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Recycling of End-of-Life Vehicle Glazing

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1 Introduction

1.1 In Europe, each year, approximately 15 million cars reach the end of their useful lives. Traditionally the last owner has generally sold these ELVs to a vehicle dismantler who will recover those parts suitable for resale. The dismantler in turn sells the remaining hulk to a shredder who will recover the metallic fractions for recycling.

1.2 Together, parts for re-use and metal recycling is currently estimated to amount for 75% of the vehicle by mass. The remaining fraction, shredder residue consists of rubber, glass, plastics, fabrics, dirt etc are consigned to landfill for final disposal

1.3 The material composition of a typical European car is shown in Table 1.

Table 1. Composition of a Typical 2000 European Car (data source ACORD)

Material	**Typical Mass (Kg)**	**% by Mass**
Ferrous Metal	780	68.3
Non-Ferrous Metal	89	7.8
Tyres	40	3.5
Electronics	8	0.7
Fluids	24	2.1
Plastics	104	9.1
Glass	33	2.9
Rubber	18	1.6
Battery	13	1.1
Others	33	2.9
Total	**1142**	**100**

1.4 The End of Life Vehicles (ELV) Directive (2000/53/EC) came into force on 21st October 2000. This directive sets targets to minimise the impact of end of life vehicles by setting targets for recycling, re-use and recovery for the materials used in the vehicle as shown in Table 2.

Table 2. the recycling targets specified in the ELV Directive

	Re-use and Recovery	Re-use and Recycling
No later than 1st January 2006	85% (for vehicles produced after 1.1.80) 75% (for vehicles produced before 1.1.80)	80% (for vehicles produced after 1.1.80) 70% (for vehicles produced before 1.1.80)
No later than 1st January 2015	95% (for all ELV's)	85% (for all ELV's)

1.5 As shown above the average glass content in a vehicle is 3.00%. Typical Glazing Parts consist of glass together with functional materials such as plastic interlayers in laminated safety glass, ceramic inks, silver printing electrical connectors, encapsulation materials, fixing clips and others – according to car manufacturer's requirements for glazing modules. The glass itself is an environmentally compatible material that can be re-melted or alternatively, after appropriate treatment, used as a secondary aggregate material.

2 Glass Types

2.1 In Europe flat glass is produced using the float process and is used for architectural and automotive applications. This is produced from a soda – lime – silica formulation i.e.

Component	Percentage
Silicon dioxide	69 - 74
Sodium oxide	12 - 16
Calcium oxide	5 - 12
Magnesium oxide	0 - 6
Aluminium oxide	0 - 3
Minor materials (traces of allowed additives for tints)	

2.2 Other soda-lime-silica glass compositions are used for bottles, jars and fibres, but there are other compositions according to the required function. These include:

- Lead – alkali glass (e.g. crystal glassware and television screens)
- Borosilicate glass (e.g. glass fibre, ovenware)
- Specialised small volume technical glasses (e.g. glass ceramics, optical)

Mixtures of glass with differing chemical contents are a cause of defects on re-melting, which makes such mixtures unsuitable for the very high quality flat glass required by the automotive industry.

3 Recycling of Automotive Glazing Parts

3.1 After removal from the vehicle the glazing part is processed to produce cullet. In the cullet processing plant the ELV glazing part is crushed and subjected to a series of refining processes i.e. magnetic separation to remove metals, air jets to blow out lighter elements such as the plastic interlayer etc.
Those materials are recycled according to their nature.

3.2 It is important to recognise that quality cullet from controlled sources is a critically important glass making raw material which can:

- Allow an increase in the batch load
- Have a beneficial effect on quality (linked to load)
- Reduce the melting energy requirements
- Reduce batch carryover levels
- Reduce atmospheric pollution
- Reduce batch costs

3.3 A typical float plant uses about 20% of cullet in a batch. For reasons associated with quality and cost, ELV derived cullet is not currently used.

The float glass manufacturing process is extremely sensitive to very low levels of contamination. The following two tables highlight the main problem areas and the risk to float glass quality if not controlled.

Table 3. Main problem areas associated with cullet usage.

Potential problem areas	Risk to float quality if not controlled
Cullet from glass of different compositions (different chemical makeup) e.g. automotive glass from several manufacturers, bottle glass and glass from tableware or ovenware.	Ream in the glass which appears as distortion. Note: Ream is simply a region of glass within the product, which has a composition different from the average.
Clear and tinted glass i.e. iron level	Glass colour and solar control properties
Contamination issues (metal attachments, adhesives, glass printing, heating and antenna wires, plastic from laminated glass)	Inclusions, bubbles, ream knots, colour variation

Table 4. Examples of the effect of contamination.

Type of contamination	Effect
Aluminium	Silicon inclusions and major bubble outbreak
Refractory particles Examples include:- Chromite >0.2mm Carborundum >0.5mm	Inclusions (small particles not detectable)
Silicon Carbide	Major bubble outbreak
Carbon	Affects melting and foaming causing inclusions and bubble. Also colour.

3.4 The contamination issues listed above in table 4 can potentially lead to a loss of 3 to 7 days flat glass production due to quality failure. This could entail a loss of €400,000 to €900,000 and would lead to severe environmental impact. The contaminated glass might not be able to be recycled resulting in the generation of a waste product (approximately 400 – 500 tonnes /day). Increased energy consumption would be required to produce the replacement glass coupled with use of more virgin raw material.

3.5 A typical cullet specification for Float Glass is shown in Table 5. Examples of specifications for Containers and Fibreglass, which are less severe, are also shown.

Table 5. Maximum permissible levels of the major contamination types usually found in cullet, for float, containers and fibreglass.

Contamination types	Particle weight / size	Float max allowed g/t	Fibreglass max allowed g/t	Containers max allowed g/t
Ferrous metals	> 0.5 g	none (2 if < 0.5 g)	65	50
Non-ferrous metals	> 0.1 g	none (0.5 if < 0.1g)	24	20
Refractory materials	> 0.2 mm	none	250	20
Organic substances	> 2 g	none (45 if < 2g)	120	3000

4 Operations Involved in the recycling of Glass from ELV's

4.1 The major operations involved in the recycling of ELV glazing parts are :

- Dismantling

The glazing part must be removed from the vehicle and sorted by type according to the proposed end use i.e. laminated, silver printed rear windows etc. The removal of the glazing part is complicated by the fact that in modern cars the fixed glazing is bonded to the body. The average time for this operation is of the order of 5 minutes / vehicle (source IDIS) which involves a cost of €4-5 / car.
It is important that any contamination is kept to a minimum if the quality standards shown in section 3 above are to be achieved.

In some cases, glazing parts are removed by the dismantler and sold for re-use.

- Cullet Processor

The cullet processor selects from the range of waste glass that is available taking into account such factors as level of contamination, continuity of supply and financial factors e.g. costs and selling prices.

The preferred source of material is container glass (bottles) which are available as a result of the extensive bottle bank schemes operating throughout Europe. Encouragement from the glass industry i.e. the flat and container glass and fibreglass industries has led to the growth of a strong independent glass cullet processing industry throughout Europe. The current position in Europe however, is that only limited quantities of ELV glass have been recycled, because in general in many countries there is no established system for dismantling and collection. A notable exception is the Netherlands where an appropriately financed scheme has been in force for several years. Also windscreen glazing parts from the repair industry where the cost of dismantling is included in the price paid by the car owner.

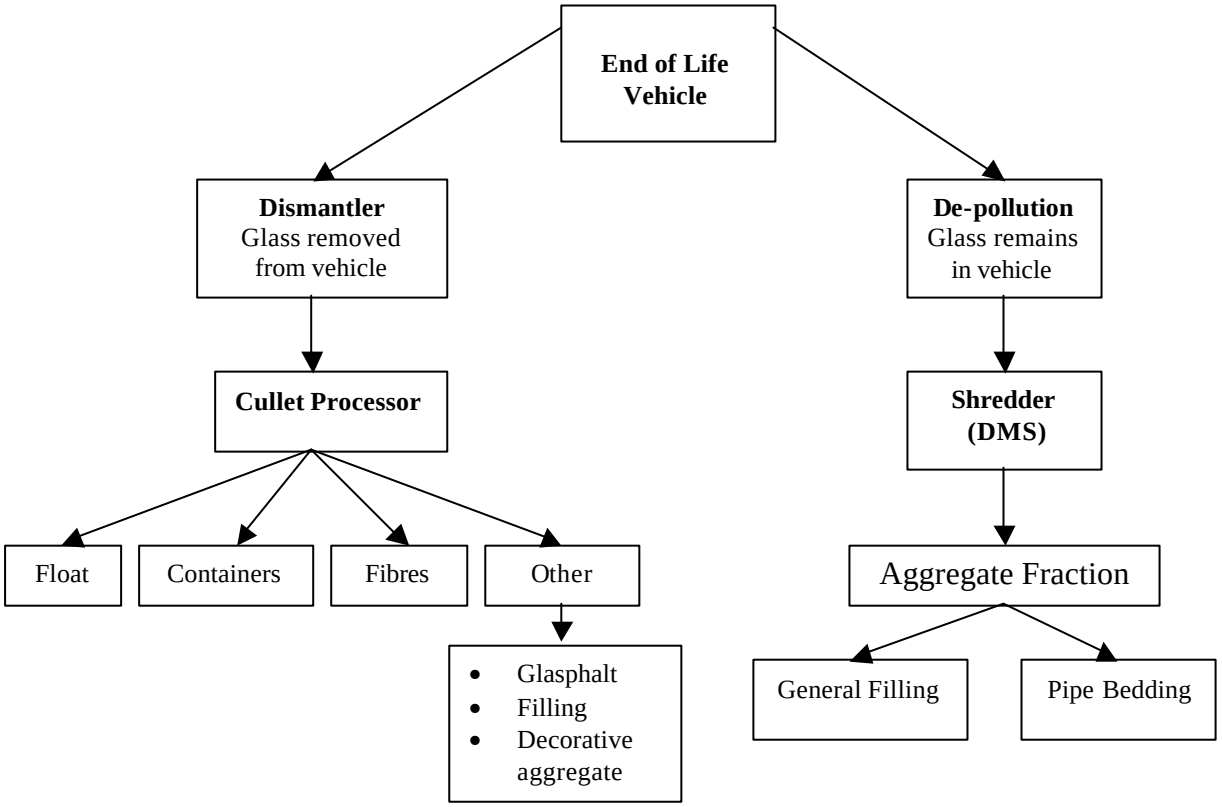
- Shredding

In this operation the whole vehicle is crushed and shredded into pieces, which are sorted into product streams. The more modern shredding plants utilise fluids of mineral suspensions of varying gravity that allow selected materials to sink while others float (Dense Media Separation – DMS). Glass left in the vehicle passes into a mixed aggregate stream consisting of stone and brick etc.

with a control upper size e.g. < 10mm. This is available as a secondary aggregate material for road making, pipe laying and building construction work.

5 Conclusion

European Member States are currently preparing legislation for the implementation of the ELV Directive. This will result in the establishment of an appropriately financed infrastructure for the collection, treatment, dismantling, shredding and recycling of components. When this is in place there is no reason why the glass cannot be recycled following one of the routes shown on the next page:



Routes for recycling of Glass from
ELV Glazing Parts

References:

- GEPVP, Tel: 02/538.43.77 Fax: 02/537.84.69 E-mail: info@gepvp.org
- CARE Report on Automotive Glass Recycling, 2004 update, Kelly Brinkler, www.caregroup.org.uk