

Section VI.K.

Guidance by source category: Annex C, Part III Source Categories

Shredder plants for treatment of end of life vehicles

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Information Document on Shredder Plants for End-of-Life Vehicles

1 INTRODUCTION

The shredding of automobiles (and major household appliances) is a process where at the heart of the shredder, a hammermill acts as a giant tree chipper by grinding the materials fed into it to fist-size pieces. The shredding of automobiles results in a mixture of ferrous metal (*e.g.*, iron-containing scrap), non-ferrous metal (*e.g.*, alloys of copper and aluminum), and shredder waste. These constituents are separated by a variety of methods, generally on-site. The ferrous and the non-ferrous metals, the so-called shredder heavy fraction, can be sold to secondary metal smelters where they are recycled into new products. Shredder waste consists of glass, fiber, rubber, automobile liquids, plastics, and dirt. This shredder waste is sometimes differentiated into shredder light fraction (SLF) and dust. For automobile shredders, the SLF makes 25 %. Modern shredder plants will have dust cleaning equipment such as cyclones or bagfilters (in fewer cases). A schematic drawing of a shredder process is given in Figure 1.

ASR often contains hazardous substances such as lead, cadmium, and PCB. Therefore, some countries have classified ASR as hazardous waste and have established legislative controls. There is not much information available as to the occurrence of PCDD/PCDF in the shredder process and to our knowledge there are no studies as to the formation of PCDD/PCDF within the process. The formation and release of PCDD/PCDF from the ELV shredding process can be explained by the fact that in the process there are present: polymers, oils and other lubricants as carbon and chlorine sources and heavy metals to catalyze the formation of PCDD/PCDF. The shredding process itself does generate sufficiently high temperatures at the surface of the materials to generate PCDD/PCDF. Finally, due to the input materials, precursor substances may be present, such as PCB (to form PCDF) or chlorinated phenols and benzenes (to form PCDD and PCDF).

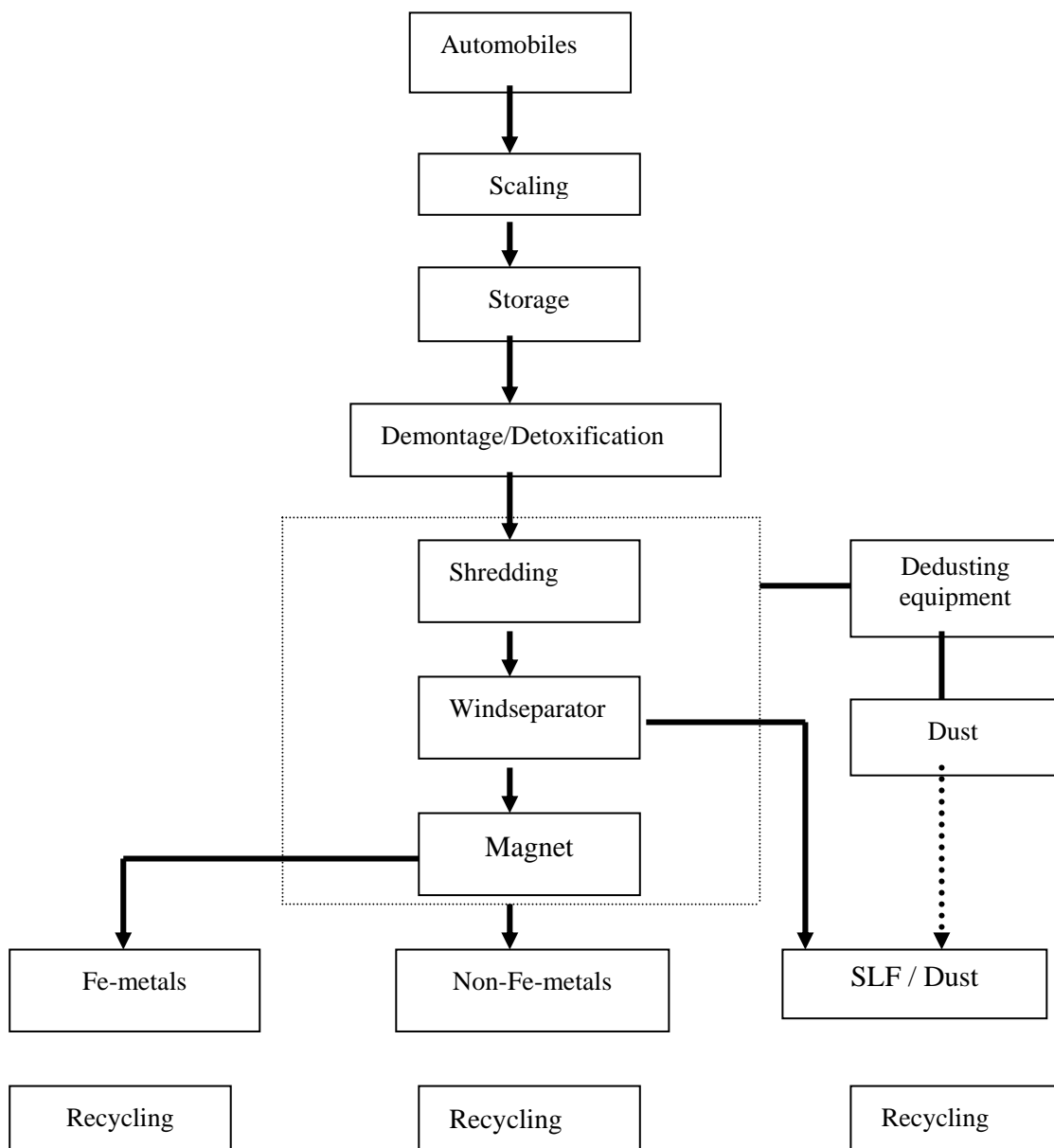


Figure 1: Shredder process and releases

2 COUNTRY SITUATIONS

The 2003 report from Landesumweltamt Nordrhein-Westfalen stipulates that worldwide there are 700 shredder plants. Of these 43 are certified according to the Ordinance for end-of-life vehicles (LUA NRW 2003). In Germany in 2001, 3,023,777 passenger cars were taken out of use; of these between 1.1 and 1.7 million cars can be considered ELV (FhG-ICT 2003). In the EU Member States it is assumed that 8-9 million tons of wastes are generated from ELV (EC 2000).

In Austria there are six shredder plants in five provinces (Laender) (WKÖ 2002). In 2002, 212,500 motor vehicles were taken out of use of which, 129,063 were dismantled in the shredder plants. The mass balance is given in Table 1.

Table 1: Mass of input and outputs of Austrian shredder plants in 2002 (WKÖ 2002)

Input/Output	Total Mass from Six Shredder Plants Combined	
ELV shredder input	98,400 t	100 %
Fe-scrap from ELV	70,900 t	72 %
Non-Fe scrap from ELV	4,900 t	5 %
Shredder waste from ELV	22,600 t	23 %

In the EU 7,530,000 ELV have been treated in 2000 as shown in Figure 2 and shredder operators existed as shown in Figure 1 (ACEA 2004).

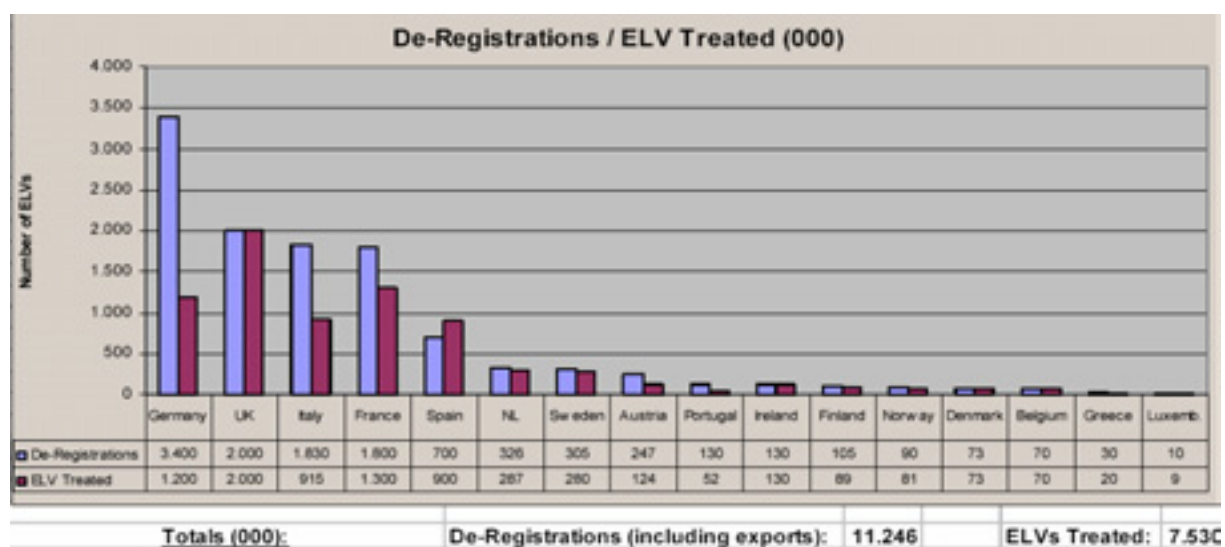


Figure 2: De-registration and ELV treated in EU Member States plus Norway

COUNTRY	Total number of Shredder Operators (Companies)	Total number of Shredder Locations	Thereof Shredder Operators certified by a Third Party	Operators take untreated ELVs and process them not de-polluted	
				No	Yes
Austria	6	6		X	
Belgium	10	12	0		X
Denmark	5	13	0	X	
Finland	2			1 Operator	1 Operator
France	15	42			X (2)
Germany	41		41	X	
Greece	2	2			X (3)
Ireland	2	2	0		X
Italy	16	18	16		X (4)
Luxembourg	0	0	0		-
Netherlands	5	11	5/11 (1)	X	
Norway	4	4		X	
Portugal	2	2 (P)	0	X	
Spain	18	21	0		X (3)
Sweden	3	6	3	X	
UK	8	37	8	X	

Figure 3: Shredder operators in EU Member States plus Norway

In the United States, approximately 10 to 12 million automobiles are recycled every year; in California, there are seven shredder plants that treat 700,000 automobiles annually and generate an estimated 287,000 tons of shredder waste (California's Automobile Shredder Waste Initiative 2002).

In Japan, about 5 million of ELV have been annually discharged and they are recycled and treated by dismantling and shredding (MOE Japan 2003).

3 POPS RESULTS

3.1 Polychlorinated Biphenyls (PCB)

Shredders for end-of-life vehicles (ELV) have relevance for POPs since:

- PCB contamination of oils has been detected (*e.g.*, 0.59-129 mg/kg in untreated shredder waste) and 2.57-45.1 mg/kg of treated shredder waste (California's Automobile Shredder Waste Initiative 2002);
- In Germany, the median PCB concentration in SLF was 5 mg/kg; 20 % of the wastes exceeded the limit value of 50 mg/kg (LUA NRW 2003);
- PCB concentrations in the fly ashes from the flue gas cleaning equipment is in the range of 10-600 mg/kg. 600 mg/kg were measured in 1996; today the concentrations are lower (maximum of 48 mg/kg) (LUA NRW 2003)

Some selected contaminants found in SLF are shown in Table 1.

Table 2: Selected contaminants found in SLF (LUA NRW 2003)

Contaminants	Unit	No of measurements	Min	Max	Median
As	mg/kg d.m.	31	1.7	350	38
Cd	mg/kg d.m.	112	0.23	550	38
Cu	mg/kg d.m.	106	0.24	409,800	10,700
Hg	mg/kg d.m.	95	0.0011	48.3	1.9
PAH (EPA)	mg/kg d.m.	233	0.0074	715	40
PCB (sum of 6 congeners times 5)	mg/kg d.m.	784	0.001	297	5.0

It has been confirmed that ASR derived from ELV contains PCB in the ppm range (Table 3) (Urano *et al.* 1999, Sakai *et al.* 1998, 2000). PCDD/PCDF contamination in engine oil from ELV could not be detected. Taking congener profile into account, the major reason can be considered that PCB containing materials which manufactured in the past were mixed in the recycling and waste processes. While POPs emission from shredding plants were not examined in these studies, in light of PCB in the ppm range in ASR, potential emission of POPs through the flue gas should be considered. This PCB release originates from the commercial PCB mixture that has been used in automobiles. These PCB are not unintentionally generated POPs and thus in a strict sense not subject to the PCB release inventory under the provisions of Article 5 of the Stockholm Convention. However, since there is no possibility to differentiate between intentional and unintentional PCB in shredder

wastes and emissions, BAT/BEP should be applied to minimize or eliminate release of any PCB from the shredder process.

Table 3: PCB content in ASR (ng/g) (Urano *et al.* 1999)

	1	2	3	4	5	6	7	8	9	10
M ₁ CB	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
D ₂ CB	1,800	590	120	500	620	900	980	520	1,300	15,000
T ₃ CB	13,000	2,600	490	2,200	4,900	9,000	8,100	2,700	12,000	200,000
T ₄ CB	3,600	390	340	340	890	7,800	6,900	2,200	13,000	160,000
P ₅ CB	2,100	230	100	310	260	440	250	450	610	4,800
H ₆ CB	880	69	35	140	89	200	81	210	270	970
H ₇ CB	95	10	6.6	16	15	21	11	26	32	210
O ₈ CB	8.8	2.0	1.7	2.4	3.1	3.1	1.9	3.7	4.7	120
N ₉ CB	1.2	N.D.	N.D.	0.37	0.62	0.46	0.29	0.96	1.0	19
D ₁₀ CB	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.27	N.D.	N.D.	N.D.
Total PCB	21,000	3,900	1,100	3,500	6,800	18,000	16,000	6,100	27,000	380,000

N.D.<0.25 ng/g

3.2 PCDD/PCDF Emissions

PCDD/PCDF have been quantified in German shredder plants (UBA 1996). From Table 4 it can be seen that all shredder had some kind of flue gas cleaning equipment and that the concentrations in the cleaned flue gas range from 0.32 to 0.43 ng I-TEQ/m³.

Table 4: PCDD/PCDF emissions in the off-gases from German shredder plants (UBA 1996)

Installation	Materials Utilized	Output a) nominal b) measured	Operating/ reference oxygen content % by volume	Number of measure- ments	PCDD/F Content in Clean Gas ngTE/m ³	Waste Gas Volume Flow Nm ³ /h	Waste Gas Treatment Remarks
hammer mill	scrap cars (90-95%) white scrap (5%)	20 t/h	no values	3	0.11;0.112; 0.2	26800	cybne deposit Venturi scrubber
rotor mill	mixed scrap (old cars, receptacles, sheeting)	56-65 t/h	20.4	4	0.19;0.24 0.4;0.43	93100	cybne deposit, swirling flow wet deposit
shredder	old cars and mixed scrap	no values		3	0.032	87000	cybne
shredder	own scrap containing non-ferrous metal	18 t/d		2	0.249;0.039	27400	spray scrubber cybne

The LUA report on European dioxin inventory stated that measured PCDD/PCDF data exist for a few shredder installations. Generally, very low concentrations (< 0.01 ng I-TEQ/m³) were found in a plant investigated in Sachsen-Anhalt. The available data were summarized as follows for emissions and emission factors to air (Table 5).

Table 5: PCDD/PCDF emissions in German shredder plants; concentrations in (ng I-TEQ/m³) (LUA 1997)

	Minimum	Maximum	Geometric mean	Arithmetic mean
Emission concentration (ng I-TEQ/m ³)	0.002	0.430	0.056	0.140
Emission factor (µg I-TEQ/t)	0.059	0.667	0.236	0.303

PCDD/PCDF have also been detected in the flue gases at shredder plants for bulky wastes: at the outlet of vapor explosion-proof 0.19 ng TEQ/m³ were found and in the water from vapor scrubbing 0.67 ng TEQ/L were determined (Towa Kagaku Co. 2001). Once again, the source of the PCB is thought to be the technical product since large amounts of wastes primarily from household including furniture, electric appliances, and some metals were shredded at this plant. In addition, steam (100 °C) was blown into the interior of the shredder to prevent explosion in the process of shredding. After passing through the shredder, the steam was scrubbed in a water tank and released to air. Coplanar PCB were detected in the scrubbing water and flue gases.

4 SELECTED LEGISLATION

4.1 Japan

Since controlled type landfill sites to dispose of ASR are insufficient, a new mechanism is building up to guarantee recycling and its appropriate treatment. In the scope of promoting recycling of ELV, a law concerning recycling of ELV will be enforced in 2005 in Japan. This law intends to guarantee recycling and proper treatment of air bags, CFCs, and ASR, as well as to clarify roles of the parties involved in ELV recycling. Especially, it plans to advance careful dismantlement and recycling of resources in the near future. During the process of dismantlement and shredding, it will aim to establish a system that avoids mixing other materials into ELV by means of setting up a standard for receipt of ASR, along with introducing license system of businesses.

4.2 European Union

Directive 2000/53/EC of 18 September 2000 established a legally binding instrument and lays down measures which aim, as first priority, at the prevention of waste from vehicles, and in addition, at the reuse, recycling and other forms of recovery of ELV and their components in order to reduce the disposal of waste and to improve environmental performance. The Directive covers vehicles and end-of-life vehicles including their components and materials. It promotes the prevention of waste and calls on manufacturers that all vehicles placed on the market after 1 July 2003 do not contain lead, mercury, cadmium, or hexavalent chromium. The Directive includes provisions for the set-up of collection systems for ELVs and authorized treatment facilities. A certificate of destruction is a prerequisite for deregistration of the vehicle. Member States shall take the necessary measures to ensure that ELV are stored and treated in accordance with existing legislation (Article 4 of Directive 75/442/EEC).

Treatment operations should include stripping of ELV before further treatment, removal and segregation of hazardous materials, pretreatment should be performed to ensure the suitability of vehicle components for reuse and recovery, especially for recycling. Reuse and recovery should be encouraged. The following targets have been set as shown in Table 6. By 31 December 2005, the targets will be re-examined. Targets beyond the year 2015 will be established. Member States have to report progress every three years (starting 21 April 2002). The Directive entered into force on 21 October 2000.

Table 6: Targets within the ELV Directive of the EU (EC 2000)

Provision	Deadline
For all ELV, the reuse and recycling shall be increased to a minimum of 85 % by an average weight per vehicle and year	Not later than 1 January 2006
For vehicles produced before 1 January 1980, the quota may be lowered to 75 % for reuse and recovery and to 70 % for reuse and recycling.	Not later than 1 January 2006
For all ELV, the reuse and recycling shall be increased to a minimum of 95 % (average weight and per year). Within the same time limit, the re-use and recycling shall be increased to 85 % by an average weight per vehicle and year	Not later than 1 January 2015

The current situation in the EU is summarized in Figure 4.

COUNTRY	Existing Legislation	Directive Implementation Status	Requirements deviating from Directive
Austria	Ordinances issued 11/2002 based on Waste Management Act 2002, Voluntary Agreement (1992)	Implemented	Economic operators not specified, Main tasks placed exclusively on manufacturers / importers, extreme complex report duties
Belgium	Voluntary Agreement 1999, Renewal Voluntary Agreement in negotiation Regional legislation Flanders 1999, Brussels 2002 and Walonia 2003	Implemented in the 3 Regions except art. 4 § 2 and 8 § 1 (Federal competence)	Free take back by 01.01.2006 on the condition of a progressive management plan approved by different administrations before 01.07.2004
Denmark	Consolidation Acts 373 & 860 (1999), Executive Order 141 (2000)	Modification of Executive Order published 19/06/02, covering the period until end of 2006	As defined in "car package" (treatment, requirements to companies, compensation)
Finland	No	In preparation (30/09/01)	Nil
France	Voluntary Agreement (1993)	The French ELV transcription decree has been sent to the council the 13th of March for adoption. (Decree N° 10)	Research: Increase recoverability (2002 90%) & incentives use, Paris marking, Information
Germany	Legislation (Altsatz VO)	Implemented since 01 July 2002	Car owners deliver ELVs to certified dismantlers, Recovery quota, Cost-free take-back, Technical requests for dismantlers
Greece	General Waste Law	Legislation expected not before mid January 04	Athens & Thessaloniki: Cost free take back 01 Jan. 2004
Ireland	Voluntary Agree. in discussion commencing 09/01	2nd draft available	None
Italy	National and regional laws	Adoption foreseen before July 2003	ELV owners deliver ELVs to authorized centers - Car makers are free to create a free-take back network. If they do so they are allowed to guarantee free-take back only if their vehicles are delivered to one of these authorized centers
Luxembourg	General waste law only	Law implemented 01 April 2003	None, however producers are responsible for Monitoring
Netherlands	Special body created by 3 organisations ARN (1993)	Implemented since 04 June 2002	Dutch Government has brought forward the EU 2015 targets to 2007 and 2006 to 2003
Norway	Governmental System (1978)	Implemented since 16 July 2002	As per ELV Directive
Portugal	Scrap Yard Decree (1998) and Voluntary Agreement (1999)	3rd. Draft dated 15.03.03	Management integrated system should (must?) be organised, transport and treatment costs must be borne by producers if negative market values appear
Spain	Legislation (RD 1383/2002)	Issued 03.01.03	Owners deliver ELVs to authorized centers. Producers shall take back ELVs. Negative market values from 1.3.07 if deficit in treatment chain defined by third party. Recovery quotas
Sweden	Car scrapping legislation (1975) Producer responsibility ordinance (1998) Regulation on vehicle dismantling operation (April 2002) Government bill (Mar. 2003) Ban of certain metals (EkoB 2003)	Remaining issues: Cost-free take back 2007, Article 9.2	Car Industry responsible for targets & reports for all cars and for free take-back (cars registered Jan 98)
UK	Statutory instrument 2003 No. 2635	In effect 3 November 2003	

Figure 4: ELV legislation and EU ELV Directive implementation (ACEA 2004)

5 CONTROL MEASURES

In principle, all measure that are considered BAT and BEP and recommended for shredders of ELV are also applicable for shredders of other wastes such as household electrical equipment and other bulky wastes.

Minimum technical requirements for treatment may include (EC 2000):

1. Sites for storage (including temporary storage) of end-of-life vehicles prior to their treatment:
 - impermeable surfaces for appropriate areas with the provision of spillage collection facilities, decanters and cleanser-degreasers,
 - equipment for the treatment of water, including rainwater, in compliance with health and environmental regulations.
2. Sites for treatment:
 - impermeable surfaces for appropriate areas with the provision of spillage collection facilities, decanters and cleanser-degreasers,
 - appropriate storage for dismantled spare parts, including impermeable storage for oil-contaminated spare parts, appropriate containers for storage of batteries (with electrolyte neutralisation on site or elsewhere), filters and PCB/PCT-containing condensers,
 - appropriate storage tanks for the segregated storage of end-of-life vehicle fluids: fuel, motor oil, gearbox oil, transmission oil, hydraulic oil, cooling liquids, antifreeze, brake fluids, battery acids, air-conditioning system fluids and any other fluid contained in the end-of-life vehicle,
 - equipment for the treatment of water, including rainwater, in compliance with health and environmental regulations,
 - appropriate storage for used tyres, including the prevention of fire hazards and excessive stockpiling.
3. Treatment operations for depollution of end-of-life vehicles:
 - removal of batteries and liquified gas tanks,
 - removal or neutralisation of potential explosive components, (*e.g.*, air bags),
 - removal and separate collection and storage of fuel, motor oil, transmission oil, gearbox oil, hydraulic oil, cooling liquids, antifreeze, brake fluids, air-conditioning system fluids and any other fluid contained in the end-of-life vehicle, unless they are necessary for the re-use of the parts concerned,
 - removal, as far as feasible, of all components identified as containing mercury.
4. Treatment operations in order to promote recycling:
 - removal of catalysts,
 - removal of metal components containing copper, aluminium and magnesium if these metals are not segregated in the shredding process,
 - removal of tyres and large plastic components (bumpers, dashboard, fluid containers, etc), if these materials are not segregated in the shredding process in such a way that they can be effectively recycled as materials,
 - removal of glass.

5. Storage operations are to be carried out avoiding damage to components containing fluids or to recoverable components and spare parts.

Primary Measures

On the basis of the above-mentioned knowledge, it can be concluded that PCB and some PCDD/PCDF emitted from shredder plants for the treatment of ELV are mainly derived from technical PCB mixtures or products contaminated with PCDD/PCDF entering the shredder plant with the objects to be shredded. The generation of new, unintentional POPs (mainly PCDD/PCDF and perhaps some PCB) seems to be much lower and may be due to thermal formation processes. Therefore, the following primary measures to prevent formation of unintentional POPs should be considered:

1. Reduction of ASR generation by enforcing thoroughly pretreatment (dismantlement);
2. Prohibition of mixing foreign materials into ELV to be shredded;
3. Strict control of PCB management;
4. Alternatives to shredding treatment (melting in electric furnace).

Secondary Measures

Measures on POPs releases at shredder plants can be considered as follows.

1. Advanced treatment of flue gas (bag filter, activated carbon filter to remove both gaseous and particle emissions);
2. Avoidance of elevated surface temperatures to avoid by-product formation;
3. Improved storage facilities for ASR;
4. Advanced treatment of waste water, if any (activated carbon adsorption).
5. Prevention measures on fire and explosion in the sense of preventing formation of by-products (?)

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