Chapter 7

Measures for Certain Waste Types

7. Measures for Certain Waste Types

7.1 Introduction

The purpose of this section is to draw attention to specific issues that have been generally described in Volume 1 of this Draft Final Report, but which we consider warrant particular emphasis. Either because of special interest by beneficiary counterparts (ie MoWEP & MoHF), and JICA (eg obsolete pesticides), or have a high impact because of volume or degree of hazardousness. The draft National Waste Strategy and Plan address the following specific waste streams:

- Packaging waste
- Waste oils
- Batteries/accumulators waste
- End of life vehicles
- Electric & electronic watse
- Waste car tyres
- Hospital waste
- Mining and quarrying waste
- Agricultural waste

In response to MoWEP request, this section describes the situation, the issues, and makes recommendations concerning the following waste types:

- PCBs (s7.2)
- Pesticides (s7.3)
- Organic chlorinated solvents (s7.4)
- Waste oils (s7.5)
- Medical waste (s7.6)

7.2 Polychlorinated Biphenyls (PCBs)

Governmental Decision No. 173/2000 introduced a special regime for the management and control of polychlorinated biphenyls and other similar compounds. This requires a national inventory of equipment containing PCBs/PCTs by 31 September 2002 and a programme to phase out these materials over a period to the end of 2010. This legal act stipulates that all equipment containing PCB/PCTs in higher concentration than 500 ppm, and volumes larger than 5 dm^3, will be disposed of by the end of 2006. Equipment with a content between 50 and 500 ppm, and volume larger than 5 dm^3, may be used only until the end of 2010. According to the same GD, a Secretariat for PCB compounds should be set up within the administrative bodies of the central authority for environmental protection, by March 31, 2002. The organisation and function of the Secretariat will be approved by Order of the Minister of Waters and Environmental Protection. This action has been taken.

PCBs are persistent organic and toxic pollutants and require very rigorous management from ‘cradle to grave’. The holders of PCB equipment will realise the potential liability costs associated with this rigorous management regime. The recycling sector will perceive an opportunity for income from recovery of the ferrous and non-ferrous and waste oil components of transformers. Experience in other countries has shown that this combination can result in illicit trade and significant environmental contamination (eg waste oils, soils, sewers and waste water treatment plants etc).

The associated potential problems are mixed and various:

- Contamination of waste oils used as fuel presents the risk of emissions of dioxins and furans
- Use of scrap metal in smelters generates similar problems
- Workers in these sectors exposed to health risks
- Spillage of PCB on soil can generate many more times its own weight (eg several hundred times more) PCB waste for disposal.

7.2.1 Current Situation

According to the provisions of this Government Decision, the following actions will be taken:

- The Secretariat will draw up a National Inventory of the equipment and materials containing PCBs, based on the inventories provided by the Environmental Protection Inspectorates, by September 31, 2002.
- The companies will elaborate plans for the disposal of the equipment and materials containing the specified compounds – by December 31, 2002;
- The receiving sites for long term PCB storage or disposal will be established – by 2002;
- After the approval of the receiving sites, the Secretariat for PCBs and the environmental protection local authorities will establish a program for transferring the PCBs to the storage sites
- Any such transfers will require prior authorisation from the EPI and only be done by permitted transport operator in accord with a designated manifest system (GD 173/Annexe 8).

The current situation is that the Secretariat is preparing this National Inventory. EPIs and Industry did not fully comply with GD 173 deadlines; the MoWEP Inventory is well advanced, but does have some recognised deficiencies:

- It is the first inventory and even with good co-operation between Conel Electrica and local EPIs, it is possible that some PCB locations have not been identified
- Some PCB equipment is from outside Romania, and the precise specification concerning PCB type / content is not known
- Establishing PCB content in some cases would destroy the functionality of the equipment (eg where the units are sealed)

The National Inventory is being prepared in accord with information obtained using the form in GD 173/Annex 2 for reporting the equipment or material containing designated compounds (>50ppm or >5 $dm^{3)}$. We have established from our 1st EPI questionnaire survey that PCB equipment can be found in at least 70% of the counties in Romania. More recent information from the MoWEP (Waste Unit) confirmed that there are only 2 counties (BISTRITA--NASAUD and HARGHITA) which do not have PCB-containing equipment and materials on their territory. Presently, the inventory of PCB equipment shows:

- 60,300 PCB transformers (PCB content not yet estimated because of equipment variety)
- 734,500 PCB condensers (estimated PCB content is 5,480 tons)

(In the UK, for example, it is estimated that a maximum of 8,000 tonnes of PCBs remains in the UK for disposal. Deducting the amount of known disposals from the amount of PCBs known to have been produced or imported has made this estimate. The actual figure may well be less. It is estimated that a significant proportion of UK PCBs is held in some 1,800 transformers and 450,000 capacitors.)

Other GD/Annexes (6 ~ 8) concern prescribed forms for disposal and/or the transfer of equipment on/off site. At this moment the MoWEP have not yet been able to identify receiving sites for long-term PCB storage or disposal. Possible obstacles to facility owners for requests for such storage facilities could be that owners have concerns about:

- Guaranteed payments for their services
- Future liabilities for site contamination
- Adverse reaction from local community

7.2.2 Major Issues and Options for Improvement

(1) PCB Manufacturing Sites

PCB itself was not manufactured in Romania, but PCB-containing equipment was, at Filiasi and in Bucuresti. It is to be expected that these sites and the surrounding receptors will be significantly contaminated. This issue requires further investigation by MoWEP.

(2) PCB Storage Sites

GD/Annex 5 provides a label format for identification of storage areas. The National Inventory will include these sites. The Study Team visited and reported their observations about the site at Filiasi. The case of PCB storage site in Filiasi, visited by the JICA study team, has shown that basic requirements for restricting access and preventing leakage have been fulfilled as best as possible. However, it is not sure that security measures against natural or industrial disasters, that must be appropriate in accordance with the level of toxicity of the substances of concern, and their potential consequences in terms of the environment and population, have been correctly evaluated. The industrial unit has an emergency plan, but the presence of fuel tanks just in front of the liquid waste storage makes this point particularly sensitive. The emergency plan cannot be considered as a sufficient guaranty of safety with the liquid PCB waste storage and a more reasonable distance with no fire or explosion risk should be kept around this sensitive site. The JICA study team could not see the risk assessment study of this site, but it is thought that risks, including those possibly resulting from natural disaster risk occurrence (flood, earthquake), have not been sufficiently considered. The site does not meet current EU standards for operation of this activity, and no information was available concerning PCB monitoring of this site.

(3) PCB Equipment in Use

GD/Annexe 3 provides label for identification of PCB equipment that remains in use. Whilst equipment remains in service the risk of PCB loss is generally small.

(4) Re-Commissioning PCB Equipment With Non-PCB Dielectric Fluids

GD/Annex 4 provides label format for identification of such equipment. This is a specialised service requiring trained personnel, and specialised equipment; we are not aware of any approved contractors in Romania for providing this complete service.

(5) De-Commissioning and Handling PCB Equipment

The removal of PCB equipment requires care so that the equipment is not damaged in such a way that PCB leakage occurs. For small equipment the risk is small. But as the equipment size, weight, and PCB volume increases – so does the risk. In particular transformers can be damaged physically during the lifting operation with consequent leakage of the PCB dielectric fluid.

(6) Transportation of PCB Equipment

Transportation of PCB equipment should be in accord with GD173 and normal ADR requirements, but in addition all units should be within steel containers. Transformers are at risk of damage with PCB leakage during loading, transportation, and unloading and should be drained of liquids by approved contractors before transport. The manifest protocol (GD/Annex 8) provides a good basis for any hazardous waste `cradle to grave' monitoring.

(7) Sampling and Analysis

Sampling and analytical capability for PCBs in various media are available, for example, in ECOIND.

(8) Disposal of PCBs and PCB Equipment

Disposal plans within the context of GD 173 currently provide for temporary storage by the holder, and transport to an approved long-term storage site(s), awaiting MoWEP decision concerning final disposal. To-date the MoWEP have not yet been able to identify receiving sites (Filiasi is full) for long-term PCB storage or disposal. Disposal of PCB / PCB equipment is a complex and costly process. Figure 7.2 illustrates a typical flow diagram for a transformer with various criteria; this information is from the Study Report of Hazardous Waste Treatment by the Japanese Foundation for Industrial Waste Treatment Promotion (1995). The high-temperature incinerators at Oltchim and Pro-Air Clean may have the capability (not proven) for destruction of PCB liquids in accord with EU Standards, but there are no facilities in Romania for incineration of `PCB solids', or dismantling / cleaning PCB equipment.

7.2.3 Initial Recommendations for Strategy for PCBs Management

Disposal plans within the context of GD 173 currently provide for temporary storage by the holder, and transport to an approved long-term storage site(s) awaiting a decision concerning final disposal. MoWEP have not yet been able to identify a suitable site. As with the 'obsolete pesticides' (see 7.3 below), consideration should be given to alternatives for final safe disposal in the short term. (This issue is also discussed in Volume 1 Chapter 5 – Treatment and Disposal of Hazardous Wastes, and Volume 2 section 6.3).

Full account will also need to be taken for PCB monitoring and decontamination of long-term storage sites during / after use. There is no easy option for total elimination of PCB wastes. All the above factors need to be taken into account within an integrated management plan, and are noted below.

(1) Awareness of Issues and Guidelines for Stakeholders (eg EPIs)

- Identification of equipment and locations by year and place of manufacture
- Acceptable criteria for disposal plans and PCB fluids' replacement activities
- Criteria for EPI inspection of equipment and reception / storage sites
- Criteria for certification of permitted transport operators
- Criteria for permitting disposal route for the `replaced PCB fluids'
- Criteria for approval of contractors for PCB handling (eg fluids' replacement, de-commissioning equipment)

(2) Inventory Review

To be done in accord with GD 173.

(3) Disposal Plans and PCB Fluids' Replacement Activities

Before starting these activities, it is important that the implications of this activity are fully evaluated.

(4) Approved Contractors

PCB handling is a specialised service and contractors require special equipment and training to provide this service. They would need to be approved in accord with Waste Law 426/2002.

7.2.4 Principles for Disposal of PCBs

Mobile `units' are not appropriate other than for low PCB content liquids, relatively small quantities, or enabling PCB `replacement' in transformers. Liquids' incineration could be considered in existing / proposed facilities in Romania, subject to agreement by the operators and rigorous testing. But, this still leaves the very much more difficult and larger problem involving transformer equipment and capacitors, and contaminated soils.

Electrical equipment containing pCBs are characterised by two major hazards:

- Potential release of PCBs, and
- Potential formation of PCDDs and PCDFs at temperatures >180^{o}C

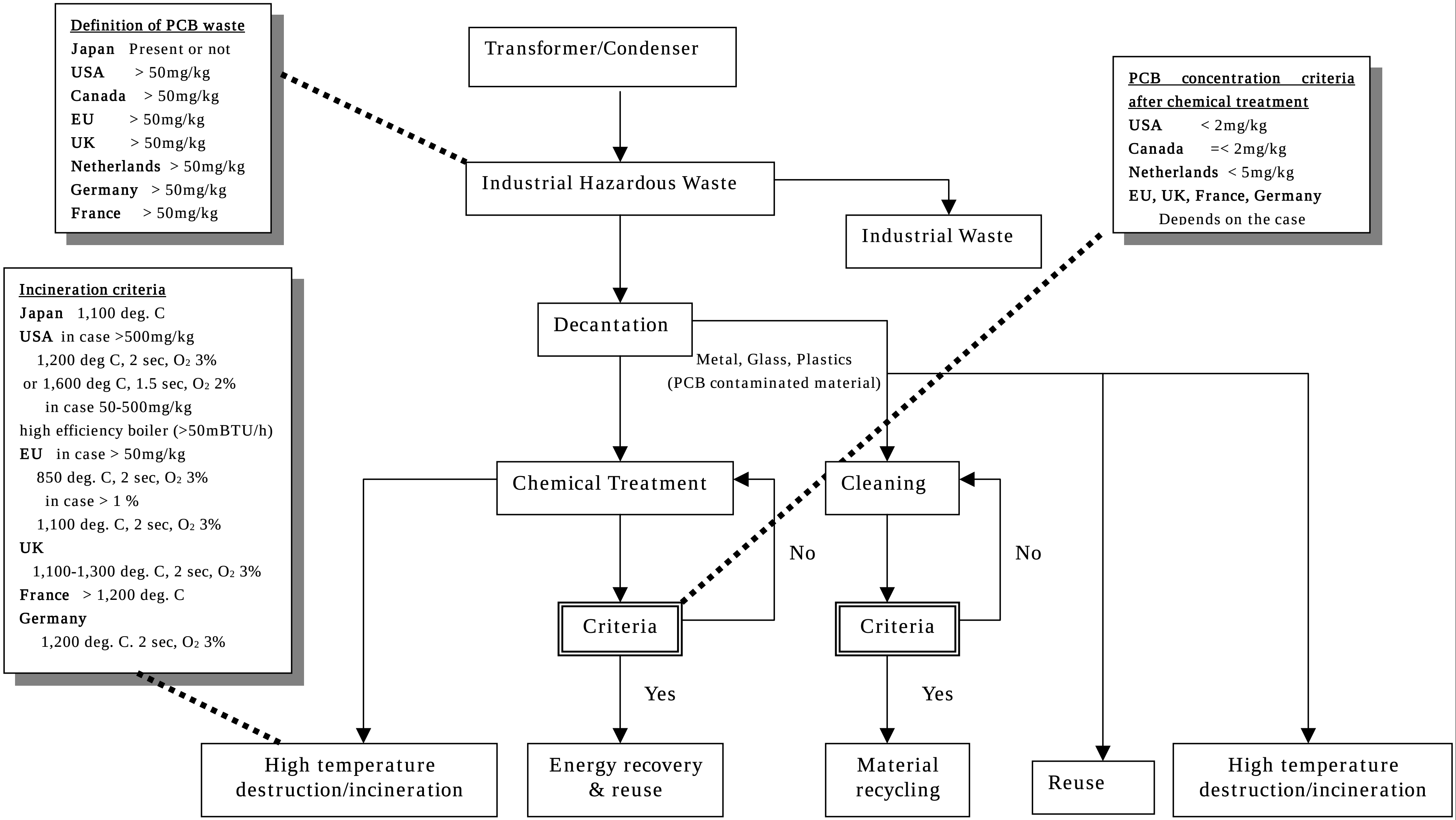
Due to these hazards, the safe disposal of such equipment has to be considered the primary objective, rather than recovery or re-use. Accordingly oils containing primarily PCBs require special thermal disposal under prescribed conditions such that destruction efficiency is >99.99995%. Alternative treatment methods, in particular for oils with a low PCB content, are de-halogenation (eg Degussa and similar processes) and catalytic high-pressure hydrogenation / dehalogenation (eg VEBA and similar processes), again to a similar and high destruction efficiency.

For solid electrical equipment (eg transformers, capacitors), possible disposal options are underground storage and thermal treatment. Any pre-treatment for this disposal (eg PCB oils are drained from equipment) should only be done in specially equipped locations, and not in-situ. Such locations require special and appropriate measures for containing and isolating any spillages and emissions to air, the staff require special training and require to be protected against PCB exposure and contamination, and suitable measures are required to ensure that PCBs are not carried out of the isolated zone (eg decontamination chamber).

If electrical equipment is to be processed for the recovery of metal, it has to be adequately decontaminated, because of the risk of PCDDs/PCDFs formation even at relatively low temperatures. It is not sufficient to simply rinse such electrical equipment, as experience has shown that significant amounts of oils containing pCBs are left in coils and in insulating materials, which may result in the formation of dioxins and equipment contamination during metal processing for recovery.

Due to the considerably higher toxicity of dioxins, even minimal PCB residues give rise to the risk of environmental contamination and detrimental health effects. Due to the significantly more extensive manipulation involved in such activities there is a very high investment cost for a transformer decommissioning plant and destruction facility; it is highly technical and requires a lot of knowledge and experience. Such a PCB processing facility could cause many environmental pollution and environmental health problems if badly operated. A better strategy for Romania is to verify the inventory, secure and monitor that inventory, and evaluate the option for final elimination by export to a proven facility as with the `obsolete pesticides' (section 7.3).

Figure 7.2.1 Illustrates A Typical Flow Diagram for A Transformer With Various Criteria



From the Study Report of Hazardous Waste Treatment
Japanese Foundation for Industrial Waste Treatment Promotion 1995

7.3 Obsolete Pesticides

The Romanian side requested that this Study pay attention to pesticides' waste. We became aware during the first mission that MoAFF were developing a Phare 2003 project application for re-packaging, collection and elimination of pesticide residues on the Romanian territory. Phare funds will not exceed 75% of the total estimated costs (Euros 4.8 million). The proposed implementation schedule is November 2003 to March 2006. This application was made on the grounds that no adequate facility to eliminate these wastes exists in Romania (or is likely to exist in the foreseeable future). The project proposal foresees to repackage these wastes, collect them, temporary store them in Romania and send them to a Member State or a Phare Country signatory of the Basle Convention with adequate facility to treat them (neutralisation, incineration, disposal). The trans-frontier shipment of the waste would be performed in compliance with the relevant UN, Basle Convention and EU regulations, in particular 94/774/EU and 259/93.

7.3.1 Current Situation

The pesticides wastes are in various packaging, some with and some without identification. They comprise liquid, powder and granule, and include DDT and HCH formulations. The Ministry of Agriculture, Food and Forests, through its county Phytosanitary Units, has performed the monitoring of pesticide residues and empty packaging materials according to Law no.85/1995. These pesticides are stored in around 340 different storage points all over the country. According to this report (which we have not been able to access), the total quantity of pesticide residue existing at country level is about 1130 tonnes, out of which:

- ~400 tonnes can be found in the storehouses of the county Phytosanitary Directions;
- ~730 tonnes can be found in the storehouses of some economic agents (legal or physical persons from the private sector).

More recently (April 2002), further inspections have been made with joint teams, including the representatives of the Environmental Guard, from local EPIs, specialty inspectors from territorial units of the MoAFF, and of local public administration. This revealed substantially (ie>60%) more materials and storage locations. These pesticide wastes are stored in about 709 storage areas at the country level, and exist in solid and liquid form. The pesticide wastes listed include identified obsolete pesticide (insecticide, fungicide, herbicide, growth regulators) and non-identified products (due to packaging deterioration).

The joint survey identified:

- ~882,7 tons solid pesticide waste and 376.812 liters liquid pesticide waste, and
- ~ 464,4 tone solid, and 166.282 litres liquid unidentified pesticide wastes.

7.3.2 Major Issues and Options for Improvement

The joint inspection identified a number of issues and made recommendations for improvement. Out of the 709 existing storage areas, only 472 have permanently guard assured. In most cases, there is the risk of stealing and selling of these wastes as "pesticide", by "irresponsible" persons. Taking into consideration the pesticide waste potential risk to environment quality and human health, for risk prevention in case of improper management of these wastes, for the majority of controlled units there have been established measures for:

- Storage of the pesticide waste in proper spaces, exclusively for this purpose, which can assure specific conditions for this product category
- Replacement of the deteriorated packaging, in safe conditions for environment quality and health of the people involved in this action
- Taking samples from obsolete pesticide waste, analysis of these in a certified laboratory in order to establish the management regime, in some cases enabling the possibility to extend the validity term in order to capitalize the active substance
- Permanent guard assurance for the storage areas, where at present it is not assured
- Prohibit for use in other purpose of the pesticide packaging
- Notice to the users and traders of phyto-sanitary products on the obligation for returning the recoverable packaging / containers, to recover these
- To respect the obligation for activity regulation from the point of view of environmental protection.

7.3.3 Initial Recommendations for Strategy for Pesticides Management

This joint inspection (MoWEP & MoAFF) proposes the analysis of the possibility of providing controlled and centralised storage in proper storage areas in each county awaiting a decision concerning final disposal via the Phare 2003 programme. The JICA Study Project supports this proposal for export of these wastes to a proven facility for final elimination.

7.4 Organic Chlorinated Solvent

7.4.1 Waste Generation

(1) Background

Chlorinated solvent is a widely used industrial chemical in various industrial sectors. They are also the most frequently detected pollutants in soil and groundwater as a result of industrial waste contamination. For example, two substances, Trichloroethylene(TCE) and Perchloroethylene(PCE), account for approx. 60% of all groundwater contamination detected in Japan.

TCE and PCE are used in cleaning and degreasing processes in the metal, electric, electronics, machine, dry cleaning and other industries. Because of their physical and chemical character, namely, very low viscosity (=high penetration index), higher specific density than water, and high vapour pressure, they can create multimedia cross contamination in environment easily. Also, they represent the most difficult to handle/treat waste type because of the high chlorine content. TCE and PCE are considered as carcinogenic. Water quality standards are set for TCE at 0.03mg/l and for PCE at 0.01mg/l in Japan and by WHO.

Important chlorinated solvents, in view of production volume and environmental impact, are as follows:

Dichloromethane (methylene chloride)
Tetrachloromethane (carbontetrachloride)
1,1,1-Trichlororthane (methyl chloroform)
Trichloroethylene (TCE)
Perchloroethylene (PCE)

Romania is producing significant quantities of chlorinated solvents, at least over 20,000 tons /year. This is quite significant quantity considering the scale of industrial activity. Still its exact consumption and waste management situation is not known. In view of its potentially large environmental impact, special attention is paid to the use and waste management of this category of chemical in this study. As noted above, characteristics of the chlorinated solvent make the problem more relevant, not only for waste, but also for air/water/soil pollution,, than any other substances. Therefore a different approach is necessary for the study. As part of the waste source generation survey, the situation of the chlorinated solvent issue was surveyed, 1) to obtain the current consumption and management situation of chlorinated solvent and to estimate the potential seriousness of the problem, and 2) to propose improvement in the Master Plan.

(2) National Production and Consumption

Understanding of the current situation of the waste related chlorinated solvents should not solely depend on the questionnaire survey. Total quantities of environmental emission to air/waster/soil plus generated waste in Romania can be computed by the following.

Total emission = Domestic Production + Import - Export- Quantities used as raw material

(Typical application of chlorinated solvent is cleaning and degreasing, but some portion may be used as raw material to produce another chemicals.)

The following figure illustrates the methodology used in the study.

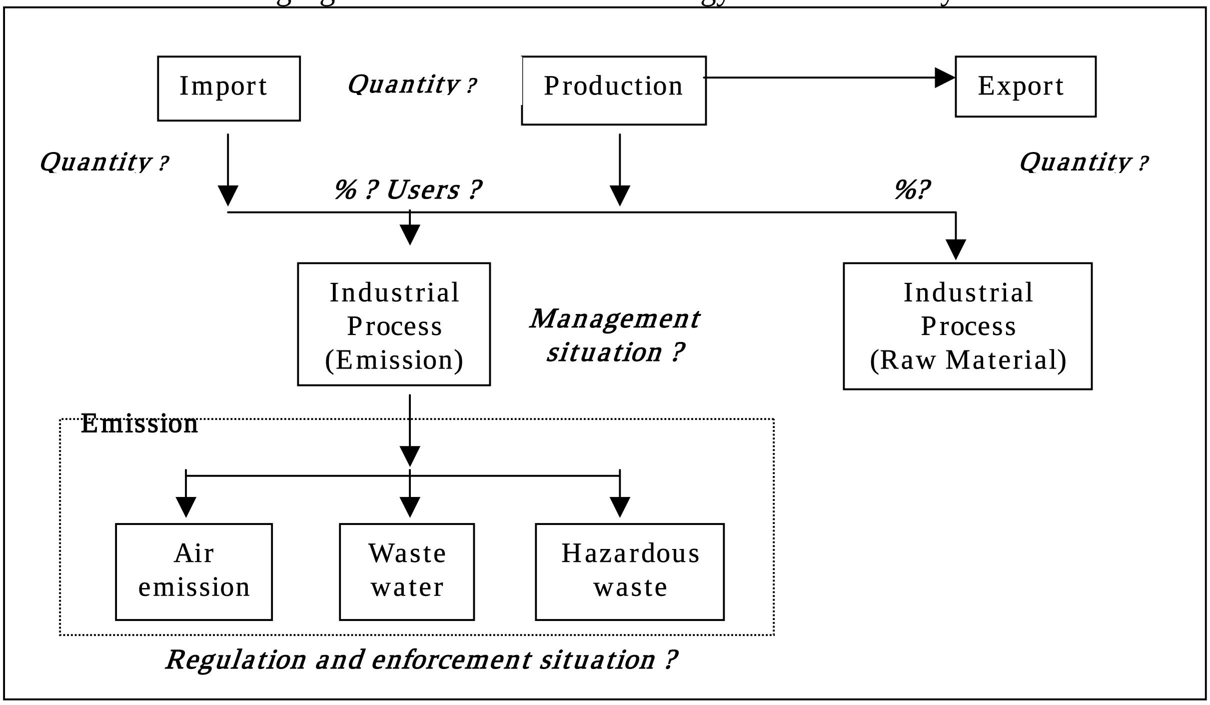


Figure 7.4.1 Study Flow Chart

There are two main chemical producers in this field in Romania, namely Oltchim in Valcea county and Chimcomplex in Bacau county. Oltchim is the main producer of carbontetrachloride and perchloroethylene according to the company's brochure and web page. Production of carbontetrachloride was completely stopped because of ozone layer protection, however. Initially Oltchim was approached to get information on their production and consumer/client group in the country. Unfortunately the request was completely refused by the company. Chimcomplex, which is another producer of chlorinated solvent was then approached for data collection. Chimcomplex provided certain data but only on confidential basis. According to Chimcomplex, all of the domestic consumption of chlorinated solvent is for degreasing and cleaning purpose and not used as raw materials.

Table 7.4.1 Production Data of Chlorinated Solvents

	1	2	3	1+2-3	
	Production (2000) Ton/year	Import (2000) ton/year	Export (2000) ton/year	**Consumption (2000) ton/year**	% of consumption/ production
Carbontetrachloride	4,734	0	4,906	**0 (-)**	0 %
Methylen chloride	?	155	968	**?**	?
Trichloroethylene	5,665	37	2,776	**2,926**	52 %
Perchloroethylene	17,984	53	12,294	**5,743**	32 %

Fortunately, kind co-operation was given by the National Institute of Statistics without any lengthy administrative procedures. The above table shows the production, export and import data of selected chlorinated solvents. Unfortunately, production data of Metylene Chloride was not available. For reference, U.K. consumption of Trichloroethylene and Perchloroethylene are 29,000 ton/year and 7,000 ton/year respectively. (source: IMPEL Workshop on the use of Chlorinated Hydrocarbons in Industrial Plants, 2000). From this data, pechloroethylene consumptiom of Romania seems to be relatively high.

Here we evaluate and compare the consumption of Romania with that of U.K., in view of industrial activity (GDP x % of industrial sector). (Source: JETRO The World 1998)

Romania GDP(96) $35.5 billion x 37%(Industrial sector) = $13.15 billion

U.K. GDP(96) $1,153.4 billion x 26%(Industrial sector) = $299.9 billion

Ratio of Industrial output	Romania : U.K. = 1 : 23
Trichloroethylene consumption	Romania : U.K. = 1 : 10
Perchloroethylene consumption	Romania : U.K. = 1 : 1.2

Obviously, Romania consumes more chlorinated solvents per industrial output than U.K., in the order of two (for trichlororethylene) and of twenty (for perchlororetylene). It should be noted again that all such consumption is currently discharged into the environment as exhaust or effluent. With tight environment enforcement in place, these emissions will be treated and generate large quantity of hazardous waste.

(3) Industrial Degreasing Facility

The major industrial application of chlorinated solvent is the degreasing process. Several industrial plants were visited to observe the management situation.

First company, ICE Felix produces computer parts. Methylene chloride was used for cleaning of printing plate for circuit board. Cleaning is manual using little containers and soaked cloths. Approx. 10kg of solvent is used to clean 20m^2 of plate. Annual consumption is approx. 4,000kg. Manual cleaning is done in the room without any cover. Side ventilation is used to discharge the solvent vapour to the atmosphere. Wastes are stored in an outside site. The site was approx. 7m x 15m. Floor is concrete and sloping was set so that any leaks or spills enter a ditch on one side. Obviously some leaks (waste oil) exist.

Second company, FEA produces parts for automatic control system used in the power industry. Perchloroethylen is used to degrease and clean the parts before electroplating. Consumption is approx. 600-1000kg/month depending on the production schedule. Here parts for cleaning are placed in open-top vapour phase cleaning bath with condensation system. Exhaust gas is discharged to the atmosphere. A distillation unit, which looks extremely old, is set just next to soaking bath to recycle old solvents. Sludge from the the distillation unit is sent to some company but details of the company were not given. The company is very keen about the issue of eliminating or reducing the use of perchloroethylene. The cleaning room has no lining on the floor.

Third company, AMCO, produces valves and fittings for the chemical industry. There are two units of automatic degreasing facilities consist of low temperature soaking bath, high temperature soaking bath, vapour degreasing bath and drying room with automatic carrying baskets. The unit is semi-closed with exhaust ventilation system. When used in full production schedule, the units consumed up to 2,000kg/month of trichloroethylene. The factory has a solvent distillation system for recycled use of solvent. The disposal method for distillation sludge is not clear.

Depending on the scale of production, a factory may use chlorinated organic solvent in the range between a few ton/year to 25 ton/year. As national total consumption is little less that 10,000 ton/year, there may be 500 - 3,000 factories in the whole country which use chlorinated solvents.

In summary, the industrial sector using chlorinated solvents seems to have relatively high awareness of the problem and willingness to eliminate or reduce its use. Some factories already operate in-house distillation units for solvent recycling. However none of the factories care much about emissions to the air which is the major consumption path of solvent. The risk of underground contamination by spill and leak and its preventive measure should be clearly conveyed.

(4) Dry Cleaning Facility

Apart from the usual industrial sector, dry cleaning is an important consumer of chlorinated solvents, especially for perchloroethylene.

Dry cleaning shops in Bucharest were field surveyed. 46 shops with dry cleaning facilities using perchloroethylene were identified. These 46 shops represent 22 cleaning companies (a company may have more than one shop). Total consumption of perchlorethylene (data limited to shops which provided answers) is over 7,000kg/month or 84 ton/year. Most of the shops consume less or about 100 l/month of solvent while a few shops consume much more.. The figure below shows the distribution pattern of perchloroehylene consumption.

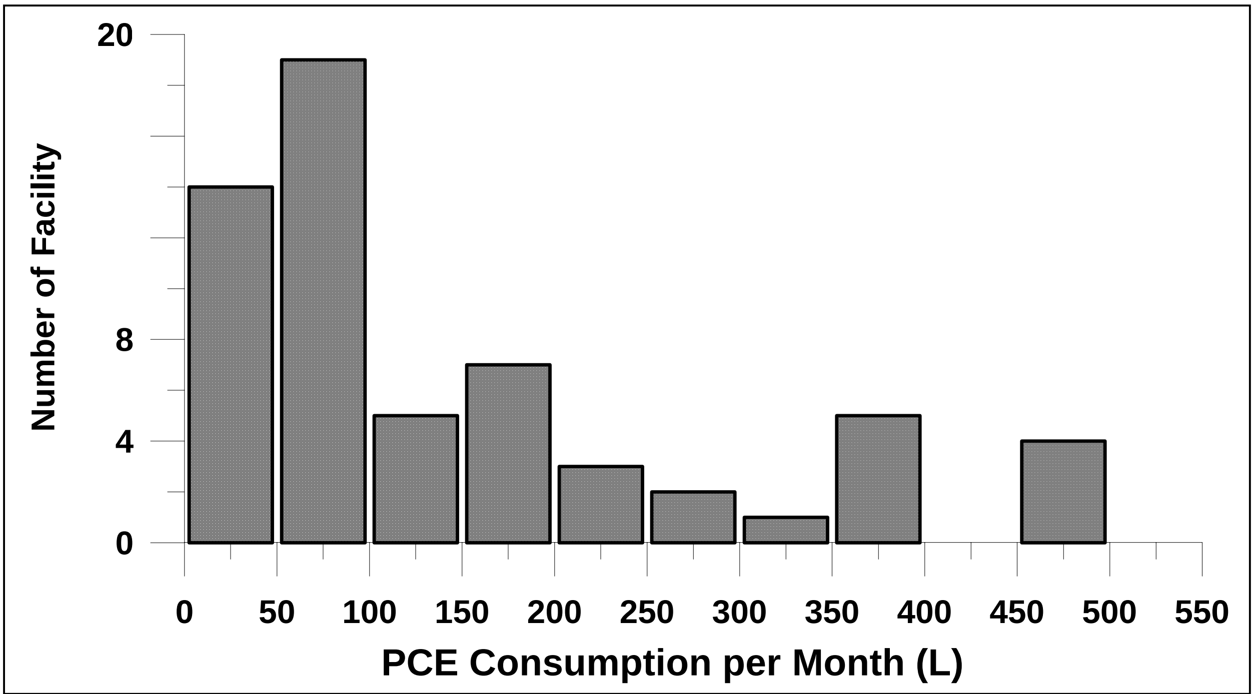


Figure 7.4.2 Perchloroethylene Consumption by Dry Cleaning Shops in Bucharest

(Source: Field Survey July-August. 2002)

Including shops not providing data, total consumption may be assumed to be around 100 ton/year. According to several local EPI officers, the number of dry cleaning facilities are about 4 to 7 per county. Therefore, the number of dry cleaning facilities using perchloroethylene around the entire nation is estimated at approx. 200 - 300 on preliminary basis. Bucharest may contribute 15 to 20% of the whole country. Then total consumption by dry cleaning will be around 500 to 670 ton /year, or approx. 10 % of total consumption of perchloroethylene.

One of the largest dry cleaning business operators was approached to interview the current situation.The company has high awareness on the environmental issue of chlorinated solvents and very sensitive in discussing details. According to the interview, the dry cleaning facilities are equipped with distillation unit and automatic carbon absorption/regeneration unit for internal solvent recycling. This is "fourth-generation" cleaning machine with complete closed circuit.

One hazardous waste generated at the facility, even if it uses fourth-generation model, is sludge residue from the distillation unit. The figure below shows the sludge quantity per processed quantity of clothes based on the permit document. According to interview, the sludge is packed in plastic bags and disposed of with municipal waste. If this is true, it may cause groundwater pollution at the waste dumping site. Proper guidance should be provided to the dry cleaning shops.

Figure 7.4.3 Sludge Generation From Dry Cleaning Facilities in Bucharest

(Source: Field Survey in July-August 2002 in Environment Permit Document in Bucharest EPI)

7.4.2 3R Situation and Recommendation

(1) Industrial Degreasing Facility

During the factory visit, a high awareness and willingness to reduce the use of chlorinated organic solvents was found. Some factories already have in-house distillation systems for recycling of solvents. (Below is the on-site distillation unit in AMCO S.A.)

This is due to not only environmental concern but also due to the cost of solvents. For example, perchloroethylene costs 0.67 EURO /kg in Romania. If a factory uses 10 ton/year of perchloroethylene, it costs 6,700 EURO/year. So, reduction of solvent may justify investment in recycling.

Technically, most of the solvent consumption is emitted into the atmosphere. Factories, in general, do not pay much attention on this aspect. Therefore, engineering improvement of exhaust systems has good potential for reducing solvent consumption at relatively reasonable cost.

Some designs of potential improvements are illustrated in the following figures.

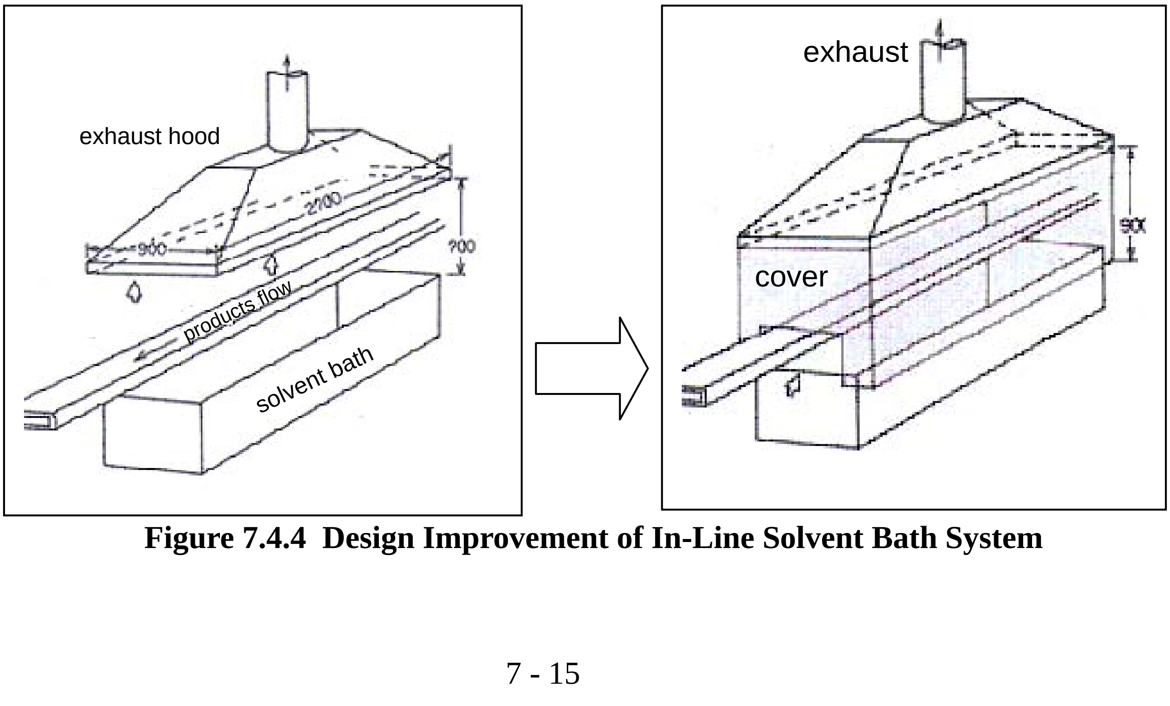
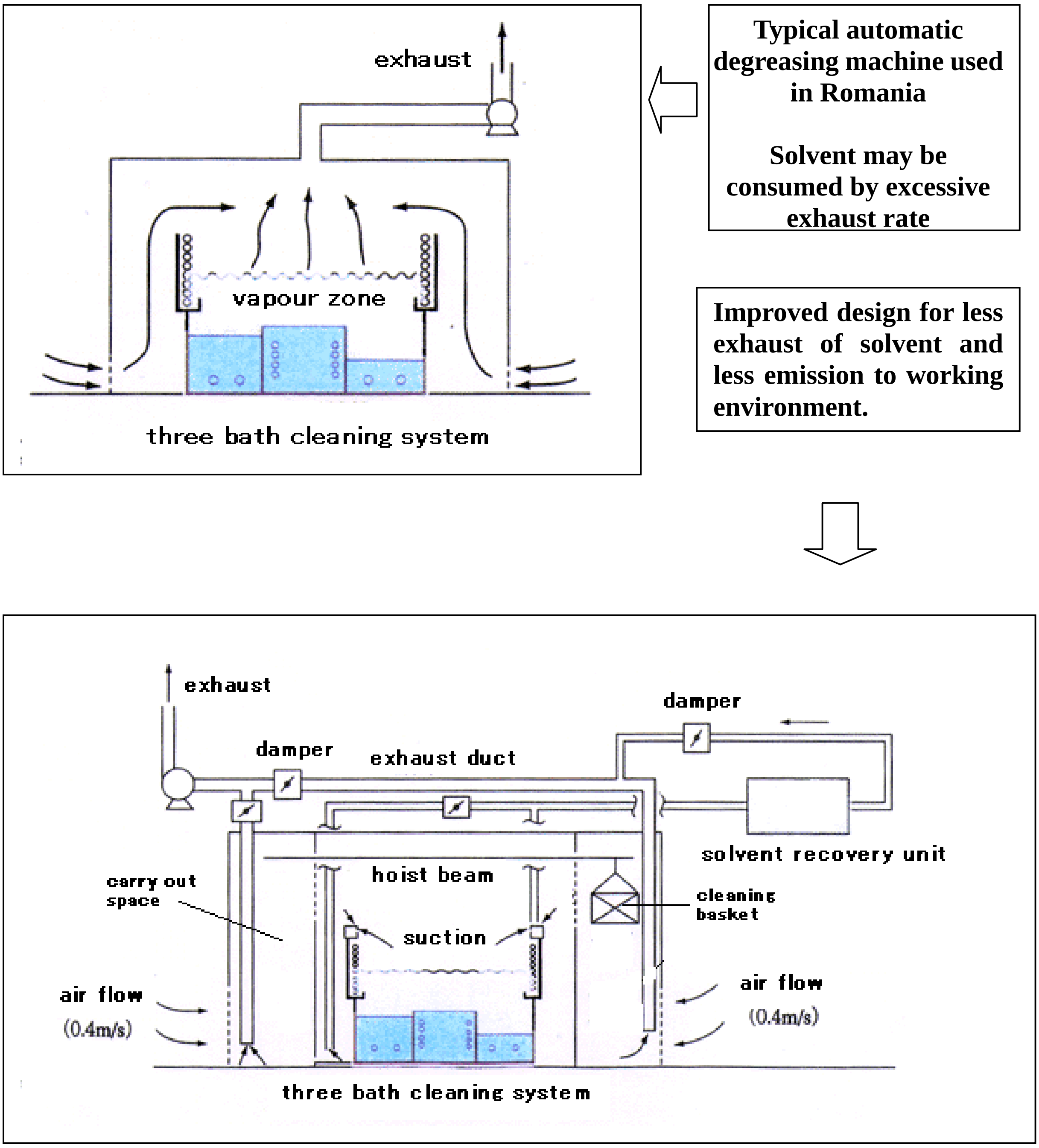


Figure 7.4.4 Design Improvement of In-Line Solvent Bath System



(Source: Japanese Small and Medium Enterprise Corporation)

Figure 7.4.5 Design Improvement of Three Bath Cleaning System

Some of the above ideas will be studied and demonstrated in one of the proposed pilot projects.

(2) Dry Cleaning Facility

Most of the dry cleaning facilities in Europe are so-called "fourth-generation" models, which have built-in closed circuit vapour recovery and solvent distillation systems, or so-called "fifth-generation" models which no longer use chlorinated solvent.. In the field survey in Bucharest, such "fourth-generation" models were found in some shops. To summarise the situation, the distribution of model years for dry cleaning facilities is shown in the figure below.

As seen in the figure, there is bi-modal distribution. One group in the year after 1994, and another group in the year before 1992. The former group of machines may represent "fourth-generation" models which already have built-in 3R capability. The latter may be the relatively old model which still consumes and emits solvent into the atmosphere. The former group accounts for approx. 1/3 of total.

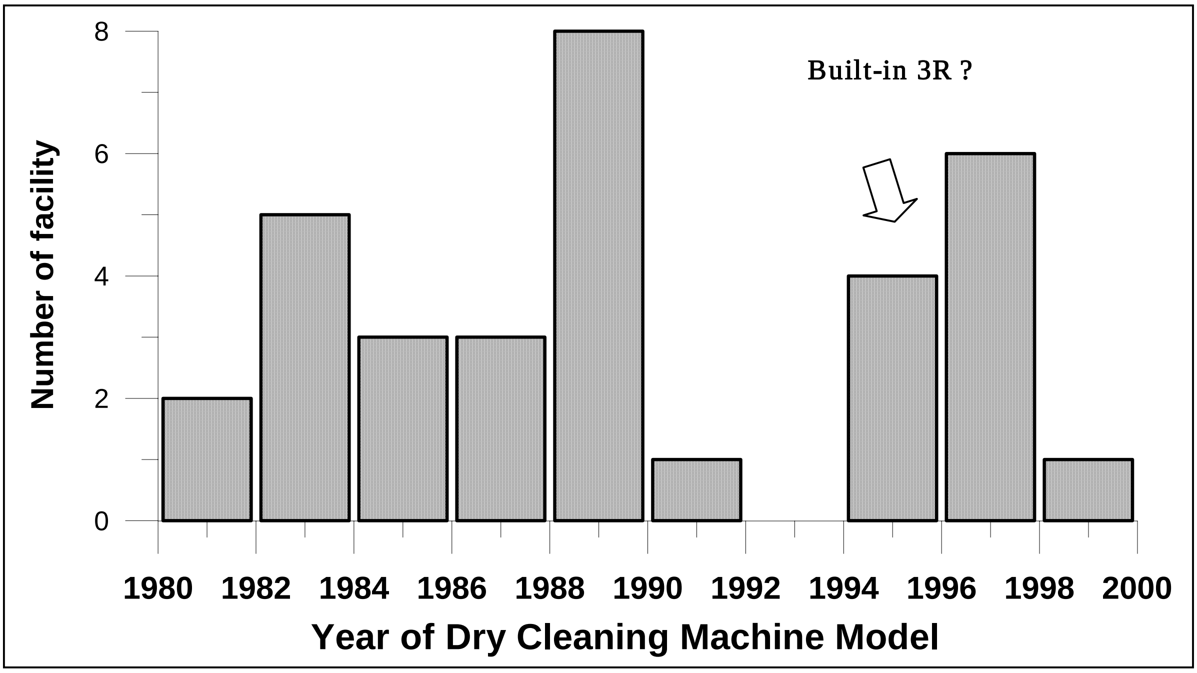


Figure 7.4.6 Distribution of Latest Dry Cleaning Machines in Bucharest

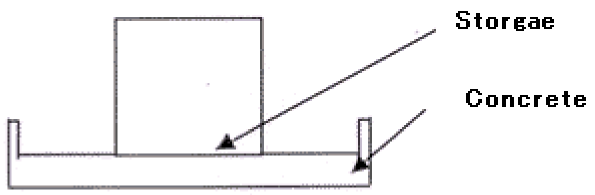
(Source: Field Survey in July-August 2002)

It is recommended to boost the replacement and modernisation of old dry cleaning facilities, by enforcement, incentive and other policy tools.

7.4.3 Treatment and Storage Situation and Recommendation

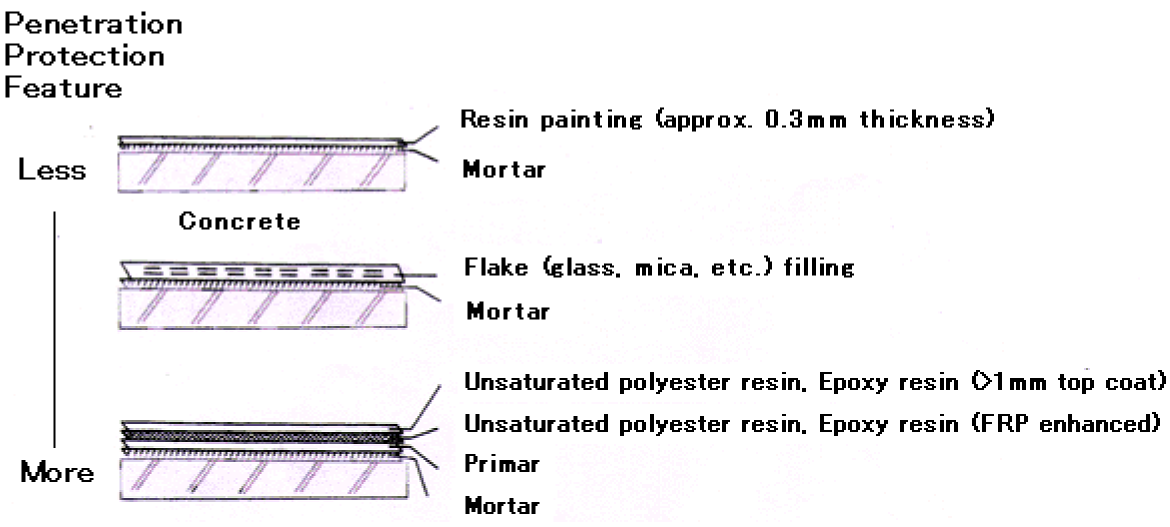
(1) On-Site Waste Storage

As stated before, organic chlorinated solvents are the most frequently detected chemicals in groundwater contamination in various countries. One reason is their high penetration capability. Even with very small cracks in the floor, the solvent can penetrate easily below ground. In this regard, special care should be taken at solvent and waste storage site as well as transportation / handling sites.



Recommended floor design of storage site

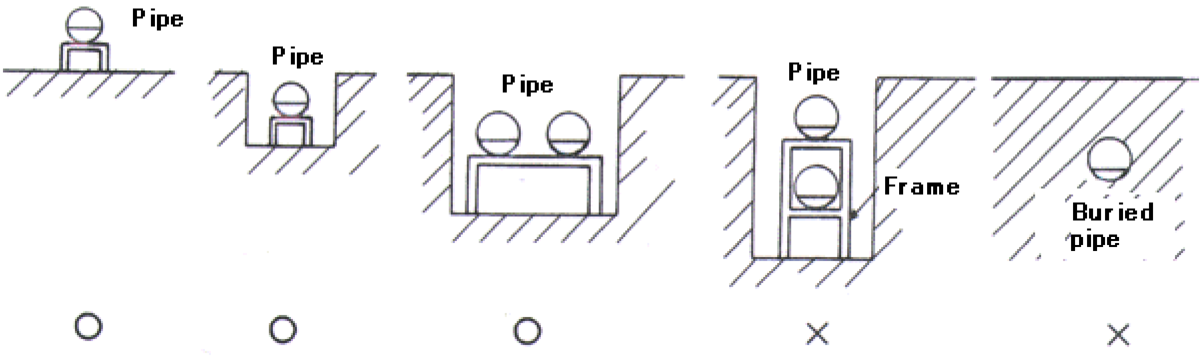
The above figure(Source: Japan Small & Medium Enterprise Corporation)shows the recommended floor design of a waste storage and solvent handling site. A protective wall should be placed for accidental spill and leakage. The recommended floor surface is explained in the figure below (Source: Japan Small & Medium Enterprise Corporation).



Recommended floor surface of solvent waste storage

The uppermost figure shows the minimum requirement to protect penetration of chlorinated solvents into the ground. The middle and bottom figures present better ways to protect against penetration. Unfortunately, there is no such surface coating in Romanian factories at present.

Furthermore, transferring of solvent by a piping system requires special caution as often it is the source of leakage. The next figure (Source: Japan Small & Medium Enterprise Corporation) shows the recommended configuration of the piping. In any case, underground systems should be avoided.



Recommended design of piping for solvent transport

(2) Air-Emission Treatment

As observed in the waste generation survey, most consumption of chlorinated solvent, at present, is by emission to the air. With introduction of the VOCs directive, such air emissions should be reduced by proper air treatment systems. Typically such a system utilises an activated charcoal unit for absorbing vapour phase compounds. After a certain time period or certain volume of gas/vapour has passed the absorbent bed, breakthrough occurs and charcoal will not absorb the vapour any longer. Then charcoal has to be replaced.. The replaced old charcoal will become hazardous waste as it contains a high concentration of chlorinated organic compound. It is expected that a large volume of such waste will be generated when air emission measures become mandatory.

If not disposed of in a proper way, this waste will contaminate the soil and groundwater. High temperature incineration at temperature above 850-900 degree C is recommended. General treatment issue and recommendation is discussed in Chapter 5 "Strategy for Treatment of Hazardous Waste".

7.4.4 Regulatory Issues

(1) Law and Regulation

Two chlorinated solvents, namely carbon tetrachloride and methyl chloroform are ODS (ozone depleting substances) and come under the Vienna Convention / Montreal Protocol and EU Directive 3093/94/EEC (relating to substances which reduce ozone layer). MWEP organises the Ozone Secretariat, which is responsible for monitoring activities regarding the phasing out of the ODS. Officially there should be almost no production of such ODS. However the Statistics Institute reveals significant production at approx. 5,000 tons/year of carbon tetrachloride. The reason for such high production is not clear at this moment.

MWEP has also started a nation-wide survey of VOCs which include chlorinated solvents following EU Directive 1999/13/EC (on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations (VOC)), with regard to air emissions. It is estimated in the position paper (for EU accession) that 235 factories should comply with this directive.

One of the most serious environmental impacts of chlorinated solvent is on groundwater contamination. EU Directive 80/68/EEC (on the protection of groundwater against pollution caused by certain dangerous substances) addresses this issue. The Romanian government requested no transition period for the implementation of this. However, in order to manage and protect groundwater, the water quality standard should include the value for chlorinated organic solvent. Without it, there is no monitoring and no pollution will be detected.

Government Decision No. 188 and NORM NTPA-001 of Feb. 28, 2002 regarding wastewater quality standards, prohibits the discharge of organic halogenated compounds in public water. Discharges of other hazardous substances such as organic mercury and so on were also prohibited. However there is not a standard or limiting value for each chemical. According to an official of MWEP, effluent standard values for industrial facilities would be determined by environmental impact assessment by the local EPI office as site-specific conditions for environmental permits. The effectiveness of such enforcement is not clear. It is recommended to apply a standard limit value to facilitate consistent monitoring.

(2) Capacity of Local EPI

EPI capacity for industrial facility management related to chlorinated organic solvent is, at this moment, not adequate. The following summarises observation at the Bucharest EPI, using dry cleaning facilities as an example.

Dry cleaning facilities commonly utilise perchloroethylene as a cleaning solvent. Therefore they have to obtain an environmental permit. The EPI office has a computerised database system for environment permits. However, the data base structure and input data quality do not contain search capability for type of industry or service category. Only name based search is possible. Therefore, practically, there is no way to find out the total number of dry cleaning facilities in Bucharest using the data base, other than by digging out the over 20,000 permit files stored in the basement, one by one.

In the field survey, 22 companies doing dry cleaning by perchloroethylene were identified. Out of 22, only 8 companies have permit files in the EPI. Re-design of the data base as well as input data validation procedure should be considered as a first step of improved management.

It is obvious that proper waste management is not possible if air emission and effluent is not properly controlled. This is especially true for chlorinated solvents which are volatile and easy to penetrate into the ground. Monitoring capability of air and water by EPI is therefore important. As for analytical capability for monitoring, EPI Bucharest has a handheld TVOC (Total VOC) detection unit by PID (Photo Ionization Detector). This provides a good on-site screening function, but compound identification is not possible. A detection tube system is recommended as an inexpensive means of field monitoring. Also EPI staff in charge should have understanding of potential seriousness of environmental risk by chlorinated organic solvents.

7.5 Waste Oil

Waste oil is generated from industries which are involved in producing and distributing oil products, such as oil refineries and gas stations, and from all other industries which consume oil products, such as the power generation, steel, machinery, chemical, automobile, and shipbuilding industries. Animal and plant oils are discharged from food industries.

Waste solvents are included in waste oil in a broad sense. However, this chapter describes waste oils and waste lubricants as well as oily wastes from petroleum industries, which create major problems for hazardous waste management in Romania, from the viewpoint of "3R." For chlorinated organic solvents, refer to 7.4.

Waste oils
- Waste fuel oil
- Waste lubricant oil
- Water containing waste oil
- Waste animal and plant oils and fats.
- Waste solvent
- Waste paint
- Oily sludge
- Others

7.5.1 Waste Fuel Oil, Waste Lubricant Oil

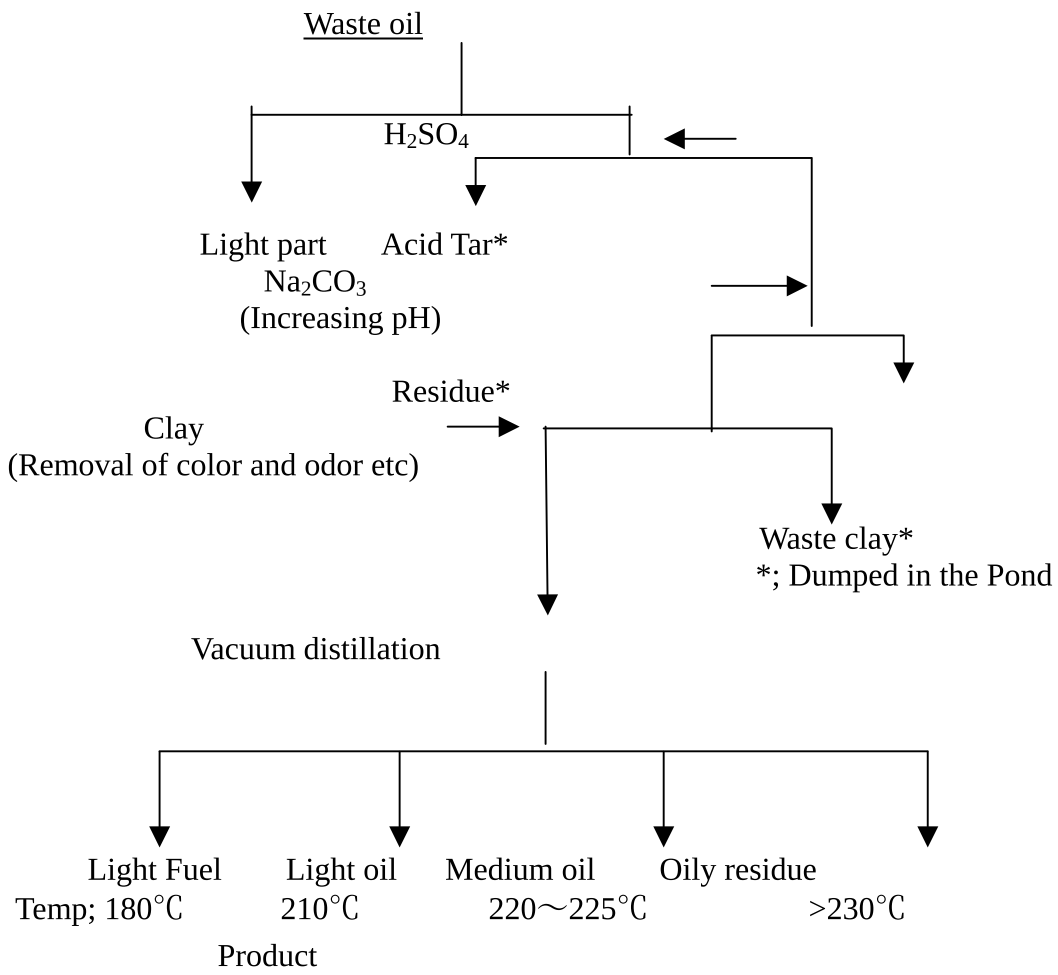
In Japan, about half of all lubricant oils are used up in operations. Almost all that remaining is subject to recycling as fuel either onsite or offsite. Thus only four percent of used lubricating oils are regenerated as lubricating oils. One of the reasons for the low rate of regeneration of waste lubricant oil is that the regeneration of waste lubricant oil needs sophisticated facilities and cost much more than producing the reclaimed fuel. Users' demand for reformed lubricant oil quality has increased significantly recently. However the price differences between reformed lubricant oil and new oils are very small and economic justification for lubricant oil regeneration is also small.

(1) Present Situation in Romania

In Romania, lubricants have been recycled conventionally using sulfuric acid treatment plus activated clay treatment. The present status of S.C. Oilreg S.A., which has been authorized by the National Commission for Material Recycling, Ministry of Industry and Resources, is described below.

1) Process

S.C. OILREG S.A. is one of the certified waste re-generators. In 1917, the company began operation of crude oil refining around Ruminic Sarat city. It changed to the waste oil re-generation business in 1952. The waste oil re-generation process used the traditional method of sulfuric acid purification and activated clay absorption. After purification, the light fuel, reclaimed engine oil and transformer oil were produced by vacuum distillation. Capacity of the waste oil re-generation facility was 60 thousand tons per year.



a) Light Fuel + Light part of chemical cleaning process

Light Fuel

b) Light oil + Medium oil (Mixing)→Base oil

Base oil +Additive→Reclaimed engine oil, transformer oil

c) Oily residue

Return to H_2SO_4 purification process. Or sold as liquid fuel

Figure 7.5.1 Flow of Waste Oil Reclamation in OILREG

2) Decline of the Business

The volume of waste oil has decreased year after year since 1989, to only 900 tons in 2001. The average annual volume of waste oil reformed during the period from 1989 to 2001 was only 10 percent of the capacity available.

Change of Regeneration Quantity of Waste Oils in S.C.OILREG S.A.

1989	1990	2001
72,000t/y	45,000t/y	900t/y

Reasons for this low rate of operation include both external and internal factors.

a. External Factors

- Collection and recycling of waste was well under control until 1989. After the revolution, however, people could freely sell wastes such as waste oil and they dumped wastes of no monetary value. This reduced the flow of waste going to recycling plants. Accordingly, REMAT became weak and many recyclers were shut down.
- The lubricant oil market in Romania has little capacity for accepting reformed oil. Moreover, producing reformed oil is costly for capital investment and ingredient adjustment.

b. Internal Factors

- Acid tar and waste clay cause problems. They are dumped in ponds excavated from the pebbly surface layer to the clay layer. The storage of waste acid tar and activated clay now totals 150 thousand tons.
- Because of the decline in business, it is difficult to purchase waste oil to be used as raw material.

In 1997 S.C.OILREG S.A. stopped the treatment of sulphuric acid purification and activated clay adsorption and vacuum distillation, and discontinued the production of reformed engine oil and transformer oil. They are now producing only reformed light fuel. Much equipment in the plant has not been used since 1997 and has deteriorated. It is judged that these facilities cannot be used unless additional investment is made. However the problems of acid tar and waste clay remain unsolved.

(2) Countermeasures

1) Prohibition of Land-Fill of Acid Tar and Waste Clay

The process of sulfuric acid treatment and activated clay treatment adopted in Romania provides problems in the treatment of sulfuric acid tar and waste clay, which are produced in a large quantity in this process. Treatment of acid tar in Japan, which was previously subjected to incineration, has become difficult because of the intensified air pollution prevention law in Japan. The high cost due to difficulties in treating acid tar, waste clay and other waste affects the business decline of waste lubricant oil regeneration in Japan.

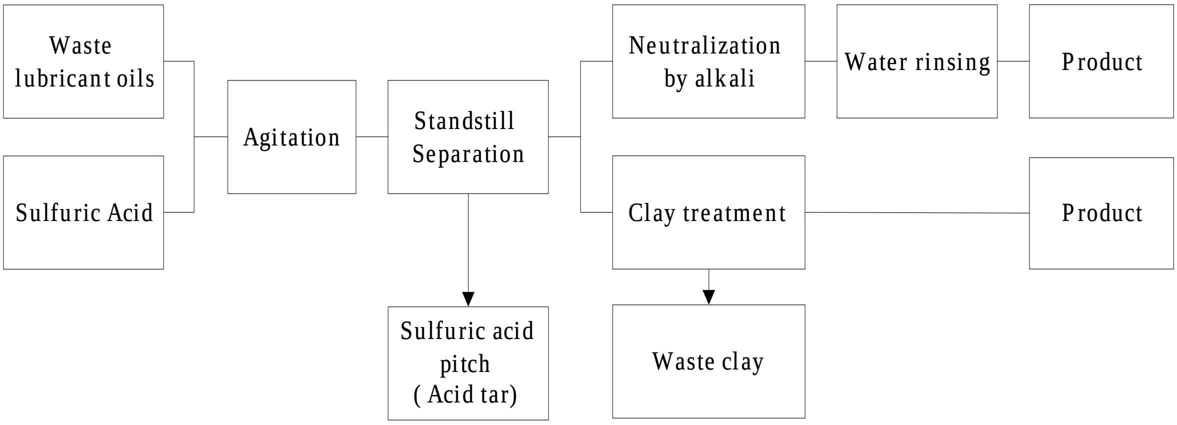


Figure 7.5.2 Conventional H_2SO_4 ＋Clay Treatment Flow of Lubricant Oil Reclamation

In the case of S.C. OILREG S.A. in Romania, acid tar and waste clay are disposed of by landfill, or are dumped into waste oil pond, which is polluting soil and ground water with sulfuric acid and oil. Landfill of acid tar should be prohibited in Romania. Waste clay, which is composed mainly of CaO, Al_2O_3 and contains absorbed oil, should be utilized as a substitute for solid fuel in cement kilns.

2) Production of Reformed Fuel Oil

As mentioned above, waste oil regeneration using the process of sulphuric acid treatment and activated clay treatmen" is not considered to be practical on a long-term basis because waste treatment in this process is difficult. This is evident from the fact that the OILREG business is declining. It is desirable to recycle fuel from waste lubrication

The following figure shows an outline flowchart for producing reformed fuel oil from waste fuel and waste lubricating oil. Waste oil, which is composed mainly of lubricating oil discharged from gas stations, automobile repair shops and other facilities can often be recycled into fuel without processing or by simple filtration and heating because such waste oil contains less sulfur and water. Reformed fuel oil can be utilized as fuel for various purposes; however, its quality standard should be established. In Japan, there is a quality standard for reformed fuel oil. The specification is shown below. Sludge generated from the process shown in the flowchart can be used as substitute fuel for cement manufacturing plants.

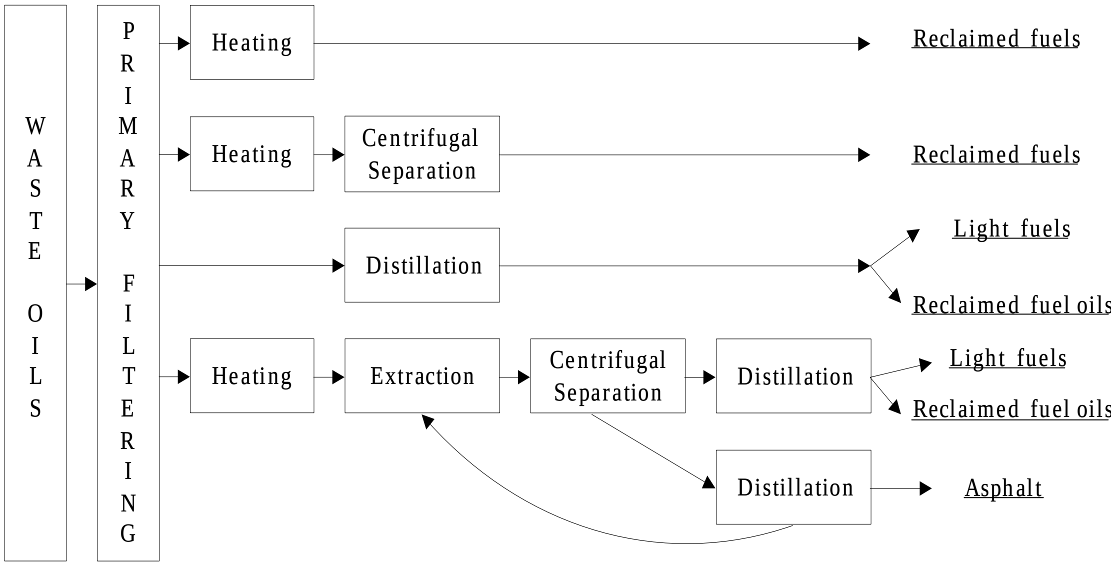


Figure 7.5.3 General Flow of Reformed Oil Production

Table 7.5.1 Specification of Reformed Fuel Oil in Japan

Parameter	Unit	Specification
Density	At 15 ℃	0.87～0.90
Flash point	℃	70～130
Kinetic viscosity	C cSt. at 50℃	15～30
Pour point	℃	-15～-35
Residual carbon	Wt%	<3.0
Moisture	vol%	<1.0
Ash	Wt%	<0.5
Sulphur	wt%	<1.0
Calorific value	kcal/kg	> 10,500

3) Production of Mixed Fuel

Oil sludge and water-containing waste oil that alone are not suitable for reformed fuel oil are mixed into an alternative fuel for cement kilns. The substitute is mixed with reformed fuel oil or even with new fuel oil to regulate the calorific value.

7.5.2 Oily Wastes (Sludge) From Petroleum Industry

(1) Oily Sludge

Almost all oily waste generated from petroleum industry is sludge. Typical oily sludges are as follows.

1) Sludge From Wastewater Treatment Plant

・Separator sludge

Refinery oily water effluent is usually primary treated in a gravity separator. Separated oil is recovered for reprocessing and oily sludge at the bottom of the separator requires periodic removal.

・Flocculation sludge

Dissolved air flotation or induced air flotation units are usually placed between the gravity separator and bio-treatment units. Heavier solids settle to the bottom of the flotation cells.

・Biological treatment

Biological sludge is produced in the process of biological treatment of refinery effluent.

2) De-Salting

Sludge and emulsion consisting of oil and water usually stabilize and require periodic removal and disposal.

3) Tank Bottom Sludge

Sludge accumulates at the bottom of crude oil and slops of storage tanks. The waste sludge, in general, consists of a mixture of water, sediment, heavy oil and rust. Since oily sludge makes up a large portion of refinery solid wastes, any improvement in the recovery of oil from sludge can reduce the volume of wastes.

(2) Generated Amount of Oily Wastes From Petroleum Refineries in Romania

In the year 2000, according to process waste data of the Ministry of Industry and Resources in Romania, ten oil refineries generated 311,919 tons of wastes. Of this amount, they recycled 40,535 tons on-site and sold 29,401 tons to offsite companies for recycling purposes. The remaining, 241,683 tons of wastes were disposed or incinerated on-site. 1,940 tons of acid tar were stored or disposed of on-site.

Names of the oil refineries in the waste data:

5 large refineries:

- SNP-PETROM ARPECIDM;
- SNP-PETROM PETROBRAZI;
- ROMPETROL PETROMIDIA;

- PETROTEL LUKOIL;
- RAFO ONESTI

5 small refineries:

- ASTRA ROMANA Ploiesti;
- ROMPETROL VEGA Ploiesti;
- RAFINARIA DARMANESTI;
- STEAUA ROMANA Campina;

Table 7.5.2 Amount of Petroleum Industry Wastes in Romania

Waste		1995	1996	1997	1998	1999	2000
A. Used in their own production processes, total, out of which	T	6.300	105.939	240.248	79.021	51.554	40.535
- polymeric cakes	T	2.500	2.290	1.475	615	90	100
- petroleum sludge	T	-	-	-	-	16.680	18.900
-slops		3.800	87.987	109.003	51.000	3.956	9.986
- desalting sludge	T	-	-	-	-	633	255
- residual acid solutions and naphtenic leachates	T	-	13.164	636	625	4.487	7.403
- spent catalysts	T	-	8	25	-	-	-
- ion exchange resins	T	-	-	-	6	-	-
-black oil from settling tanks	T	-	-	-	26	68	-
- organic solvents	T	-	1	14	-	-	-
- cresylic leachate*	T	-	2.089	2.895	3.419	-	-
- Sludge from tanks cleaning	T	-	400	126.200	23.330	25.640	3.891
B. Reused by third parties, total, out of which:	T	50.036	61.986	51.967	13.248	30.497	29.701
- polymeric wastes	T	247	315	362	156	214	120
- petroleum sludge	T	13.100	27.934	28.125	8.500	1.090	2.736
- residual acid solutions and naphtenic leachates	T	450	450	450	450	2.813	450
- carbide sludge	T	42	45	10	-	12.290	7.252
- alumina sludge	T	365	180	217	224	90	5
- spent catalyst	T	357	54	26	30	2	18
- oil residues reziduuri uleioase	T	-	-	10	40	-	-
- Salt solutions containing sulfate or sulfite	T	55	58	43	14	12	-
- organic solvents	T	-	-	10	5	-	-
- petroleum residues	T	35.100	32.630	16.944	-	10.710	16.647
-slops	T	-	-	-	-	614	682
- acid tars	T	320	320	320	320	320	320
C. Disposed of (landfilled/incinerated), total, out of which:	T	49.826	184.725	54.934	37.577	549.339	241.683
-desalting sludge	T	10.000	10.350	8.172	3.364	2.498	2.087
-sludge from waste water treatment	T	27.550	158.186	29.679	24.679	28.680	44.651
- sludge from tanks cleaning	T	770	4.170	2.809	3.041	2.694	1.871
- sludge from internal effluents	T	92	1	4	80	500	3

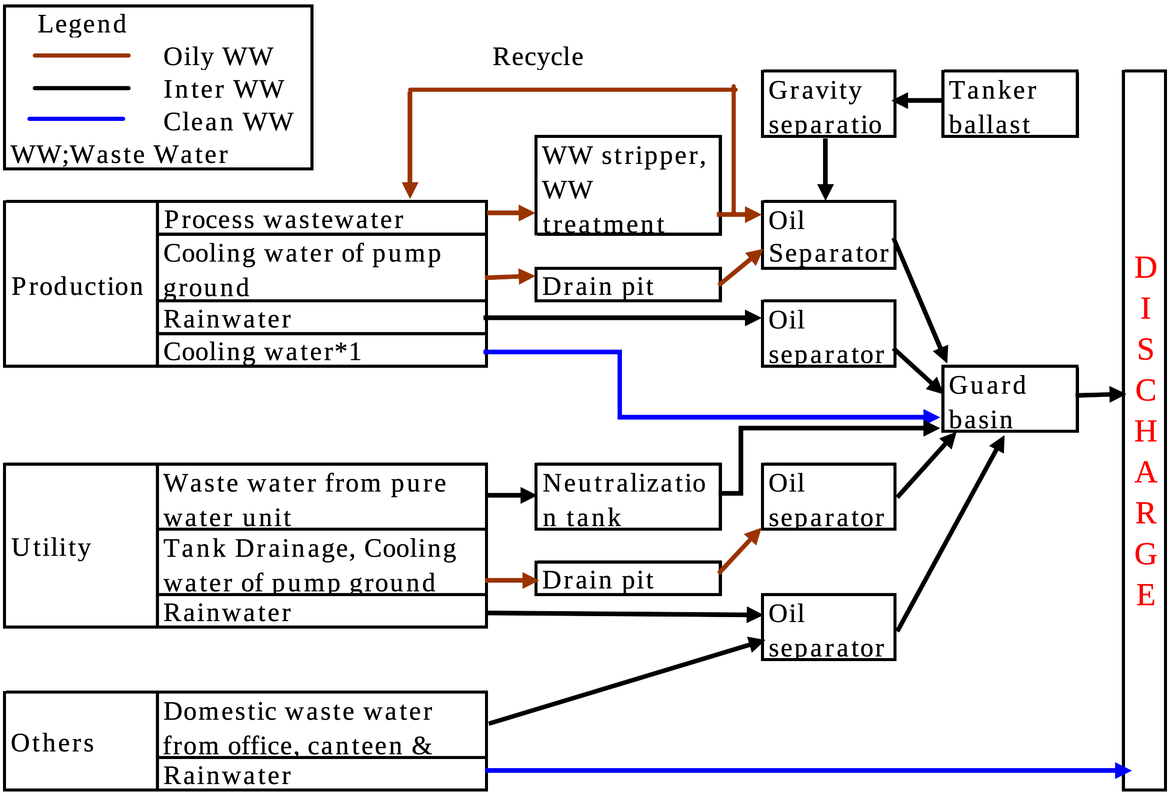
Waste		1995	1996	1997	1998	1999	2000
treatment							
-spent catalysts containing valuable metals	T	-	14	26	22	42	5
- other spent catalysts	T	133	88	111	504	431	425
- sludge type spent catalysts	T	-	-	245	151	54	-
- furnace slag and ash	T	-	1.600	600	1.000	986	1.040
- coke waste	T	-	50	262	50	1	
- ion exchange resins	T	22	1	1	1	12	1
- solutions and sludge from ion exchange regeneration	T	-	-	-	-	512.552	183.000
-column filling and inert material	T	20	35	40	15	20	25
- spent clay filters	T	597	420	376	191	15	-
- oil residues	T	5.749	150	91	48	38	23
- acid tars	T	2.463	2.100	2.553	1.809	1.966	1.940
-salt solutions containing sulfates and sulfites	t	190	77	61	192	160	558
- spent active carbon	T	12	-	-	-	-	-
- petroleum residues	T	253	2.008	5.432	275	594	4.079
-petroleum sludge from waste water treatment	T	1.975	5.475	5.075	2.155	2.157	1.975
Total	T	106,162	352,650	347,149	129,846	630,409	311,919

(Source; Ministry of Industry and Resources)

(3) Promotion of Oily Sludge Reduction

Wastewater in oil refineries contains oil as a major pollutant. The first priority is to prevent dewatered sludge from oil refineries (oily sludge) from being generated in the wastewater treatment process in order to reduce its volume. For prevention, it is effective to divide the wastewater treatment process according to the extent of oil-mixing (oil content) and reduce the volume of water to be treated and the volume of sludge generated. An outline of the general wastewater treatment of an oil refinery is shown in the figure below.

It is important to divide wastewater into the following three groups according to the oil content for treatment: oily wastewater, intermediate wastewater, and clean wastewater.



*1:Cooling water from facilities that have no oily contamination

Figure 7.5.4 Outline of the General Wastewater Treatment of An Oil Refinery

(4) Promotion of Recycling: Mixed Fuel for Cement Kilns

As described above, most of the oily sludge and water containing waste oil can be mixed with other fuels. Table 7.5.3 shows a typical example of the properties of waste oil sludge and acid tar stored in the waste oil pond of the Romanian Oil Refinery.

Waste oil sludge in the waste oil lagoon is difficult to convert into fuel without any pre-treatment, because it has high water content. It will be necessary to reduce the water content by dehydration using a two-stage or three-stage centrifuge or by mixing with other solid waste. On the other hand, acid tar, which is about pH 1, is a strong acid. It is necessary to neutralize it entirely or partially for reasons of handling, maintenance of equipment, etc. In any case, the problem is that it is difficult to extract acid tar from a waste oil lagoon in an economical way. Before mixing, it is essential to use a high-viscosity pump and a screw conveyor to extract it from the lagoon.

Table 7.5.3 Examples of Waste Oils and Acid Tar in Waste Oil Lagoons

Refinery	Sample	Area (m)	Quantity (m3)	pH	Calorific Value (kcal/kg)	Water (%)	Sulfur (%)	Ash (%)
A	Lagoon19	130×100×0.5	6,500	1.5	7,592	13.2		
	Lagoon14	100× 40×0.9	3,600	1.0	7,116	18.4	2.6	
	Lagoon17	140×100×2.1	29,400	1.0	5,970	23.2		
B	Lagoon 1	110× 60×1.3	8,580	6.5	6,931	42.0		
C	Lagoon 1	285× 120×0.1	3,420	3.0	8,549	21.6		

7.6 Medical Wastes

7.6.1 Introduction

Medical Wastes (wastes from healthcare establishments – hospitals, clinics, doctors, dentists etc.) are recognised as a key issue by the Ministry of Water and Environmental Protection and by the Ministry of Public Health. Many of these wastes are regarded as hazardous wastes. Table 7.6.1 shows the entries from the European Waste List identified as “hazardous wastes”.

Table 7.6.1 – Hospital Waste Generation Factors

18	*Wastes from Human or animal healthcare and/or related research*
18 01	**Wastes from natal care, diagnosis, treatment or prevention of disease in humans**
18 01 03*	Wastes whose collection and disposal is subject to special requirements in order to prevent infection
18 01 06*	Chemicals consisting of or containing dangerous substances
18 01 08*	Cytotoxic and cytostatic medicines
18 01 10*	Amalgam waste from dental care
18 02	**Wastes from research, diagnosis, treatment or prevention of disease involving animals**
18 02 02*	Wastes whose collection and disposal is subject to special requirements in order to prevent infection
18 02 05*	Chemicals consisting of or containing dangerous substances
18 02 07*	Cytotoxic and cytostatic medicines
20	**Municipal Wastes (Household waste and similar commercial, industrial and institutional wastes) including separately collected fractions**
20 01	**Separately collected fractions**
20 01 31*	Cytotoxic and cytostatic medicines

Table 7.6.2 shows hazardous waste generation estimates prepared by the Institute of Public Health based on data reported to the Directorate of Public Health by 8 Judets (Counties).

The JICA team validated this figure by means of survey and estimated generation per day per occupied bed and calculated a total for Romania of 16,750 tons per year. Table 7.6.2 shows the generation factors used, and the total generation was calculated based on total number of 156,766 beds occupied for 275.1 days per year.

The estimation is for hazardous wastes generated by hospitals. The total waste generation (hazardous + non-hazardous) would be expected to be in the region of 75,000 per year.

Table 7.6.2 – Estimated Hazardous Medical Waste Generation

Type of Hospital	**Estimate of Waste Quantity**			
	Kg/day	t/yr	# of units	Total Generation (t/yr)
County Hospitals				
Minimum quantity	128	47		
Maximum quantity	661	241		
Average quantity	335	122	84 hospitals	10,248
Municipal Hospitals				
Minimum quantity	16	5.8		
Maximum quantity	50	18.2		
Average quantity	31	11.3	141 hospitals	1,593
Special Hospitals				
Minimum quantity	9	3.2		
Maximum quantity	196	71.5		
Average quantity	52	19	20 hospitals	380
Medical Centres				
Minimum quantity	0.3	0.11		
Maximum quantity	96	35		
Average quantity	22	8	34 centres	272
Municipal Bucharest*				
Minimum quantity	8	3		
Maximum quantity	641	233		
Average quantity	150	54	47 units	2,538
Romania total based on average generation				**15,031**

* Estimate for Bucharest based on actual 2001 data.

Table 7.6.3 – Hospital Waste Generation Factors

	Generation rate (grams / day / bed)			
Waste Type	Romania	Germany	Switzerland	USA
Infectious Waste	297			
Sharps	86			
Human tissue	5.4			
Total	388.4	640*	500*	1,000*

* Healthcare waste management – Bucharest (Flemish Government funded study)

A study undertaken by Ms. A. Vandeputte checked the quantities of waste during two days in the St. Pantelimon, Bagdasar and University Hospital in Bucharest. 0,38 kg/bed.day were measured. This data combined with the data in the above table gives confidence that the 15,000 t/y – 16,750 t/y estimate is reasonable.

7.6.2 Current Situation in Romania

Typically in Romania the management of medical wastes is poor and severely under-funded. Particularly:

- Medical wastes were poorly segregated by category and by hazard, since Ministerial Order no. 219/2002 regarding the management of healthcare wastes, management has been improving, wastes are better segregated in most health care units, but containerisation is still poor.
- Wastes generated in hospitals are commonly burnt in “cremators” which operate at relatively low temperatures and feature minimal emissions control or no emissions control;

Considerable work has been undertaken to begin to improve the management of medical wastes in Romania. Much of this work has been funded by the Flanders Government, and was undertaken in three pilot hospitals. This work has resulted in considerably improved hospital waste classification and segregation in the pilot hospitals and efforts are being made to disseminate the results.

There are currently three merchant facilities in Romania, they comprise basic fixed-hearth incinerators. These facilities are operated by ProAirClean in Timisoara, Mondeco in Suceava and S.C Mercator DV COM S.R.L. in Bucharest. These have had limited success capturing the medical waste market due to the reluctance of the waste generators to pay cost of treatment and disposal and generally serve smaller private sector waste generators. ProAirClean have switched to taking industrial waste rather than medical waste. The incinerators themselves may have problems meeting full EU standards.

7.6.3 Options for Medical Waste Management

The key to sound management of medical wastes is their efficient identification, characterisation, classification and segregation. It is particularly crucial to segregate hazardous wastes from non-hazardous.

A number of technologies exist for the treatment and disposal of hazardous medical wastes, each has advantages and disadvantages. The established technologies are listed in Table 7.6.4 along with these advantages and disadvantages.

Table 7.6.4 – Technologies for Management of Hazardous Medical Wastes

Technology	***Advantages***	***Disadvantages***
Incineration	• Will effectively treat all categories of medical wastes. • Highly robust, established technology. • Highly flexible.	• Relatively expensive.

Technology	***Advantages***	***Disadvantages***
Plasma Incineration	• Will effectively treat all categories of medical wastes.	• Very expensive. • Not fully established technology.
Autoclaving / Other steam systems	• Autoclaves will inactivate most pathogens (the majority are inactivated between 60^{o}C and 80^{o}C) • Relatively low temperature system. • Low cost system	• Not effective at inactivating bacterial endospores. • Waste needs pre-processing or post-processing e.g. shredding.
Chemical disinfection (e.g. Glutaraldehyde, Quaternary Ammonium, Hypochlorite, Chlorine Dioxide)	• Can inactivate even highly resistant micro organisms. • Low cost.	• Waste needs pre-processing e.g. shredding to maximise surface area presented for disinfection. • **Only surface of waste is reliably disinfected**. • Many disinfecting materials are themselves highly hazardous.
Microwave (actually a thermal treatment)	• Will inactivate the majority of pathogens. • Relatively low temperature system. • Easy to manage system. • Relatively low cost.	• Not effective at inactivating bacterial endospores. • Possible operational and reliability issues. • Waste needs pre-processing or post-processing e.g. shredding.
Irradiation (Gamma)	• Can be very reliable system.	• Extensive shielding for workers is necessary. • Visible characteristics of waste unaffected (requires post-treatment e.g. shredding, prior to disposal)
Irradiation (e-beam)	• Claimed to be highly effective.	• New system, not fully established technology.

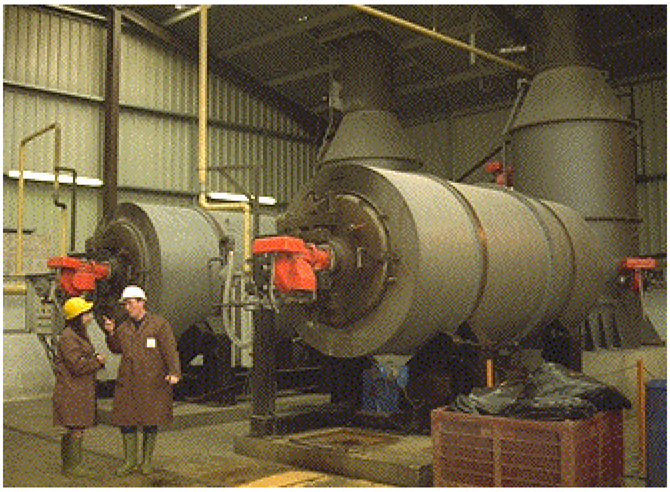
Table 7.6.5 shows general applicability of technology by type of medical waste (source: “Safe Management of Healthcare Wastes” WHO 1999).

Table 7.6.5 – Technologies for Management of Hazardous Medical Wastes

Technology	***Infectious Waste***	***Anatomical Waste***	***Sharps***	***Pharmaceutical Waste***	***Cytotoxic Waste***	***Chemical Waste***	***Radioactive Waste***
Rotary kiln incineration	Yes	Yes	Yes	Yes	Yes	Yes	Low level infectious
Pyrolytic incineration	Yes	Yes	Yes	Small quantities	No	Small quantities	Low level infectious
Single chamber incinerator	Yes	Yes	Yes	No	No	No	Low level infectious
Chemical disinfection	Yes	No	Yes	No	No	No	No
Wet thermal treatment	Yes	No	Yes	No	No	No	No
Microwave irradiation	Yes	No	Yes	No	No	No	No
Other method				Return expired drugs to supplier	Return expired drugs to supplier	Return expired chemicals to supplier	Decay by storage

It can be seen from the preceding table and discussions of limitations, that the only technology believed to be wholly reliable for all types of hazardous medical waste is incineration. Therefore incineration is the preferred technology for hazardous medical wastes.

Figure 7.6.1 - Basic Clinical Waste Rotary Kiln



If hazardous medical waste containing the less resistant pathogens, for which the lower temperature thermal systems are effective, can be efficiently segregated then those lower temperature thermal processes could be used for those wastes. **If effective segregation cannot be guaranteed then all infectious and hazardous wastes must be treated by incineration.**

Similarly, if effective segregation of hazardous medical wastes from non-hazardous medical wastes cannot be guaranteed then all medical wastes should be treated by incineration.

All of the common technologies referred to above may be applied at source in hospitals or may be operated by third parties at other locations. The operation of these technologies by third parties has become commonplace due to the ever higher standards required by the EU.

All hospitals, and indeed other healthcare establishments are in a similar position. They have inadequate facilities for safe management of infectious medical wastes and insufficient funds available to develop such facilities. Under these circumstances it is logical to consider the development of regional facilities to serve medical waste generators.

7.6.4 Collection and Transportation

If medical wastes were to be managed at regional facilities a key issue will be the collection and safe transportation of the wastes.

ProAirClean and Mondeco provide a transportation service for medical wastes to their incinerators. Neither have significant capability for long distance transportation of large quantities of medical wastes.

If strategic, regional, facilities are to be developed then collection and transportation systems will need to be developed to serve the regional facilities. Either road transport or rail transport could be used. The road network in Romania is currently poor making long-distance road transportation problematic.

An option that may be worth considering is to locate large regional incinerators near railway sidings and locate satellite transfer stations at suitable railway sidings. Local road transportation could collect wastes from the waste generators and transport the wastes to the transfer stations for subsequent rail transfer to the regional treatment facility in refrigerated rail containers.

7.6.5 Strategy Options

Consideration could be given to developing a number of regional incinerators to EU standards. Key issues to resolve are:

- How many units should be developed?
- Where should they be located?
- Who is to develop and operate them?
- How are they to be funded?
- How are capital and operating costs to be recovered?
- How are wastes to be transported to the facilities?

7.6.5.1 Number and Locations of Incinerators

Regarding the number and locations of medical waste incinerators, the basic options are:

- To upgrade/replace all existing units to meet EU standards – likely to be by far the most expensive option in the long term.
- To develop a small number of large strategic incineration facilities, for example as proposed in the Flanders Report – likely to be the most cost effective in the long term but may have collection and transportation problems.
- To develop a large number of strategic incineration facilities to serve slightly smaller geographical regions.

Strategic incineration facilities could be located at the larger hospitals or could be developed on dedicated sites away from the hospitals, chosen for ease of transport / access.

This issue cannot be considered in isolation, it is to a certain extent linked to the issue of Who should develop them.

7.6.5.2 Who Should Develop and Operate Facilities

In terms of who should develop the necessary incineration facilities there are several options, the main ones being:

- Development by the larger hospitals and operated as a service to other hospitals;
- Developed by a "non-profit" organisation formed by a group of hospitals;
- Developed by third parties for operation as a merchant service to medical waste generators.

Development by the larger hospitals or a group of hospitals for operation as a non-profit organisation is potentially the most cost effective option. Third parties are unlikely to be interested in developing the facilities without strong contractual / financial guarantees from the Ministry of Public Health / Government.

7.6.5.3 Funding Facility Development and Costs Recovery

Essentially, the development of facilities will have to be funded by the government or by private sector. As indicated above, the private sector is unlikely to be willing to invest in development of these facilities without substantial guarantees from government.

Either way, it may be possible to attract donor investment funds at highly preferential rates but once again the government will need to guarantee such an investment loan and demonstrate that the investment itself is financially sound – i.e. demonstrate that the costs, plus profit can and will be covered, logically from the waste generators.

The current funding of hospitals is inadequate and in such a situation proper waste management is likely to be one of the first aspects of hospital operation to be affected. This means that a mechanism for payment for services needs to be developed in such a way that the funds are "ring-fenced" and cannot be spent in other ways. A current example is the insurance system which funds drugs and medicines, although this has suffered lost funds this year.

7.6.5.4 Waste Collection and Transportation

As indicated earlier, this is a key issue and needs to be considered as an integral part of the strategy to develop the facilities.

Waste collection and transportation could be undertaken by the individual waste generators, the facility operators, by third party contractors or most likely a combination of these.

Consideration should be given to the use of medical waste reception and transfer stations to enable use of the rail network for medical waste transportation or to enable more efficient use of the road network.

7.6.5.5 Next Steps

Given the number of and size of hospitals in Bucharest and its surrounding regions it is sensible to proceed with the development of a strategic regional incineration facility for

Bucharest and Ilfov (and perhaps also to serve some of the counties in the Southern Region) as quickly as practicable.

It is recommended that a feasibility study be undertaken to determine the optimum solution for facility development which will meet the medical waste management needs of Romania within the planned implementation programme in preparation for EU Accession.