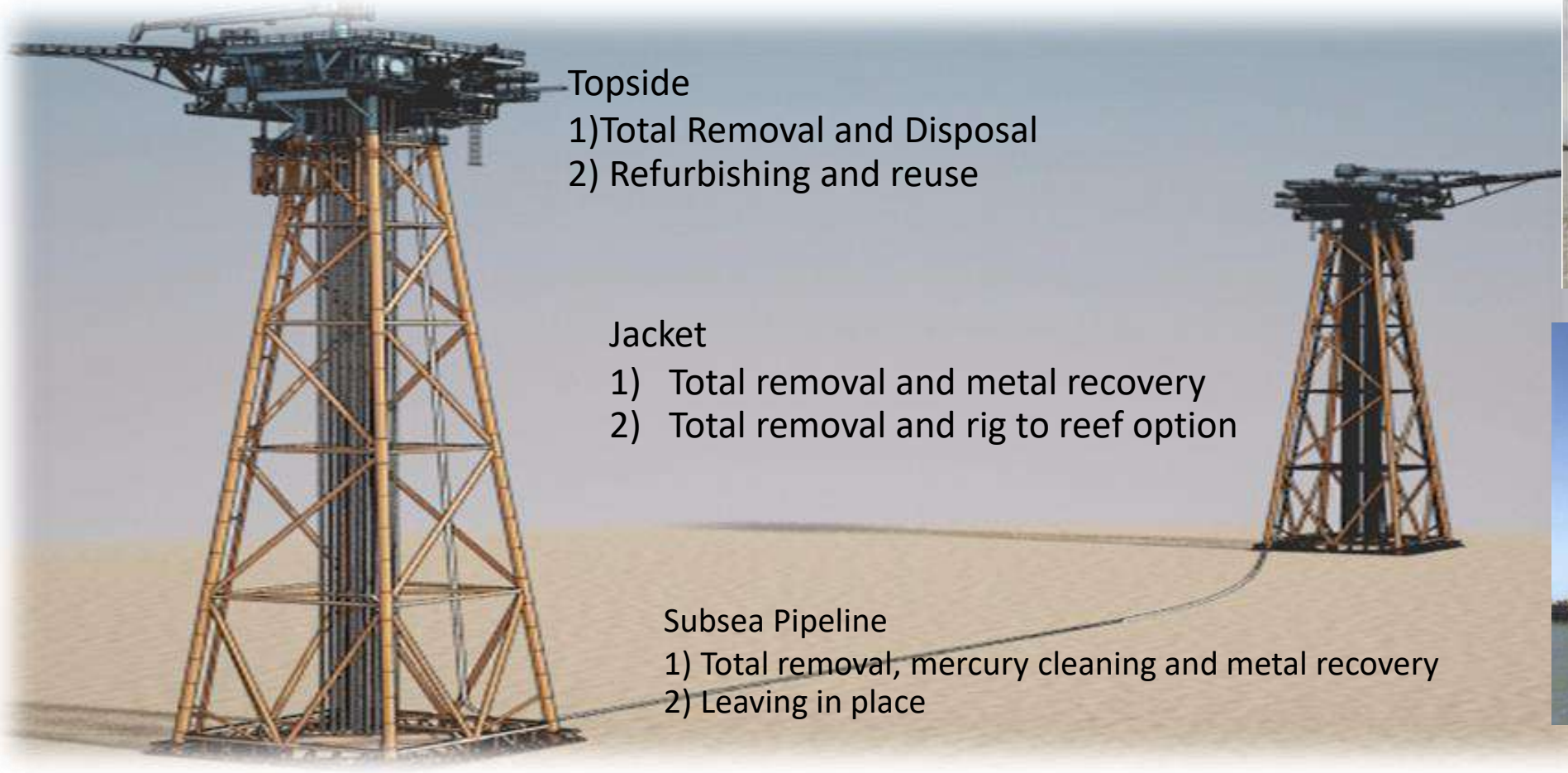
- Condensate
  - An effort was made to eliminate suspended mercury particles from condensate at an offshore location. This process results in the generation of mercury sludge, which can be disposed of by injecting it offshore.
  - Petrochemical plants that receive domestic mercury laden condensate also has installed the MRU.

Mercury Management in Offshore Oil and Gas Facility Decommissioning

Narongsak Chaiyasit, Ph.D.
Synergy Plus Co., Ltd.

Wellhead Platform and Subsea Pipeline Decommissioning Options

Thailand is in an initial phase of the offshore O&G decommissioning. And major installation to be removed include a) Wellhead Platform and Subsea pipeline



Topside
1)Total Removal and Disposal
2) Refurbishing and reuse

Jacket
1) Total removal and metal recovery
2) Total removal and rig to reef option

Subsea Pipeline
1) Total removal, mercury cleaning and metal recovery
2) Leaving in place

In-situ Subsea Pipeline Chemical Mercury Decontamination: Field Study

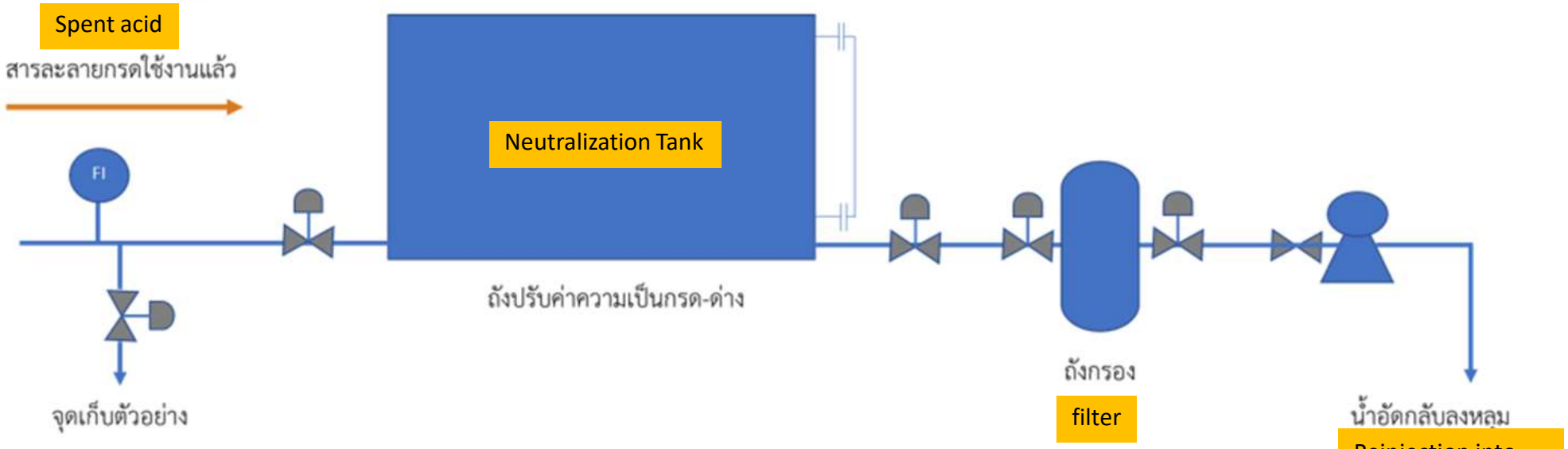
Subsea pipeline

acid plug

1 km

สารละลายกรดปริมาตร xxx ลูกบาศ์กเมตร

รูปที่ xxx การเติมสารละลายกรดลงในท่อที่ผ่านการล้างทำความสะอาดแล้วแบบหลายช่วง (section) ในการเก็บตัวอย่างแบบโดยอ้อม



รูปที่ xxx การจัดการสารละลายกรดที่ถ่ายออกจากท่อที่ผ่านการล้างทำความสะอาดในการเก็บตัวอย่างแบบโดยอ้อม

Field pilot trial of the situ-mercury decontamination was conducted offshore with three subsea pipelines and was proven to be Successful in reducing the mercury in the pipeline matrix to be lower than the TTLC standards with the spent acid reinjected into the well.

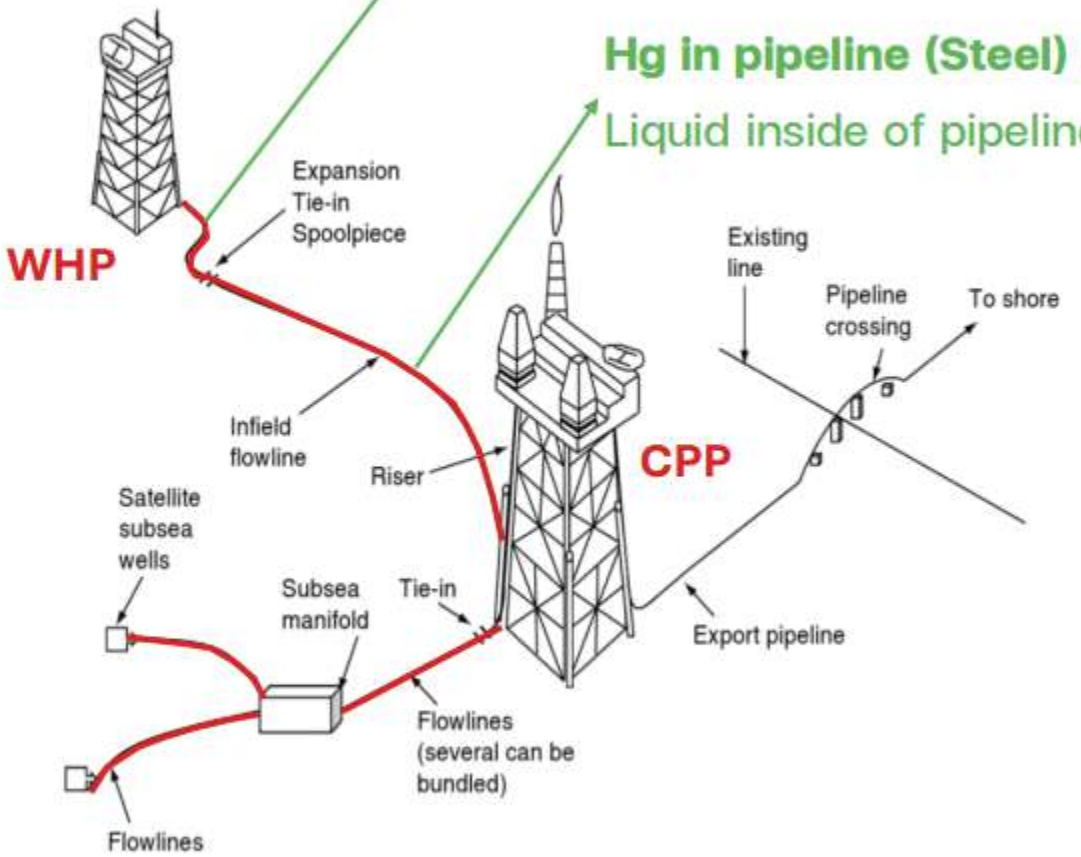
Subsea pipeline
Leaving in-place options (after acid leaching)
Study

Hg in liquid release during Execution :

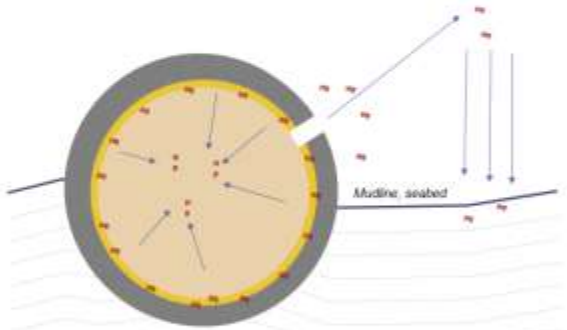
1.1) Pipeline leave in place option when remove Tie-in spool

Hg in pipeline (Steel) during leave in place (Long Term Release) :

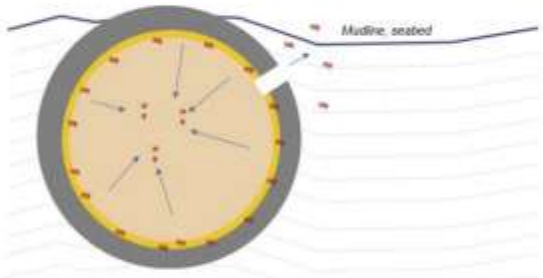
Liquid inside of pipeline shall release after leakage of pipeline



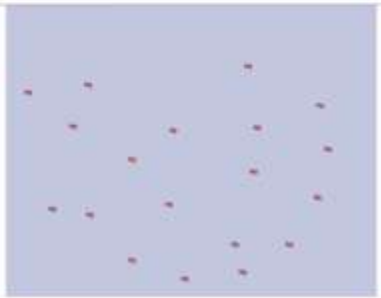
1.2) Leak above mudline



1.3) Leak below mudline



1.4) Long Term Hg in sediment



Subsea pipeline sampling, analysis and verification methods

นำ sampling PIG ใส่ลงใน PIG launcher

Put the sampling PIG into PIG Launcher

เพิ่มแรงดันน้ำเพื่อขับให้ sampling PIG วิ่งไปตามเส้นท่อและหยุดในตำแหน่งที่กำหนดไว้

Launching the PIG – propelled by seawater

Paused the PIG at the determined location

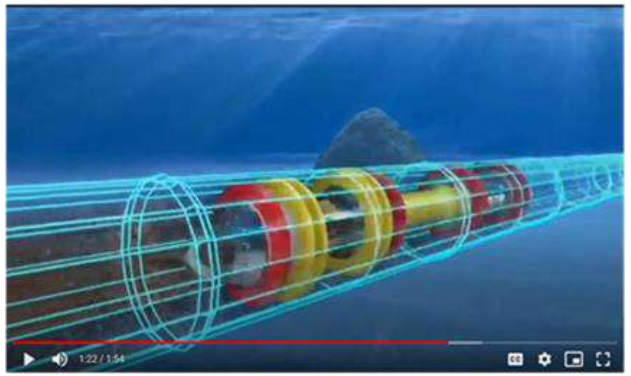
ภายหลังจาก sampling PIG หยุดแล้ว หัวเจาะก็เจาะเริ่มทำงาน

หัวเจาะทำการเจาะที่ผนังด้านบนของท่อตามระดับความลึกที่กำหนดไว้

Drilling the pipeline's internal surface

เศษผนังท่อที่ได้จากการเจาะจะตกลงมาในช่องเก็บตัวอย่างที่แยกออกจากกัน

Collection of the drilled debris in the PIG's magazine



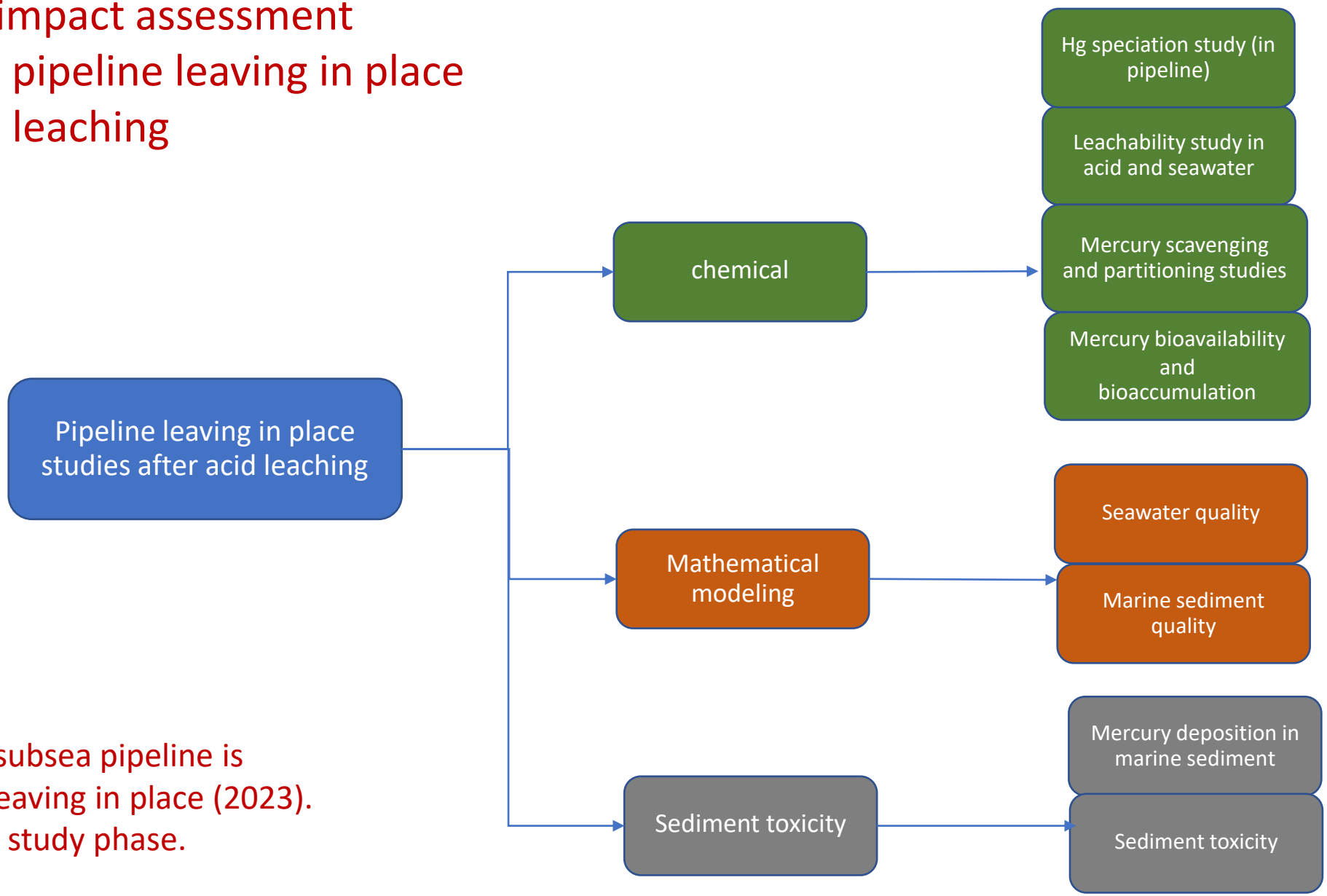
ภายหลังจากการเก็บตัวอย่างเสร็จ Sampling PIG จะย้ายไปเก็บที่ตำแหน่งถัดไป

Moving to the next sampling location

ROVULA
A COMPANY UNDER AI AND ROBOTICS VENTURES

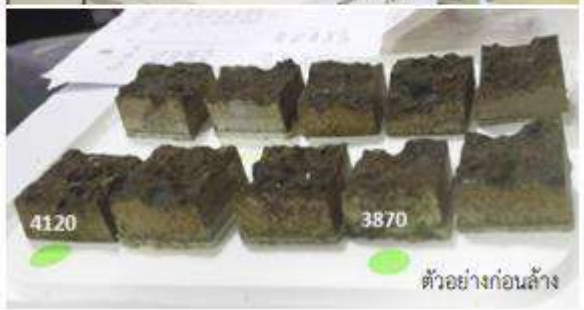
Technology proven subsea sampling service provided by PTTEP's sister company

Ecological impact assessment
For subsea pipeline leaving in place
- after acid leaching

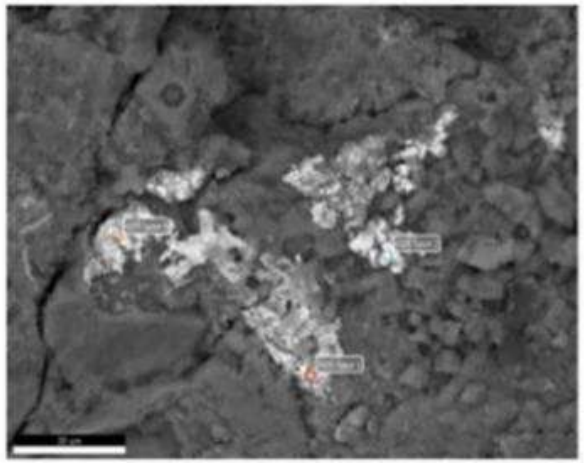


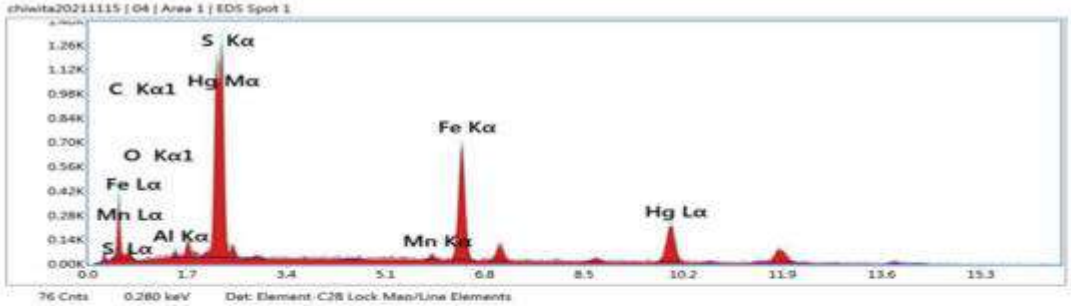
Note; none of subsea pipeline is
Permitted for leaving in place (2023).
This is only the study phase.

Mercury Speciation study on pipeline surface



SEM-EDS Analysis

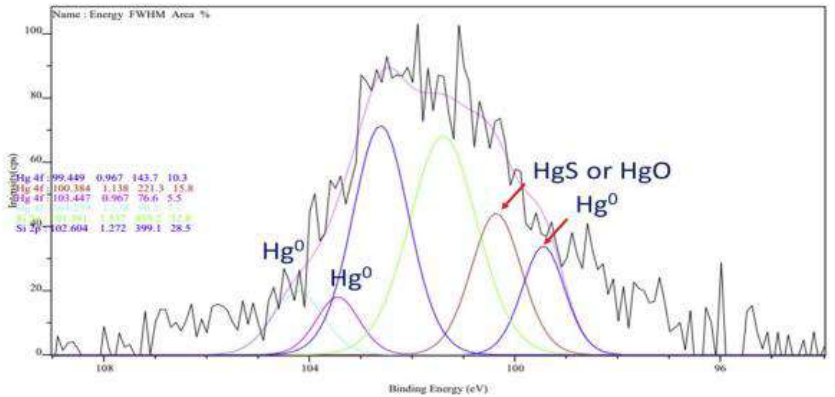


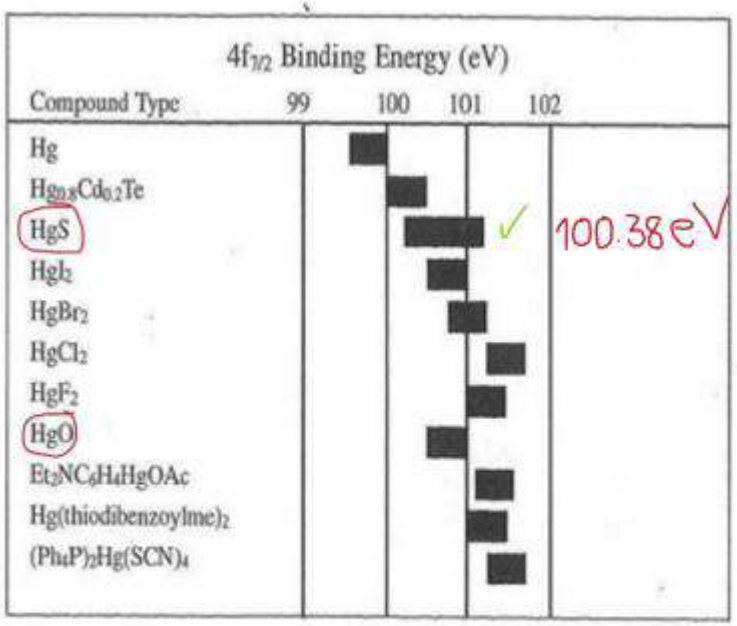


Smart Quant Results

Element	Weight %	Atomic %	Net Int.	Error %	Kratio	Z	A	F
C K	4.48	16.84	20.74	18.06	0.0120	1.3481	0.1986	1.0000
O K	14.45	40.77	133.33	12.45	0.0354	1.3016	0.1882	1.0000
Al K	0.91	1.52	25.26	18.22	0.0041	1.1787	0.3829	1.0009
S K	8.33	11.73	323.37	6.61	0.0625	1.1902	0.6274	1.0044
Mn K	0.97	0.80	25.28	27.13	0.0098	1.0339	0.8760	1.1119
Fe K	21.29	17.20	520.04	3.87	0.2215	1.0538	0.9021	1.0946
Hg L	49.57	11.15	222.08	7.85	0.3889	0.7718	1.0202	0.9962

XPS – Analysis; Pipeline before chemical leaching





Perkin-Elmer Corporation
Physical Electronics Division

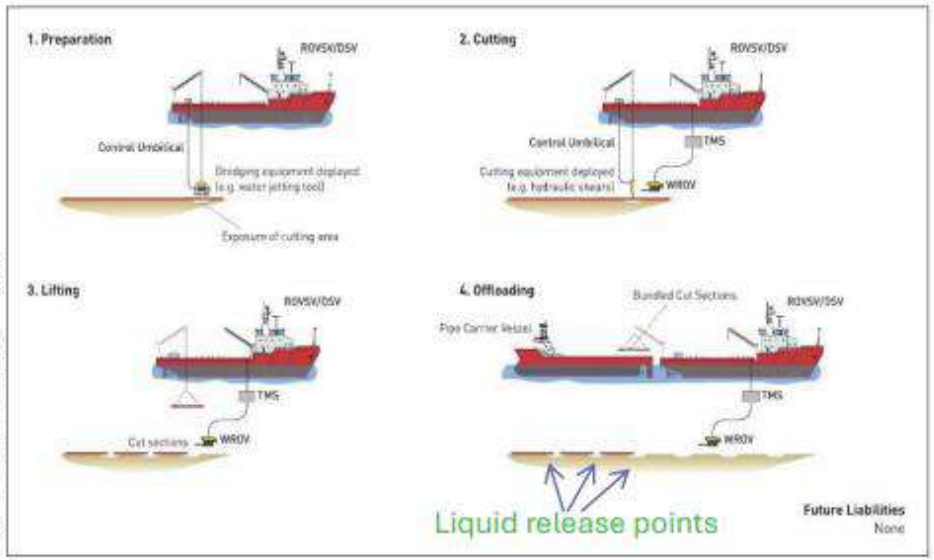
Total subsea pipeline Removal options - after seawater flushing Study

Hg in liquid release during Execution :

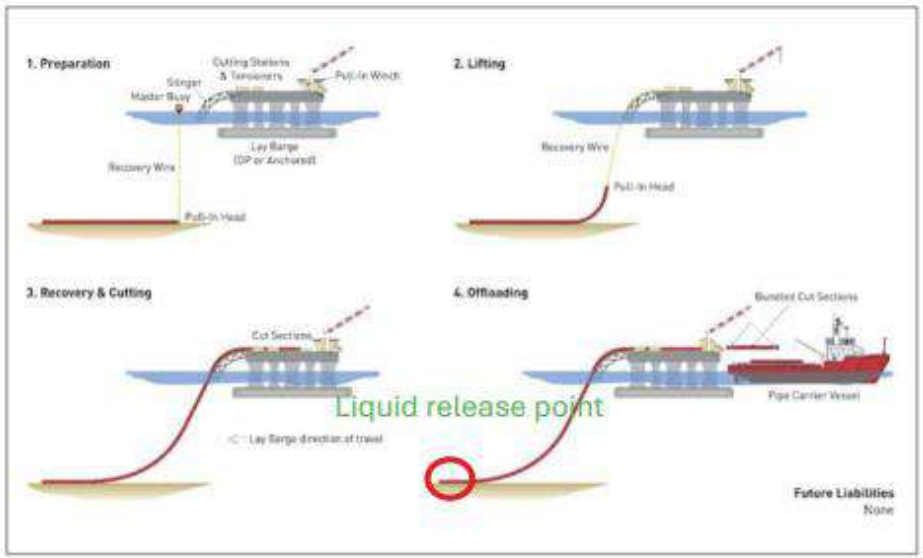
2.1) Totally Remove Option when remove Tie-in spool

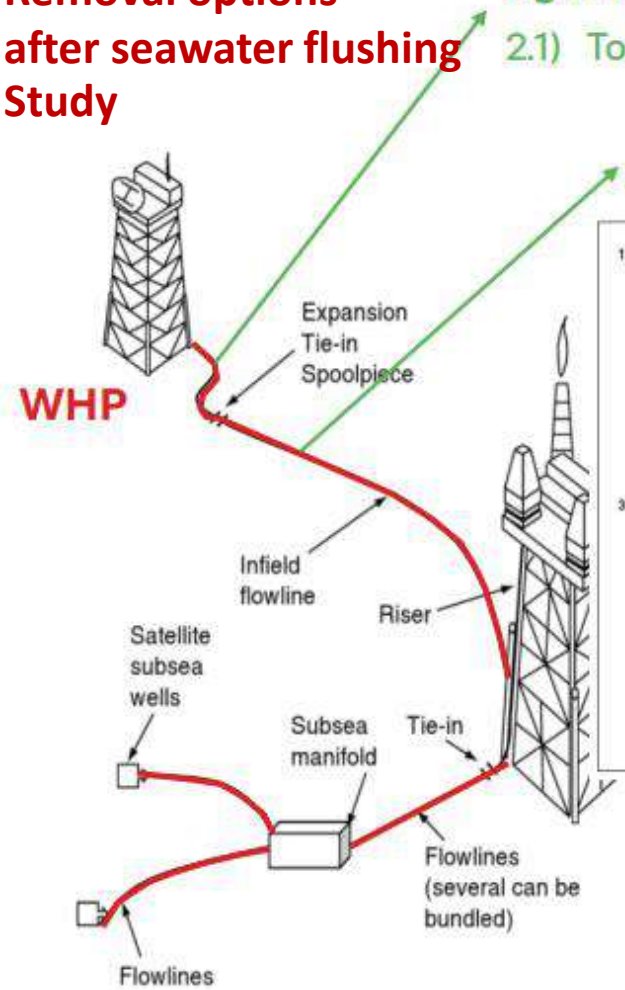
(Same with option 1.1)

2.2) Pipeline Totally Remove Option by cut to small pieces technic



2.3) Pipeline Totally Remove Option by reverse S-lay technic



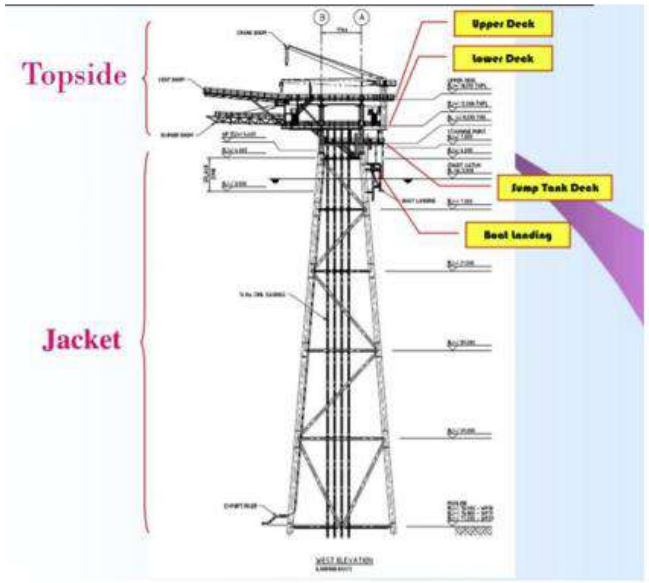


Studies conducted by Chulalongkorn University, Synergy Plus and Petroleum Institute of Thailand

- Seawater quality modeling study
- Marine sediment quality modeling study

Total Wellhead Platform Topside And Jacket Removal for cleaning and Recycling at onshore dismantling yard

Several onshore dismantling yards that in Thailand which are licensed for mercury cleaning and dismantling



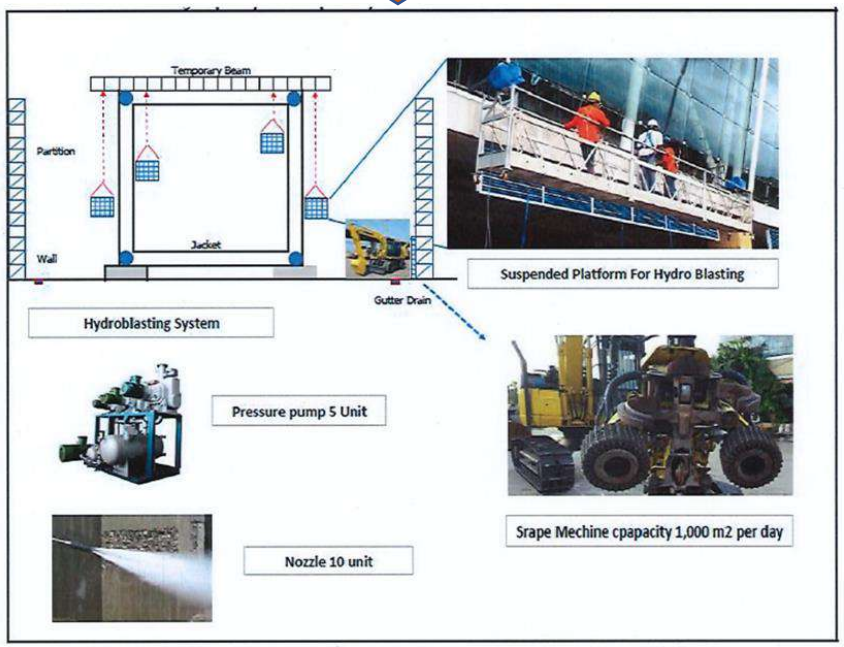
Transportation of WHP’s topside and jacket to onshore licensed dismantling facility

WHP Jacket Dismantling Process

Offshore transportation by tow barge

SPMT Transfer to laydown area

Laydown on contamination laydown area



Jacket cleaning of marine growth and binnacle

Jacket leg cutting

Final cutting and transport to designated smelter

WHP Topside Dismantling and Mercury Decontamination Process

การขนส่งส่วนบนแท่นหลุมผลิตโดยเรือบรรทุกมาที่ท่าเรือโครงการ

การขนส่งส่วนบนของแท่นหลุมผลิตโดย SPMT มายังพื้นตัดแยก

การตัดแยกส่วนบนของแท่นหลุมผลิตที่ปนเปื้อน

การล้างสิ่งติดตั้งปนเปื้อนด้วยเครื่องฉีดน้ำแรงดันสูงหรือด้วยการจุ่มในสารเคมี

การตรวจสอบสารปนเปื้อนภาคสนามและการเก็บตัวอย่างเพื่อวิเคราะห์ในห้อง Lab

การตัดย่อยและการขนส่งไปโรงหลอมเหล็ก

ขั้นตอนการล้างและตรวจสอบสิ่งติดตั้งที่ปนเปื้อน

Topside screening and dismantling

Cold cutting
Control of Hg vapor – local exhaust or habitat

Moving Hg contaminated equipment into enclosed building or unit with mercury ventilation and Hg filter

Blind all opening of the removed equipment and pipe from the topside of WHP

Preliminary screening of equipment using Field Portable-XRF

Pre-cleaning by Field Portable X-ray Fluorescent Spectrometer (FP-XRF)

Mercury cleaning by ultra-high pressure hydro blasting and chemical soaking

Ultra-high pressure Hydro blast or Chemical cleaning

Post-cleaning FP-XRF screening

Sampling and Laboratory analysis – TTLC standards

Final FP-XRF Screening and laboratory analysis

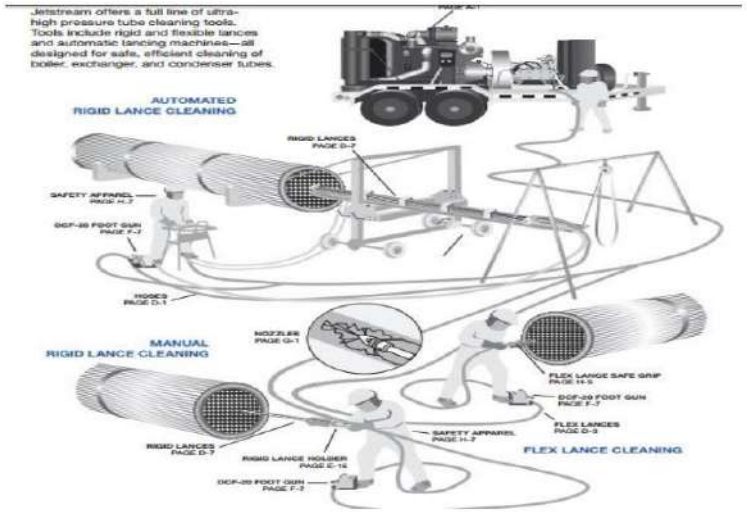
Draft guideline for sampling and analysis of the oil and gas installation and equipment after cleaning

Final cutting and transportation to recycling facilities

Mercury Decontamination Process

Mercury decontamination is conducted in a closed area with air pollution treatment system

Ultra high pressure hydro-blasting

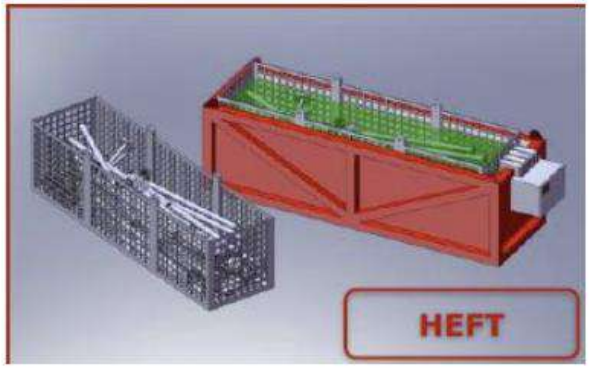


http://www.waterblast.com/uploadedFiles/Site/Service_and_Support/Resources/20KCatalog(5).pdf

During blast cleaning

Completed Sponge-Jet blast cleaning application

Chemical soaking



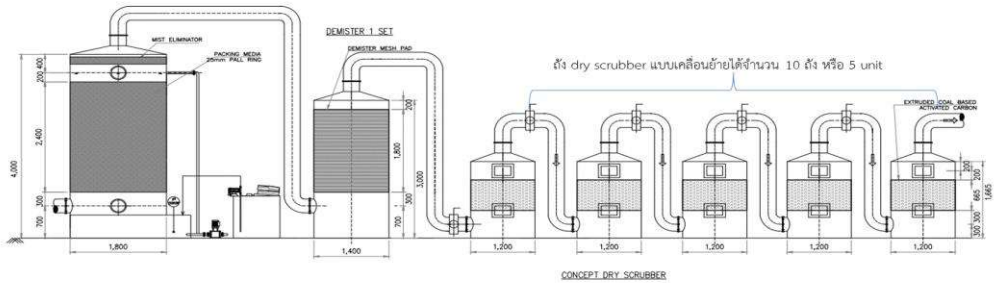
From: Presentation on Mercury Removal Technology: THIS, Lee Hunter

Close-looped chemical circulation

From: Presentation on Mercury Removal Technology: THIS, Lee Hunter

The tanks is provided with a cover with a vent to air treatment system

Wet scrubber



Hg Waste Treatment – Mercury Recovery

Thermal Desorption

- Undertaken at 550 ^{0}C for 30-40 hrs
- Heating is done under vacuum to prevent explosion for waste with HCs
- Residues after treatment – catalyst (metal recovery), others (hazardous waste incinerator or cement kiln

Vacuum Distillation

- To separate Hg, HC and Condensed Water
- HC & condensed water – finally disposed of in Haz Incinerator
- Elemental Hg – sold for further uses in allowed product

Gas Treatment

- Gas is treated through
- Cryogenic – to condense HC
- Wet Scrubber – to treat H2S
- Hg and HC Catalyst – to remove HC and Hg

Lessoned learn from Thailand Oil and Gas Industry on mercury management

- Produced water, even with low levels of mercury, should be reinjected into depleted wells instead of being discharged overboard to prevent environmental contamination.
- Mercury-contaminated sludge should also be reinjected into depleted wells to minimize offshore and onshore handling and transportation.
- Feasibility studies should be conducted to assess the technical viability of pulverizing and reinjecting spent MRU catalysts into depleted wells.
- Due to the significant environmental risk, insurance companies cannot provide environmental liability coverage for the total loss of mercury waste containers during transboundary shipment.
- A dedicated mercury decontamination facility is essential to ensure worker safety and control the release of mercury into the environment during maintenance activities on oil and gas equipment.
- Transportation of mercury wastes should be minimized and carried out using UN certified drums (class X or Y) to meet safety standards.

Lessoned learn from Thailand Oil and Gas Industry on mercury management

- To minimize the generation of mercury waste transportation onshore and prevent environmental release, the offshore reinjection method should be utilized. This method reduces the need to send mercury waste for the recovery process, which may have the potential for environmental release of recovered elemental mercury at the end of the product's life cycle.
  - Produced water – Hg contaminated
  - Mercury contaminated sludge – from vessel cleaning, ship cargo tank sludge removal
  - MRU catalyst – needs more technical trail for pulverization and slurrification method
- For managing of the mercury management for the middle stream process, the following shall be considered:
  - To establish a standard for mercury content in sales gas, treatment processes should be provided since from the upstream phase of natural gas production. Gas separation plants should incorporate Mercury Removal Units (MRUs) to control mercury levels in the final products and safeguard sensitive process equipment.
  - Further investigations should be conducted to remove mercury-laden suspended solids from condensate in offshore processes. This will ensure that the supplied condensate to petrochemical factories contains minimal levels of mercury.
  - The refinery shall installed the MRU at the naphtha phase to control release of the mercury into atmosphere.
  - Petrochemical industries should also install MRUs at appropriate locations within their processes to control mercury specifications in the final products.
- In situ mercury decontamination of PIG-able subsea pipelines has demonstrated the ability to reduce mercury levels below the Threshold Limit Concentration (TTLC) limit. Spent acid from the cleaning process, which contains mercury, can be safely reinjected into depleted wells.

The Guidelines developed by Thailand related to mercury management in oil and gas industry

1. Guideline for Identification and Assessment of Mercury Decontamination Techniques for Installation and Equipment from Oil and Gas Decommissioning in Thailand, Department of Mineral and Fuels, Ministry of Energy, Thailand (Thai)
2. Guideline for Site Selection of a Decommissioning Facility Receiving Mercury Impacted Installation and Equipment from Oil and Gas Decommissioning Activities, Department of Mineral and Fuels, Ministry of Energy, Thailand (Thai)
3. Operational, Health, Environment and Safety Requirements for a Decommissioning Facility Receiving Mercury Impacted Installation and Equipment from Oil and Gas Decommissioning Activities, Petroleum Institute of Thailand (Thai and English)
4. Guideline for Field Screening, Sampling and Analysis of Oil and Gas Equipment and Installations after Mercury Decontamination, Department of Mineral and Fuels, Ministry of Energy, Thailand (Thai)
5. Studies for best practical environmental options for decommissioning of offshore wellhead platform and subsea pipeline (ongoing)

Global Mercury Partnership Online Session
"Managing Mercury along the oil and gas value chains: sharing of experience and best practices"
July 18, 2023

Challenges in the Latin American Region for the management of mercury in the oil and gas sector

Alberto Santos Capra
BCRC - Argentina

CRBAS
Centro Regional Basilea para América del Sur

The Basel Regional Center for South America for Training and Technology Transfer (CRBAS) has been located at the National Institute of Industrial Technology (INTI) Buenos Aires, Argentina, since 1999.

Being a technological benchmark for the South American region, its objective is the formation and strengthening of control and production structures in the South American region (Argentina, Bolivia, Brazil, Colombia, Chile, Ecuador, Paraguay, Peru, Venezuela and Uruguay).

CRBAS
Centro Regional Basilea para América del Sur

INTI Instituto Nacional de Tecnología Industrial

Ministerio de Economía Argentina

Secretaría de Industria y Desarrollo Productivo

Projects Hg BCRC Argentina

- **2011 Minimization and environmentally safe management of wastes that contain mercury in chlor-alkali plants in the Argentine Republic**

- **2015 Development of Plans for Mercury Risk Management in Latin American and Caribbean Countries**

Objective: To strengthen Argentina's capacity to identify sources, quantify emissions, and determine priority actions to address mercury issues within the framework of the Minamata Convention, and with a view to its implementation.

National Inventory of Mercury Releases in Argentina: Level1for Oil and gas sector using the National Energy Balance

CRBAS
Centro Regional Basilea para América del Sur

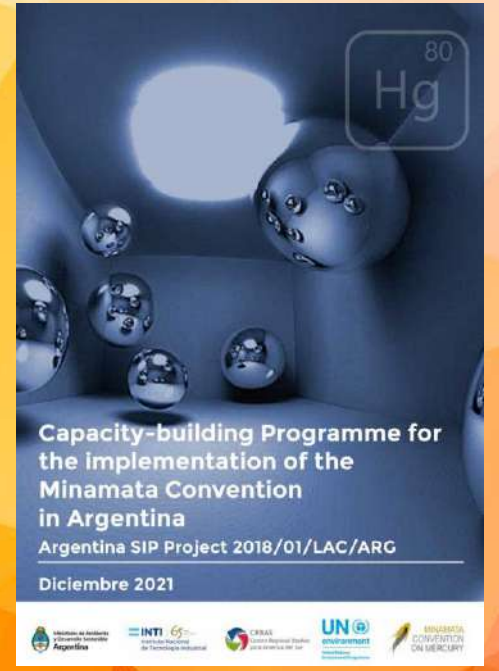
Projects Hg BCRC Argentina

- 2016 Identification Feasible Potential Strategies for Environmentally Sound Management of Used Lamps in Chile. Publication May 2021

Objective: To assist the Ministry of the Environment of Chile in the development of strategies to improve the management of used lamps.

- 2019 Capacity Building Program for the Implementation of the Minamata Convention (SIP) Project 2018. Publication December 2021

Objective: to strengthen the country's capacity to implement Article 4 of the Convention and develop information generation mechanisms to comply with the Minamata Convention



CRBAS
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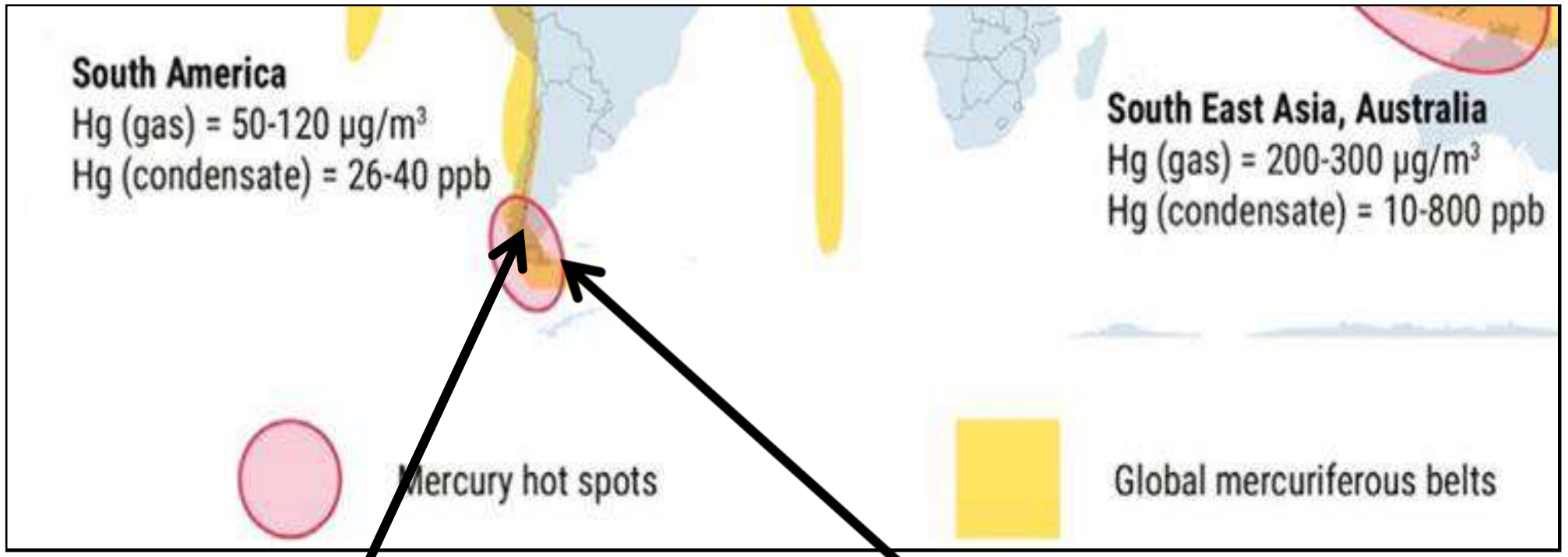
Workshops Hg BCRC Argentina

- Workshop Launch Development of Plans for Mercury Risk Management in Latin American and Caribbean Countries. April 13, 2016
- Project Closing Workshop Development of Plans for Mercury Risk Management in Latin American and Caribbean Countries. May 15, 2016
- Regional Consultation Meeting for Latin America and the Caribbean in preparation for the first Conference of the Parties to the Minamata Convention on Mercury. July 25 to 28, 2017
- Side Event: Special Session with UNIDO. Mercury Waste Management in GRULAC (Group of Latin American and Caribbean Countries). July 27, 2017
- Communication Workshop Development of Plans for Mercury Risk Management in Latin American and Caribbean Countries (UNEP-GEF Project). August 17 to 18, 2017
- Workshop Identification Feasible Potential Strategies for Environmentally Sound Management of Used Lamps in Chile. December 18, 2020

CRBAS
Centro Regional Basilea para América del Sur

The Austral Basin is located in the extreme south of South America and covers part of the Argentine provinces of Santa Cruz and Tierra del Fuego, the Strait of Magellan



Santa Cruz Province
Ministry of Environment
Ministry of Health and Environment

Province of Tierra del Fuego, Antarctica and South Atlantic Islands
Environment Secretariat
Ministry of Production and Environment

Santa Cruz Gobierno de la provincia | MINISTERIO DE SALUD Y AMBIENTE — Secretaría de Estado de Ambiente

Ministerio de Producción y Ambiente — Secretaría de Ambiente — somos Gobierno de Tierra del Fuego

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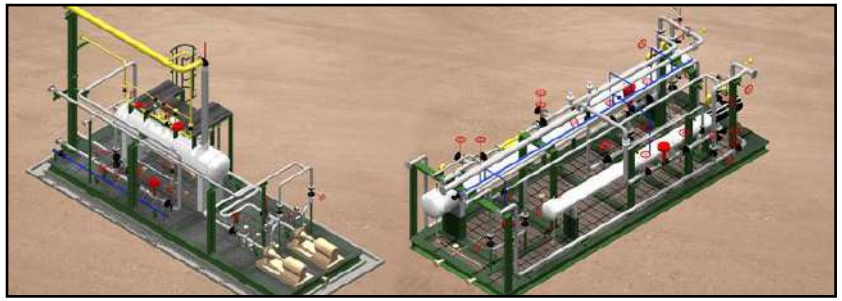
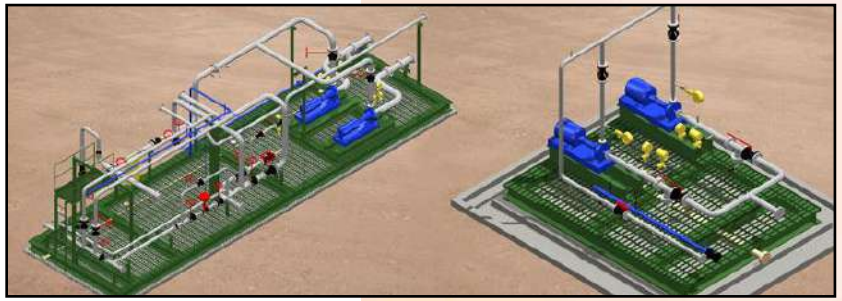
Provinces





- **Santa cruz**

✓ The exploitation of crude oil is in charge of the Compañía General de Combustibles – Oil field maría inés

✓ All crude produced is operated in an on shore upstream mercury removal plant (MRP)

✓ The plant was Developed by PETROBAS ARGENTINA and Union Oil Company of California (UNOCAL) and commissioned in 2006

✓ The oil was filtered through a diatomaceous earth precoated candle filter

✓ The removed waste material containing residual mercury matter was reinjected in diluted aqueous form to a deep disposal well near the MRP, through the deep injection method D3 Annex IV Basel Convention

✓ The bottoms of storage tanks that could contain wastes are heated so as not to generate sludge

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Provinces

- **Tierra del fuego**

- ✓ Crude oil is not processed in the province
- ✓ Mercury concentration analysis
- ✓ It is exported to Chile, the United States of America and the Netherlands
- ✓ Technologies are being presented to eliminate the mercury waste generated

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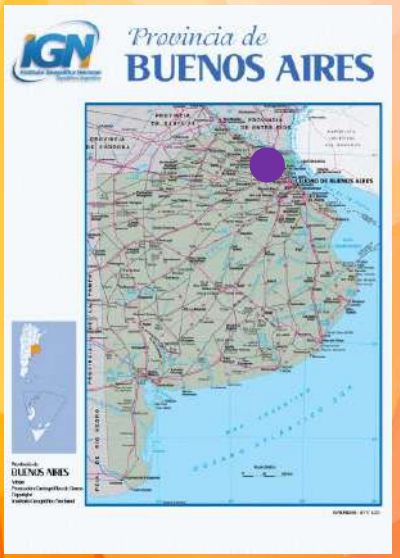
Hg in a refinery in Buenos Aires

- ✓ The Campana Refinery in the Province of Buenos Aires was warned through crude assay updates and external alerts of the potential (2009)
- ✓ The Refinery initiated sampling of its crudes and various refinery streams based on the chemistry of the mercury distribution
- ✓ in the different cuts, for the analysis, a laboratory was used for the presence of mercury. On that occasion, samples of inputs and even of the crude oils were sent separately, to external laboratories in the United States of America, detecting high levels of mercury in the crude oil from the Escalante Field in Comodoro Rivadavia in the Province of Chubut
- ✓ Based on the first tests carried out, the Refinery acquired the first equipment detection of Hg at low concentrations in Argentina in order to monitor hg levels during the process and in commercial products



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Challenges Oil and Gas sector and Hg in the Region

- ✓ Data on emissions and releases
- ✓ Decommissioning of infrastructure
- ✓ Detecting and monitoring; global harmonized studies with comparable analytical techniques
- ✓ Laboratories infrastructure and inter-laboratories exercises
- ✓ Lack of emissions factors of processing technologies
- ✓ Expertise in corrosion and embrittlement controls
- ✓ Concentration maps updated
- ✓ Mercury waste management: saturated waste water filters and adsorbent from MRUs; sludge from maintenance, cleaning operations

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¡Thank you!

¡Muchas gracias!

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Treating Mercury Waste Generated by the Production of Oil and Gas in Ghana

Managing mercury along the oil and gas value chains: sharing of experience and best practices - Virtual event

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Accra, 18 July 2023

Oil and Gas Industry in Ghana: An Overview

- Ghana's oil and gas industry is still in its developing stage with operations in the downstream sectors, mid-stream as well as upstream
- That notwithstanding, the sector has experienced significant growth, particularly since the discovery of oil in commercial quantities in the Jubilee fields in 2007 (first significant deep-water discovery)
- Average crude oil production capacity has been declining slightly over time, with an average 176,000 barrels per day in March 2023
- Full commercial natural gas production started in 2014 and production peaked in 2020 reaching nearly 2.4 million metric tons of oil equivalent.
- Natural gas is sent via pipeline from the Kwame Nkrumah FPSO to the onshore Atuabo natural gas processing facility and is used for domestic power generation

Oil and Gas Industry in Ghana: An Overview

- At present, Ghana has three major offshore oil and gas fields namely:
  - Jubilee
  - Tweneboa, Enyera & Ntomme (TEN)
  - Sankofa
- Major oil and gas activities are conducted by international oil companies such as
  - Tullow Ghana,
  - Vitol
  - Kosmos Energy
  - ENI
  - Aker Energy

Treatment of Mercury Waste in the Oil and Gas Industry in Ghana (I)

- Baseline Monitoring Surveys were conducted in 2011-2013

- Mandatory environmental monitoring surveys (EMS) are to be conducted regularly offshore

- Objectives of the monitoring survey are to:
  - provide comparison of the quality status with previous measurement and with baseline values
  - identify elevated levels of some target environmental pollutants
  - access medium to long-term impacts of routine offshore discharges

Treatment of Mercury Waste in the Oil and Gas Industry in Ghana (II)

- Mercury content:
  - Slightly elevated concentrations of mercury have been recorded at the Jubilee and TEN fields (2018 and 2019).
  - It is alleged that levels are unlikely to negatively impact on benthic communities at those stations
  - Assessment of sediment mineralogy are to be conducted to provide information on the source of the elevated mercury concentrations observed

Treatment of Mercury Waste in the Oil and Gas Industry in Ghana (III)

- **Current practices**:
  - Information gathered from the various oil companies indicate that:
    - zero or no mercury is released during operations therefore there is no consideration of modes of disposal
    - they however have sand treatment units in the produced water systems for the treatment and disposal of produced sand
    - sand units are not online or operational since there is no sand production

Conclusions/Recommendation

- This short investigation has revealed that:
  - Mercury production, treatment of waste and disposal has not been a concern for regulators (EPA) and player in the oil and gas sector

- EPA and other regulators need to take immediate action to monitor the sector in compliance with Ghana's obligation under the Minamata Convention on Mercury

- The Oil and Gas sector must be sensitized to take immediate steps to monitor mercury production and introduce appropriate technologies to treat mercury waste and dispose of them in an environmentally sound manner

Questions and Discussions

THANKS FOR THE KIND ATTENTION

Managing mercury along the oil and gas value chains: sharing of experience and best practices

Closing remarks

by Rodges Ankrah, *Environmental Protection Agency of the United States, Chair of the Partnership Advisory Group*