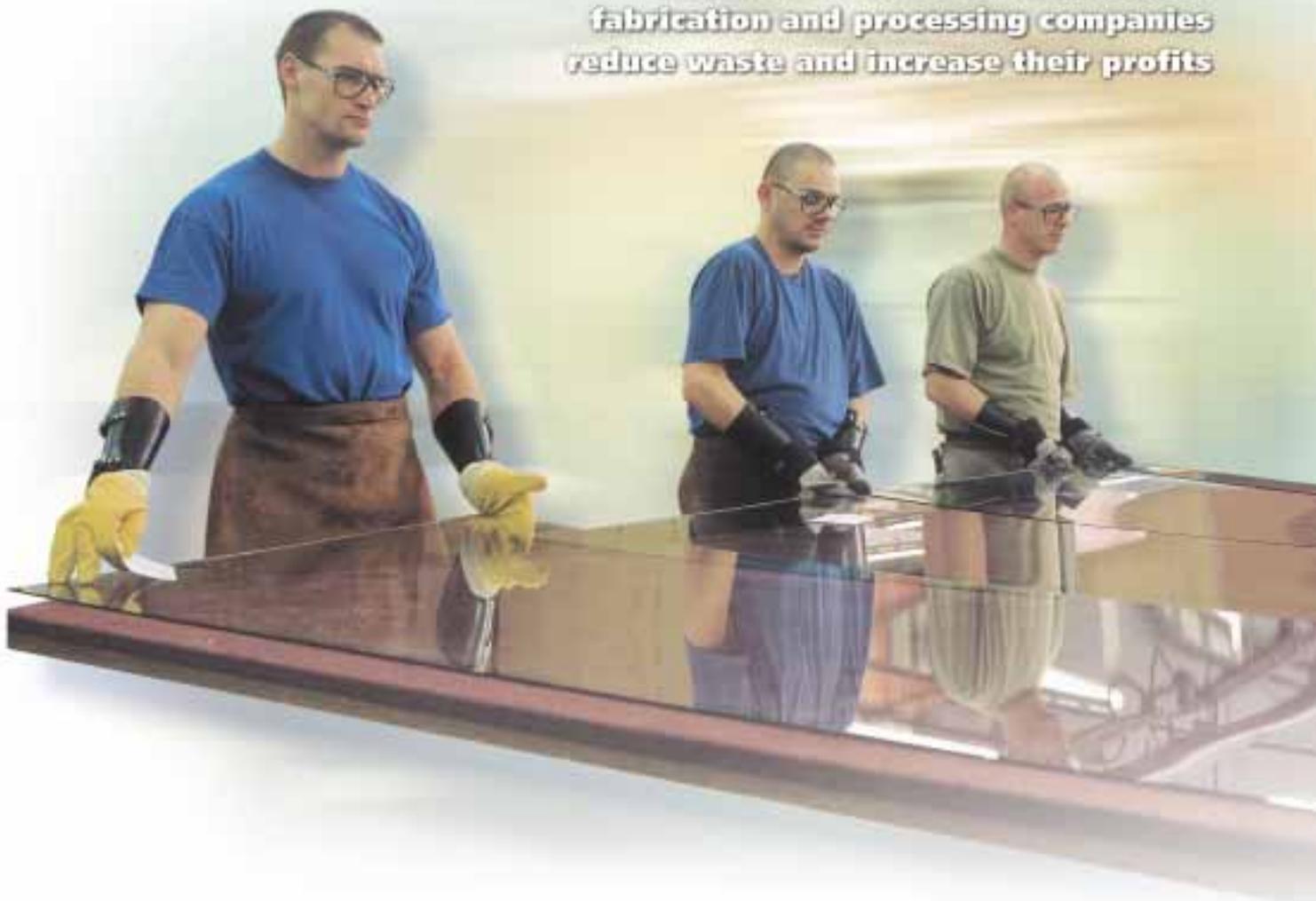




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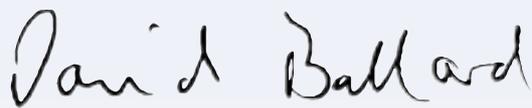
COST SAVINGS FROM REDUCING WASTE IN THE GLASS AND GLAZING INDUSTRY

**This Good Practice Guide provides
practical advice to help flat glass
fabrication and processing companies
reduce waste and increase their profits**



This document is a useful guide on the best way to reduce waste and save money for companies involved in the glazing industry.

I would suggest that any company involved in this area of business read it to increase their profitability and benefit the environment straight away.



**D E Ballard
Chief Executive
Glass and Glazing Federation**



Glass and Glazing Federation

Introduction

The glass fabrication and processing industry carries out a wide range of activities. These activities progressively add value to glass through the production process. Integrating good practice, from the delivery of materials to the dispatch of finished products, ensures optimum efficiency, ie converting the maximum amount of material purchased to saleable product using the least effort.

Waste minimisation is both good environmental practice and good business practice, and is the key to efficiency. It helps to optimise raw materials use, staff time, utility consumption and waste management. **Implementing a systematic waste minimisation programme in your company will save you money - typically 1% of business turnover.** This benefit goes straight to the bottom line.

This Good Practice Guide explains the basic principles of waste minimisation and outlines key issues for the glass fabrication and processing industry. Good practice tips for waste minimisation are given in four checklists covering general glass processing activities, fabrication, processing and cullet management. Use the colour-coded margin markers to help you find your way round the Guide. Principles are in green, issues are covered in the orange section and tips are in pale green. Sources of further help and information are given at the end of the Guide.

The Guide was prepared following consultations with the Glass and Glazing Federation (GGF) and representative companies from the fabrication and processing sectors.

Who should read this Guide?

This Guide is aimed at companies in the glass fabrication and processing sectors that use glass as a raw material and carry out the following activities:

- cutting;
- arassing;
- toughening;
- laminating;
- grinding and bevelling;
- polishing;
- drilling;
- sandblasting;
- acid processes;
- bending;
- sealed unit manufacture;
- window assembly.



What is waste minimisation?

Reducing the amount of material used and waste generated while manufacturing the same amount of product reduces both your production costs and your company's impact on the environment.

Companies often start thinking about waste minimisation by looking at how waste can be re-used or recycled. However, waste is not just the contents of your skips and bins. Waste is a much bigger issue and includes:

- wasted raw materials;
- wasted time;
- wasted utilities (water, compressed air, gas, electricity and steam);
- rework costs;
- the costs of handling, storing, treating and processing waste;
- waste disposal costs.

Although quick savings can be made by re-using and recycling waste, the real savings are achieved by preventing waste occurring in the first place. This ensures that the ratio of materials and utilities consumed to saleable product is as low as possible. Good environmental management and waste minimisation focus on how you manufacture products and contribute directly to your company's efficiency.

What are the benefits of waste minimisation?

Implementing a systematic waste minimisation programme will:

- **Save you money.** Typically 1% of business turnover can be saved through waste minimisation - generating extra profit through reduced production costs per finished item. For a company with a 10% sales margin, a 1% reduction in costs equates to a 10% increase in profits.
- **Provide better control** over your material/utility consumption and waste management costs.
- **Reduce the cost of complying** with environmental legislation.
- **Improve your standing with customers** seeking assurance that their suppliers are operating on a sound environmental basis.

Stop and think for a moment. How much business growth would be required to increase your profits by 10%? The equivalent business growth can often be achieved by optimising efficiency on existing production and turnover, ie through a waste minimisation programme.



How is waste minimisation achieved?

Waste minimisation is a cost-saving exercise, not an add-on cost. It is achieved through a range of techniques including:

- good housekeeping;
- effective staff training;
- preventing waste through quality checks at various process stages;
- material and utility management;
- re-use and recycling;
- modified or new processes involving cleaner technology.

Many waste minimisation measures are no-cost or low-cost. They focus on good housekeeping, training and procedures that ensure process and quality controls identify problems early on. This is particularly important in the glass fabrication and processing industry because identifying and preventing problems quickly avoids waste being generated during later production stages - when considerable value has been added to the glass.

The financial benefit of waste minimisation

As well as reducing disposal costs, a successful in-house waste minimisation programme will also reduce your production costs. The 'true cost' of waste is a function of how much added value has been put into waste before it is lost from the production process. For example, if a product is broken in the goods-out department, causing it to be lost as waste, the true cost of that waste will be:

**True cost of waste =
Cost of wasted raw materials + lost time + cost of utilities used + waste treatment + disposal costs**

For your main process waste (over a selected time period, eg a year or a week), including off-cuts and damaged finished product, use Table 1 to estimate the true cost of waste to your business.

If you do not have all the data you need to fill in Table 1, your accounts department will have readily available information on materials and services bought, product sold and waste disposal costs.

Once completed, Table 1 will reveal the 'true cost' of the process waste your business generates. By minimising waste, the true cost to the business will be returned as profit to your bottom line.

Table 1 Calculating the true cost of waste

Process waste	Original raw material cost (£)	Treatment and disposal costs (£)	Estimated lost production time and processing costs ¹ (£)	Total 'true cost' of waste (£)
Glass cullet 162 tonnes/year	97 200	6 480	20 days @ £120/day	106 080
Water used				
Effluent				
Energy used				
TOTAL	£	£	£	£

¹ Can include lost production time and time spent disposing of waste. For example, breaking a finished unit may cost you the time you spent making it.

Integrating waste minimisation good practice into your business

Following the seven steps shown in Fig 1 will provide you with a framework within which to implement an in-house waste minimisation programme. Many waste minimisation actions can be achieved at no cost and low cost, so integrating waste minimisation into your activities makes excellent business sense.

There are often barriers to the introduction of an in-house waste minimisation programme into any business. In the glass fabrication and processing sector, the most important barriers are:

- little awareness of the benefits of waste minimisation, making it difficult to 'sell' the concept to staff;
- the need to maintain overall output and 'due date' targets limiting the time available to improve process efficiency;
- limited time and resources available to train staff in how to implement good housekeeping measures and improve process operation.

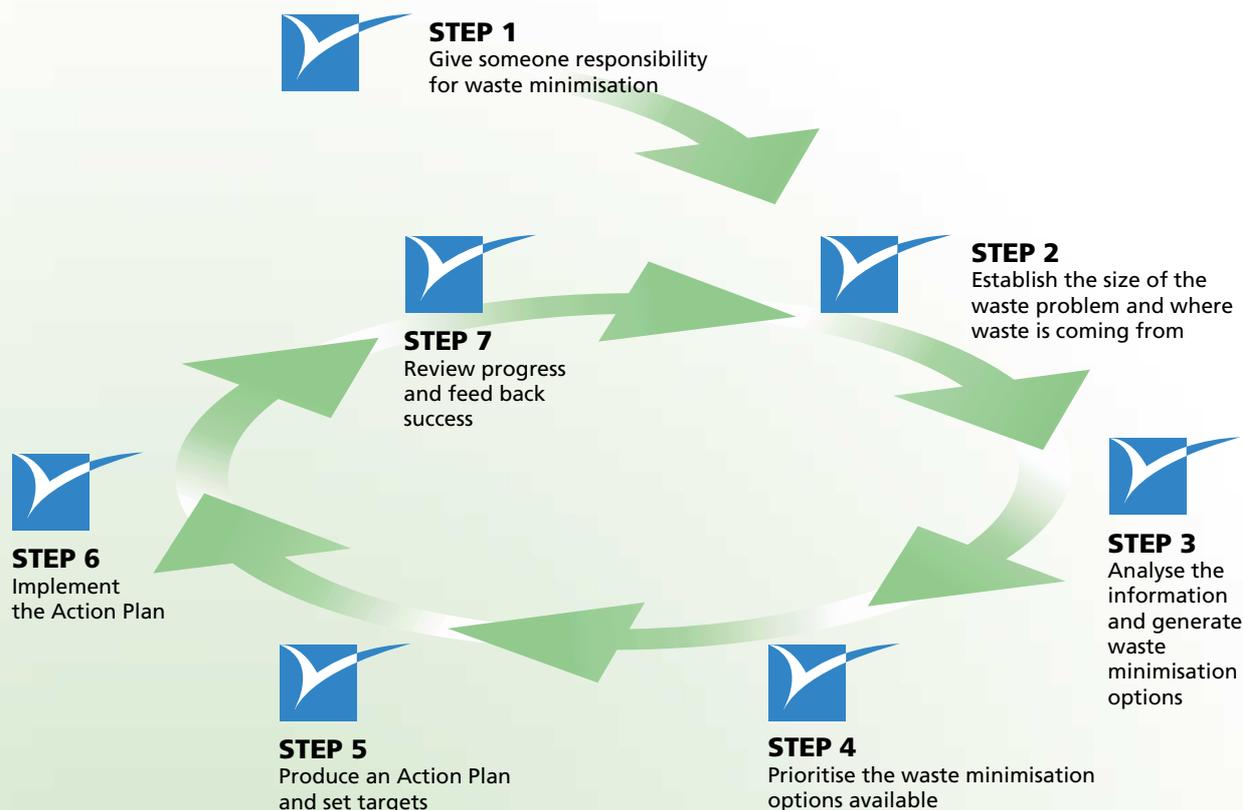
Making staff participation a fundamental part of an in-house waste minimisation programme will nurture greater 'ownership' of improvements and will lead to further projects being stimulated.

Production performance in the glass fabrication and processing industry is often measured according to overall output and 'due date'. Using performance measurements that relate directly to process efficiency will improve overall control and help you to develop good practice. Examples of performance benchmarks that can be used to set targets for improvement include:

- cutting yield;
- glass waste/tonne of saleable product;
- energy costs/tonne of saleable product.

Shortage of time and resources for training need not be a barrier. Promotion of waste minimisation and good housekeeping during staff induction training will be paid back many times over in reduced waste. Notice-boards, team briefings, newsletters, e-mail and 'on-the-job' instruction are also good ways of getting across the waste minimisation message to staff.

Fig 1 Step-by-step approach to waste minimisation



Key issues in glass fabrication and processing

The key production costs in the fabrication and processing sectors are glass, labour and energy. Water and pvb laminate off-cuts are also significant cost items for certain processes (see Table 2). In terms of quantity and overall costs, waste glass 'cullet' (off-cuts, breakages, etc) is the most significant waste, although in terms of unit cost, some other process wastes may be more valuable but are generated in smaller quantities, eg aluminium.

Table 2 Key costs in glass fabrication and processing

Fabrication	Processing
Glass	Glass
Gas	Gas
Electricity	Electricity
Spacer bar	pvb laminate
Frame materials, eg PVC-u, aluminium and wood	Hydrofluoric acid and hydrochloric acid
Waste glass 'cullet'	Water
	Waste glass 'cullet'

Cullet generation

Cullet generation is the net result of a number of decisions and actions made during the production process that impact on material and utility use. Minimising cullet, therefore, reduces linked production costs.

The main sources and causes of cullet generation are:

- cutting activities;
- poor storage and handling techniques;
- inadequate maintenance of equipment and machines;
- lack of checks leading to downstream processing problems;
- poor staff awareness of optimum operating techniques and process settings.

Some cullet generation is generally unavoidable - particularly at the cutting stage when glass optimisation is typically around 94%. Cullet generated during later stages of the production process can often be avoided through operator training, quality checks and good practice. Cullet generated from glass that has passed through a number of production processes has added value. The true cost of waste at later process stages can be considerable (see Table 1) - even allowing for income or reduced disposal costs from cullet recycling.

Implementing the good housekeeping and other low-cost measures described in this Guide will reduce your production costs and increase your profit margins. Progress can be monitored by benchmarking cullet generation against production.



How to reduce waste in glass fabrication and processing

Opportunities to reduce waste - and thus save money - exist throughout glass fabrication and processing. Practical examples of good practice are given below in a series of checklists. Use these checklists to help you brainstorm ideas for reducing waste in your company.

General waste minimisation good practice

Opportunities to reduce waste arise in a range of common activities, eg delivery, storage, cutting, handling and cullet management. Many of the measures in the checklist below are intended to minimise glass damage and the potential for breakage.

GENERAL MEASURES TO REDUCE WASTE	
Benchmarks	<ul style="list-style-type: none"> ■ Set performance benchmarks related to production efficiency, eg cutting yields and amount of cullet generated per tonne of saleable product.
Management, planning and quality	<ul style="list-style-type: none"> ■ Develop a 'right first time' philosophy. ■ Carry out quality checks at critical stages to minimise problems leading to rejected product and downstream processing of rejects. ■ Monitor the cost of processing defects.
Delivery and storage	<ul style="list-style-type: none"> ■ Arrange for 'just-in-time' delivery to minimise storage time and related damage. ■ Develop delivery acceptance procedures and quality checks designed to improve the quality of glass used and reduce the amount of defects/breakages. ■ Measure the amount of breakage in each delivery and charge back any loss to your supplier. ■ Increase stillage size to reduce space requirements and the number of glass lifts. ■ Maintain stillages at an angle of 5 or 6°. ■ Use battens to optimise storage conditions and avoid damage to glass. ■ Keep the glass storage area free from rainwater leaks and dust to reduce staining, the need for cleaning and the possibility of slippage and damage during handling.
Cutting	<ul style="list-style-type: none"> ■ Set targets for glass utilisation. Try to do better than the typical value for the sector of 94%. ■ Design your cutting programme and patterns to minimise waste. ■ Train staff in cutting machine operation, glass breaking and glass stacking. ■ Check the glass before cutting for bubbles, shells, cracks and scratches. ■ Check that equipment is operating properly. ■ Check the accuracy of the 'squareness' of cut-on cutting equipment. ■ Box in the cutting tables to ensure that cullet goes to the side of the table rather than dropping underneath. This avoids unnecessary contamination of the cullet - leading to its disposal rather than being recycled. ■ Catalogue and store significant off-cuts for future use.
Glass handling and processing	<ul style="list-style-type: none"> ■ Reduce the potential for breakage by optimising the layout of the shop floor to minimise the need for handling and the distances that raw materials and products are moved. ■ Train staff to handle glass and end-products correctly to avoid bruising, scratching and damage. ■ Track glass (origin, quality and batch) to enable further processing problems to be prevented if some of a particular batch causes preventable process waste. ■ Check that glass is stacked correctly to avoid problems with automatic de-stacking equipment. ■ Ensure that the correct lifts and equipment are used for lifting and manoeuvring glass from delivery vehicles to factory storage areas. ■ Ensure that racks are well-maintained with unworn felt/rubber padding and set at the correct angle, ie 3°.

GENERAL MEASURES TO REDUCE WASTE (CONTINUED)

Glass recycling	<ul style="list-style-type: none"> ■ Collect waste flat, float and clean glass separately from other glass types and contaminants (eg wood and metals) for recycling. ■ Collect coated, coloured and laminated glasses separately for recycling. ■ Make sure that ceramic, coloured or fire retardant glass does not contaminate flat, float and clean glass forwarded for recycling. ■ Order replacement skips for cullet collection before the ones in use become full. This will avoid glass spilling on the ground and having to be disposed of to landfill because it is contaminated.
Packaging waste	<ul style="list-style-type: none"> ■ Increase the size of the glass blocks to reduce the amount of timber end-cap.
Washing and finishing	<ul style="list-style-type: none"> ■ Ensure that the water supply to washing and finishing machines is turned on only when required. This will save water and effluent costs by reducing water consumption. ■ Use reverse flow cleaning-in-place (CIP) for glass washing. This allows water (which has often been demineralised) to be used repeatedly - say five times. ■ Recycle water from washing and finishing machines to reduce water consumption and effluent generation. ■ Install conductivity monitors to monitor water quality and thus maximise recycling.
Maintenance	<ul style="list-style-type: none"> ■ Ensure that all machinery is well-maintained and clean to reduce mistakes, accidents and breakage. ■ Assign machines to operators and provide budgets for regular maintenance regimes to increase operator ownership.
Site layout	<ul style="list-style-type: none"> ■ Set out production areas to optimise material flow logistics. This reduces both the potential for breakage and the time taken to move the product.

Good practice in glass fabrication

Specific opportunities to save waste in glass fabrication focus on the manufacture of sealed units and frames.

GOOD PRACTICE IN GLASS FABRICATION

Sealed units	<ul style="list-style-type: none"> ■ Check for waste at key points in the manufacturing process. Record the amounts and consider ways of eliminating or reducing this waste. ■ Collect steel and aluminium off-cuts separately for recycling or return to your supplier. ■ Minimise desiccant use by calculating the exact amount required for the volume of the sealed unit. ■ Maintain the correct temperature for sealant storage and use to avoid wasting batches and to optimise sealant application. ■ Stagger breaks in production to avoid the need to purge sealant from machines before and after breaks. ■ Ensure that the optimum amount of sealant is used for a given gap between panes of glass by monitoring actual and target use. ■ Check the quality of two-part sealant mixes to ensure correct performance. ■ Store finished products in safe areas to minimise damage.
Fabrication of frames	<ul style="list-style-type: none"> ■ Check that the dimensions and quality of the profile material (eg look for rubs, marks and scratches) are acceptable to avoid subsequent wastage. ■ In sawing processes, minimise grip waste and, on mitres, cut to the width of the blade. ■ For PVC-u profiles: <ul style="list-style-type: none"> – order steel and aluminium reinforcement in pre-cut lengths to avoid on-site waste; – recycle waste PVC-u by regranulating and blending it into secondary profiles, ie not the all-weather sections but the secondary parts of the profile; – sell PVC-u swarf from drilling/cutting and sprues from welding operations to a reprocessor. ■ If mistakes do occur: <ul style="list-style-type: none"> – recover fittings, hinges, handles, locks and glass in a material reclaim unit; – granulate uncontaminated PVC-u frames; – recycle aluminium frames.

Good practice in glass processing

Specific opportunities to save waste in glass processing are concerned with activities such as laminating, toughening, bevelling and grinding.

GOOD PRACTICE IN GLASS PROCESSING	
Acid processes	<ul style="list-style-type: none"> ■ Use high-quality sealing coating to avoid mistakes and thus minimise waste and rework.
Sandblasting	<ul style="list-style-type: none"> ■ Check the pattern cutting (the most critical stage) to ensure accurate sandblasting. This will avoid waste generation and the need for reworking. ■ Re-use grit and change it only when necessary. ■ Use the best quality sealing coating to avoid mistakes and thus minimise waste and rework.
Drilling	<ul style="list-style-type: none"> ■ Cut a slot from the edge of the glass to reduce the incidence of breakage.
Laminating (resin)	<ul style="list-style-type: none"> ■ Before starting to laminate, ensure that the glass is clean and dry to avoid trapping moisture. ■ Use demineralised water to avoid staining on internal surfaces. ■ Ensure that glass is securely clipped to avoid movement during processing. ■ Check that bubbles are not present in the resin before curing with ultraviolet light. ■ Use the correct cure time.
Laminating (pvb)	<ul style="list-style-type: none"> ■ Maintain suitable conditions for the storage and use of pvb laminate. This will avoid deterioration of the laminate and ensure efficient application. ■ Keep the lamination equipment free of dust to avoid contaminating the product. ■ To guarantee accurate application, check that the lamination equipment is square to the laying table. ■ Inspect the laminated glass after autoclaving to ensure that downstream processes are not supplied with faulty material. ■ Trim the pvb overhang from laminated glass to avoid slippage and damage in subsequent processes, eg on double glazing lines. ■ Maintain autoclaves, cranes and hot air systems correctly to provide efficient and optimum operation. ■ Integrate driers with compressed air systems and autoclaves to avoid staining due to solid deposits, and the need for cleaning.
Bevelling and grinding	<ul style="list-style-type: none"> ■ Turn on the water supply to bevelling and grinding machines only when they are in use. Turn off the water when the machines are not in use. ■ Recycle the water from bevelling and grinding machines to reduce water and effluent costs.
Bending	<ul style="list-style-type: none"> ■ Check moulds thoroughly to prevent quality problems. ■ To avoid unnecessary cracking, raise the oven hood at an appropriate speed and reduce the hood temperature correctly. ■ Utilise the bed space under the oven hood as much as possible to optimise production rates. ■ Operate the oven hood overnight when cheaper energy is available.
Toughening	<ul style="list-style-type: none"> ■ Plan work to maximise periods of continuous operation. This avoids start-up and shutdown, thus reducing energy use and other production costs. ■ To avoid rejects, check the glass for staining before processing. ■ Ensure that ovens and chillers are programmed accurately for each job to optimise heating/cooling time and to minimise the potential for breakage. ■ If a print is applied to the glass, place the print face-up to avoid damaging the rollers and having to stop the process to clean them. ■ Operate the toughener overnight when cheaper energy is available.

Making the most of cullet

You can minimise the total amount of cullet generated, but it is generally not possible to eliminate its production. Recycling your cullet rather than sending it to a landfill will make the most of cullet that is generated - reducing both your costs and your impact on the environment.

Cullet is produced during manufacturing and in secondary activities, eg fitting windows. It is important to include cullet from all processes in your waste management strategy.

Flat glass cullet can be recycled into flat glass, glass fibre or glass wool insulation. Good cullet management will improve cullet quality and thus increase the amount that can be recycled. Contact the Environment and Energy Helpline on freephone 0800 585794 for details of companies that collect flat glass cullet for recycling.

The level of contamination in your cullet has a direct influence on its value and saleability. Generating contaminant-free cullet is, therefore, vital to the financial viability of cullet recycling. There are two main types of contamination:

- inclusions - non-glass materials, eg sealed unit and window frame materials or laminated glass;
- colour contamination - mixed cullet of different colours.

Improving the purity of cullet and preventing colour contamination will increase the value and recyclability of your cullet.

GOOD PRACTICE IN CULLET MANAGEMENT

Reducing contamination	<ul style="list-style-type: none"> ■ Prevent non-glass materials becoming mixed with cullet. ■ Segregate waste streams to prevent mixing of different colours and types of glass. ■ Provide alternative skips for other waste materials. ■ Label all skips clearly.
Management	<ul style="list-style-type: none"> ■ Make one person responsible for ensuring that cullet skips are: <ul style="list-style-type: none"> – inspected daily for inclusions and colour contamination; – well-maintained and clearly labelled. ■ Mark skips clearly with which types of cullet are acceptable and which are unacceptable. ■ Provide skips for unacceptable waste next to cullet bins. This will reduce inclusions. ■ Make yourself aware of the cullet specification required by your cullet collector. ■ Ensure that cullet generated off-site (eg breakage during window fitting) is returned and placed - without any inclusions - in the appropriate skips.
Training	<ul style="list-style-type: none"> ■ Provide staff with regular training in cullet management. ■ Provide clear, written procedures so that everyone knows exactly what to do. ■ Ensure that contractors do not use cullet skips for their waste.
Pick-up	<ul style="list-style-type: none"> ■ Check that the cullet in the skips has no inclusions before the skips are collected by your cullet collectors. ■ Use a limited number of cullet collectors to ensure training and communication on cullet handling remain effective. ■ Ensure that contaminated loads are not forwarded to recyclers. Prices for consignments may change if minimum requirements are not met.

Further help and advice

The Environment and Energy Helpline (0800 585794) can:

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Send you copies of relevant Environmental Technology Best Practice Programme publications. For example, *Profiting from Less Waste* (ET206) outlines the full range of material on waste minimisation now published by the Programme and *Finding Hidden Profit - 200 Tips for Reducing Waste* (ET30) draws on the combined experience of companies and consultants to give practical tips based on industry examples.
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Provide free, up-to-date information on environmental issues and collectors/recyclers of flat glass cullet.
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Tell you about relevant environmental and other regulations that could affect your operations.
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Tell you about the free advice on energy technologies and energy management provided by the Energy Efficiency Best Practice Programme (see also <http://www.energy-efficiency.gov.uk>).
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Arrange for a specialist to visit your company free of charge if you employ fewer than 250 people (at the discretion of the Helpline Manager).



Another useful contact is:

The Glass and Glazing Federation,
 44 - 48 Borough High Street, London SE1 1XB.
 Tel: 020 7403 7177. Fax: 020 7357 7458.
<http://www.ggf.org.uk>



Glass and Glazing Federation

This Guide was produced by the Environmental Technology Best Practice Programme.
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For more information about the Environmental Technology Best Practice Programme and how its free services can help you, please phone the

ENVIRONMENT AND ENERGY HELPLINE 0800 585794

world wide web: <http://www.etbpp.gov.uk>

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