GG277

Finding and reducing waste in plastics processing

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Summary

Waste is any aspect of your operations that fails to add value. It is a significant hidden cost for many plastics processing companies and typically costs 10 - 15 (or even 20) times more than the costs of disposal. While some waste is unavoidable, much of it is not. Most companies can achieve savings of at least 1% of turnover by implementing a systematic waste minimisation programme. Improving environmental performance can, therefore, make a large contribution to business success.

This Good Practice Guide aims to help managers in the plastics processing industry to track business efficiency using waste as a key performance indicator. Taking action to reduce waste will result in significant cost savings, leading to increased profits. It will also help your company to remain competitive and to comply with environmental legislation.

The Guide is intended to help companies wishing to make quick savings from an initial assessment of their environmental performance. Companies are urged to start by preventing waste (ie before value is added to polymer) and to aim for a first-time yield for each polymer equal to their mass balance yield. Making your mass balance yield as close as possible to 100% will reduce polymer waste and increase your business efficiency.

The Guide describes:

- the benefits of waste as a key performance indicator;
- how to identify and collect performance data;
- how to prioritise areas requiring improvement;
- how to gain the support of all employees;
- how to overcome barriers to improving performance;
- a range of no-cost and low-cost measures to reduce waste;
- how to realise quick cost savings and other benefits by reducing waste;
- the need for regular assessment and review to maintain continual improvement in performance.

A series of 11 checklists are provided, as Microsoft® Word files on the CD-ROM in the back pocket of the Guide, to help companies assess their current performance and to identify opportunities to make quick savings. The CD-ROM also contains PDF files of a number of other useful Envirowise publications. Printed copies of these publications are available free of charge through the Environment and Energy Helpline on freephone 0800 585794.

Contents

Environmental performance as a business indicator

This Good Practice Guide is intended to help managers in the plastics processing sector to track business efficiency using waste as a key performance indicator. Waste is any aspect of your operations that fails to add value. It is a significant hidden cost for many companies and it includes the costs associated with:

- regrinding products that are not utilised first time, eg reduced value, and increased labour, energy and maintenance costs;
- managing scrap polymer, waste packaging and other solid wastes;
- wastewater collection, treatment and disposal;
- inefficient use of utilities and processing fluids, eg water, electricity and hydraulic oil;
- emissions to the atmosphere.

The cost of waste is usually much more than the cost of disposal. It is typically 10 - 15 (or even 20) times more, when the costs of polymer, other materials, consumables, rework, energy, water, labour, landfill tax, coatings, printing and lost opportunities for producing saleable product are taken into account. While some waste is unavoidable, much of it is not. It may have been ignored or described in other ways, eg allowance, purge, regrind, rejects, rework, runners, scrap and sprues.

Even efficient companies produce waste. The average cost of waste is approximately 4% of turnover. Most companies can achieve savings of at least 1% of turnover by implementing a systematic waste minimisation programme. If your gross profit is 5%, then avoidable waste amounting to 1% of turnover is equivalent to 20% of the profit margin. Improving environmental performance can, therefore, make a large contribution to business success.

What was 1% of your turnover last year? This is how much you could save by implementing a systematic approach to waste minimisation.

If the true cost of waste is ten times the cost of waste disposal, then reducing waste disposal costs by just £10/week is equivalent to saving £5 000/year. At a gross profit of 5%, this is equivalent to sales of £100 000/year.

1.1 The benefits of waste as a key performance indicator

1.1.1 Reducing costs and increasing profits

Environmental performance and business success are closely related. For example, you pay for the polymer, energy and other resources used in your manufacturing process. You then pay again when a proportion of these resources is not used productively and/or is disposed of as waste. Regrinding and re-using polymer in-house is still waste because it requires more labour and energy, and effectively loses the labour and energy used during first-time processing. The opportunity to manufacture saleable product the first time the polymer enters the manufacturing process is also lost.

Although it is not possible to eliminate all waste, you can achieve significant cost savings by reducing waste. Many of the measures described in Section 6 are no-cost or low-cost.

1.1.2 Complying with legislation

Improving your environmental performance means less polluting outputs from your business. These smaller quantities should be easier to manage, represent less risk and, in many cases, make it easier to comply with relevant environmental legislation.

1.1.3 Winning more business and keeping existing customers

Increasingly, companies and organisations are taking an interest in the environmental performance of their suppliers. For example, some expect suppliers to implement an environmental management system (EMS) certified to the international standard, ISO 14001[1]. Others seek to work in partnership with their suppliers to improve environmental performance.

Improving your environmental performance is likely to help you win new work and to keep existing customers by meeting their environmental purchasing criteria. While this Guide does not explain how to meet specific customer criteria, it does describe a cost-effective and practical strategy for improving environmental performance. It will help you to demonstrate to customers that your company is taking a responsible approach to environmental issues.

Improving environmental management is a work-winning strategy

A company with fewer than 20 employees was required by one of its customers in the automotive industry to implement an environmental management system. Soon after the system was certified to ISO 14001, new work valued at around £20 000 was won from another customer.

1.2 Assessing your environmental performance

To make improvements to your environmental performance, you need to establish the current position. You can do this by looking at:

- Changes to the environment as a result of business activities, ie environmental impacts. These impacts are usually considered by looking at the activities likely to cause them, particularly business inputs and outputs. This approach is likely to maximise resource and cost savings.
- How well the company complies with environmental legislation.
- Existing environmental management practices and procedures.
- Accidents and incidents with adverse environmental impacts, ie their occurrence, management and prevention.

If you want to implement an EMS that complies with ISO 14001, you need to consider all aspects of your environmental performance. This Guide concentrates on business inputs and outputs, as this is where you can quickly reduce your costs. However, companies working towards the implementation of a formal EMS will still find this Guide helpful.

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[1] For practical advice on how to implement an EMS, see Good Practice Guide (GG251) *Environmental Management Systems for the Plastics Industry*. GG251 is available in PDF format on the CD-ROM in the back pocket of this Guide or as a printed copy, free of charge, through the Environment and Energy Helpline on freephone 0800 585794.

Complying with environmental legislation is also important. For the latest advice about the environmental legislation governing your operations, contact the Environment and Energy Helpline on freephone 0800 585794.

1.3 How to use this Guide

The different Sections of the Guide take you through the various stages of assessing your business performance based on waste as a key performance indicator. Advice on how to enlist the help and support of others is given and specific tasks relating to data, analysis, investigation and recruiting others are described. Table 1 shows the Guide's structure and what to expect from each Section.

Checklists are provided, on a CD-ROM in the back pocket of the Guide, to help you to assess your environmental performance and to identify ways of saving money by reducing waste. These checklists and forms are provided as Microsoft® Word files for you to print out as required. A disk icon in the margin indicates when you should look on the CD-ROM for a particular file. The checklists are also given as printed versions in Appendix 2.

The scoring system used in the checklists allows you to assess current performance in terms of the answers to a series of questions. Completing these checklists regularly (say, quarterly), and comparing the results with the previous time, will help you to identify where to concentrate your efforts. This work will also help you to achieve continual improvement.

In addition, the CD-ROM contains PDF files of a number of other publications from Envirowise that you may find useful. If you would prefer a free printed copy of any of these publications, contact the Environment and Energy Helpline on freephone 0800 585794. The contents of the CD-ROM are listed in Appendix 3.

The techniques described in the Guide will allow you to make quick savings following a rapid first assessment of business efficiency and environmental performance. The Guide is not intended to provide comprehensive advice on how to carry out the detailed evaluation of environmental performance required to achieve certification to ISO 14001.

Table 1 The Guide's structure and key outputs

Section	Title	Topics	Checklists
1	Environmental performance as a business indicator	Benefits of assessing environmental efficiency.	
2	Plastics processing and the environment	Benefits of following the waste hierarchy. Environmental impacts of plastics processing.	1 Do you have an effective waste minimisation programme?
3	Planning your assessment of environmental performance	Collecting base-line information. Benchmarking. Importance of gaining senior management commitment. How to gain commitment. Involving others.	2 Identifying priorities for improvement. 3 Identifying sources of environmental data. 4 Progress towards setting priorities and gathering base-line data. 5 Progress towards gaining organisational commitment.
4	Assessing your environmental performance	Techniques for gaining a better understanding of environmental performance, including: ■ identifying process inputs and outputs; ■ process mapping; ■ determining first-time yield; ■ performing a mass balance; ■ determining mass balance yield.	6 First-time yield for polymer use. 7 Mass balance calculation and allocation. 8 Progress towards reducing the true cost of waste.
5	Gaining operator support and involvement	Reasons for staff to become involved. Awareness-raising techniques.	9 Progress towards gaining support from operators.
6	Practical measures to reduce waste costs	Suggestions used by other plastics companies to improve.	10 Progress towards implementing measures to reduce waste costs.
7	Next steps	Suggestions to enable further progress.	11 Progress towards implementing an EMS.

Plastics processing and the environment

Many aspects of plastics processing can - and usually do - have an impact on the environment. Do you know how your business impacts on the environment? Table 2 summarises the main potential impacts likely to be under a company's direct control. Many of these impacts either result from waste or are made worse by waste, ie solid waste, liquid waste, trade effluent, inefficient use of energy, inefficient use of water and emissions to the atmosphere of dust, noise, gas, particles and steam.

Table 2 Potential environmental impacts under the direct control of plastics processors

Process/activity	Potential environmental impact
Design	■ Decisions at this stage have positive and/or negative implications for most of the potential environmental impacts that arise during plastics processing. Aim to design the most efficient product while seeking to minimise the environmental impacts that may arise at all stages of its life.
Materials purchasing	■ Air pollution, water pollution and litter arising from the disposal of waste packaging.
Processing and use of materials	■ Air and water pollution arising from the processing and disposal of solid and liquid wastes (including effluents).
	■ Contamination of land and water through mishandling and poor storage.
	■ Contribution to the formation of photochemical smog through the release of volatile organic compounds (VOCs).
	■ Noise, litter and dust nuisance.
Energy use	■ Depletion of finite resources.
	■ Climate change resulting from carbon dioxide emissions during electricity generation etc.
Water use	■ Loss of habitats, alterations in the seasonal cycle of plants and animals, impaired amenity, water pollution and lowered water tables.
	■ Impacts associated with water treatment (eg related to chemicals, energy and wastes).
	■ Potential for Legionnaires' disease.
Products	■ Depletion of resources used for packaging.
	■ Climate change resulting from carbon dioxide emissions released during the transportation of materials and packaging.

Other environmental impacts will arise:

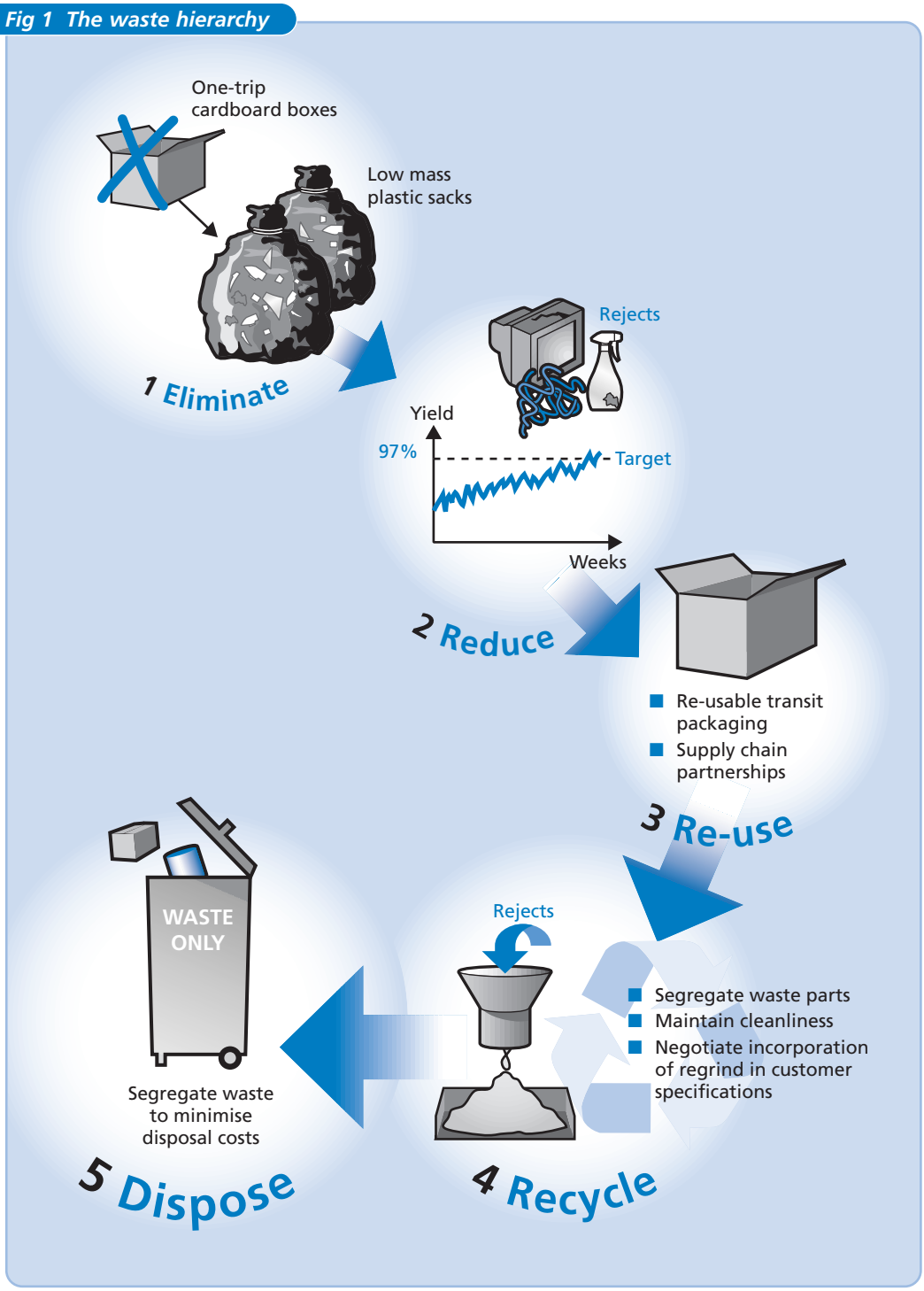
- before materials arrive on-site, eg depletion of finite resources such as hydrocarbons and climate change caused by carbon dioxide emissions associated with the manufacture and transportation of the materials;

- during the use of some plastics products, eg premature breakage has a range of environmental implications while the weight of a car part can affect fuel consumption;
- at the end of each product's useful life, eg impacts associated with litter, recycling and/or disposal.

2.1 Prevention is better than cure

There is a priority in the ways that waste should be dealt with to maximise cost savings and the benefits to the environment. Understanding the waste hierarchy (see Fig 1) can help companies to identify the most cost-effective opportunities to reduce waste and save money. Eliminating or preventing waste from occurring in the first place is the best way of reducing your environmental impacts and thus improving your environmental performance.

Fig 1 The waste hierarchy

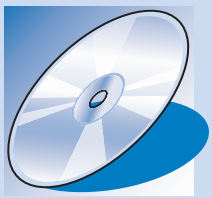


Water re-use saves money

Styropack (UK) Ltd employs 60 people at its Aberdare site in South Wales where expanded polystyrene mouldings are manufactured 24 hours a day for use in packaging by a range of customers. Styropack produces 5 m^3/day of effluent as a result of softening water for boilers. This effluent used to be discharged directly to drains, but it is now captured in storage cisterns for use in cleaning operations. The capital cost of this initiative was £800. Water supply costs have fallen by approximately £1 600/year, giving a payback period of just six months.

2.2 Does your company have an effective waste minimisation programme?

Use Checklist 1 to assess your company's attitude to waste minimisation and the environment. The checklist uses a scoring system to help you to decide whether you could improve your company's waste minimisation programme. The higher your score, the better your performance and the lower your score, the more scope there is for improvement.



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Planning your assessment of environmental performance

Planning is the key to success of any task - from making a new moulding to implementing a waste minimisation programme. This Section will help you to set priorities and to identify the data you need to make waste one of your key performance indicators. It also contains advice to help you gain the support of other people in the company - another vital element of a successful waste minimisation programme.

3.1 Setting priorities

Every aspect of plastics processing has cost and environmental implications. However, it is not sensible to try and investigate them all immediately. It may also not be realistic, or productive, to implement a number of changes at the same time. As time and resources for the project are likely to be limited, decide your priorities before beginning to assess your environmental performance.

Use Checklist 2 to decide the priorities for your company. Base your decision on:

- how much you spend each year on different items;
- the inputs and outputs most likely to yield opportunities to improve efficiency.

The checklist suggests certain priorities. Consider whether these are appropriate to your circumstances and alter them as necessary.

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3.2 Identifying base-line information

Base-line data provide a yardstick against which to measure your progress and to compare your performance with other sites and companies (see Section 3.3). You may already have more information about your current environmental performance than you realise. For example, invoices are a useful source of amounts and costs.

Checklist 3 shows possible sources of existing environmental performance data. Use it to identify:

- the sources relevant to your priority areas;
- who holds that data;
- if you think new data are needed to fill gaps, to bring data up-to-date and/or to increase your understanding.

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When collecting data, ensure that all data:

- are still applicable, eg they relate to current production methods;
- are accurate, eg delivery quantities are checked;
- do not contain built-in allowances for waste, eg yield loss and tolerances;
- use consistent units;
- are adjusted for changes in stock levels.

A waste base-line tool, developed by Envirowise, may help you to record quantities and costs. *Waste Account: Count the cost of waste for your business and measure your savings* (ET225) is available in PDF format on the CD-ROM in the back pocket of this Guide or as a printed copy free of charge through the Environment and Energy Helpline on freephone 0800 585794.

3.3 Benchmarking

Comparing your performance with that of other companies will help you to put your environmental performance into context and it will give you an idea of what can be achieved. It should also help to persuade senior management of the need to improve.

Use Environmental Performance Guide (EG252) *Benchmarking Waste in Plastics Processing*[2] to compare your company's polymer costs, polymer utilisation, waste costs, utility costs and packaging costs with others in the plastics processing industry.

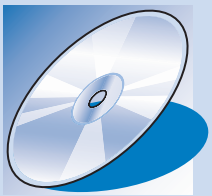
Benchmarking between sites boosts performance

British Polythene Industries plc monitors the environmental performance of its subsidiaries every month. This gives individual sites the incentive to identify any problem areas as well as striving for continual improvement.

The following are monitored and benchmarked:

- waste disposal to landfill;
- waste recovery;
- expenditure on waste;
- materials;
- electricity;
- gas;
- oil;
- water.

Use Checklist 4 to assess your progress in setting priorities for improvement and obtaining base-line information.



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3.4 Gaining senior management commitment

People have a key role to play in the success or failure of plans to assess your environmental performance. Because changes to the culture of the whole company may be necessary, senior management must be committed to ensuring the initiative is a success. Resources need to be allocated and staff empowered to take the process forward.

Middle managers need to understand both how to gain senior management commitment and why environmental performance is important. A good way to begin is to seek allies. Identify a senior manager or director who may be sympathetic or whose department would benefit directly. Approach senior managers responsible for relevant areas, eg the senior manager responsible for waste disposal. Choose a good moment to broach the subject - outline your ideas and, perhaps, promise more detailed information. Offer the manager a copy of this Guide, explaining why it is relevant to the company.

[2] Available in PDF format on the CD-ROM in the back pocket of this Guide or as a printed copy free of charge through the Environment and Energy Helpline on freephone 0800 585794.

3.4.1 Making a presentation to the board

Once you have gained an ally or key contact within the senior management team, consider your strategy for introducing suggestions to the board. This might entail your contact gaining a slot on the board agenda or an approach to the company secretary.

Make the most of your opportunity to address the board. Prepare a formal and professional presentation, using colour, figures and diagrams to make it interesting and attractive. Make the presentation relevant to the company and to the audience. Allow time for a short 'questions and answers' session after the presentation and remember to be enthusiastic.

You may find the set of PowerPoint overheads contained in Good Practice Guide (GG125) *Waste Minimisation Pays: Five business reasons for reducing waste* helpful when planning your presentation. The text of GG125 is provided as a PDF file on the CD-ROM in the back pocket of this Guide, together with a copy of the overhead templates in Microsoft® PowerPoint®. A printed copy of GG125 (with a disk containing the PowerPoint® file) can also be obtained free of charge through the Environment and Energy Helpline on freephone 0800 585794.

Tips for gaining corporate commitment

- Emphasise opportunities for early success and any cost savings already achieved. This will help to gain and maintain senior management commitment to the drive to improve environmental performance.
- Stress short payback periods for any investment needed.
- Highlight known major sources of waste. Explain that the greatest waste is often a waste that cannot be seen.
- Indicate the implications for human resources.
- Discuss any perceived difficulties.
- Point out the potential impact of environmental legislation, eg packaging waste regulations[3].
- Gain the support of line managers. Without their support, it will be difficult to make any progress.

3.5 Overcoming barriers

In efforts to gain allies and in presentations, you need to anticipate the barriers that might be encountered. These may include statements such as:

"It will cost too much money" or "All environmental controls cost money".

"We don't have the expertise to do anything about it."

"We've tried it all before. Jim did it three years ago but found…"

"We cannot spare your time or anyone else's time. Increasing sales is a much more important task."

"We don't have much waste to minimise."

"We don't have any impact on the environment."

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[3] Ask the Environment and Energy Helpline, on freephone 0800 585794, for advice on the latest environmental legislation affecting your operations.

Use the information given in Section 1 to explain why reducing waste warrants just as much attention as increasing and/or maintaining turnover. Stress that any cost savings go straight to the bottom line whereas only a small proportion of turnover ends up as profit.

3.5.1 Stress the hidden cost of waste in plastics processing

Counter arguments that there is little scope for reducing waste costs by pointing out that:

- Waste may not be recognised as such because it is assumed to be inevitable or because some other word is used to describe it. *Finding Hidden Profit: 200 Tips for Reducing Waste* (ET30) includes a list of 121 euphemisms for waste. These include allowance, purge, regrind, rejects, rework, runners, scrap and sprues.
- The cost of waste is usually much more than the cost of disposal. The true cost of waste is typically 10 to 15 (and up to 20) times more. For polymer waste, the true cost of waste is greater the later it arises in the production process.

  The true cost of waste polymer includes:

  - costs incurred in all previous processing stages;
  - lost opportunities for producing saleable product because labour and equipment have been used to make waste (includes regrinding, reprocessing or reworking);
  - costs of materials, ancillary materials, consumables and part-processed materials;
  - labour associated with handling and processing materials, ancillary materials and part-finished products (includes regrinding, reprocessing and reworking);
  - energy (including energy used for compressed air) used during the transportation, processing and handling of polymer and other materials (includes regrinding, reprocessing and reworking);
  - packaging of subsequently wasted materials that has to be disposed of;
  - management and monitoring of wasteful processes;
  - waste disposal costs at each stage, including the discharge of any trade effluent.
- Landfill tax is set to increase at a rate of £1 per tonne per year so as to be £15/tonne by 2004/2005. Trade effluent charges are also increasing significantly as a result of higher wastewater treatment standards.

Tips for overcoming barriers

- List the barriers you expect to be raised by senior management and sketch out the basis of your counterarguments. For example, to counter the argument *"All environmental controls cost money"*, explain that there are many examples in plastics processing where improving environmental performance can reduce costs. Point out that the company currently has insufficient performance data to decide what environmental controls and management interventions are required. Cite Industry Examples from this Guide in support of these arguments.
- Identify and estimate the costs and benefits of some no-cost and low-cost measures (see Section 6) to reduce waste. Use your figures to convince senior management that benefits can be realised quickly with a rapid payback. Don't forget to reflect the true cost of the waste concerned.

3.5.2 Highlight the benefits of improving environmental performance

Barriers usually focus around financial and resource issues. However, pointing out the benefits of complying with environmental legislation and keeping/winning customers can also help to gain senior management support:

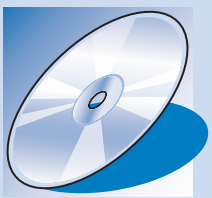
- Identify some non-financial benefits that are realistic and which will help senior management to appreciate that support is warranted. Improved relations with environmental regulators and higher staff morale are common consequences of improved environmental performance.
- Gather together relevant Industry Examples from this Guide, other publications and from other plastics processors.

3.6 Who else should be involved at this stage?

Unless the company is very small, it is not generally effective if only one person carries out the assessment. Involving a team of people will help to ensure the workforce is committed to achieving and maintaining improved environmental performance:

- Set up a team involving machine operators and other relevant operating staff as well as line managers. Operators often have good ideas and suggestions about how to improve performance.
- Nominate someone to take responsibility for implementing the drive to improved environmental performance. The tasks of the project 'Champion' include:
  - setting up a project team to undertake the assessment and to implement measures to improve performance;
  - allocating tasks and resources;
  - establishing appropriate forms and channels of communication to keep everyone in the company informed of progress and to encourage them to contribute.
- Ensure senior managers have given authority to the Champion and that adequate resources have been made available.
- Obtain more information about people issues from Good Practice Guide (GG27) *Saving Money Through Waste Minimisation: Teams and Champions.* GG27 is provided as a PDF file on the CD-ROM in the back pocket of this Guide. Alternatively, a printed copy of GG125 (with a disk containing the PowerPoint® file) can be obtained free of charge through the Environment and Energy Helpline on freephone 0800 585794.

Use Checklist 5 to plot your progress towards gaining organisational commitment to the project. This checklist uses a simple yes/no scoring system.



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Assessing your environmental performance

Your first-time yield (FTY) and mass balance yield (MBY) provide numerical measures of your environmental performance, as part of your business efficiency.

$$\text{FTY} = \frac{\text{annual weight of saleable polymer production}}{\text{total annual weight of polymer throughput}} \times 100$$

$$\text{MBY} = \frac{\text{annual weight of saleable polymer production}}{\text{annual weight of virgin polymer consumed}} \times 100$$

They can also be combined to establish the cost of polymer waste. The other elements of the true cost of waste can then be added:

True cost of waste = FTY cost + MBY cost + Other costs

where:

$$\text{FTY cost} = \frac{(100 - \text{FTY})}{100} \times \text{annual cost of running the process*}$$

* wear and tear, energy, manpower etc.

$$\text{MBY cost} = \frac{(100 - \text{MBY})}{100} \times \text{annual cost of materials}$$

When seeking to improve your environmental performance by reducing polymer waste:

- aim for an FTY equal to your MBY;
- make your MBY as close as possible to 100%.

If first-time yield is tackled as your main priority, mass balance yield will probably improve without significant additional effort.

In most companies, where regrind use is allowed in most products, the amount sent to waste will be much less than the amount reground and the mass balance yield will be closer to 100% than in the example given in the ensuing Checklists 6 and 7. These are from a medical products company where regrind was prohibited. Typically, mass balance yield may be 98% and first-time yield may be 90%.

First, you need to determine the amounts of the inputs and outputs to your process in a given period, say a year.

4.1 Process inputs and outputs

Start by identifying the main inputs and outputs for your process. Copy and amend Fig 2 to show any additional inputs and outputs applicable to your business. Delete any that do not apply. An electronic version of the diagram is provided as a JPG file on the CD-ROM in the back pocket of the Guide.

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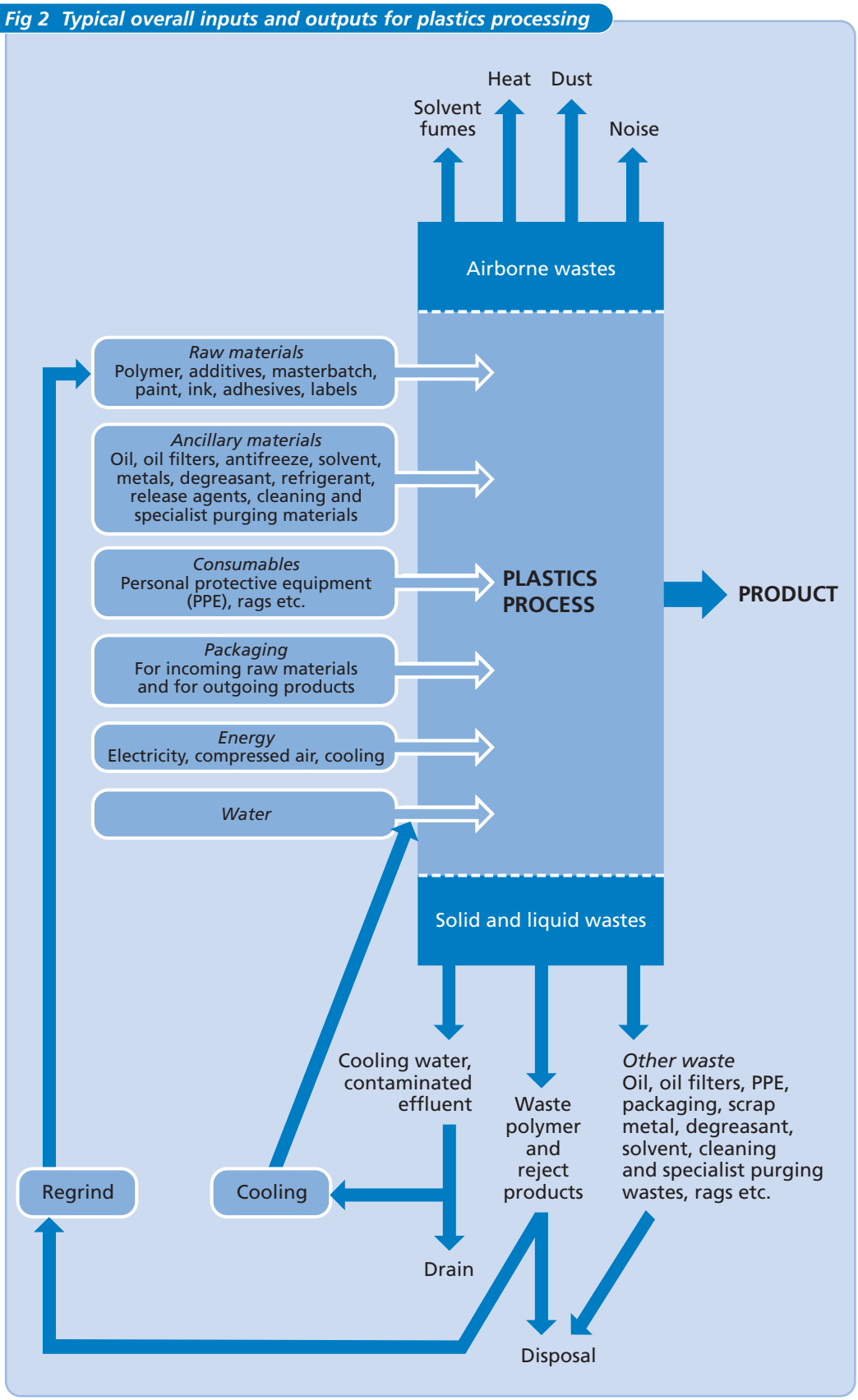
Fig 2 Typical overall inputs and outputs for plastics processing

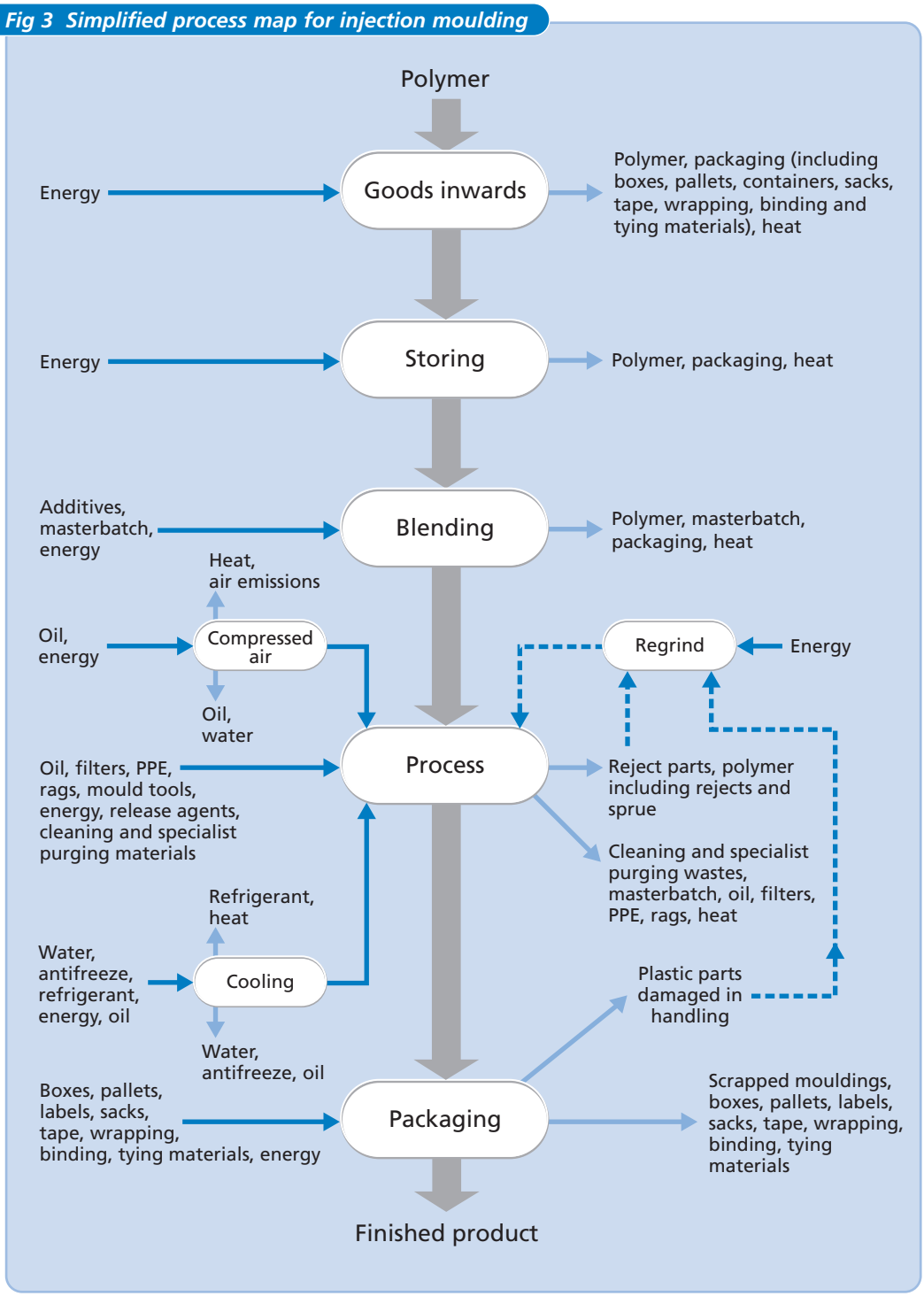


Now look more closely at the different stages of your process and identify where inputs are used and outputs arise. For example, waste polymer can occur at many points during the production process. Where the waste occurs has considerable implications for its true cost. Preparing a detailed process map will help you to identify the waste saving opportunities with the greatest potential to reduce costs.

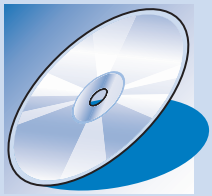
Fig 3 shows a process map for the main injection moulding processes and the links between these processes. Process maps for blow moulding, film moulding or extrusion moulding differ in some aspects but share many common elements.

Remember, what comes in must come out in some way and somewhere. Any input could be a waste if it does not leave as part of a value-added product.

Fig 3 Simplified process map for injection moulding



Copy and adapt Fig 3 to map out each of your company's processes. You may wish to show different machines separately, but try not to make your map too complicated. An electronic version of the diagram is provided as a JPG file on the CD-ROM in the back pocket of the Guide. Alternatively, draw your own map.



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Some companies may need to produce process maps for a wider range of processes, including:

- assembling;
- blending;
- compounding;
- compressed air production;
- converting;
- cooling;
- cutting;
- finishing;
- goods inwards;
- maintenance;
- mould-making;
- moulding;
- packaging;
- painting/coating;
- printing;
- regrinding;
- space heating;
- storing;
- trimming;
- vacuum raising;
- washing.

Help in identifying waste

Various tools have been produced by Envirowise to help companies identify where waste arises and where environmental performance is poor. Contact the Environment and Energy Helpline on freephone 0800 585794 for advice on which ones are best for you.

4.2 Measuring performance

Process mapping helps to identify many environmental performance issues, but it does not distinguish their importance. Applying the priorities you selected using Checklist 2 (see Section 3.1) will allow you to focus on those processes that may have poor environmental performance or, at least, warrant further investigation.

- Use your base-line data (see Section 3.2) to mark total quantities of your priority inputs and outputs on your process map(s). Don't forget to include the quantities of polymer sent for regrinding.

In most cases, you should be able to obtain the data you need from that identified in Checklist 3 (see Section 3.2). Some inputs and outputs may need more detailed measurements or estimates. However, pinpoint accuracy is not required the first time.

- Where possible, convert quantities to a common unit, eg tonnes or kg.
- Give quantities for a given period, eg a year, and adjust them for stock changes, ie:

  Annual quantity of input materials or products =
  Opening stock + Inputs/outputs in the year – Closing stock.

- Record the numbers of each product produced during this period and the average weight of polymer that each contains. This will allow you to calculate the total output weight of finished products.
- **Do not adjust your figures to make them balance. Any discrepancies may well be the waste you are seeking to identify.**

Tips on measurement

- Obtain an initial indication of water and effluent flows using a bucket of known capacity and a stopwatch. Establish the quantity collected during a measured period. Scale up this amount to estimate annual flow.
- Use simple weighing scales to measure small quantities of solids.
- Obtain the amounts of larger quantities of waste from waste disposal documentation, invoices, observation and/or estimation.
- Estimate energy use by individual processes on the basis of rated consumption or using portable meters. Fixed meters are much better - contact the Environment and Energy Helpline on freephone 0800 585794 for advice.
- The weight in grammes that passes in 36 seconds is equivalent to the weight in kilogrammes that passes in one hour.

Some useful conversion factors:

1 000 litres	=	1 m^3
1 gallon	=	0.0045 m^3
1 cubic foot	=	0.0283 m^3
1 cubic yard	=	0.7646 m^3
1 imperial pound	=	0.4536 kg
1 m^3 of water	=	1 tonne

4.2.1 Calculating first-time yield

First-time yield is a better measure of efficiency and environmental performance than mass balance yield because it allows for the inefficiencies associated with producing waste and regrinding it.

Although regrinding rejects for re-use in production may be better than sending them off-site for recycling or disposal, it is an inherently wasteful activity. It requires significant inputs of additional energy, labour and ancillary materials such as oil. It also means lost opportunities for moulding machines to make saleable product; such opportunities have costs associated with them in terms of sales capacity and additional maintenance.

Short-term factors affecting first-time yield

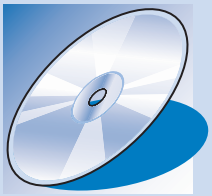
As first-time yield is a hidden cost of waste, it is more difficult to ascertain its true level within a business. At best it will inflate any costs which truly scale with production. Obviously, over the short term most overheads such as back office operations, sales, space heating, factory rent, depreciation, maintenance etc are mainly fixed. First-time yield will inflate more direct controllable costs, including a high proportion of direct labour and some overhead costs such as energy, consumables and some additional labour charges.

Long-term factors affecting first-time yield

Over the long-term, however, any cost associated with production or support of production will be directly related to production levels. This is because over long periods of time your factory premises will have to be larger (to accommodate more machines, more workers, more back office operations etc), and you will need more equipment, people etc. You will even need more sales effort to reach break-even. It is, therefore, fair to say that over the long term, almost all of these costs will be inflated by low first-time yield. All of this extra cost will be unrecoverably lost as the rejects go back into the process through the regrinding machine.

Typical hidden costs of waste in first-time yield

At a typical plastics firm, gross margin may be 40%, and profit before tax may be around 10%. As proportions of total production costs, overheads may represent 30%, labour 15%, and materials 55%. Making some reasonable assumptions from these figures, the short-term estimate (low bound) of the first-time yield cost is that it will be impacting on about 13.5% of turnover. Long term, FTY will affect around 41% of turnover. A steady first-time yield of 90% implies wastage of 10% and, therefore, costs around 1.4% of turnover (equal to nearly 15% of profits) in the short term. However, in the long term it will cost 4% of turnover (equal to nearly 50% of profits).



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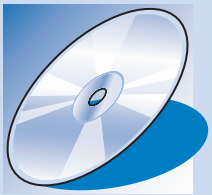
Complete Checklist 6 to determine the first-time yield for the various polymers used by your company. During the early stages of improving environmental performance, your first-time yields may be significantly less than your mass balance yields. The aim is to make first-time yield the same as mass balance yield, while making mass balance yield as close as possible to 100%.

4.2.2 Performing a mass balance calculation



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Use Checklist 7 to perform a mass balance calculation for waste polymer, amending it as necessary to suit your circumstances. The checklist includes example data from a real injection moulding process as an illustration. The performance of companies with good quality management and environmental management practices may be significantly better.

The mass balance involves finding the difference, for a specified period, between the amount of polymer that enters the business and the amount that leaves it as saleable product. The result represents waste (or waste associated with variations in the weight of saleable product that have not been accounted for). The waste is then allocated to each process as appropriate. If the total amount of waste does not equal the total of the allocated quantities, then there may be an output that you have not yet identified or an inaccurate allocation.

Because polymer is the most expensive raw material and the main component of finished mouldings, it is worth spending some time producing a detailed balance.

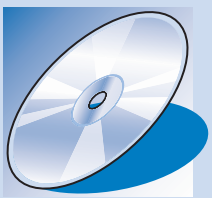
Use a similar approach for other priority inputs such as water and packaging. For water, you can check your allocation of input quantities by measuring the amount of effluent leaving the site.

Your mass balance calculations will highlight which areas give rise to significant amounts of material that do not leave the business as product. Consider the scope for improving performance and minimising these wastes. Allocating costs to each point where an output occurs will help to focus attention on areas with the greatest potential for cost savings. Remember to calculate the true cost of each waste as far as possible.

4.2.3 Calculating mass balance yield

Calculating your mass balance yield is a good starting point for evaluating the mismatch between polymer coming into the business and leaving as product. It is also a key performance indicator for business efficiency, which can be used for benchmarking (see Section 3.3).

The mass balance yield for plastics processing should be at the upper end of the 90 - 100% range. However, high percentages do not necessarily indicate efficient businesses because they fail to take account of the reworked product. Reworking is inherently inefficient; it reduces the capacity available to make saleable product because scrap has been made instead. (This is why first-time yield is a more useful overall indicator.)



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Use Checklist 7 to calculate the mass balance yields for the various polymers used by your company.

The value of polymer wasted can be calculated from the mass balance yield and the annual cost of polymer purchased. This calculation will indicate the financial importance of minimising polymer waste.

The financial importance of maximising first-time yield and mass balance yield

Continuing the example shown in Checklists 6 and 7:

Our example firm makes medical products where quality standards are very high, and scrap cannot be reground. It has a turnover of £631 000, and it is spending £315 700 on materials. The FTY is 82% and the MBY is 88%.

FTY cost

$$\text{FTY cost} = \frac{(100 - \text{FTY})}{100} \times \frac{\text{\% of turnover actually affected by waste}}{100} \times \text{turnover}$$

Low bound (operating on ≈13.5% of turnover in the short term)

$$= \frac{(100 - 82)}{100} \times \frac{13.5}{100} \times £631\,000$$

$$= £15\,333$$

High bound (operating on ≈41% of turnover in the long term)

$$= \frac{(100 - 82)}{100} \times \frac{41}{100} \times £631\,000$$

$$= £46\,568$$

MBY cost

$$\text{Value of polymer wasted} = \frac{(100 - \text{MBY})}{100} \times \text{Annual cost of materials}$$

$$= \frac{(100 - 88)}{100} \times (451 \text{ tonnes} \times £700/\text{tonne})$$

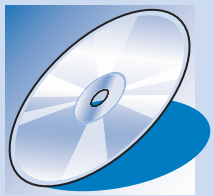
$$= £37\,884$$

These figures can be compared with the company's actual profit before tax of £63 100.

4.3 Assessing progress

Calculating first-time yields and mass balance yields provides key indicators of business efficiency and environmental performance. These values should be reviewed weekly, or at least monthly, so that problems are spotted early and the results of improvements can be measured.

Use Checklist 8 to assess your progress towards improving your first-time yields and reducing waste costs.



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Gaining operator support and involvement

Operators are key players in improving any aspect of business efficiency. Raising people's awareness of efficiency in terms of environmental performance will help to enlist their support and encourage participation.

Approach a recognised member of the workforce, eg a union representative, about the project. Point out the advantages to operators of a successful waste minimisation programme and allay any concerns about potential extra duties.

Seek out operators with interest or knowledge of environmental issues, eg use a poster on the company notice-board.

Having a project team (see Section 3.6) that meets regularly and consists of people who are motivated will help to maintain momentum. To encourage volunteers, agree with management to offer a small incentive to encourage participation, eg providing a free meal for a lunchtime meeting. Make it clear that every member has something to contribute and do not exclude people on the basis of their position within the company. Someone working on a process may well have the best ideas on how to improve it and on how to involve their workmates.

For more advice on how to win support, see Good Practice Guide (GG27) *Saving Money Through Waste Minimisation: Teams and Champions* and (ET228) *Workforce Partnerships to Reduce Waste and Save Energy.* Both are available in PDF format on the CD-ROM in the back pocket of this Guide or as a printed copy free of charge through the Environment and Energy Helpline on freephone 0800 585794.

'Spot the Waste' competition leads to significant savings

Six teams at Lever Brothers Ltd's Warrington site generated over 200 ideas for reducing waste as part of an innovative 'Spot the Waste' competition launched jointly by the site's Safety and Environment Manager and the Operations Manager. Many of the ideas were justified on economic grounds and estimated savings of £30 000/year have been achieved.

For more details of the competition, see Industry Example 9 from Good Practice Guide (GG27) *Saving Money Through Waste Minimisation: Teams and Champions*.

5.1 Messages that motivate

Operators may have little knowledge of environmental issues and may see environmental initiatives as more work for no reward. They may also feel that they have nothing to contribute to such projects.

Explaining the benefits to operators of reducing waste will help to overcome these barriers, eg:

- increased profits mean that the company is more able to reward staff and to invest in better equipment;
- a profitable and competitive company offers greater job security;
- an improved working environment.

Helping to protect the environment can make people feel good about themselves. Raising money for charity through environmental improvement can add to this feeling of goodwill.

Tips for increasing motivation to improve

- Develop a suggestions scheme to encourage people to think about environmental performance. Offer an incentive for successful ideas, eg tokens, cash or a contribution to a charity chosen by the workforce.
- Treat all ideas with respect. Acknowledge each idea and provide feedback on why a suggestion is being implemented or why it is considered impracticable. Without feedback, people will lose interest and morale will suffer.
- Give public recognition to ideas. This makes people feel appreciated and proud.

Excellent payback on investment in a suggestions scheme

"We spend a fortune on bonuses to reward workers' ideas and their performance on waste. Every year we pay out a total of one month's worth of the annual savings from their efforts. It's the best payback of any of our investments."

Manager of a plastics company.

5.2 Awareness-raising techniques

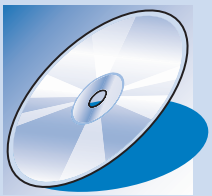
Use on-the-job training and short formal presentations to raise environmental awareness. Include basic facts about environmental problems, how the company and the individual contributes to them, current performance and the advantages to staff of taking more notice of environmental issues. You can also use the opportunity to outline some simple improvement measures. Keep records to make sure that everyone receives training.

Tips for raising operator awareness

- Use posters to stress the advantages of environmental responsibility, provide information on best practice or report positive results.
- Run a competition for the operators' children to design the posters. Give prizes for the best posters and display them.
- Keep posters clear, concise and free from jargon. Avoid being dictatorial. Use colour, humour, cartoons etc.
- Choose carefully the locations where posters are put up and change them regularly, eg operational areas, next to the moulding machines or places where people queue for food and drink.
- Use other media, eg e-mail, intranet pages, audio-visuals and newsletters.
- Attract interest with a competition, eg measure an aspect of environmental performance for each shift and create a league table with prizes/perks for the winners.

Awareness-raising is a priority

The Managing Director of Visqueen Building Products believes that staff awareness, involvement and motivation are key factors in achieving environmental improvements. Environmental awareness training, involving video and overhead presentations, is supported by a booklet and quizzes with prizes. Meetings are held regularly to keep all employees informed of progress.



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Use Checklist 9 to measure your progress in gaining support from your operators.

Practical measures to reduce waste costs

This Section suggests some simple no-cost and low-cost measures that other companies have found useful when seeking to reduce their operating costs by improving their environmental performance. For more ideas, contact the Environment and Energy Helpline on freephone 0800 585794 and ask about the range of free publications specifically for the plastics sector and about waste minimisation in general. Some of these publications are provided as PDF files on the CD-ROM in the back pocket of this Guide.

6.1 Ask why

- Question statements that a waste or environmental impact is unavoidable. Find out why it is occurring and then think of as many ways as possible to eliminate or reduce it. Ask questions and view practices with a fresh pair of eyes.
- Discover why performance has changed and make the necessary adjustments. Learn from the experience and from successes, eg a high first-time utilisation of polymer.
- Review each stage in the production process to see if it can be simplified. Processes that fail to add value are particularly questionable.

Monitoring waste helps to deliver more 'right first time' product

Dragon Plastics Ltd uses a variety of polymers to make caps and closures for the pharmaceuticals, cosmetics, automotive and household products sectors. Rework is considered an unacceptable waste by the company, which has kept records concerning this since 1992. The quantities associated with each type of defect are recorded, including colour variation, start-up, trials, flash, shorts, voids, gate pip, scrap and old stocks. Costs are then allocated to each category to raise awareness among employees and to drive through performance improvements. A similar approach is adopted for controlling the costs of scrap produced by the finishing department.

6.2 Measuring to Manage

Effective management requires knowledge of how performance is changing. An on-going and regular programme to measure and monitor key performance indicators such as waste is essential. You will then be in a position to set and review your targets for improvement.

Remember: If you don't measure it, you can't manage it.

Measuring to Manage increases efficiency

The extensive and flexible software monitoring system operated by Styropack (UK) Ltd is used to increase efficiency by:

- producing shift monitoring reports that highlight production problems;
- making shift managers accountable for production capacity;
- enabling information to be reported to staff;
- allowing optimum procedures to be determined through comparative monitoring of resource use;
- automating certain aspects of production, eg compressor operation;
- improving production logistics;
- identifying problems at an early stage, thus minimising downtime.

6.3 Quality assurance

- Aim for 'right first time' production.
- Apply quality assurance procedures at all stages of production to ensure defects are identified before they are processed or handled further (ie before any more money and effort are wasted).
- Track reject rates in real time.
- Take action to correct variations in quality as soon as they are detected.
- Have quality assurance staff present during the final stages of making changes to machine settings. Approval can then be given as soon as the product is made within specification, thus minimising waste.
- Apply statistical process control (SPC) to determine whether your process is performing satisfactorily and thus minimise waste. This technique is described in Good Practice Guide (GG223) *Preventing Waste in Production: Industry Examples*[4] and Good Practice Guide (GG224) *Preventing Waste in Production: Practical Methods for Process Control*[4].

6.4 Materials and packaging

- Supervise all deliveries to minimise the risk of spills and waste.
- Buy recompounded waste polymer in lieu of virgin polymer whenever practicable. Discuss this option with your customers, particularly when the physical properties, eg colour, are critical for the product's end use.
- Use a gear pump (liquid pump) to ensure that accurate doses of cheap regrind are delivered to the die-head.
- Store polymer in silos when appropriate to reduce waste during handling and reduce packaging disposal costs. The unit cost of the polymer may also be less.
- Where silos are not practicable, use 'octobins' which provide a more cost-effective storage and delivery solution than bags or sacks.
- Take care when transferring polymer to silos from octobins that have previously contained reground waste polymer. Residual contamination in such octobins can ruin the entire contents of a silo.

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[4] Available in PDF format on the CD-ROM in the back pocket of this Guide or as a printed copy free of charge through the Environment and Energy Helpline on freephone 0800 585794.

- Train operators on how to avoid spills when handling raw materials. Use of correct techniques will reduce waste and minimise the risk of polymer, additives or masterbatch entering drains or sewers.
- Where possible, convey materials to machines automatically, with feeders operating on demand rather than constantly.
- Maintain high levels of housekeeping.
- Involve suppliers and customers in discussions about how to reduce packaging.
- Where possible, re-use incoming packaging as outgoing packaging or for storage.

Tips for reducing packaging costs

For advice on reducing the amount of packaging your company uses and the associated costs, see:

- Good Practice Guide (GG140) *Cutting Costs and Waste by Reducing Packaging Use*
- Good Practice Guide (GG141) *Choosing and Managing Re-usable Transit Packaging*
- *Unpack those Hidden Savings: 120 Tips on Reducing Packaging Use and Costs* (ET250).

All three publications are available in PDF format on the CD-ROM in the back pocket of this Guide or as a printed copy free of charge through the Environment and Energy Helpline on freephone 0800 585794.

6.5 Mould tools

- When designing components and injection moulds, consider ways of minimising waste and reducing the amount of polymer needed to meet customer specifications.
- Maintain tools and replace them as necessary to minimise waste due to worn tools.
- Simulate moulding conditions using computer technology to check performance before making moulds.
- Rework old mould tools for new components.
- Bolster-type moulds with replaceable cavities can reduce the effort and cost required to make new moulds.

6.6 Moulding

- Balance shot weight to the machine capacity.
- Maintain equipment regularly to prevent oil leaks. Use a drip tray where oil leaks still occur.
- Plan production to minimise mould changeovers. This saves time and reduces waste during set-up.
- Avoid unnecessary waste when feeding raw materials to moulding machines. Gravimetric control of masterbatch additives gives better control of additive levels and reduces the hidden cost of overdosing.

Simple changes reduce pre-moulding wastes

Dragon Plastics Ltd used to mix polymer and colour in a mezzanine storage area and then feed the mixture by gravity through tubes to the moulding machines located almost 5 metres below. This arrangement wasted the raw materials remaining in the tubes every time a colour change was required. To avoid this waste, the company now uses volumetric dispensing units that mix polymer and colour at the point of blending in the moulding machines. The change has produced savings of over £35 000/year in the costs of raw materials and waste disposal. This excludes the cost savings associated with reduced handling and packaging disposal.

- Implement a system to ensure that the optimum moulding machine settings are used for each product run. Allocate responsibility for checking the settings each day and restrict the number of people authorised to change settings. These steps will maximise operating efficiency and minimise waste generation during set-up.

Optimised machine settings reduce waste

Media Moulding Technology Ltd makes components and assemblies for blue chip companies in the automotive, teletronic, garden and kitchenware markets. The company realised that machine setting was viewed as a 'black art' and that different operators used very different settings. Furthermore, shift changes gave rise to unnecessary waste. The company now records optimum settings on machine setting sheets that are referred to every time a job is run. These sheets are checked during the product audit procedure; any departures from the settings have to be recorded and approved. Where real improvements are confirmed, the sheets are amended.

- When moulding one part around another, avoid making too many or too few of the inserts (particularly when different colours are involved).
- Fit hydraulic oil bypass filtration systems to injection moulding machines to increase the lifetime of the oil and main oil filter. These systems, which filter oil continually rather than just when it is used, consist of additional pipework, a small pump and a filter.

Oil cleansing systems save money

A plastics company produces disposable plastic products used in research and medicine. Injection, extrusion and blow moulding are carried out at its site, which operates 24 hours a day. The company now fits oil cleansing systems to all injection moulding machines. The benefits include:

- reduced frequency of oil changes from approximately once a year to about every two or three years;
- reduced volume of hydraulic oil bought, saving approximately £100/year on each moulding machine;
- less wear and tear on equipment;
- reduced downtime;
- lower maintenance costs with inexpensive filters used by the bypass system;
- extended life of the main filters (giving significant annual cost savings);
- payback period of approximately 15 months for each machine.

- Reduce damage to finished mouldings by automated rather than manual removal.
- Minimise contamination of waste polymer by not allowing purged polymer to mix with other materials and not allowing waste polymer to fall onto the floor or into drip trays. Waste polymer loses value when it is contaminated with substances that make regrinding or recycling less feasible.
- Regrind unavoidable waste polymer in-house. This has lower cost and environmental impacts than off-site processing.

6.7 Cooling systems

- Enclose all water cooling in closed-circuit systems.
- Consider controls on make-up water.
- Check regularly for water leaks and drips, and eliminate any that are found.
- Reduce the volume of cooling water required for cooling in extrusion troughs to its optimum level.
- Run cooling systems to match production needs. Leaving cooling systems running when they are not needed is extremely wasteful. Built-in closed circuit cooling systems on injection moulding machines avoid this problem.

6.8 Printing and coating

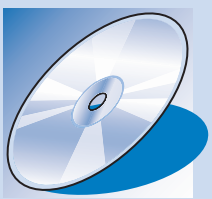
- Use high solids or water-based inks and coatings where possible instead of solvent-based products.
- Use high volume, low pressure (HVLP) spray guns. They are more efficient and use less coating material than conventional spray guns.
- Contact the Environment and Energy Helpline on freephone 0800 585794 for details of free publications giving advice on how to reduce waste and environmental impacts during printing and coating processes.

6.9 Energy

- Switch off machines and/or fit timers to reduce energy use during idle time. This will also reduce the polymer waste associated with purging polymer degraded by excess heat.
- Fit insulation jackets to heater barrels.
- Check compressed air installations every week for leaks and repair those found immediately.
- Match motor size to equipment demand and specify higher efficiency motors (HEMs). Fit variable speed drives and soft start units.
- See Appendix 1 for details of some of the many useful free publications produced by Envirowise. Contact the Environment and Energy Helpline on freephone 0800 585794 or visit the web site: www.envirowise.gov.uk

Insulation cuts energy costs

A plastics company calculates that fitting lagging jackets and downrating the heater bands has reduced the heater band energy consumption by as much as 33%. The company plans to explore the possibility of fitting jackets to extrusion and blow moulding machines as well as its injection moulders.



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Use Checklist 10 to assess your progress towards implementing measures to reduce waste costs.

Next steps

Once you have completed the checklists supplied with this Guide, you should have:

- a better picture of your environmental efficiency and the extent of your hidden waste, eg your polymer mass balance yields and first-time yields;
- identified which processes have the worst financial and environmental performance;
- decided your priorities for taking action to reduce waste costs;
- identified why current practices in priority areas are less than efficient and produce more waste than necessary;
- identified what can be done to make improvements in these priority areas;
- gained the support of senior management for improving business efficiency and environmental performance;
- involved the entire workforce in your programme to reduce costs by reducing waste;
- realised that improving environmental performance is a journey not a destination.

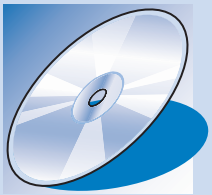
On-going measuring and targeting are vital to ensuring continual improvement in business efficiency and environmental performance. Continued success will also depend on maintaining senior management commitment and employee involvement.

Completing the 11 checklists at least once each quarter will help you to monitor progress and to identify where further attention needs to be concentrated.

Once you have gained high scores or answered 'yes' to most of the questions, your business will be ready for further initiatives to improve performance. These could include:

- Undertaking an initial review as described in ISO 14004, which gives general guidelines on principles, systems and supporting techniques for environmental management systems. This would give you a wider perspective on your environmental performance, including compliance with legislation, all environmental impacts (not just direct impacts from processes), management practices, procedures, policies and incident management.
- Implementing an environmental management system (EMS) complying with ISO 14001, which gives general guidelines on principles, systems and supporting techniques for environmental management systems. This would build on your initial review, and cover a wide range of environmental management issues, including formal environmental policy, procedures and plans, setting objectives and targets, management plan, training, documentation, emergency preparedness, auditing and corrective action.

  Implementing an EMS provides a systematic way of ensuring that efforts are maintained and improved in all aspects of environmental management. Your customers may also require you to implement an EMS. For practical help in implementing an EMS, see Good Practice Guide (GG251) *Environmental Management Systems for the Plastics Industry*. GG251 is available in PDF format on the CD-ROM in the back pocket of this Guide or as a printed copy free of charge through the Environment and Energy Helpline on freephone 0800 585794.
- Undertaking an Environmental Performance Evaluation as defined by ISO 14031. This might entail setting and taking periodic measurements against management performance indicators, environmental condition indicators and operational indicators such as waste.



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- Publishing reports containing information on your environmental performance. Such reports serve the needs and interests of the public, shareholders, financiers, regulators, Government, employees and other stakeholders.

Use Checklist 11 to assess your progress towards implementing an EMS in your company and achieving even greater cost savings and other benefits. An EMS will help you to integrate environmental issues into everyday management and to make waste minimisation part of your company culture.

If you need more help

The Environment and Energy Helpline (0800 585794) can:

- Provide free up-to-date information on environmental issues, equipment suppliers and techniques described in this Guide.
- Tell you about relevant environmental and other regulations that could affect your operations.
- Send you copies of relevant Envirowise publications (see Appendix 1).
- Tell you about the free advice on energy technologies and energy management provided by The Energy Efficiency Best Practice Programme (see Appendix 1).
- 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).

Envirowise

Free publications that will help you to save money by implementing a systematic approach to waste minimisation include:

- Think about how much waste is costing:
  - *Cutting Costs by Reducing Waste* - a video introducing the benefits of waste minimisation (V159)
  - *Waste Minimisation Interactive Tools (WMIT)* - easy-to-use software (IT96).
- Obtain top level commitment:
  - Good Practice Guide (GG125) *Waste Minimisation Pays: Five business reasons for reducing waste.*
- Find out where waste is occurring in your company:
  - *A Fresh Pair of Eyes: Identifying Waste Minimisation Opportunities* - a video to help you find out where waste is occurring in your company (V217)
  - *Waste Mapping - Your route to more profit* (ET219)
  - Good Practice Guide (GG38C) *Cutting Costs by Reducing Waste: A self-help guide for growing businesses.*
- Record your base-line information:
  - Environmental Performance Guide (EG252) *Benchmarking Waste in Plastics Processing*
  - *Waste Account: Count the cost of waste for your business and measure your savings* (ET225) and CD-ROM (IT249).
- Begin your waste minimisation programme:
  - *Finding Hidden Profit: 200 Tips for Reducing Waste* (ET30)
  - Good Practice Guide (GG25) *Saving Money Through Waste Minimisation: Raw Material Use*
  - Good Practice Guide (GG26) *Saving Money Through Waste Minimisation: Reducing Water Use*
  - Good Practice Guide (GG27) *Saving Money Through Waste Minimisation: Teams and Champions*
  - Good Practice Guide (GG253) *Finding Hidden Profit for Smaller Companies.*
- Tackle specific areas:
  - Good Practice Guide (GG67) *Cost-effective Water Saving Devices and Practices*
  - Good Practice Guide (GG140) *Cutting Costs and Waste by Reducing Packaging Use*
  - Good Practice Guide (GG141) *Choosing and Managing Re-usable Transit Packaging*
  - *Unpack those Hidden Savings: 120 Tips on Reducing Packaging Use and Costs* (ET250)
  - Good Practice Guide (GG152) *Tracking Water Use to Cut Costs*
  - *Free Help to Stop Your Profits Evaporating - Practical Advice for Cost-effective Solvent Management* (ET209).

- Implement an EMS:
  - Good Practice Guide (GG251) *Environmental Management Systems for the Plastics Industry*.

Many of these publications are available as PDF files on the CD-ROM in the back pocket of this Guide. Alternatively, free printed copies are available through the Environment and Energy Helpline on freephone 0800 585794.

Abstracts of these and other Envirowise publications can be seen on the web site: www.envirowise.gov.uk

Energy Efficiency Best Practice Programme (EEBPP)

Energy efficiency is a key aspect of environmental performance in the plastics processing industry. Detailed information on how to reduce your energy bills is available from the Energy Efficiency Best Practice Programme. Its free publications are available free of charge through the Environment and Energy Helpline on freephone 0800 585794 or via its web site (www.energy-efficiency.gov.uk).

Good Practice Guide (GPG292) *Energy in Plastics Processing - a Practical Guide* is a good starting point for information about all aspects of energy use in the plastics industry.

Environment Agency

The Environment Agency's NetRegs web site (www.netregs.environment-agency.gov.uk) provides practical advice to help companies in England and Wales to understand their legal obligations.

Printed versions of the checklists

This Appendix contains printed copies of the checklists provided on the CD-ROM disk in the pocket at the back of this Guide as Microsoft® Word files. The 11 checklists provided on the CD-ROM are listed in Table A1.

Table A1 Checklists to help you assess and improve your environmental performance

File name	Checklist
GG277checklist1.doc	Do you have an effective waste minimisation programme?
GG277checklist2.doc	Identifying priorities for improvement
GG277checklist3.doc	Identifying sources of environmental data
GG277checklist4.doc	Progress towards setting priorities and gathering base-line data
GG277checklist5.doc	Progress towards gaining organisational commitment
GG277checklist6.doc	First-time yield for polymer use
GG277checklist7.doc	Mass balance calculation and allocation
GG277checklist8.doc	Progress towards reducing the true cost of waste
GG277checklist9.doc	Progress towards gaining support from operators
GG277checklist10.doc	Progress towards implementing measures to reduce waste costs
GG277checklist11.doc	Progress towards implementing an EMS

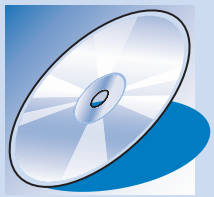
CHECKLIST 1

Do you have an effective waste minimisation programme?

A score of four indicates a high level of performance and a score of zero indicates very poor or non-performance. Example scores are given for possible responses to the first question. Use this example to develop your own responses for each score for the other questions.

Date:	**Scored by:**		**Score**					
Performance indicator	**Indicative question**	**Level**	**0**	**1**	**2**	**3**	**4**
Understanding of environmental impacts	Do senior managers understand the company's environmental impacts?						
	All senior managers understand all the company's environmental impacts.	*Full*					■
	Some senior managers understand all the company's environmental impacts.	*Good*				■	
	Some senior managers understand some of the company's environmental impacts.	*OK*			■		
	Some senior managers have a limited understanding of the company's environmental impacts.	*Poor*		■			
	No senior manager understands the company's environmental impacts.	*None*	■				
Reducing costs by minimising waste	Are all possibilities exhausted before progressing through the waste hierarchy for each waste stream?						
							■
						■	
					■		
				■			
			■				
Different waste streams	Is the waste hierarchy applied, as appropriate, to all forms of waste?						
							■
						■	
					■		
				■			
			■				

CHECKLIST 2			
Identifying priorities for improvement			
Are the suggested priorities appropriate and in the right order for your business? Make any alterations you feel are necessary.			
Date:	**Assessor:**		
Inputs and outputs	**Suggested priorities**	**Priorities for your company**	**Comments**
Polymer A	1		
Polymer B	2		
Saleable product	3		
Packaging	4		
Process heat	5		
Compressed air	6		
Additives/masterbatch	7		
Cleaning and specialist purging materials	8		
Oil and oil filters	9		
Solvents and coatings	10		
Water	11		
Waste disposal costs	12		



GG277
checklist2.doc

CHECKLIST 3

Identifying sources of environmental data

Date:	Completed by:			
Performance indicator	**Examples**	**Possible data sources**	**Holder**	**New data needed? Y/N**
Production	Weight of saleable product	Production records		
Sales	Numbers and weight of mouldings sold Turnover (for benchmarking relative performance from year to year)	Sales invoices, accounts Annual results report		
Raw materials	Polymer, masterbatch, printing inks, paint	Purchase invoices Production schedules Stores records Records of reject rates and rework Stocktaking records Management information systems		
Ancillary materials	Solvents, oils, process cleaning materials			
Consumables	Personal protective equipment, office materials, general cleaning materials			
Packaging for materials and products	Boxes, pallets, labels, containers, tubes, bags, sacks, tape, etc Wrapping, binding and tying materials Could be paper, board, timber, glass, metals, plastics or ceramics	As for raw materials Information gathered to show compliance with packaging legislation (if applicable) Suppliers		
Utilities	Gas, electricity, fuel, water	Invoices, meters, plant ratings		
Solid waste	Dust, purge, regrind, rejects, rework, runners, scrap polymer, scrap metal, sprues, flash, trimmings, etc	Internal monitoring for environmental, QA, health and safety, financial, staff incentive or other purposes Waste disposal invoices Special waste consignment notes Waste transfer notes Sales to merchants or dealers Waste stockpiles		
Liquid wastes and effluent	Cooling water, compressed air condensate, waste oil, spent solvent, water treatment residues, etc	Water company monitoring of trade effluent discharges Water bills Waste disposal invoices Special waste consignment notes Waste transfer notes		
Emissions to atmosphere	Dust, refrigerant gas leaks and fumes from coating operations, eg painting and degreasing tools, and cleaning operations	Monitoring data for LAPC (if applicable) Maintenance records		

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CHECKLIST 4

Progress towards setting priorities and gathering base-line data

A score of four indicates a high level of performance and a score of zero indicates very poor or non-performance. Example scores are given for possible responses to the first question. Use this example to develop your own responses for each score for the other questions.

Date:	**Scored by:**		**Score**				
Performance indicator	**Indicative question**	**Level**	**0**	**1**	**2**	**3**	**4**
Setting priorities	Have priority areas for action been established?						
	All aspects of the business have been considered in setting priorities.	*Full*					■
	Nine priority areas have been identified.	*Good*				■	
	Six priority areas have been identified.	*OK*			■		
	Three priority areas have been identified.	*Poor*		■			
	No priorities have been set.	*None*	■				
Base-line data	Have base-line data been identified for all priority areas?						
							■
						■	
					■		
				■			
			■				
Benchmarking	How does the company compare with the costs given in *Benchmarking Waste in Plastics Processing* (EG252)?						
							■
						■	
					■		
				■			
			■				

CHECKLIST 5				
Progress towards gaining organisational commitment				
Date:	**Assessor:**			
Performance indicator	**Indicative question**	**Yes**	**No**	**Comments**
Winning allies	Has an ally who will help to gain the full support of senior management been identified and won over?	❑	❑	
Preparation of case	Has a well-structured presentation been prepared that sells the need to assess environmental performance?	❑	❑	
Quality of case	Does the presentation convince you?	❑	❑	
	Does it overcome the potential arguments management may raise?	❑	❑	
	Does it identify no-cost and low-cost measures that will bring quick cost savings?	❑	❑	
	Does it mention other benefits of improved environmental performance?	❑	❑	
	Does it include examples from other companies that have reduced costs by making environmental improvements?	❑	❑	
Management commitment	Have senior managers approved the project?	❑	❑	
Project Champion	Has someone been nominated to be Project Champion?	❑	❑	
	Has the Champion been given appropriate responsibilities?	❑	❑	
Project team	Has a project team been formed?	❑	❑	

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CHECKLIST 6

First-time yield for polymer use

Date:	Assessor:				
Item		**Example**	**Polymer A**	**Polymer B**	**Polymer C**
Unit of measurement		All weights in tonnes			
A	Annual weight of virgin polymer* consumed (adjusted for stock changes)	451			
B	Annual weight of saleable polymer production (adjusted for stock changes)	395			
R	Annual weight of polymer reprocessed on-site	29			
S	Total annual weight of polymer throughput (A + R)	480			
First-time yield (FTY = B/S x 100)		**82%**			
Now allocate the waste shown in row R to the processes that produce it. Measure the amount over a known period (eg week or month) and then calculate annual quantities. Don't forget that inspection can be a significant cause of waste.					
D	Moulding				
E	Inspection				
F	Packaging				
G	Include other processes as appropriate to the business, eg assembly, printing, coating				
H	Total allocated waste (D + E + F + G)				
I	**Unallocated waste requiring investigation (R - H)**				

* For the purposes of this checklist, the weight of virgin polymer should include any waste polymer bought in from external sources.

CHECKLIST 7

Mass balance calculation and allocation

Date: **Assessor:**

Item		Example: Polymer A	Priority 1	Priority 2	Priority 3 .....
Unit of measurement		tonnes/year	..... /year	..... /year	..... /year
A	Weight of virgin polymer* consumed (adjusted for stock changes)	451			
B	Weight of saleable polymer production (adjusted for stock changes)	395			
C	Total amount of waste (A - B)	56			
Mass balance yield (MBY = B/A x 100)		**88%**			
Now allocate the waste shown in row C to the processes that produce it. Measure the amount over a known period (eg week or month) and then calculate annual quantities. Don't forget that inspection can be a significant cause of waste.					
J	Goods inwards	2			
K	Storing	3			
L	Blending	8			
M	Moulding	30			
N	Packaging	6			
O	Include other processes as appropriate to the business	-			
P	Total allocated waste (J + K + L + M + N +O)	49			
Q	**Unallocated waste requiring investigation (C - P)**	7			

* For the purposes of this checklist, the weight of virgin polymer should include any waste polymer bought in from external sources.

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CHECKLIST 8					
Progress towards reducing the true cost of waste					
Date:	**Assessor:**				
Performance indicator	**Indicative question**	**Yes**	**Some work**	**No**	**Comments**
Inputs and outputs	Have all inputs and outputs been identified and shown on a diagram?	❑	❑	❑	
Process mapping	Has a process map been drawn up for each process?	❑	❑	❑	
Mass balancing	Are all priority inputs and outputs allocated and/or measured periodically?	❑	❑	❑	
	Are inputs reconciled with outputs periodically to ensure the way in which all priority inputs find their way out of the business is known?	❑	❑	❑	
	Are quantities of non-priority inputs and outputs reconciled periodically?	❑	❑	❑	
Problem areas	Is there a clear picture of where waste could be reduced?	❑	❑	❑	
Mass balance yield (MBY)	Is the mass balance yield for each polymer calculated every week or month?	❑	❑	❑	
	Have you used the MBY to estimate the value of polymer wasted?	❑	❑	❑	
	Are MBYs close to 100% being achieved?	❑	❑	❑	
First-time yield (FTY)	Are FTYs for each polymer calculated every week or month?	❑	❑	❑	
	Are FTYs almost the same or equal to MBYs?	❑	❑	❑	
Packaging waste	Are you monitoring your packaging waste?	❑	❑	❑	
True cost of waste	Has the true cost been calculated for all waste, including the value of all materials, waste disposal costs, packaging, labour, energy, opportunity costs and all processing prior to the waste being generated?	❑	❑	❑	

CHECKLIST 9

Progress towards gaining support from operators

Date:	Assessor:				
Performance indicator	**Indicative question**	**Yes**	**Some work**	**No**	**Comments**
Winning allies	Have you identified and won over employees who will help to improve environmental performance?	❑	❑	❑	
Project team	Has a team been formed?	❑	❑	❑	
Awareness-raising	Has on-the-job training been given to raise awareness of environmental issues?	❑	❑	❑	
	Has a formal presentation been given to existing staff to raise awareness of environmental issues?	❑	❑	❑	
	Are new employees made aware of environmental performance requirements?	❑	❑	❑	
Posters	Are relevant posters displayed in strategic locations and changed regularly?	❑	❑	❑	
Notice-board	Is the company notice-board used for environmental performance matters?	❑	❑	❑	
Suggestions	Has a scheme for gathering suggestions been designed and implemented?	❑	❑	❑	
Competition	Is the environmental performance of different shifts measured and publicised?	❑	❑	❑	
Other techniques for raising awareness	Have other awareness-raising techniques been identified and implemented?	❑	❑	❑	
Maintaining momentum	Are all awareness-raising techniques kept under review, modified and repeated as appropriate?	❑	❑	❑	
Rewarding success	Is credit given to those employees who help the company improve its environmental performance?	❑	❑	❑	

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CHECKLIST 10					
Progress towards implementing measures to reduce waste costs					
Date:	**Assessor:**				
Performance indicator	**Indicative question**	**Yes**	**Partly**	**No**	**Comments**
Asking why	Are the reasons known why all identified wastes arise?	❑	❑	❑	
Measuring to Manage	Is environmental performance measured and monitored in a formal on-going programme?	❑	❑	❑	
Target-setting	Are targets set for improving environmental performance and is performance against them kept under constant review?	❑	❑	❑	
Finding solutions	Have ways been identified to minimise waste production for all priority outputs?	❑	❑	❑	
	Have you looked at all relevant Envirowise and EEBPP publications?	❑	❑	❑	
Quality assurance	Are quality assurance procedures applied so as to detect defects as early as possible?	❑	❑	❑	
Improvements	Have the improvements indicated in this Section been considered and applied where appropriate?	❑	❑	❑	
	Have employee suggestions been gathered and assessed for feasibility?	❑	❑	❑	
	Have all cost-effective improvements been implemented?	❑	❑	❑	

CHECKLIST 11					
Progress towards implementing an EMS					
Date:	**Assessor:**				
Performance indicator	**Indicative question**	**Yes**	**Partly**	**No**	**Comments**
Advice	Has a copy *of Environmental Management Systems for the Plastics Industry* (GG251) been obtained?	❑	❑	❑	
Initial review	Has an initial review been carried out that covers all aspects of environmental performance (including environmental legislation and emergency planning)?	❑	❑	❑	
Corporate culture	Is environmental management integrated fully into all aspects of the business?	❑	❑	❑	
Environmental policy	Has an environmental policy been written? Is it available to the public and kept under review?	❑	❑	❑	
Environmental aspects and impacts	Have aspects of the business with impacts on the environment been identified and prioritised? Are they kept under review?	❑	❑	❑	
Legislation	Do you have a clear picture of which environmental legislation applies to the company? Is there a system for identifying legislation that will apply in the future?	❑	❑	❑	
Objectives and targets	Have environmental objectives and targets been set? Is there a system for checking performance against them?	❑	❑	❑	
Management programme	Is there a maintained programme for achieving objectives and targets?	❑	❑	❑	
Organisational structure	Have roles and responsibilities for environmental management been allocated?	❑	❑	❑	

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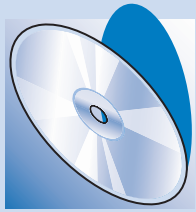

Resources	Have adequate human and financial resources been allocated to enable environmental performance to be maximised?	❑	❑	❑	
Training	Are staff training needs assessed and met at all times?	❑	❑	❑	
Communications	Is there an internal system for communicating environmental management matters?	❑	❑	❑	
Documentation	Are all aspects of your environmental management practices documented? Are these kept up-to-date and is document circulation controlled?	❑	❑	❑	
Procedures	Have written procedures for managing environmental performance been implemented? Are they maintained?	❑	❑	❑	
Suppliers and customers	Have you assessed your environmental performance in relation to your suppliers and customers?	❑	❑	❑	
Emergency preparedness	Do you have procedures for preventing, managing and mitigating emergencies that may have implications for your environmental performance?	❑	❑	❑	
Monitoring and measurement	Do you monitor, measure and evaluate your environmental performance?	❑	❑	❑	
Non-conformance	Do you identify, investigate and rectify poor environmental performance?	❑	❑	❑	
Record-keeping	Is a procedure implemented for identifying, maintaining and disposing of records relating to environmental performance?	❑	❑	❑	
Auditing	Do you audit all aspects of environmental management in the business periodically?	❑	❑	❑	
Management review	Are regular reviews carried out by senior management to ensure that environmental management is being carried out in accordance with the company's environmental policy? Are changes directed as necessary?	❑	❑	❑	

About the CD-ROM

The CD-ROM in the back pocket of the Guide contains electronic versions of the Guide's 11 checklists as Microsoft® Word 97 files and a number of Envirowise publications as PDF files. A copy of Acrobat® Reader™ 4.0 is supplied to enable PDF files to be read. The slide presentation from *Waste Minimisation Pays: Five business reasons for reducing waste* (GG125) is provided as a Microsoft® PowerPoint® 97 file. The contents of the CD-ROM are listed in Table A2.

The CD-ROM is designed to run on PCs operating Windows® 95/98/NT. Simply insert the disc in your PC's CD-ROM drive and follow the instructions on your screen. If you use the CD-ROM, you agree to the disclaimer printed on the inside back cover of the Guide.

If you have any problems with either the CD-ROM or the files it contains, please contact the Environment and Energy Helpline on freephone 0800 585794.

Table A2 Files on the CD-ROM in the back pocket of the Guide

Finding and reducing waste in plastics processing	
GG277checklist1.doc	*Do you have an effective waste minimisation programme?*
GG277checklist2.doc	*Identifying priorities for improvement*
GG277checklist3.doc	*Identifying sources of environmental data*
GG277checklist4.doc	*Progress towards setting priorities and gathering base-line data*
GG277checklist5.doc	*Progress towards gaining organisational commitment*
GG277checklist6.doc	*First-time yield for polymer use*
GG277checklist7.doc	*Mass balance calculation and allocation*
GG277checklist8.doc	*Progress towards reducing the true cost of waste*
GG277checklist9.doc	*Progress towards gaining support from operators*
GG277checklist10.doc	*Progress towards implementing measures to reduce waste costs*
GG277checklist11.doc	*Progress towards implementing an EMS*
GG277fig2.jpg	*Typical overall inputs and outputs for plastics processing*
GG277fig3.jpg	*Simplified process map for injection moulding*
Publications specific to the plastics processing industry	
GG251.pdf and 11 files from accompanying diskette	*Environmental Management Systems for the Plastics Industry*
EG252.pdf	*Benchmarking Waste in Plastics Processing*
General waste minimisation	
GG227.pdf	*Cost-effective Management of Lubricating and Hydraulic Oils*
GG125.pdf and GG125.ppt	*Waste Minimisation Pays: Five business reasons for reducing waste*
GG25.pdf	*Saving Money Through Waste Minimisation: Raw Material Use*
GG27.pdf	*Saving Money Through Waste Minimisation: Teams and Champions*
GG38C.pdf	*Cutting Costs by Reducing Waste: A self-help guide for growing businesses*
GG253.pdf	*Finding Hidden Profit for Smaller Companies*
ET30.pdf	*Finding Hidden Profit: 200 Tips for Reducing Waste*
ET225.pdf	*Waste Account: Count the cost of waste for your business and measure your savings*
ET228.pdf	*Workforce Partnerships to Reduce Waste and Save Energy*

Table A2 Files on the CD-ROM in the back pocket of the Guide (continued)

Reducing energy costs	
GPG292.pdf	*Energy in Plastics Processing - A Practical Guide*
Reducing water costs	
GG26.pdf	*Saving Money Through Waste Minimisation: Reducing Water Use*
GG67.pdf	*Cost-effective Water Saving Devices and Practices*
GG152.pdf	*Tracking Water Use to Cut Costs*
Reducing packaging costs	
GG140.pdf	*Cutting Costs and Waste by Reducing Packaging Use*
GG141.pdf	*Choosing and Managing Re-usable Transit Packaging*
ET250.pdf	*Unpack those Hidden Savings: 120 Tips on Reducing Packaging Use and Costs*
Preventing waste in production/statistical process control	
GG223.pdf	*Preventing Waste in Production: Industry Examples*
GG224.pdf	*Preventing Waste in Production: Practical Methods for Process Control*
IT96.pdf	*Waste Minimisation Interactive Tools (WMIT) - easy-to-use software*
Training	
GG106.pdf	*Cutting Costs by Reducing Waste: Running a workshop to stimulate action*
GG174.pdf	*Profiting from Practical Waste Minimisation: Running a workshop to maintain the momentum*

Envirowise – Practical Environmental Advice for Business – is a Government programme that offers free, independent and practical advice to UK businesses to reduce waste at source and increase profits. It is managed by AEA Technology Environment and NPL Management Limited.

Envirowise offers a range of free services including:

- Free advice from Envirowise experts through the Environment and Energy Helpline.
- A variety of publications that provide up-to-date information on waste minimisation issues, methods and successes.
- Free, on-site waste reviews from Envirowise consultants, called Fast Track Visits, that help businesses identify and realise savings.
- Guidance on Waste Minimisation Clubs across the UK that provide a chance for local companies to meet regularly and share best practices in waste minimisation.
- Best practice seminars and practical workshops that offer an ideal way to examine waste minimisation issues and discuss opportunities and methodologies.

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