

Diagnostics & Treatments for Smart Life Cycle Management of Oils and Transformers

Case Histories of PCBs + DBDS Decontamination

Keywords: transformers, oils, insulating fluids, loss preventions, SF₆, corrosion, corrosive sulfur, DBDS, additives, contaminants, diagnosis, integrated treatments, PCBs/POPs.



Vander Tumiatti

- President and Founder of Sea Marconi (1968) - Turin (Italy)
- Ass. Secretary IEC TC 10 (International Electrotechnical Commission) Geneva-CH
- IEC AWARD 1906 – 2009
- ACS Member (American Chemical Society)
- IEEE Member (International Electrical Engineering)
- Expert PEN - UNEP (POPs-PCBs Elimination Network - United Nations Environment Programme) Geneva – CH

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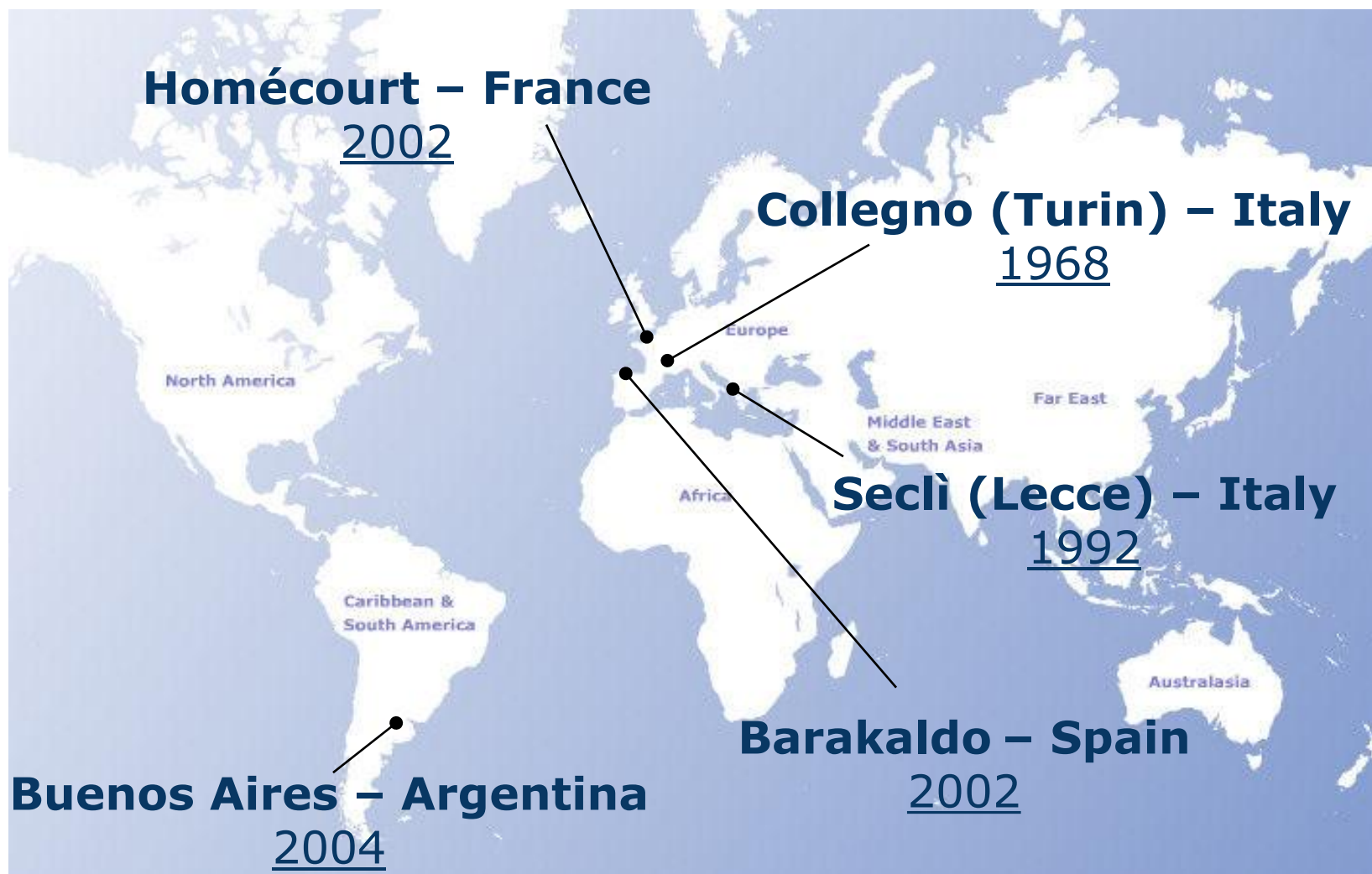
1. Sea Marconi Introduction
2. TransfoClean 4.0
3. Fluid Carrier Approach
4. Criticality: PCBs/POPs
5. Solution: Smart DMUs + PCBs Dehalogenation (CDP Process®)
6. Case Histories
7. Worldwide on-site services
8. Conclusions

Key information

- **Foundation:** 1968, by Vander Tumiatti in Turin Italy
- **Mission:** Protection of company assets and environmental resources
- **Activities:** Research, Technologies, Services and Products for Energy & Environment
- **Clients:** > 3,000 users in the energy, industry and service sectors in Europe, South America and others countries
- **Human resources:** 100 employees, engineer, doctors (chemistry, mechanics, economics, ICT, etc.) and qualified technicians
- **Diagnostics:** lab Accreditation, EN ISO 17025, Databases, hi-tech instruments
- **Decontamination:** on site Mobile Units (DMU) different sizes
- **Quality:** ISO 9001, Globe (Sea Marconi Technologies)
- **Patents:** EEC, USA, others countries patented processes
- **R & D:** Qualified by Italian Ministry of University and Scientific Research
- **European Project:** HALOCLEAN APPLICATION; contract number - G1RD-CT-2002-03014 (Principal Main Contractor)
- **Experts:** members in WGs (IEC, CEN, CIGRE)



Where we are



Main locations

Headquarter:
Collegno (Turin,
Italy)



Homécourt (Lorena Region, **France**)

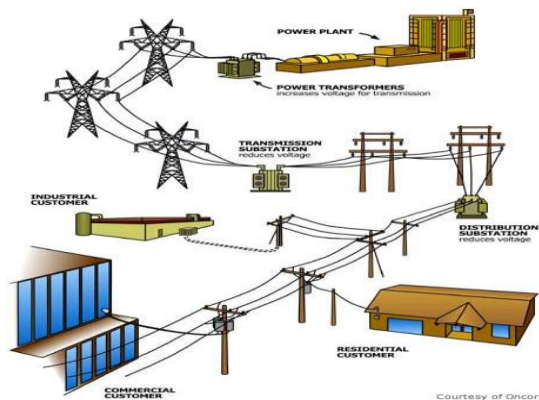


Technical Capabilities

Power transformers treated per year (2015)	562
PCBs Dehalogenation (CDP Process)	67
Depolarisation and Reclaim (Chedcos)	135
Reconditioning (Chedcos)	360
Oil mass treated per year (2015)	4365 ton
PCBs Dehalogenation (CDP Process)	661 ton
Depolarisation and Reclaim (Chedcos)	1687 ton
Reconditioning (Chedcos)	2015 ton
Number of Decontaminat. Modular Unit (DMU)	25
Oil samples analysed per Year (2015)	14.821
Oil Test performed per Year (2015)	88.468
Transformers and equipment database	> 75.000
Diagnostics database	> 200.000

Scenario and applications

Energy & Environment



Transformer = Strategic Asset



Insulating Oils Management



...other Insulating Fluids, such as natural esters, synthetic esters, silicon liquids, Askarels - PCBs based, SF6

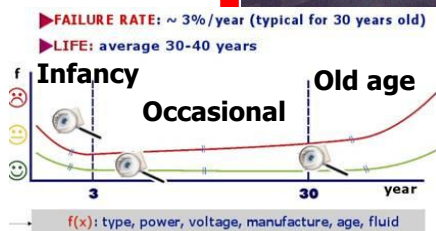
Oil & Transformer Management



Insulating Oil represents about:
5% value of transformer and
25% weight of transformer

Knowledge Value From Case Histories

Failure $\Rightarrow$ Explosion $\Rightarrow$ Fire



Black-Out Risk

Losses

- Direct: Assets & Persons
- Indirect: Loss Production
- Environment: Soil, Water, Air (contamination by Oil, PCBs/POPs, PCA, etc.)



Knowledge Value from Accidents



Russia, 2009

GSU Transformer Explosion at RusHydro power plant (6500 MW)

(72 dead)...



Turkey, 2014

Transformer Explosion in a coal mine

(301 dead)...



Europe, 2011

GSU Transformer Explosion in a power plant

No victims...

Standards and Guidelines



Resilience: innovative approach for high temperature Natural Ester fluids

ARWtr
2016
La Toja Island

2. High-Temperature Standards

9

Richard P. Marek

High-Temperature Transformers:
History, Standards and Applications

High-Temperature Liquids

- Natural esters are proliferating
 - Now produced from many different seeds
 - Esters are used at high-temperature more frequently
 - Ratings based on manufacturer's recommendations and application experience
 - No standards available to determine thermal class of a liquid
- Proposal to begin CIGRE study group
- Standard is needed


Nomex.

The 5th International Advanced Research Workshop on transformers, (2)3-5 October 2016

La Toja Island, Spain

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From the presentation of Richard P. Marek

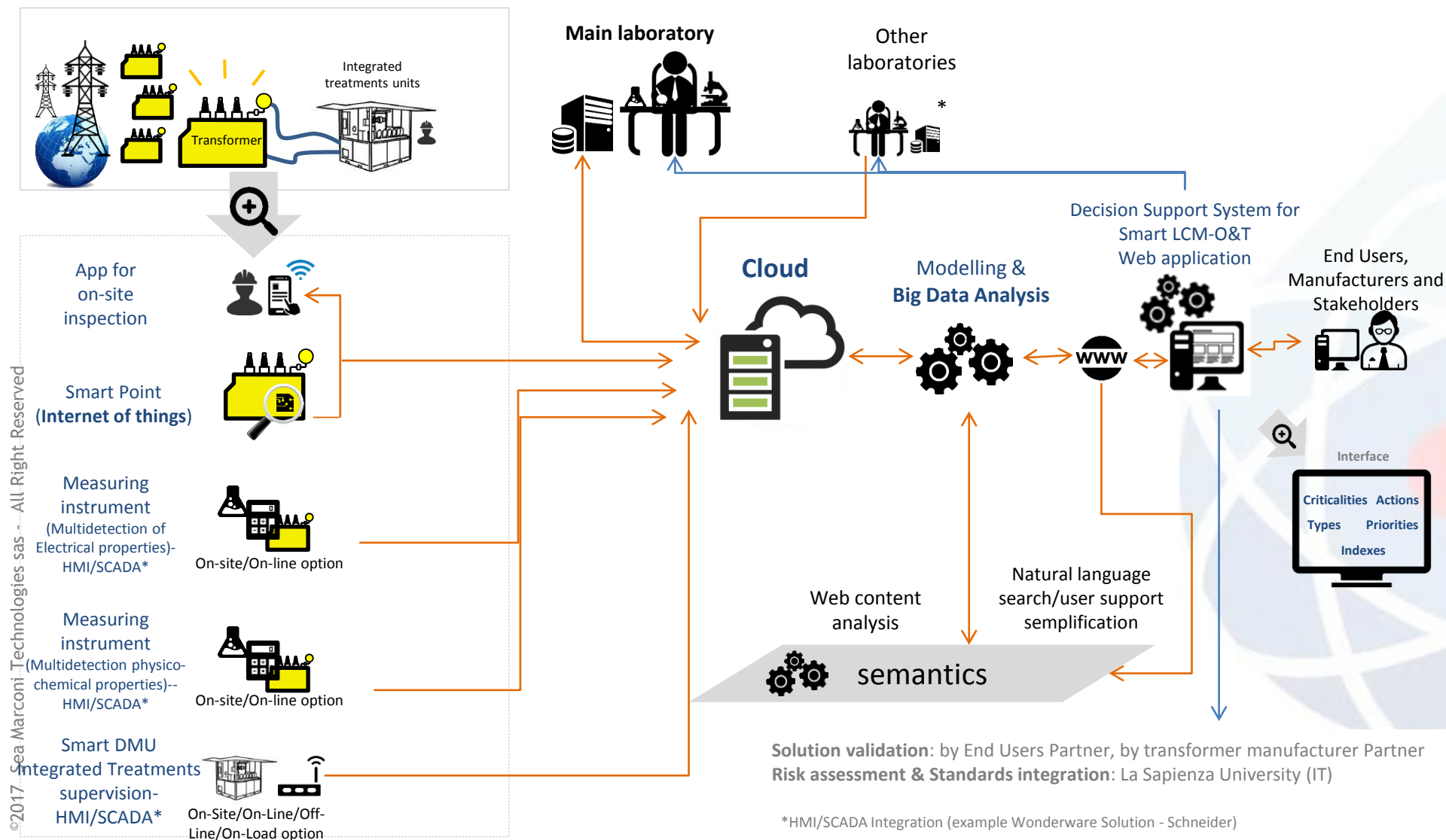
TransfoClean® 4.0



TRANSFOCLEAN®
LOSS PREVENTION & ENVIRONMENTAL PROTECTION

A. CLEAN from Defects
B. CLEAN for Environment
C. CLEAN for People

Integrated approach

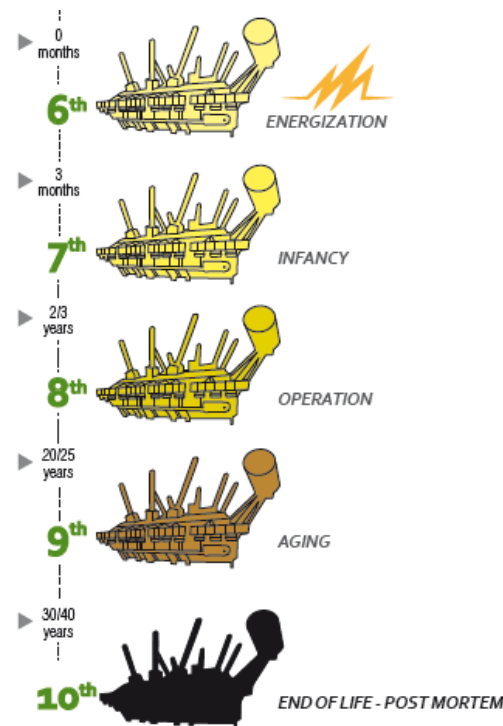
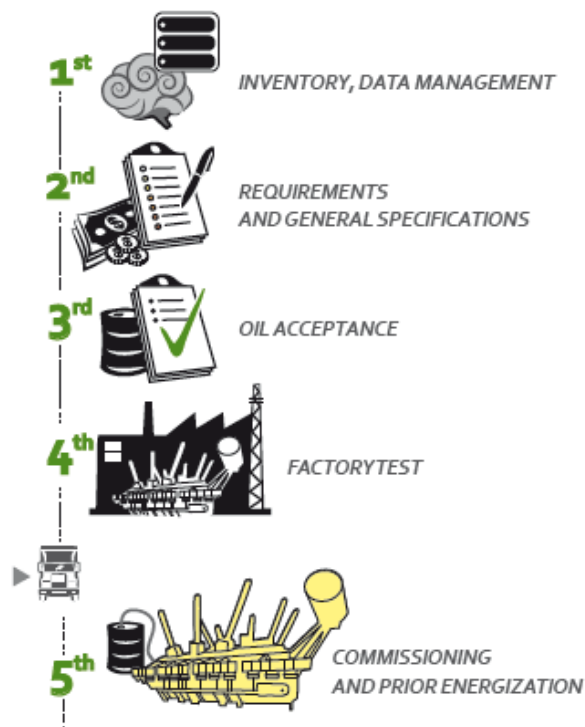


Sustainable Solutions

based on the following Open Innovation Points

- I. Scientific:** publications and patents
- II. Technologies:** BAT – Best Available Techniques
- III. Economics:** fast ROI – Return of Investments
- IV. Environmental:** BEP – Best Environmental Practices
- V. Social:** Green Jobs creations
- VI. State of the Art:** in advance to the Technical Standards
- VII. International Standards:** IEC, CENELEC
- VIII. Independence** from manufacturers and producers
- IX. Experience** and case histories from 1968 – robust database
- X. Global** Vision and **local** partnership network

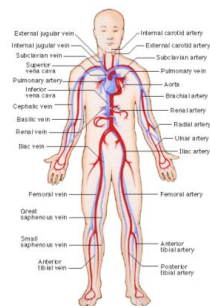
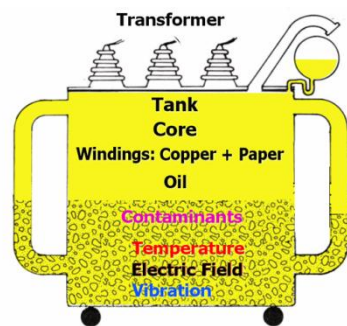
10 Steps for Smart LCM (Life Cycle Management) of Oil & Transformers



Applied to different Transformers and Insulating Fluids: Mineral insulating oil, Natural esters, Synthetic esters, Silicon liquids, Askarels - PCBs based, SF6, Others...

ElectroChemistry vs BioChemistry

“Oil Carriers” equivalent to “Human Blood”



Oil & Transformer

Oil sampling vs Blood sampling



Representative samplings of Oils

Oil analysis vs Blood analysis



Diagnostics & Prognostics (Criticalities, Actions, Priorities, Indexes)

Oil Treatments vs Human Blood dialysis



Smart DMU (On-Site, On-Line, On-Load)

Criticalities and Solutions

TransfoClean provide a specific Solution for each Criticality during each Step of the Life Cycle of the Oil and Transformer

Top 10 Criticalities

("diseases") based on over 50 typical criticalities

1. Accident with Explosion and Fire (with possible PCBs and/or SF6 contaminants)
2. Electrical, Thermal and Mechanical failure
3. Electrical, Thermal and Mechanical fault
4. Corrosive Sulfur and Corrosion (C₁, C₂, C₃, C₄)
5. PCBs/POPs & Environment
6. Oil Chemical Degradation
7. Paper Aging
8. Moisture in Paper and Oil
9. Sludge, Solid Deposits (degradation by-products)
10. SF6 in Oil - Seal defects

Top 10 Solutions

based on over 50 Sea Marconi solutions

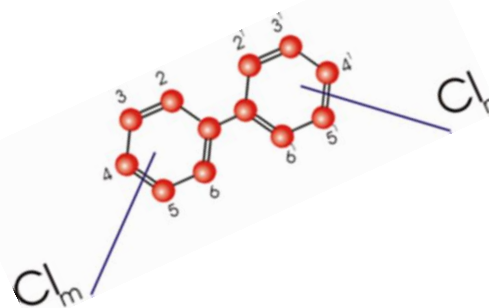
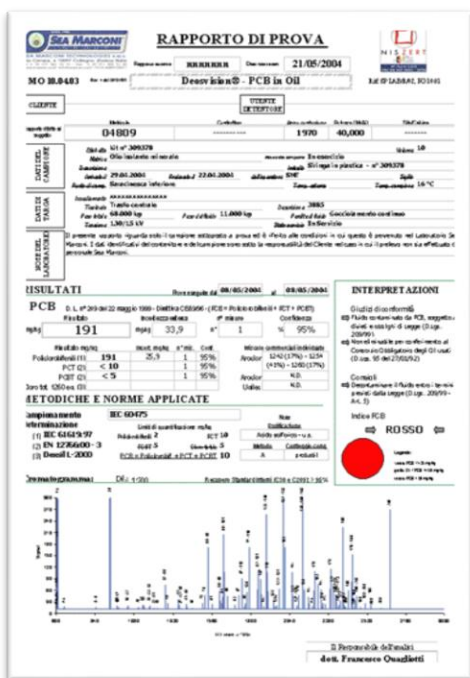
1. Analysis and Diagnosis
2. Focused analysis and supplementary Diagnosis
3. Post failure diagnosis
4. Depolarization of corrosive compounds
5. Dehalogenation of PCBs in oil
6. Depolarization for oil acidity
7. Transformer desludging
8. Transformer and insulating paper dehydration
9. Physical decontamination treatment
10. Transformer oil refilling (oil change)

Criticality: PCBs/POPs

PCBs: Carcinogenic to Humans – Group I

IARC - International Agency for Research on Cancer (April, 10th 2013)

International Agency for Research on Cancer



According to IEC 61619, EN 12766, IEC 60296, IEC 60422, CENELEC 50503

CENELEC CLC/TR 50503 (02/2010)

Scope:

"....toward the Life Cycle Management (LCM) of insulating liquids ... with the following objectives :

- a) Reduction of risks for workers, public health and environment, arising from human error, malfunction, or failures of the equipment that cause fires or spillage of hazardous and Persistent Organic Pollutants (POPs);*
- b) Implementation of the "Best Available Techniques" (BAT) "Best Environmental Practices" (BEP) and methodologies available for safety , whilst taking into account the surroundings and the criteria of self-sufficiency and functional recovery;*
- c) Technical faisability of the activities within the prescribed time schedules, taking into account current legislation and economical feasibility ."*

Problem: PCBs contamination

Solution: PCBs Free Program

Life cycle management (LCM) of oil filled transformer contaminated by PCBs based on: **State of the Art, IEC & CENELEC Standards, Best Available Techniques (BAT) and Best Environmental Practice (BEP)**

- ❖ PCBs Inventory
- ❖ Control of PCBs
- ❖ PCBs Decontamination and/or elimination of equipment and fluid contaminated

PCBs/POPs Free and Environmental protection

BEFORE DECONTAMINATION

AFTER DECONTAMINATION



PCB Destruction

Main Available techniques

Combustion Technology

- Retrofilling: combustion of contaminated oil/equipment – need of replacement

Non-combustion Technologies (Dehalogenation)

After treatment the oil can be reused

- Sodium and Lithium processes
- KPEG process
- CDP Process®

Sodium, Litium and derivates

(Ref IEC 60422, Ed. 4 2013, 11.4.2)

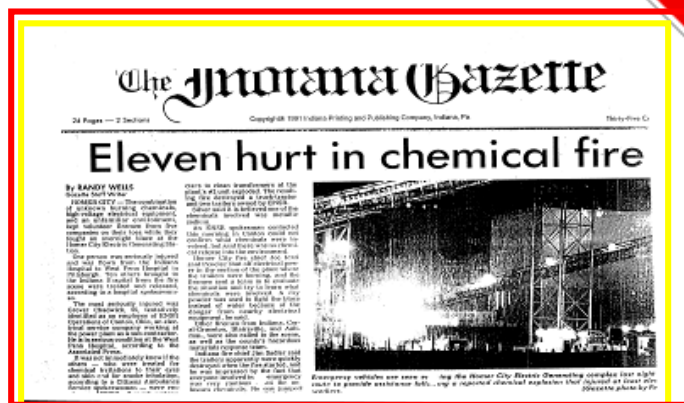
- Alkaline metals sodium, lithium and derivates
- Oil Temperature > flash point (150-300 °C)
- Risks of explosion and fire with water and air
- Non continuous process



NON CONFORMITY



EC Directive 96/61/CE



Polyethylene-glycole and hydroxide of potassium (KPEG) (Ref. IEC 60422, Ed. 4 2013, 11.4.3)

- **Liquid reagent formed by Polyethylene-glycole and hydroxide of alkaline metal (K, Na)**
- **Oil Temperature > flash point (130-150 °C)**
- **Limited efficiency for some PCB congeners (Aroclor 1242)**
- **Non continuous process**



DANGER

DEHALOGENATION (PCB Decontamination)



CDP PROCESS® (Ref. IEC 60422, Ed. 4 2013, 11.4.4)

- Exclusive Technology developed by Sea Marconi
- Use of solid reagent for de-chlorination of PCBs
- Low operational pressures and temperatures ($< 100^{\circ}\text{C}$)
- Defined as Best Available Technique (BAT) by Decree of Italian Ministry of Environment (June 7th, 2007)

Different configurations:

- Closed circuit (continuous mode – mobile units)
- Open circuit (batch mode – stationary plant)
- Mixed configuration

Kits for Smart Field Tests & Smart μ Lab

**Kit for
Total Chlorine/PCB**



SM-TCPs

**Kit for
Total Corrosive Sulfur**



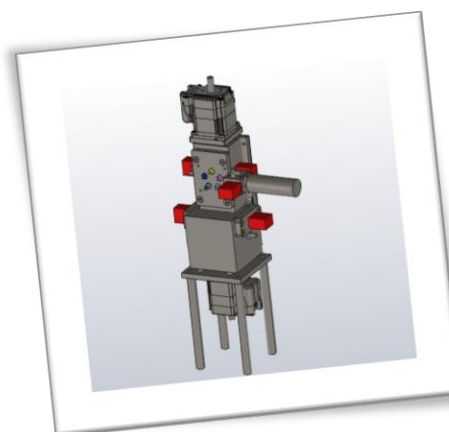
SM-TCS

**Kit for
Total Acid Number**



SM-TAN

**Smart μ Lab for
Sampling and MultiDetection
of DGA, SF₆, Particles, Moisture,
and ...**



Sea Marconi production line for DMU (Decontamination Modular Unit)



Smart DMU BETA for Integrated Treatments



- Onsite
- Closeloop
- Onload
- H24
- SCADA
- Remote control
- Safety devices
- Smart sensors
- ...

**1 Smart DMU
=
3 Sustainable Solutions**



**A. Decontamination
B. Depolarisation
C. Dehalogenation**

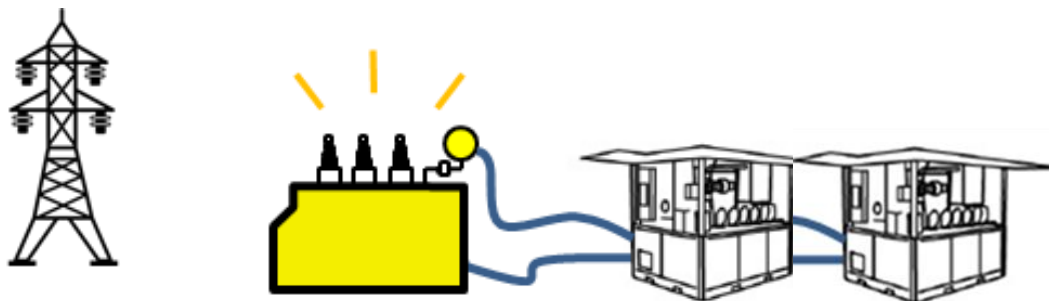
New Cartridges and Reagents for Integrated Treatments of insulating liquids



1 Smart DMU = 3 Sustainable Solutions

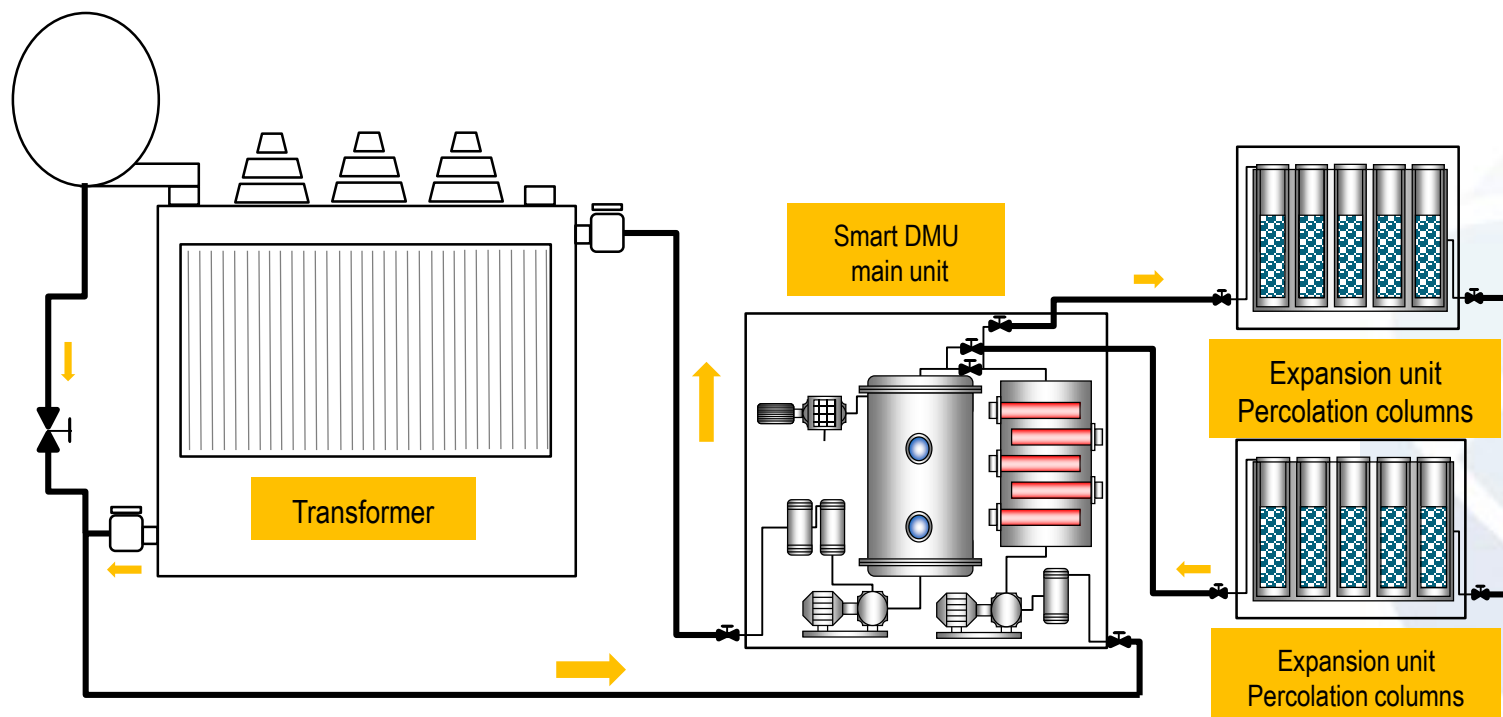
Main function	Decontamination	Depolarisation	Dehalogenation
Recovery of dielectric properties (gas, water, particles)	✓	✓	✓
Recovery of the chemical properties of the oil (acidity, delta tg, colour)		✓	✓
Elimination of sulfur corrosive contaminants, DBDS		✓	✓
Elimination of dissolved organo-metallic contaminants		✓	✓
Dehalogenation/Detoxification of PCBs/PCTs/PCBTs, POPs compounds etc.			✓

«Smart DMU» means (1)



- Modular plant for insulating liquid integrated treatment contained in electrical equipment
- BAT/BEP – Stockholm Convention
- One solution for many criticalities - unique worldwide technology able to carry out through the same unit 5 types of oil treatment processes
- Modular configuration allows flexibility

Hydraulic connection (DMU – transformer) and closed-loop oil circulation



Smart DMU – reagent and the columns heart of technology

The oil flows through the column filled with special solid reagent (patented by Sea Marconi). The patented reagent is composed by a suitable mixture of inert aluminosilicate support and active chemical reagents.

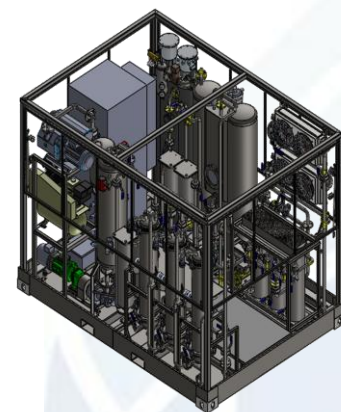


The patented reagent decontaminates the oil with PCBs (and other chemical physical contaminants) converting the PCBs into biphenyl and an inert and harmless inorganic salt.

Smart DMU 2000L/35K-6 (BETA)

Smart DMU 2500L/50K-4C (ALFA)

Total Flowrate [l/h]	2.000	2.500
Heating Capacity [kW]	35	50
Vacuum capacity [m3/h]	105	160
Overall dimension [mm] LxWxH	2.900 x 2.100 x 2.200	
Columns [n°]	3+3	2+2
Empty weight [kg]	2.460	2.600

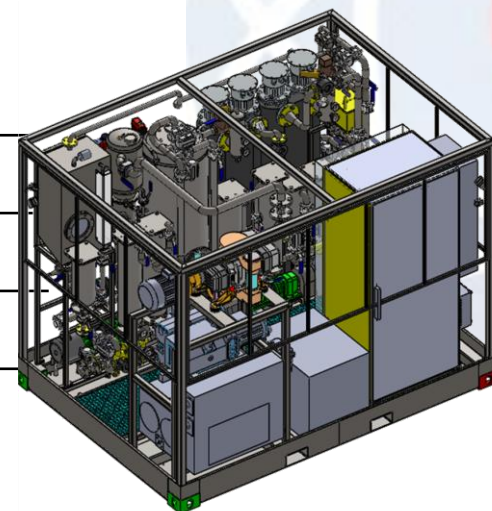


Smart DMU - main unit

Model	Smart DMU 6000L/100K GAMMA	Smart DMU 2500L/50K TETA
Total Flowrate [l/h]	6.000	2.500
Heating Capacity [kW]	100	50
Vacuum capacity [m3/h]	160+730	205
Overall dimension [mm] LxWxH	2.900 x 2.100 x 2.200	
Empty weight [kg]	2.850	2.640

Function

☒	Oil circulation	☒	Mechanical oil filtration
☒	Oil heating	☒	Degassing and vacuum dehydration
☐	Dehalogenation	☐	Selective depolarization
☐	Oil reclamation	☒	Oil reconditioning

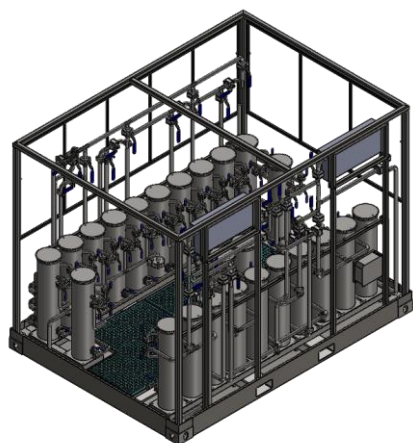


Smart DMU - expansion module

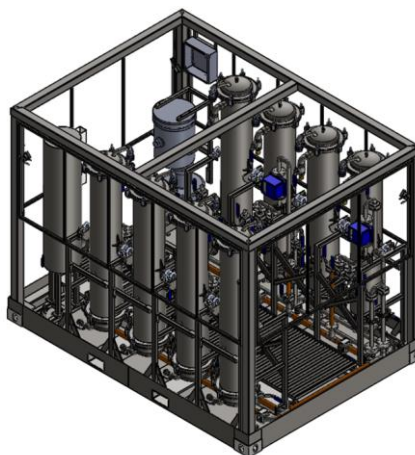
Function

■	Oil circulation	■	Mechanical oil filtration
■	Oil heating	■	Degassing and vacuum dehydration
■	Dehalogenation	■	Selective depolarization
■	Oil reclamation	■	Oil reconditioning

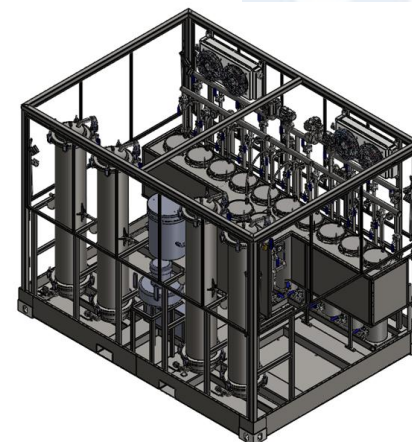
Smart DMU E24c
(standard columns)



Smart DMU E8C
(extended columns)



Smart DMU E12C&4C
(hybrid configuration)
(standard & extended columns)

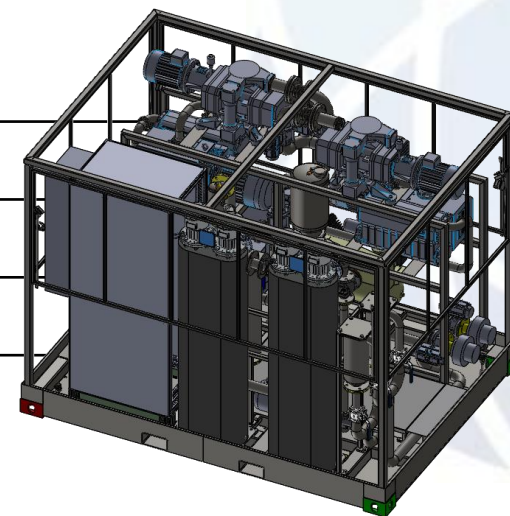


Smart DMU HV 100K/2000V

Total Flowrate [l/h]	10.000
Heating Capacity [kW]	100
Vacuum capacity [m3/h]	2x (300+1000)
Overall dimension [mm] LxWxH	2.900 x 2.100 x 2.200
Empty weight [kg]	3.050

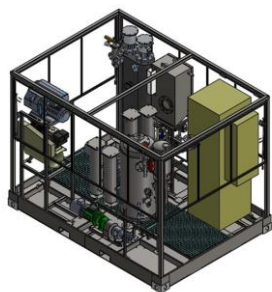
Function

☒	Oil circulation	☐	Mechanical oil filtration
☒	Oil heating	☒	Vacuum drying
☐	Dehalogenation	☐	Selective depolarization
☐	Oil reclamation	☐	Oil reconditioning



MODULARITY: easy configuration and integration for different process

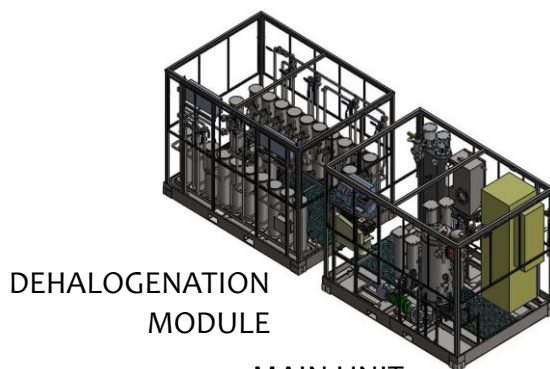
for Reconditioning
Treatment Process



MAIN UNIT



for Chemical
Treatment Process

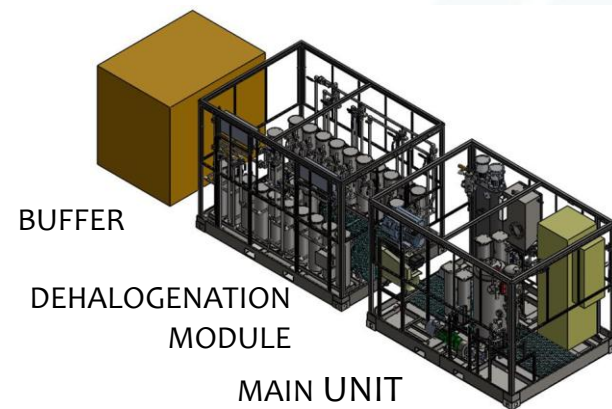


DEHALOGENATION
MODULE

MAIN UNIT



for Chemical
Treatment Process
on energized transfo



BUFFER

DEHALOGENATION
MODULE

MAIN UNIT



Easy Logistics

- Compact size of modules
- Easy to handle
- Suitable for transport in ISO 20ft or 40ft container

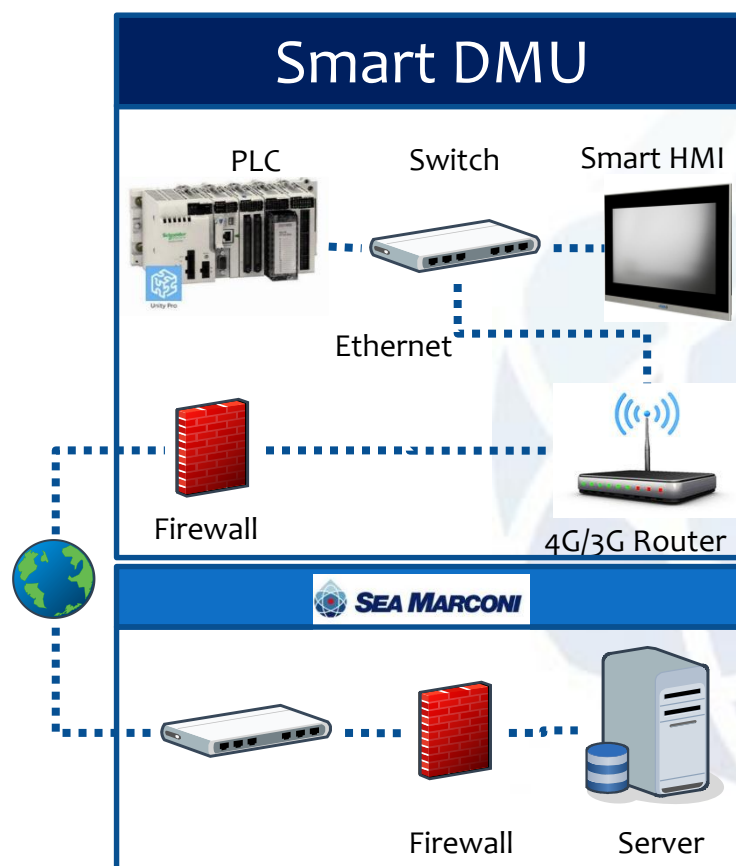


SAFETY & CONTROL

ADVANCED CONTROL SYSTEM

Smart DMU Control Data Acquisition and Transmission

- Situational awareness interface
- High performance data storage
- FTP file transfer to remote storage server
- Hot-swap translations
- Live troubleshooting
- Remote assistance and «over-the-air» upgrades
- Embedded 4G Dual SIM Cellular connectivity



Continuous Closed-Loop Dehalogenation Process

Italian Ministry of the Environment, the Territory and the Seas

Decree 29/01/2007 - Published on the Official Gazette n.133:



Guidelines for the identification and utilization of the **Best Available Techniques on Treatment of PCBs**, apparatuses and wastes containing PCBs and stocking systems

Table E3 - Decisional matrix for the various available techniques

METHODS	Functional Safety	Environmental safety	Operator Safety	Eco-balance and Emissions	Global Cost/Benefit Ratio
Retrofilling	***	**	***	*	**
Sodium, Lithium and Derivates	*	*	*	**	*
KPEG	**	***	***	**	**
Continuous Closed-Loop Dehalogenation (CDP Process®)	***	***	***	****	****

**** = OPTIMUM; *** = GOOD; ** = AVERAGE; * = CRITICAL

Dehalogenation of PCBs and Environmental protection



Patent:

EEC 0675 748

USA 5.663.479

The closed-loop,
continuous-mode,
risk-free
decontamination of
PCBs

The exclusive and **safe** technology for the Dehalogenation/Detoxification of PCBs in insulating oils with the **functional recovery** and **"PCBs-FREE"** re-classification of transformers

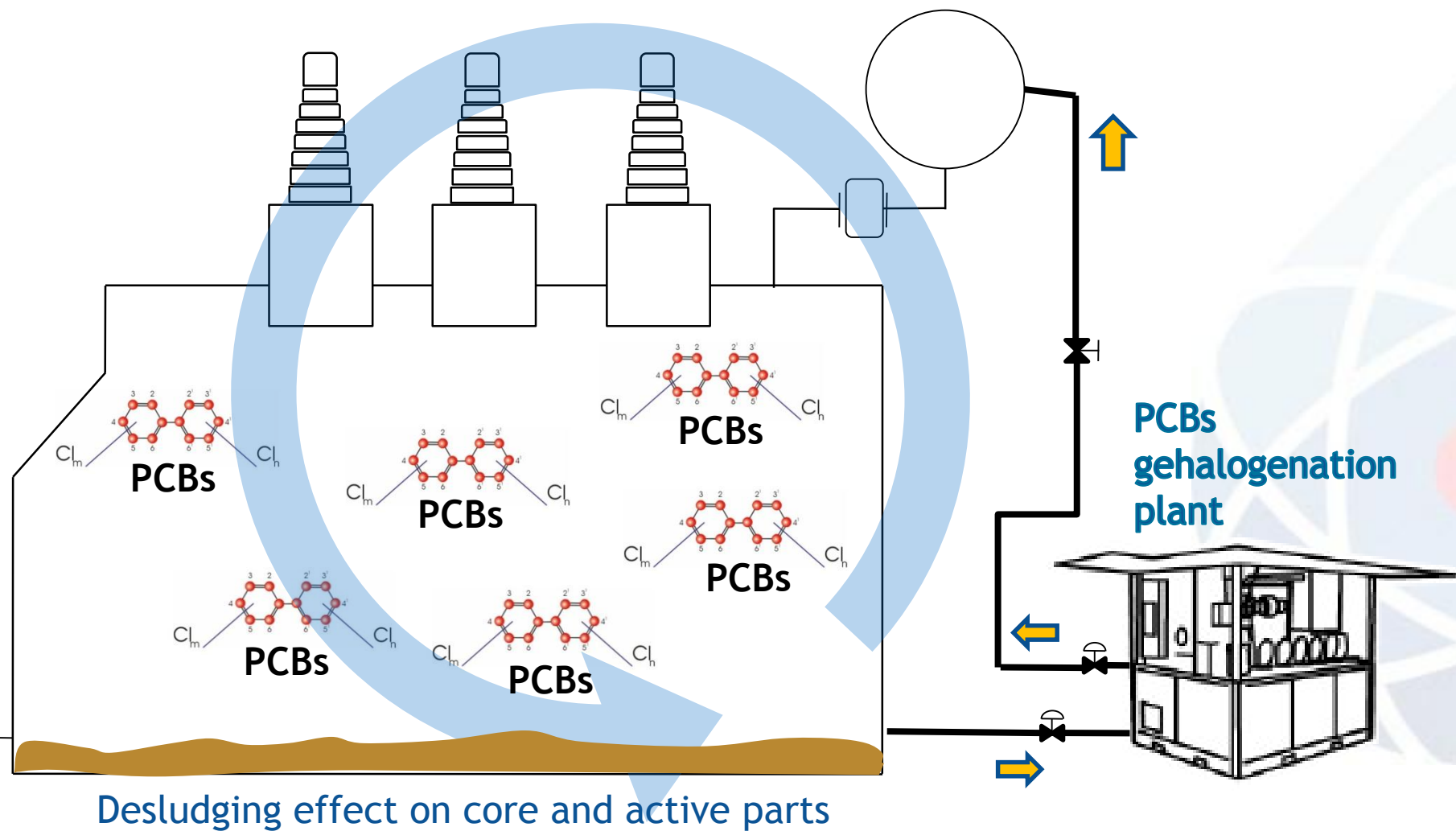
PCBs dehalogenation with Modular Unit (DMU)

The oil flows through the column filled with special **solid reagent** (patented by Sea Marconi). The patented reagent is composed by a suitable mixture of inert alumino-silicate support and active chemical reagents.



The patented reagent decontaminates the oil with PCBs (and other chemical physical contaminants) converting the PCBs into biphenyl and an inert and harmless inorganic salt.

Schema of PCBs dehalogenation treatment



Features of the dehalogenation process

(CENELC TR 50503 8.4.2.3; IEC 60422 Ed 3 12.4.4; Cigre Brochure no. 413 10.1.4)

- Exclusive Technology developed by Sea Marconi
- Use of solid reagent for de-chlorination of PCBs
- Low operational pressures and temperatures ($< 80 - 100^{\circ}\text{C}$)

PCBs dehalogenation + oil regeneration simultaneously = recovery of oil properties and extension of transformer life-time



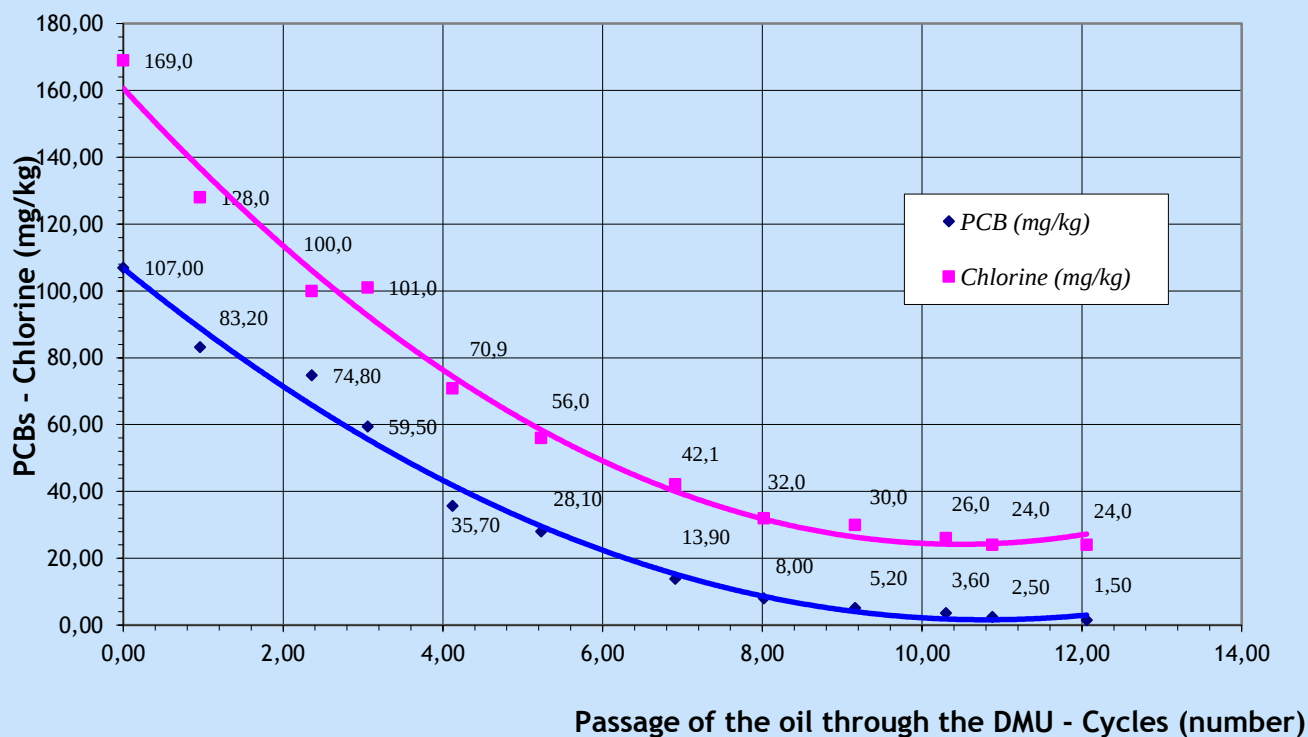
- **NO "Oil replacement technology"**
- **NO PCB Waste**
- **ON-SITE** Process: No need for transportation of "big" transformers
- PCB-decontamination of oil in continuous, closed loop (without draining the transformers)
- Performed with **DMU** (Mobile Decontamination Units) – safety and high automated

Dehalogenation & Detoxification of PCBs

Continuous Dehalogenation Process (CDP PROCESS®)

AUTOTRANSFORMER 250 MVA 400 KV

Curve of PCBs / Chlorine concentration as a function of the passage of the oil through the DMU (cycles)



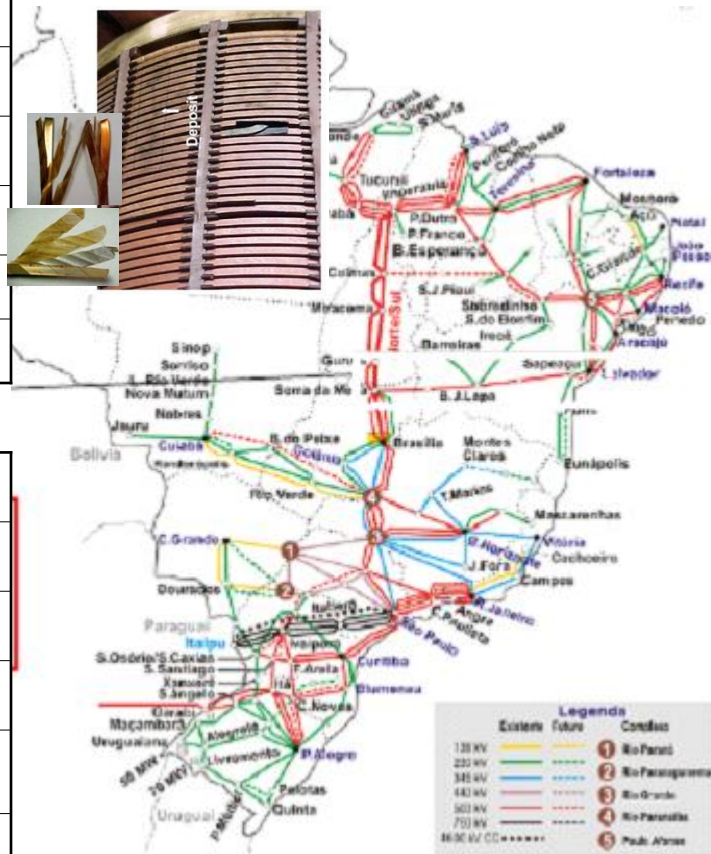
1st CASE HISTORY:

«C1 - DBDS & Corrosive Sulfur» BRAZIL 2005

Transmission system: 76 Equipment

TSN	
Lines	1181 km
Substations	6
Total reactors	40
Reactors with corrosive sulfur	37 (92,5%)
Total failed reactors	15 (37,5%)

Novatrans	
Lines	1278 km
Substations	6
Total reactors	36
Reactors with corrosive sulfur	13 (36,11%)
Total failed reactors	-

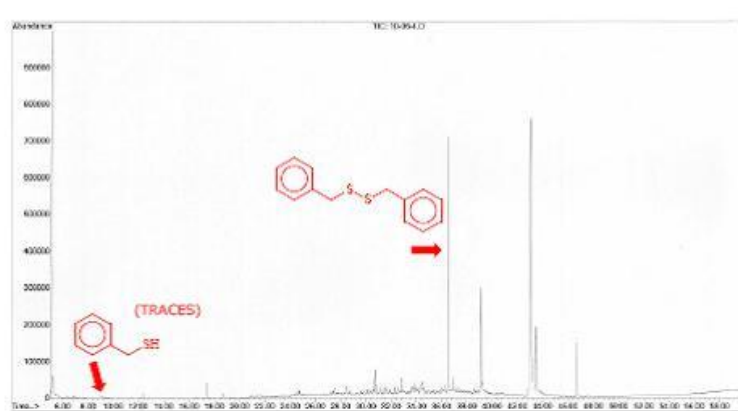


1st CASE HISTORY:

«C1 - DBDS & Corrosive Sulfur» BRAZIL 2005

Transmission system: 76 Equipment

DBDS identification by Sea Marconi lab (GC-MS) - July 2005



DBDS (DiBenzylDiSulfide) in Oil “Sulfur compound, **very corrosive** to metal surface (i.e. steel, copper and silver) **at normal operating temperatures**”

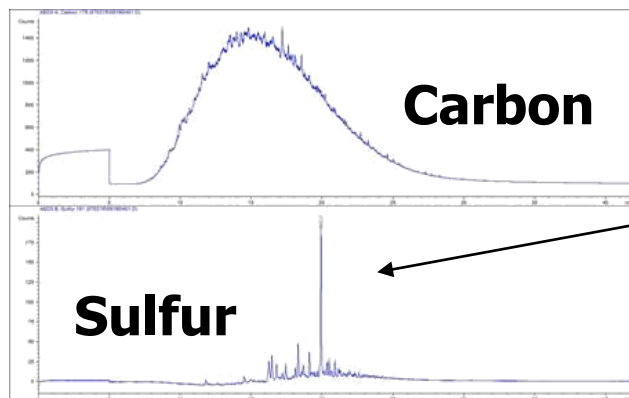
1st CASE HISTORY:

«C1 - DBDS & Corrosive Sulfur» BRAZIL 2006

Transmission system: 76 Equipment

DBDS confirmation by Sea Marconi Lab (GC-AED)

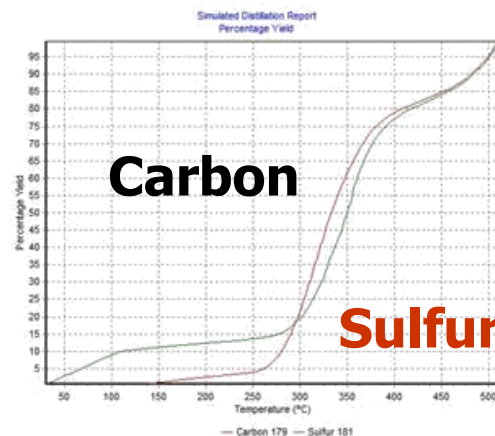
SM-IFED Results: "Naphthenic Base Oil with DBDS" - NYNAS NYTRO 10 GBN



**IFED with GC-AED
fingerprint**

DBDS

Distillation profile



Percentage Yield Table		
	Carbon 179 Temp. (Deg. C)	Sulfur 181 Temp. (Deg. C)
ISP: 0.5%	136.00	30.00
5.00%	241.00	68.00
10.00%	289.00	109.00
15.00%	290.00	278.00
20.00%	298.00	301.00
25.00%	304.00	314.00
30.00%	310.00	323.00
35.00%	314.00	329.00
40.00%	321.00	336.00
45.00%	327.00	344.00
50.00%	333.00	350.00
55.00%	340.00	356.00
60.00%	348.00	360.00
65.00%	357.00	368.00
70.00%	366.00	377.00
75.00%	381.00	391.00
80.00%	408.00	418.00
85.00%	452.00	458.00
90.00%	481.00	494.00
95.00%	499.00	501.00
ISP: 99.5%	509.00	512.00
Total Carbon 179: 8240.100 %		
Total Sulfur 181: (no 2F)		

1st CASE HISTORY:

«C1 - DBDS & Corrosive Sulfur» BRAZIL 2009

➔ Solutions: DMU & Selective Depolarisation on-load/off-load

Before depolarisation

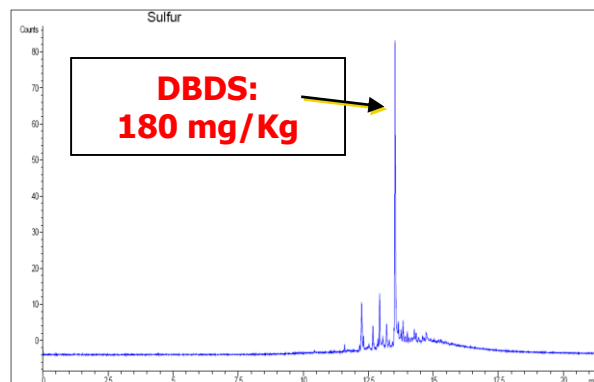


ASMT Scale: 4c

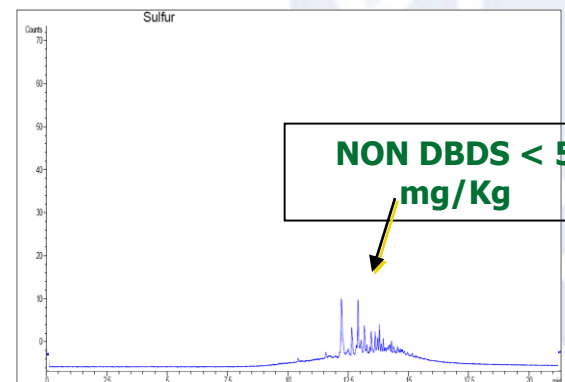
After depolarisation



ASMT Scale: 1a



DMU



Successfully implemented on all fleet of Transformer and Reactors

2nd CASE HISTORY:

PCBs + «C1 - DBDS & Corrosive Sulfur» SWEDEN 2012

Primary aluminium factory: 8 Rectifier Transformers

➔ **Solutions: DMU & PCBs Dehalogenation + Selective Depolarisation On Load**

Manuf.: Brown Boveri

Year: 1930

Power [MVA]: 19

Voltage [KV]: 13

Oil Mass [Kg]: 15,000

Oil type: mineral blended



	PCBs [mg/Kg]	DBDS	IFT [mN/m]	CCD test	TAN [mg KOH/g]	DF
Before treatment	29	18	24	corrosive	0,34	0,230
After treatment	0,37	< 5	42	non corrosive	0,01	0,002

GUARANTEE: PCBs < 2 mg/Kg

3rd CASE HISTORY:

PCB + «C2 - NON DBDS & Corrosive Sulfur» FRANCE 2012

Hydro Power Plant: 3 GSU Transformers

➔ **Solutions: DMU & PCBs Dehalogenation + Selective Depolarisation On Load**

Manuf.: Alsthom

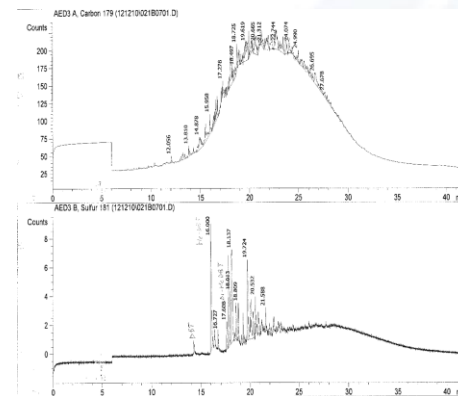
Year: 1965

Power [MVA]: 80

Voltage [KV]: 220

Oil Mass [Kg]: 35,000

Oil type: naphtenic blended Oil



	PCBs [mg/Kg]	TCS DBDS Eq. [mg/Kg]	CCD	DBTP [mg/Kg]	TAN [mgKOH/g]	DF
Before treatment	96	64	Corrosive	16	0.194	0.13737
After treatment	26	<10	Non corrosive	14	0.01	0.05144

4th CASE HISTORY:

PCBs + «C2 - NON DBDS & Corrosive Sulfur» FRANCE 2013



Solutions: DMU & PCBs Dehalogenation + Selective Depolarisation On Load

Type: Grid Transformer

Manuf.: Alsthom

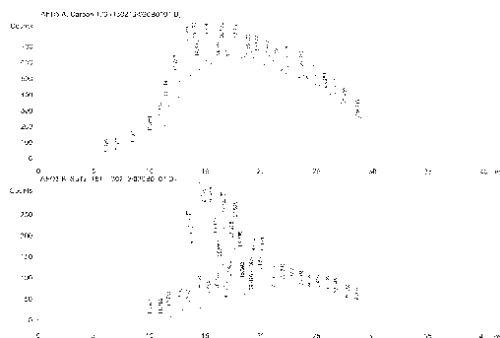
Year: 1957

Power [MVA]: 50

Voltage [KV]: 225

Oil Mass [Kg]: 38,000

Oil type: blended mineral Oil



	PCBs [mg/Kg]	Total sulfur [mg/Kg]	DBTP [mg/Kg]	TCS DBDS Eq.	CCD	IFT	Color	TAN [mgKOH/g]
Before treatment	81	21,600	380	140	Corrosive	19.5	6.9	0.096
After treatment	20	20,500	280	<10	NON Corrosive	26	3	<0.03

GUARANTEE: PCBs < 40 mg/Kg



Brasilia, February 9-10, 2017

5th CASE HISTORY:

«C4 – NON Sulfur Corrosion & Metal dissolution» ITALY 2003

Hydro power plant

➔ **Solutions: DMU & Selective Depolarisation On Load**

Type: Power Transformer

Manuf.: OTE

Year: 1986

Power [MVA]: 30

Voltage [KV]: 130

Oil Mass [Kg]: 28,000

Oil type: Paraffinic oil Agip ite 360



	Cu [mg/Kg]	TAN [mgKOH/g]	COLOR	DF
Before treatment	43	0.213	3	1.168
After treatment	1.23	0.03	1	0.074

6th CASE HISTORY:

«PCBs + C2 - NON DBDS & Corrosive Sulfur + C4 – NON Sulfur Corrosion & Metal dissolution» France 2013

Hydro Power Plant On –Load Integrated Treatments



Manufactures	Jeumont Schneider
Year	1969
Power	105 MVA
Voltage	225 KV
Oil Mass	29.000 Kg
Total Mass	126.000 Kg
Oil Type	Mineral



OIL PROPERTY (IEC 60422 ed. 4 2013-01)	BEFORE	AFTER
Colour (ASTM D1500-07)	>8	2,7
Breakdown Voltage (kV)	73,1	75
Water content (mg/Kg)	6	2
Acidity (mg KOH/g)	0,294	< 0,01
Dielectric Dissipation Factor at 90°C	1,023	0,09211
TCS - Total Corrosive Sulfur - DBDS equivalent (mg/Kg)	69	8
Interfacial tension (mN/m)	18,8	33,3
Z-FAL (mg/Kg)	0,583	< 0,05
Total PCB content (mg/Kg)	71	25
Copper dissolved (mg/Kg)	64	2
Particles (ISO 4406:1999)	23 / 20 / 14	17 / 15 / 10
Note: PCBs Garantie < 50 mg/Kg		

7th CASE HISTORY:

PCBs/POPs Free & Environmental Protection FRANCE 2004-2012

Utility – Power transformer of generation (nuclear, thermal, hydro), transmission and distribution

Total Transformers = **1,093**



Solutions: DMU & PCBs Dehalogenation + Selective Depolarisation On Load/ Off Load

Power max [MVA]: 760

Voltage max [KV]: 400

Oil Mass [Kg]: 75,000 each

PCBs max [mg/Kg] = **5,000**

PCBs target [mg/Kg] = **<20** (after 90 days)



8th CASE HISTORY:

PCBs/POPs Free & Environmental Protection GreenField Project, South Korea 2010



9th CASE HISTORY:

PCBs/POPs Free & Environmental Protection UNIDO Project, Macedonia 2012



10th CASE HISTORY: PCBs/POPs Free & Environmental Protection UNIDO Project, Mongolia 2012

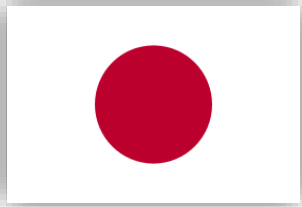


11th CASE HISTORY:

PCBs/POPs Free & Environmental Protection SESA Project, Mexico 2013



Japan 2015



Sea Marconi realized a mobile plant (40 feet containerized) for decontaminate Oil & Transformer with PCBs

EXTRAORDINARY PERFORMANCE: PCBs < 0,5 mg/kg

Sea Marconi has done an enormous **redesign** job coming to define a **new technological concept**: lighter and smaller, schemes fluidic optimized, higher performance, optimizing the use of materials



United Kingdom 2015



Sea Marconi realized a stationary plant for decontaminate (and recycle) Oil with PCBs and corrosive sulfur

Treatment capacity: 4,600 tons of oil per year

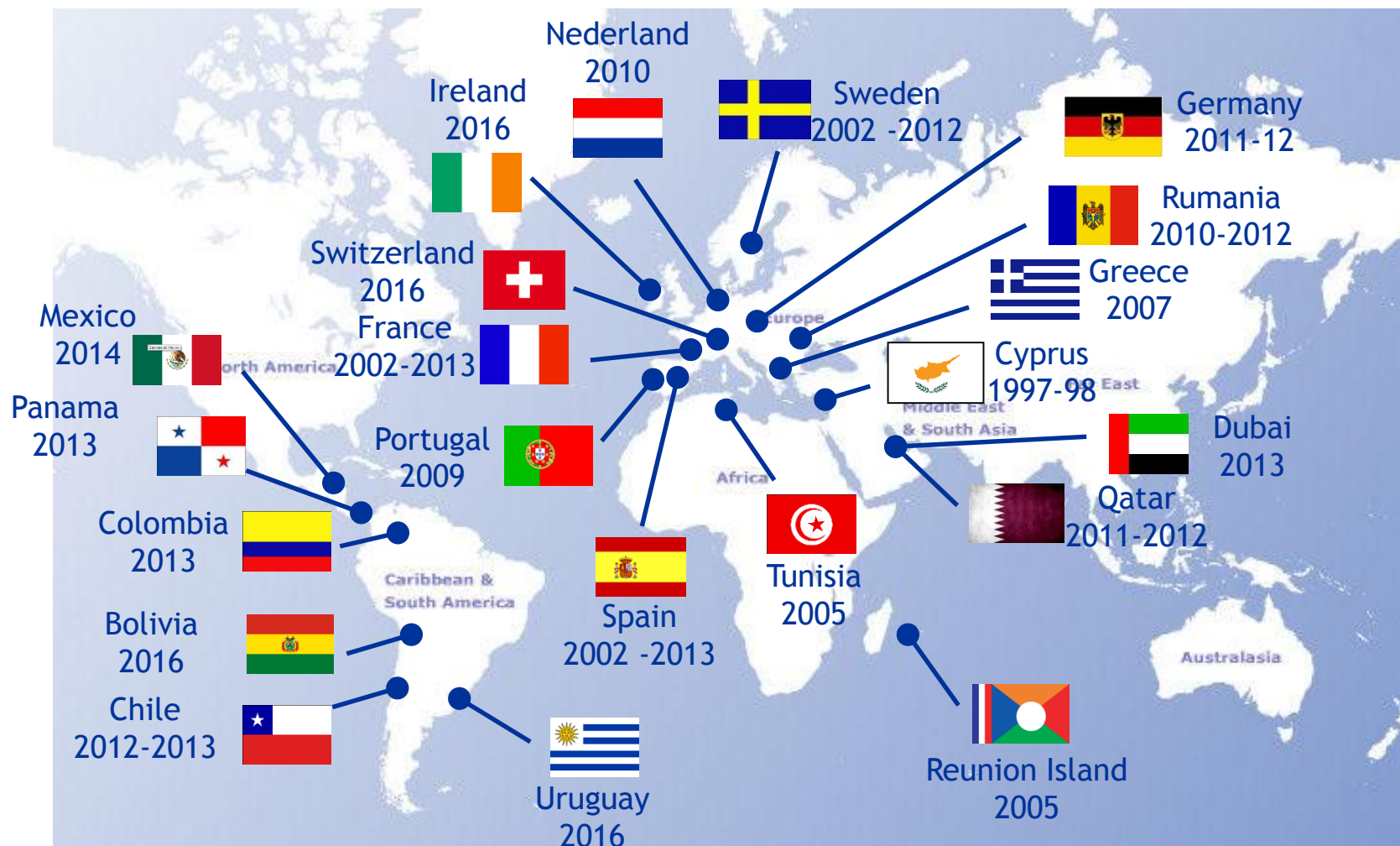
PCBs target [mg/Kg] = **< 2**

DBDS target [mg/Kg] = **< 5**

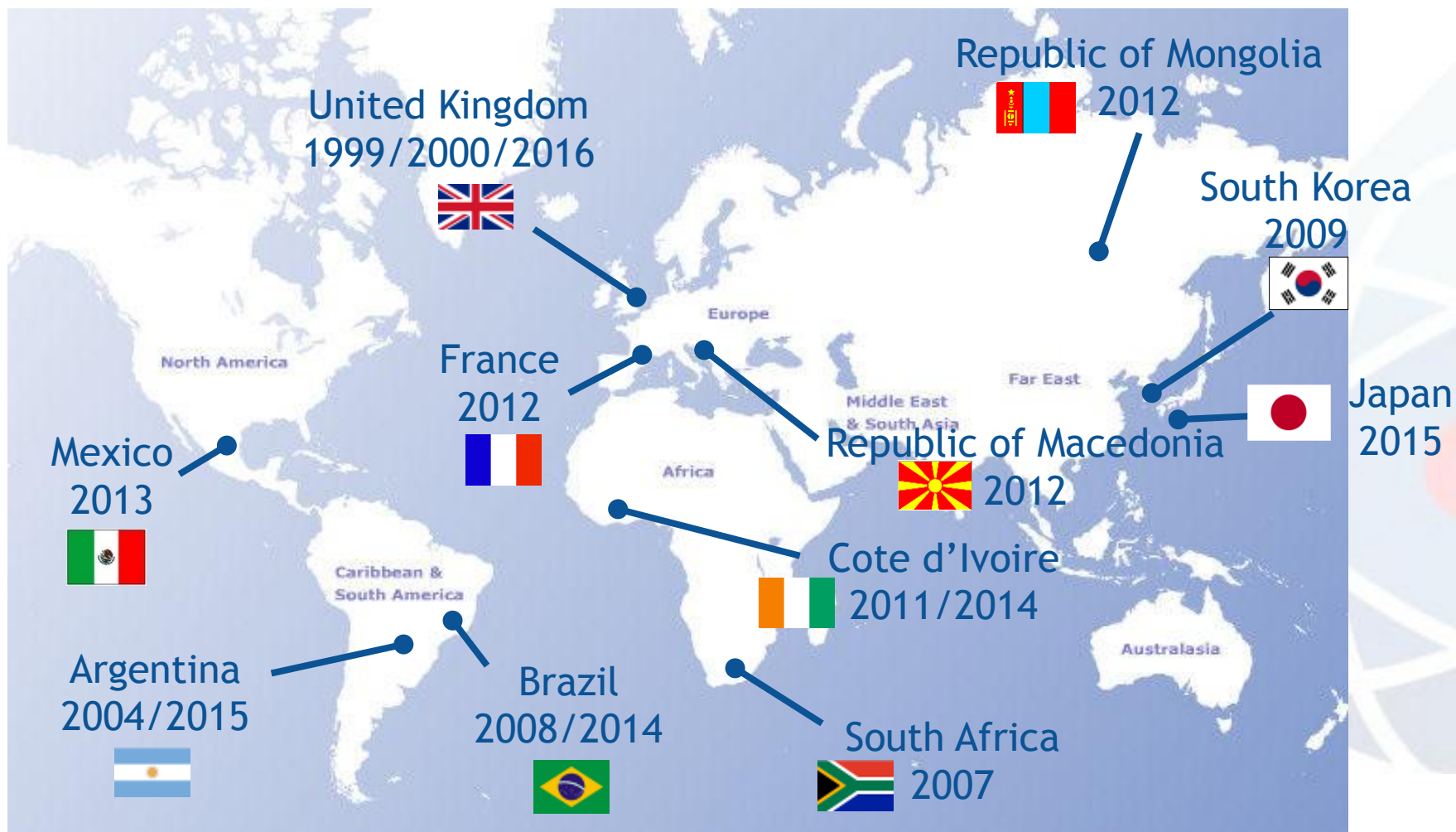
The plant is **easily expandable** to accommodate the treatment capacity of the customer (**15,000 tons/year**)



Worldwide On Site Service



Technology Transfer to Customers/Local partners





Sustainable Solutions for Global Challenges

CONCLUSION

Solutions for Loss prevention LCM O&T Key Factors

- a. State of the Art (2016)
- b. Technical Standards (IEC, CENELEC, etc.) and Guidelines (CIGRE, etc.)
- c. Best Available Techniques (BAT)
- d. Best Environmental Practices (BEP)
- e. Accredited Laboratories (ISO IEC 17025) with uncertainty determination for each Test
- f. Qualified Expertise based on a Robust database and Case Histories

Thank you for your kind attention



Q & A



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