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TRANSLATION (by Giovanni Boasso) OF

Abstract from

**OFFICIAL GAZETTE
of the Republic of Italy
No 133 of 7 June 2007**

**Decree of 29 January 2007 issued by
Ministry of the Environment and the Protection
of the Territory and the Seas**

“Enacting of the guidelines for the identification and utilisation of the best available techniques on the subject of waste management for the activities listed in enclosure I of Legislative Decree of 18 February 2005, no. 59.”

OMISSION

**ENCLOSURE TO ART 1 BEING AN INTEGRAL PART OF THE DECREE
“Guidelines providing the criteria for the identification and utilisation of the best available techniques ref. art 3 paragraph 2 of legislative decree 372/99”**

“Guidelines relative to existing systems for the activities within the IPPC categories”.

5 WASTE MANAGEMENT

**(Treatment of PCBs, apparatuses and wastes containing PCBs
and stocking systems)**

total 15 pages

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N. 133

MINISTERO DELL'AMBIENTE
E DELLA TUTELA DEL TERRITORIO
E DEL MARE

DECRETO 29 gennaio 2007.

Emanazione di linee guida per l'individuazione e l'utilizzazione delle migliori tecniche disponibili in materia di gestione dei rifiuti, per le attività elencate nell'allegato I del decreto legislativo 18 febbraio 2005, n. 59.

DECRETI, DELIBERE E ORDINANZE MINISTERIALI

MINISTERO DELL'AMBIENTE E DELLA TUTELA DEL TERRITORIO E DEL MARE

DECRETO 29 gennaio 2007.

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IL MINISTRO DELL'AMBIENTE E DELLA TUTELA DEL TERRITORIO E DEL MARE

DI CONCERTO CON

IL MINISTRO DELLO SVILUPPO ECONOMICO

E

IL MINISTRO DELLA SALUTE

Visto il decreto legislativo 18 gennaio 2005, n. 59, recante «Attuazione integrale della direttiva 96/61/CE relativa alla prevenzione e riduzione integrate dell'inquinamento» e in particolare l'art. 4, comma 1 che prevede l'emanazione di linee guida per l'individuazione e l'utilizzazione delle migliori tecniche disponibili, nonché che l'autorizzazione integrata ambientale sia rilasciata, tra l'altro, nel rispetto delle linee guida medesime e l'art. 4, comma 2, che prevede che, fino all'istituzione di una nuova commissione integrata secondo le disposizioni dello stesso comma, operi la commissione istituita con decreto del Ministro dell'ambiente e della tutela del territorio del 19 novembre 2002 (pubblicato nella *Gazzetta Ufficiale* della Repubblica italiana n. 302 del 27 dicembre 2002) ai sensi dell'art. 3, comma 2 del decreto legislativo n. 372/1999;

Acquisiti gli elaborati tecnici riportati in allegato al presente decreto, predisposti dalla commissione istituita con decreto del Ministro dell'ambiente e della tutela del territorio del 19 novembre 2002 (pubblicato nella *Gazzetta Ufficiale* della Repubblica italiana n. 302 del 27 dicembre 2002) ai sensi dell'art. 3, comma 2 del decreto legislativo n. 372/1999;

Sentita la Conferenza unificata istituita ai sensi del decreto legislativo 25 agosto 1997, n. 281 nella seduta del 5 ottobre 2006;

Decreta:

Art. 1.

Emanazione delle linee guida per l'individuazione e l'utilizzazione delle migliori tecniche disponibili

Ai sensi dell'art. 4, commi 1 e 2 del decreto legislativo 18 febbraio 2005, n. 59, sono emanate linee guida recanti i criteri specifici per l'individuazione e l'utilizzazione delle migliori tecniche disponibili, per gli impianti esistenti che esercitano le attività rientranti nelle categorie descritte ai seguenti punti dell'allegato I del medesimo decreto:

5.1. Impianti per l'eliminazione o il ricupero di rifiuti pericolosi, della lista di cui all'art. 1, paragrafo 4, della direttiva 91/689/CEE quali definiti negli allegati II A e II B (operazioni R 1, R 5, R 6, R 8 e R 9) della

direttiva 75/442/CEE e nella direttiva 75/439/CEE del Consiglio, del 16 giugno 1975, concernente l'eliminazione degli oli usati, con capacità di oltre 10 tonnellate al giorno;

5.2. Impianti di incenerimento dei rifiuti urbani quali definiti nella direttiva 89/369/CEE del Consiglio, dell'8 giugno 1989, concernente la prevenzione dell'inquinamento atmosferico provocato dai nuovi impianti di incenerimento dei rifiuti urbani, e nella direttiva 89/429/CEE del Consiglio, del 21 giugno 1989, concernente la riduzione dell'inquinamento atmosferico provocato dagli impianti di incenerimento dei rifiuti urbani, con una capacità superiore a 3 tonnellate all'ora;

5.3. Impianti per l'eliminazione dei rifiuti non pericolosi quali definiti nell'allegato II A della direttiva 75/442/CEE ai punti D 8, D 9 con capacità superiore a 50 tonnellate al giorno.

Tali linee guida, che costituiscono parte integrante del presente decreto, sono riportate in allegato.

Per criteri di tipo generale e per la definizione dei sistemi di monitoraggio relativamente alle categorie di attività citate al comma 1, le linee guida riportate in allegato sono da considerarsi unitamente alle linee guida generali e alle linee guida in materia di sistemi di monitoraggio già emanate per le attività rientranti nelle categorie descritte ai punti 1.3, 2.1, 2.2, 2.3, 2.4, 2.5 e 6.1 nell'allegato I del decreto legislativo 4 agosto 1999, n. 372, con decreto del 31 gennaio 2005, pubblicato nel supplemento ordinario n. 107 alla *Gazzetta Ufficiale* 13 giugno 2005.

Art. 2.

Entrata in vigore

1. Il presente decreto entra in vigore il giorno successivo alla pubblicazione nella *Gazzetta Ufficiale* della Repubblica italiana.

Il presente decreto sarà trasmesso agli organi di controllo per la registrazione e pubblicato nella *Gazzetta Ufficiale* della Repubblica italiana.

Roma, 29 gennaio 2007

*Il Ministro dell'ambiente
e della tutela del territorio
e del mare*
PECORARO SCANIO

*Il Ministro
dello sviluppo economico*
BERSANI

Il Ministro della salute
TURCO

Registrato alla Corte dei conti il 30 aprile 2007

Ufficio controllo atti Ministeri delle infrastrutture ed assetto del territorio, registro n. 4, foglio n. 156

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Glossary

Section D.2

- **D.2 Available Technologies for the decontamination and their classification**

D.2.1 Generalities and classification

The general methodological approach to which the decontamination technologies must refer to must comply with the following requisites:

- the reduction of risks for workers, public health and the environment, deriving from troubles or failures of the equipment that could originate fires or spills of hazardous and persistent products;
- the application at “state of the art” of the best safety available techniques and methodologies, privileging criteria of proximity, self-sufficient and functional recovery;
- the technical and economical workability of the activities suggested or imposed by current regulations and legislation, within the prescribed time.

The first classification of the decontamination technologies and processes used for equipment containing insulating liquids contaminated by PCBs relates to the capacity or not for the functional recovery of the insulating liquid and permits the distinction between:

- a **changing the contaminated insulating liquid (refilling or retro-filling)** with non-contaminated liquids, having equivalent or better functional and environmental features and subsequent transportation and disposal of the PCBs;
- b **decontamination by chemical dehalogenation** targeted toward the detoxification of hazardous and persistent compounds and the functional recovery of the insulating liquid and the equipment as well.

An additional classification of the decontamination technologies can be based upon the operational modes of circulation and/or production in the process:

- a **open-cycle processes**, involving the draining of the apparatuses and the handling and transfer of the liquid containing PCBs into other containers for the treatment or the disposal;
- b **closed-cycle processes**, operating without draining the equipment, by a direct connection of the apparatus used for the decontamination to the equipment containing the PCBs;
- c **discontinued processes (batch)**, in which, constant volumes (batches) of liquid containing PCBs are drained from the equipment and subject to a series of non-simultaneous chemical or physical process, but occurring in sequential phases, well distinguished among themselves;
- d **continuous processes by circulation**, where the liquid containing PCBs is subject to a series of simultaneous chemical and physical processes, by the circulation through the decontamination apparatus. This condition does not require the even partial draining of the equipment and/or the use of external tanks with the function of compensation or additional capacities of external insulating liquids.

To prevent possible problems for the cutting-off of services in the electric power sector and in production industries and essential services, it is possible to use some of the above technologies both “*on-site*” and at specialised centres. For this reason, it is also possible to classify the decontamination technologies into three categories:

- a. intervention in a specialised centre (off site) involving the removal and the hauling of the equipment and the insulating liquid container in it;
- b. interventions on site setting the equipment “out of service”;
- c. interventions on site keeping the equipment “in operation”.

The choice of the best technologies and/or operational modes must be done as a function of the characteristics of the equipment and the requirements for a continuous operation. Generally, the techniques capable of operating “on-site” with the equipment in operation (for electrical equipment energised and under load) are privileged. This technique prevents, also, the risks and costs for the removal and transportation of equipment and hazardous liquids, particularly high and unacceptable for high power and large transformers. These techniques provide considerable financial advantages, as well.

Independently from the technology used and the operational modes implemented, the performance of a decontamination intervention must include:

- definition of the requisites of continuity of the operation, operational conditions, risks and safety conditions, competences and times for the implementation;
- preliminary analytical checks and evaluation of the functional degradation of the insulating liquid and the equipment;
- transportation, installation and arrangement of the systems and materials required to perform the intervention;
- decontamination operations according to the techniques and modes selected, performed by authorised companies and qualified personnel specifically trained and instructed;
- final analytical checks and inspections of the results of the intervention, repeated after a congruent period of time from the date of the decontamination;
- re-classification “NO PCB” of the equipment in accordance with the standards and specifications required;
- disposal of the waste produced during the operations of the cycle.

D.2.2 Decontamination technologies

The main technologies currently available for the decontamination of electrical equipment and insulating liquids are those indicated in Standard CEI 10-38.

D.2.2.1 Changing the contaminated insulating liquid (*refilling o retro-filling*)

The refilling technology represents a simple type of solution. Also, it was one of the very first used for the decontamination of equipment containing PCBs, since technologies operating with chemical actions on the contaminants were unavailable.

It is an open type, “confined”, discontinued process, including the following operating phases:

- complete draining of the contaminated insulating liquid and transferring it into appropriate tanks or reservoirs for the handling of hazardous wastes to be forwarded for disposal;
- draining and dripping of the equipment with the scope of removing the largest possible quantity of PCBs contaminated liquid;
- washing of the equipment with solvents (typically chlorinated, example perchlorinated ethylene) or new PCBs free liquid with the purpose of decontaminating porous solid materials;
- full filling of the equipment with new PCBs free insulating liquid, having characteristics complying with the applicable technical standards;
- transportation and preliminary stocking of the PCBs insulating liquid removed from the equipment and all the liquids and solvents resulting from the operations described above in compliance with the national and international (in case of trans-frontier transportation of wastes);
- disposal by incineration of the PCBs insulating liquid removed from the equipment and all the liquids and solvents in appropriate authorised installations.

The effectiveness of this technique in terms of reduction of the concentration of PCBs below the required threshold (typically 0,005% by weight peso) is strongly dependent from the initial concentration of the contaminant.

The draining and washing action, in fact, is not capable of fully removing the contaminated insulating liquid present in the equipment, thus increments of the concentration of PCBs are found through time in the new insulating liquid, due to the release of contaminants by the impregnated porous materials.

Experience demonstrates that, in case of a simple changing of the insulating liquid, the residual concentration of PCBs in the new insulating liquid, measured after 90 days of operation of the equipment after the decontamination phase, is included between 10 and 15 % of the value of the initial concentration (efficiency 85 – 90 %).

Consequently, in case of initial concentrations exceeding 0,05% in weight (500 mg/kg) the concentration of PCBs measured after 90 days from the end of the initial decontamination can result in excess of the required threshold (typically 50 mg/kg) originating the need for a repeated cycle.

Under an eco-balance point of view, the method has an elevated consumption of non-renewable resources (120 – 150 % of oil per washing cycle) and produces an elevated quantity of CO₂ equivalent (transportation and incineration).

D.2.2.2 Processes of chemical type based upon the dehalogenation of PCBs in insulating liquid

The chemical and chemical-physical decontamination process of equipment and insulating liquids contaminated by PCBs have generally the objective of removing the chlorine present in the molecules of biphenyl (PCBs, PCTs) and other halogenated compounds (ex. PCBTs) and their conversion into easier biodegradable and non- dangerous compounds. Thus, such processes provide the detoxification of PCBs and the functional recovery of the insulating liquid itself and the same equipment, that, consequently, can be kept in operation

Here below, the main chemical-physical processes currently available are illustrated.

D.2.2.2.1 Dehalogenation processes with sodium, lithium and derivatives

Several processes use the dehalogenation technique with sodium, lithium and derivatives. Among them we quote:

- the “GoodyearTyre & Company” (USA) process;
- the “Pytlewski” (USA) process;
- a variant of the above said process, developed at industrial level by the company SunOhio (USA) using a liquid mixture of sodium- naphthalene (“PCBX” process);
- the FLUIDEX (South Africa) using fine-grained metallic sodium powders;
- the process based upon metallic sodium developed by BC HYDRO & ONTARIO HYDRO during the first eighties and adopted by ENERVAC CORPORATION (Canada);
- the process developed in 2002 by KIOSHI (Argentina) for application on insulating oils destined mostly to be used as fuel.

In Italy a patent application (MI99A002078 del 06/10/1999) by ECOCALOR Srl (ELMA Srl) and ECOLSIR Srl has been deposited regarding “Apparatuses for the dehalogenation of dielectric and diathermic mineral oils contaminated by organic chlorinated and/or sulfurised compounds and oxidised acid compounds”.

The dehalogenation techniques using sodium, lithium and derivatives are discontinued processes, since they require external tanks with the function of compensation and additional capacities of external insulating liquids. Such processes are applicable with closed or open cycles, using reagents mixable

with the oil, based upon metallic sodium, sodium hydride, lithium hydride and additives for the de-chlorination of PCBs in insulating oils.

The process used in Italy includes the following operational phases:

- draining, total or partial, of the insulating liquid and transfer into a compensation tank with a preliminary de-hydration treatment of the oil containing PCBs;
- heating of the oil to a temperature between 150 and 300 °C;
- reaction of the oil and the alkaline metal hydride (sodium or lithium) for the dehalogenation of the PCBs and de-sulphurisation of the oil using a continuous flow of nitrogen to minimise the risk of explosion and/or fire;
- separation of the reagents and reaction sub products of the oil by decanting and/or centrifugation.

The oil obtained at the end of the above phases is no more suitable for the immediate use in electrical equipment in operation. For this purpose, it must be subject to subsequent purification/regeneration phases:

- filtration and adsorption on earths or activated clay;
- degassing, dehumidification under vacuum and micro-filtration.

The above phases can be applied on the site of installation of the equipment (on-site) by mobile systems or at dedicated fixed system installations.

Normally, the capacity of these systems provides the decontamination of fixed amounts of oil of about 1,500 – 2,000 litres each time, taken from the equipment and subject to the various operations, performed in sequence.

For what the capacity of reduction of the concentration of PCBs to values below the required threshold is concerned, these processes are characterised by an elevated functional efficiency, independently from the value of the starting concentration.

The stability through time of the values obtained, in case of reuse of the oils and equipment decontaminated, is subject to the same limitations and some critical operational factors identified for the refilling, since the decontamination process is performed on the oil drained from the equipment, thus it has a lesser effectiveness for the decontamination of the equipment itself (especially when the initial contamination is particularly high).

Under many perspectives, this operational mode is equivalent to the change of the insulating oil (refilling) with the difference that the oil, instead of being transported and incinerated, is decontaminated in order to reuse it in the equipment.

For what the possibility of recovering the dielectric and chemical properties of the insulating liquid, to allow its reuse, is concerned, these processes require supplementary regeneration and purification treatments of the oils.

In any case, due to the high temperatures and reaction conditions, some chemical-physical characteristics of the oil can be subject to alterations, such that the compliance with the standard

requisites (standard IEC 60222) are jeopardised also due to the volatilisation of the lighter fraction and the de-sulphurisation of the oil, that is due to the removal of the natural oxidation inhibitors (sulfur and aromatic compounds).

Moreover, these treatment processes generate a dispersion in the oil of ionic and polar compounds that can degrade the insulating properties of the internal insulations (insulating papers) generating conditions favourable for the creation of partial discharges with possible negative incidences even such to cause a reduction of the useful life of the equipment.

The extreme processing conditions, in the zone where the pyrolysis and cracking of the oil starts, can favour also the formation of polycyclic aromatics that are classified carcinogenic for humans.

For such specific reasons, these processes are not particularly recommended for implementation on equipment and insulating oils destined to continue in operation after the decontamination, in particular on strategic equipment and sensitive sites.

The priority critical factor of this technique is the elevated risk of explosion and/or fire due to the use of sodium lithium and derivatives having a very high reactivity with moisture and other oxidised compounds present in oils in operations (alcohols, acids CO₂ etc.).

Particularly critical are also the phases of stocking, handling, transportation and use of sodium, lithium and derivatives. It is necessary to ensure a temperature of 15-25 °C under all operational conditions, as well as complying with the Public Security regulations on the matter (Royal Decree 18/6/1931, N. 773) for products that, under operational circumstances, could become “explosive”.

In relation with the specific risks of explosion/fire, it is indispensable to implement the measures necessary to minimise risks in compliance with the requisites of Legislative Decree 12 June 2003 title VIII bis, integrating Legislative Decree 626/94 to prevent the formation of explosive atmospheres such to endanger the health and safety of workers or inducing “critical incidences and/or unreasonable risks” with reference to standard CEI 10-38.

An additional critical factor is linked with the use of the method on small sized transformers where it is necessary to drain completely the equipment without the possibility of optimising the decontamination process of liquid and equipment.

D.2.2.2.2 Dehalogenation process with polyethylene glycol and potassium hydroxide (KPEG)

These processes (Patents USA N.4.353.793 of 12/10/1982, N.4.410.422 of 18/10/1983, N.4.352.718 of 28/09/1982 General Electric Company – Brunelle D.J; N.4.781.826 of 01/11/1988 General Electric Company – Mendiratta) developed but superseded by troubles linked with the use of metallic sodium, use a liquid reagent mixable with the oil, formed by polyethylene glycol (PEG) and the hydroxide of an alkaline metal (typically KOH) for the de-chlorination of PCBs in insulating oils.

This type of process, industrialised by S.D. MYERS (USA), is generally used in a discontinued mode (batch) on the location of installation of the equipment or in a dedicated centre.

They are discontinued processes, since they require external tanks with the function of compensation and additional capacities of external insulating liquids.

The operational phases that can be identified are as follows:

- complete or partial draining of an aliquot of insulating oil of about 1,000-2,000 kg;
- heating the oil at a temperature typically between 110 and 140 °C to activate the reaction of the liquid polyglycol;
- reaction between the oil and the mixture of PEG and KOH for the dehalogenation of the PCB;
- separation of the liquid reagents and the sub products of the reaction by decanting and/or centrifugation;
- filtration and adsorption on earths or activated clay;
- degassing, dehumidification under vacuum and micro-filtration.

For what the capacity of reduction of the concentration of PCBs to values below the required threshold limit is concerned, this process presents a satisfactory functional efficiency, independently from the starting concentration value, although it has bigger difficulties in the decontamination of the biphenyls with a low Chlorine content (Aroclor 1242).

For what the possibility of recovering the dielectric and chemical properties of the insulating liquid, the technology does not present the critical factors typical of the sodium, lithium and derivatives based processes, since it operates at temperatures lower than the flash point of mineral oils (140 °C).

However, it could present difficulties in separating the oil from the liquid reagent and the reaction sub-products at the end of the dehalogenation.

An additional critical factor is linked with the use of the method on small sized transformers where it is necessary to drain completely the equipment without the possibility of optimising the decontamination process of liquid and equipment.

D.2.2.2.3 Dehalogenation process in continuous and closed-loop circuit

This process, developed by Sea Marconi Technologies since 1982 and designated as CDP PROCESS (last patents EEC n. 0675748 of 04/06/1997; USA 5.663.7479 etc) represents an innovative technology, innovating and improving the KPEG and Niagara Mohawk Power Corporation – USA (Patent Peterson 4.532028 variant KPEG + DMS.) solving the major critical operational factors of the previous processes.

The innovation is the use of a granulate solid reagent not mixable with the oil, formed by mixtures of polyethylene glycols and solid poly propylene glycols with high molecular weight, a mixture of bases

and a radical initiator or other catalysers placed in a column to de-chlorinate progressively at low temperature (80-100°C) the aromatic halides also when particularly stable (PCBs, PCTs, PCBTs, PCDDs, PCDFs) and operate, at the same time, the depolarisation of the oil and the decontamination from other contaminants.

This type of multifunctional process is performed in a continuous manner by the closed-loop circulation of the oil, without draining the contaminated equipment; the latter is simply connected to a decontamination mobile unit, with a variable flow from 700 through 2,000 l/h. These mobile units are modular systems with compact dimensions equipped with automatic safety and process control systems capable of operating under all operational conditions (power generating stations, primary and transformation cabins, bunkerised substations etc.). Also, the mobile units can be equipped with spill protection systems (Spill Guard), self-cleaning systems also capable of eliminating emissions into the atmosphere (Emx-Clean) and automatic supervision and control systems for all the safety parameters of the process to prevent the origin of possible accidents.

By operating the CDP Process in “closed loop”, thus without drainings even partial of the insulating liquids, it results fully complying with Directive 76/769/CE of 26 July 1976. The use of the CDP Process – both with mobile units, near the equipment (cabins, electric substations etc.) and at equipped Centres for the decontamination of PCBs is comparable to maintenance activities (CEI 10-38) when the electrical equipment have not reached the end of operational life.

During the continuous circulation, the insulating liquid is subject to decontamination operations proceeding simultaneously, as described here below:

- heating of the oil at a temperature between 80 and 100 °C;
- chemical dehalogenation by percolation under pressure on the solid reagent, pre-prepared in filtering cartridges contained in appropriate containers (columns);
- depolarisation by percolation under pressure on adsorbent particle supports with a high surface;
- degassing, dehumidification under vacuum and micro filtration

For what the capacity of reduction of the concentration of PCBs to values below the required threshold limit is concerned, this process presents a satisfactory functional efficiency, independently from the starting concentration value. The operational experience demonstrates that, in general, a single intervention is sufficient to ensure the reaching of the required threshold limit also starting from initial concentrations of 500-1000 mg/kg of PCBs. With higher concentrations, up to 50,000 mg/kg of PCBs. It has been demonstrated that several interventions through time are necessary.

The stability through time of the values obtained, in case of reuse of the decontaminated oils and equipment is ensured by the circulation of the oil itself that acts as a solvent for the progressive extraction of the PCBs from the porous materials inside the equipment. The typical efficiency of a single intervention is 93-97%.

Known case histories demonstrate that the concentration of PCBs measured on a large population of power transformers in operation after 12 months from the performance of the decontamination stays stable at values at 3.5 % of the initial concentration, even in case of starting values exceeding 500 – 1.000 mg/kg.

For what the possibility of functional recovery of the dielectric and chemical properties of the insulating liquid is concerned, the process is surely the most advantageous, ensuring the achievement of the characteristics of the oils complying with the strictest requisites recommended by the standards (IEC 60422).

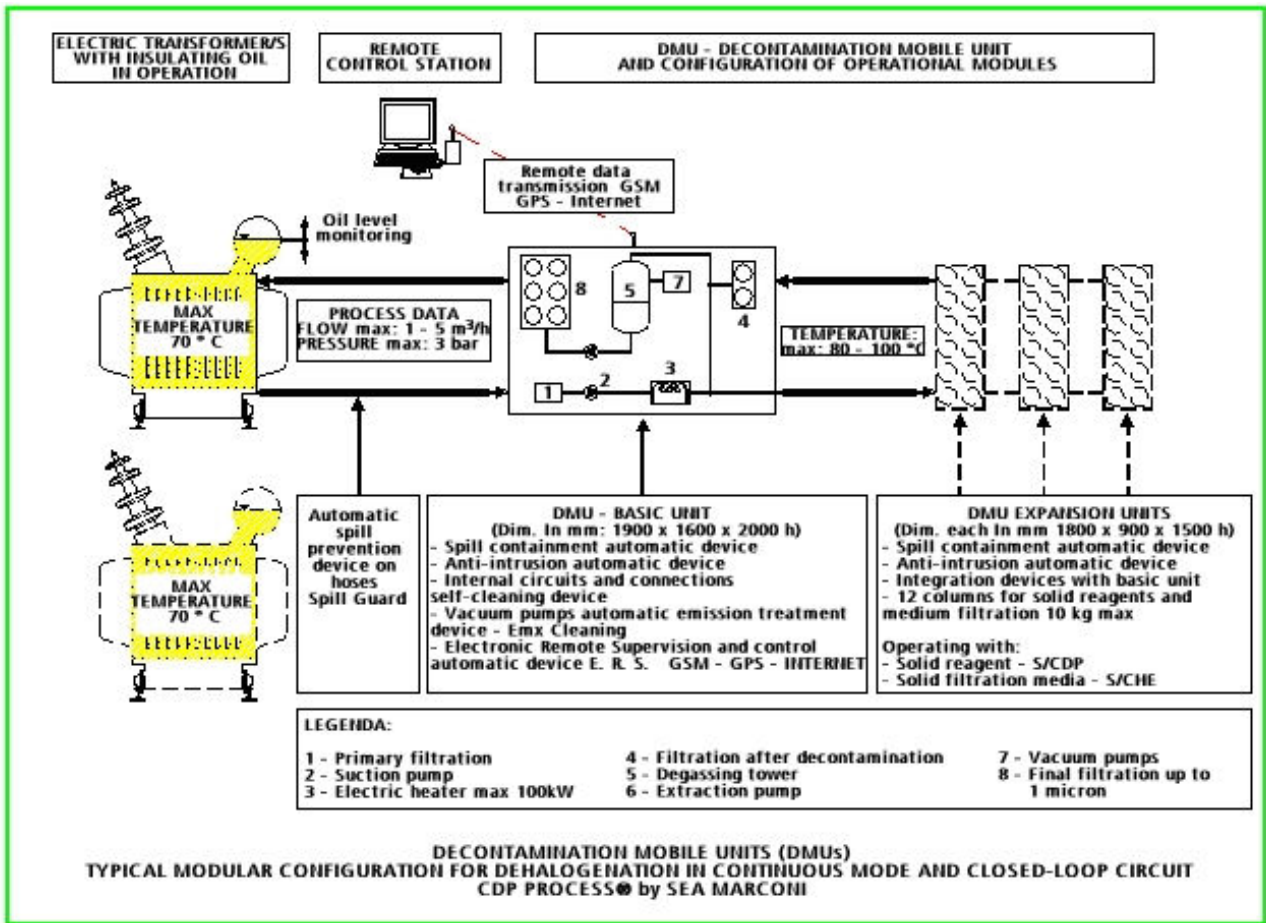
The same process, not draining the equipment, is capable of ensuring the stand-by of 2-4 hours and the technical feasibility of the performance of the operations energised and under load also on high capacity power transformers.

On distribution transformers, typically of power 250 kVA (about 800 kg as total weight of the equipment with 200 kg of oil), the process is implemented in continuous and closed-loop, providing the simultaneous decontamination of 4-6 or more transformers, properly grouped in batches, in a Unit and a Specific Multiple Connection.

The CDP PROCESS technology, for its special configuration and operational procedures, is currently considered the most effective and flexible response for the implementation of Directive 76/769/CE of 26 July 1976 in the sector of the management and decontamination of PCBs in continuous and closed-loop without draining, of electric transformers and insulating liquids in operation. In France, such technical maintenance technique is normally applied with DMU mobile systems (Ref. Prefecture de Meurthe et Moselle, Direction des Action Interministerielles, Bureau de l'Environnement, Arrete n. 2002/01 of 17/01/02, SEA MARCONI TECHNOLOGIES France, Nancy).

The CDP PROCESS has been used for years, also on large fleets of transformers, without causing any accident.

Under the point of view of process safety, this technology is the one that currently determines the lowest risk for workers, public health and the environment and it is also considered the safest and reliable in terms of functional performances without inducing critical incidences during the subsequent Life Cycle of the transformer and/or apparatus containing insulating liquid in operation.



E.3 General comparative evaluation

A comparative evaluation of the various technologies available for the decontamination of PCBs is proposed on the basis of the following factors:

- safety of workers;
- environmental safety ;
- functional safety;
- eco-balance and emissions;
- cost/benefit ratio.

Table E3 – Decisional matrix for the various available techniques

TECHNIQUES	Functional safety	Environmental safety	Workers safety	Eco-balance and emissions	• Global cost/benefit ratio
Refilling	***	**	***	*	**
Sodium, lithium and derivatives	*	*	*	**	*
KPEG	**	***	***	**	**
Continuous closet-loop (CDP)	***	***	***	****	****

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

Based upon what indicated in these Guidelines and in relation with the different operational scenarios analysed it is possible to indicate that the Best Available techniques (BATs) result:

- a) **for transformers or equipment “in operation” contaminated by PCBs:** the dehalogenation in continuous and closet-loop;
- b) **for transformers or equipment contaminated by PCBs “at end of life”:** the dehalogenation in continuous and closet-loop or chemical processes (KPEG or al sodium, lithium and derivatives) used in fixed equipped centres;
- c) **for transformers or equipment “in operation” insulated by PCBs:** changing the oil (refilling) integrated by the subsequent dehalogenation in continuous and closed-loop circuit. This operation must be carefully evaluated in advance in terms of an accurate feasibility project with a cost/benefit analysis;
- d) **for transformers or equipment “at end of life” insulated by PCBs:** decontamination with the integration of processes for the recovery of the solid materials making the equipment.