GG264
GUIDE

ENVIRONMENTAL
TECHNOLOGY
BEST PRACTICE
PROGRAMME

REDUCING COSTS THROUGH EFFECTIVE SWARF MANAGEMENT

GOOD PRACTICE: Proven technology and techniques for profitable environmental improvement

REDUCING COSTS THROUGH EFFECTIVE SWARF MANAGEMENT

This Good Practice Guide was produced by the Environmental Technology Best Practice Programme

Prepared with assistance from:

Foster Wheeler Energy Ltd

SUMMARY

Engineering companies in the UK face escalating waste disposal charges and pressure from legislative bodies to reduce their impact on the environment. Effective swarf management will improve your company's image and help the environment, while saving you both money and effort. A machine shop producing up to 10 tonnes/year of swarf can typically save around £1 200/year by adopting simple no-cost and low-cost swarf reduction and handling methods.

The benefits of effective swarf management include:

- reduced machining time;
- reduced waste disposal and energy costs;
- maximum market price obtained for each material;
- smaller storage capacity required;
- less time spent handling swarf.

This Good Practice Guide describes practical measures to help machine shops achieve cost and environmental benefits by adopting a systematic approach to swarf management based on the waste hierarchy. No-cost and low-cost ways of preventing swarf production, reducing the amount of swarf produced and minimising contamination to increase the value of swarf are explained and illustrated with Industry Examples. The advice given is applicable to any company, but especially to machine shops producing several tonnes or less of mixed swarf a year.

The Guide stresses the importance of:

- purchasing the optimum size and type of raw materials;
- using the optimum techniques to minimise swarf production;
- segregating different types of swarf;
- minimising contamination with cutting fluids and rainwater;
- making staff aware of the benefits of good swarf management.

An action checklist is given at the end of the Guide, together with useful contact details.

CONTENTS

1 INTRODUCTION

section 1

All companies with machine shops face escalating waste disposal charges and pressure from legislative bodies to reduce their impact on the environment. More sustainable swarf management practices will improve your company's image and help the environment, while saving you time, labour and money.

The benefits of effective swarf management include:

- reduced machining time;
- lower waste disposal and energy costs;
- maximum market price for each material;
- less storage capacity required;
- less time taken for swarf handling.

This Good Practice Guide is intended to help engineering companies achieve cost and environmental benefits by improving their swarf management practices. The Guide:

- explains how to promote awareness of swarf management issues;
- gives advice on how to minimise the generation of swarf;
- provides information on proven technologies for the recovery, handling, segregation and recycling of metal swarf;
- gives contact details for metal recyclers/merchants and suppliers of swarf handling equipment and briquetting services.

Practical measures are described in the Guide to help companies develop an action plan based on the waste hierarchy, ie prevention, reduction, re-use, recovery and finally disposal (see Fig 1 overleaf). The advice given is applicable to any company, but especially to machine shops producing several tonnes or less of mixed swarf a year. It is particularly relevant to small 'jobbing' companies with a wide range of operations and where a number of different metals are machined or processed.

The Guide explains how to:

- Prevent and minimise swarf production, ie the first stages of the waste hierarchy.
- Manage the swarf that is unavoidably produced to maximise its value.
- Segregate swarf so as to facilitate re-use or recycling.
- Sell your swarf for recycling at its maximum price. But remember: recycling will cost money, as the price you receive for the swarf will be less than the purchase price of the original metal.

Disposal need only be considered as a last resort, and only for unavoidable swarf that cannot be re-used or recycled. Disposal costs a company money and has an adverse environmental impact.

Significant cost savings can be made by implementing a systematic approach to the management of swarf. For a machine shop producing around 10 tonnes/year of swarf, cost savings of around £1 200/year can be achieved by adopting simple no-cost and low-cost swarf reduction and handling methods.

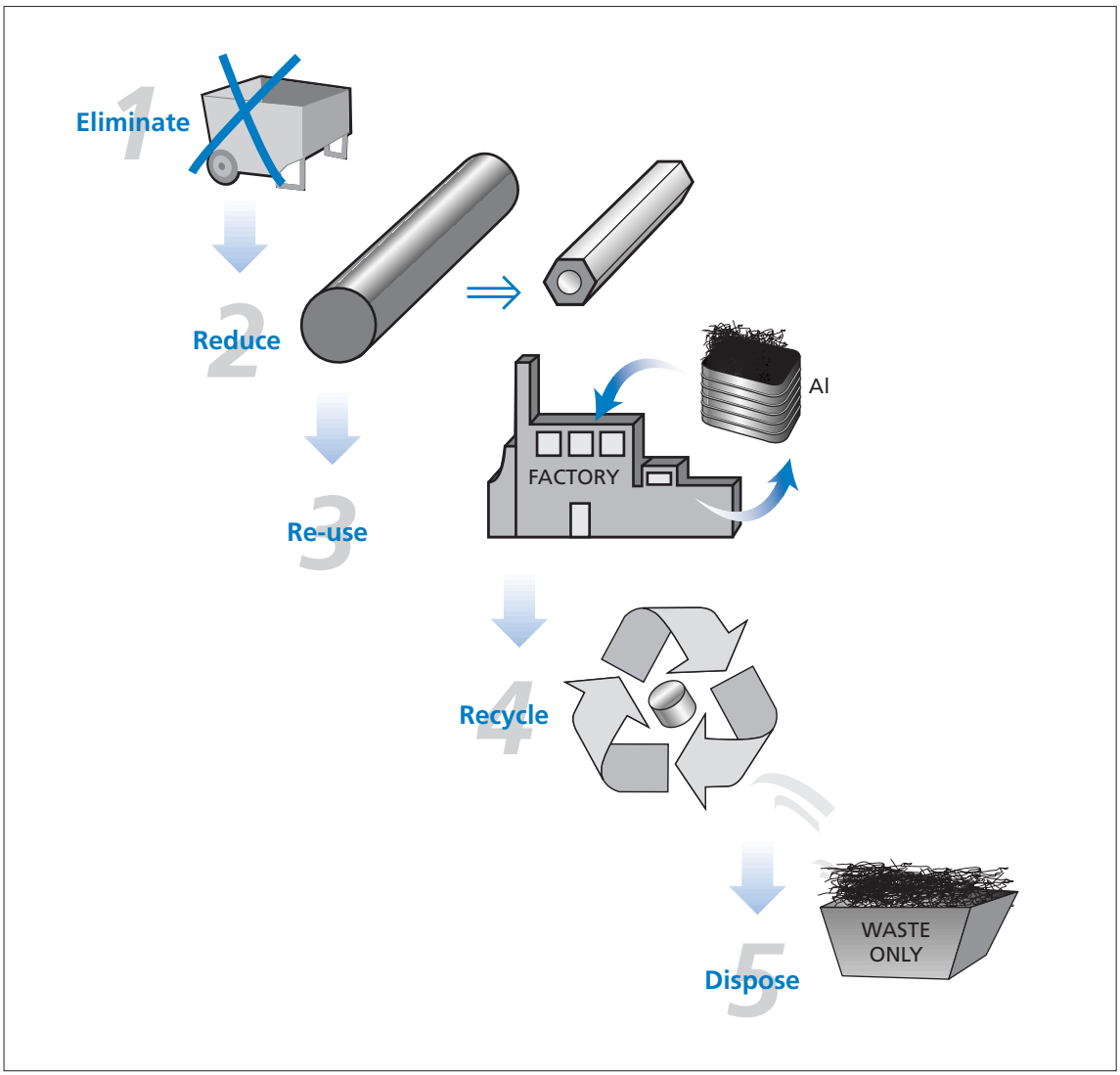

Fig 1 The waste hierarchy

Effective swarf management can save your company money by improving the returns on your swarf by up to 25%.

2 MINIMISING SWARF PRODUCTION

The extra time and effort taken producing excess swarf uses labour and costs money. Before looking at re-use and recycling, it is important to consider ways of minimising the amount of swarf produced in the first place. The advantages of reducing swarf production include:

- reduced machining time;
- potentially lower feedstock costs;
- less swarf to be handled.

Awareness starts with looking at where you are now, ie identifying and measuring your chief sources of swarf.

- Measure the quantity of swarf produced.
- Note which machines or processes are the main sources of swarf.
- Use this base-line information to find out how much you can improve by adopting measures to reduce swarf production.

2.1 TECHNIQUES TO REDUCE SWARF QUANTITIES

Table 1 shows how various techniques can be used to solve particular problems and thus reduce the amount of swarf produced.

Issue	Problem	Technique
Excessive machining	Oversized stock	Use near-size stock.
	Hollow components	Use hollow stock (rather than bore out the core) or spun castings.

Table 1 Techniques to minimise swarf production

- **Purchasing the optimum size and shape of feedstock material**, eg bar stock of appropriate diameter and length will reduce the amount of machining needed and hence the quantity of swarf produced.
- **Implementing 'near net shape' techniques** in forging operations will minimise the amount of metal removed in subsequent machining operations.
- **Cold welding by powder metallurgy** may be appropriate for some industries. Powder metallurgy involves cold pressing metal powders at high pressures (up to 11 tonnes/cm^2) to produce parts with a density 95% that of solid metal. The technique, which is applicable to components weighing up to 3 kg, has a metal utilisation of around 95%. Another advantage is that it often allows components, eg engine parts, to be produced in a single operation instead of being produced as separate forged or cast parts that have to be assembled.
- **Use of spun castings.** Spinning the casting as it is poured improves gas removal and thus produces a better quality casting. Spun castings are normally used for speciality alloys, and may be considered for the production of items with a large central hole such as external gear cogs. Unlike many forgings, spun castings do not have a hard surface (which can damage tools) and significantly reduce both machining time and swarf production.

- Why not contact your suppliers and discuss what they can do to help (but make sure they are not simply pre-machining non-optimal stock for you)?

section 2

Using hexagonal brass hollow bar reduces swarf production

BICCGeneral UK Components Division, a medium-sized engineering company on Merseyside, has minimised swarf production during the manufacture of cable glands by purchasing hexagonal brass hollow bar. The benefits of this change include:

- reduced swarf production;
- machining time reduced by around 20% compared to solid bar;
- reduced energy consumption.

Hexagonal brass hollow bar for machining

3 THE VALUE OF SWARF

It is not generally possible to eliminate swarf production, so the next stage is to look at ways of improving the management of the swarf that is produced. This Section examines the potential value of swarf and how this can be maximised.

3.1 THE FACTORS THAT AFFECT SWARF VALUE

These factors are summarised in Table 2.

Factor	Issue
Quantity	■ There is an optimum quantity as very small amounts are not economical to transport. Swarf should be stored (segregated and covered) until it is worthwhile.
	■ Larger quantities can be sold direct to a recycler.
Site location	■ Cost of transporting to dealer or recycler.
Market forces	■ Scrap metal values vary widely according to supply and demand in the UK and overseas.
Metal type	■ Different metals have different values (see Fig 2).
Metal purity	■ Once mixed, metals are difficult to separate.
Contaminated with cutting fluid	■ Storage problems.
	■ Increased transport costs.
	■ Not accepted by recycler.

Table 2 Factors affecting the value of swarf

The current low value of steel means the economics of recycling steel swarf are not favourable. Other metals fetch higher prices (see Fig 2). As waste disposal costs increase, the recovery of metal wastes becomes a much more attractive proposition.

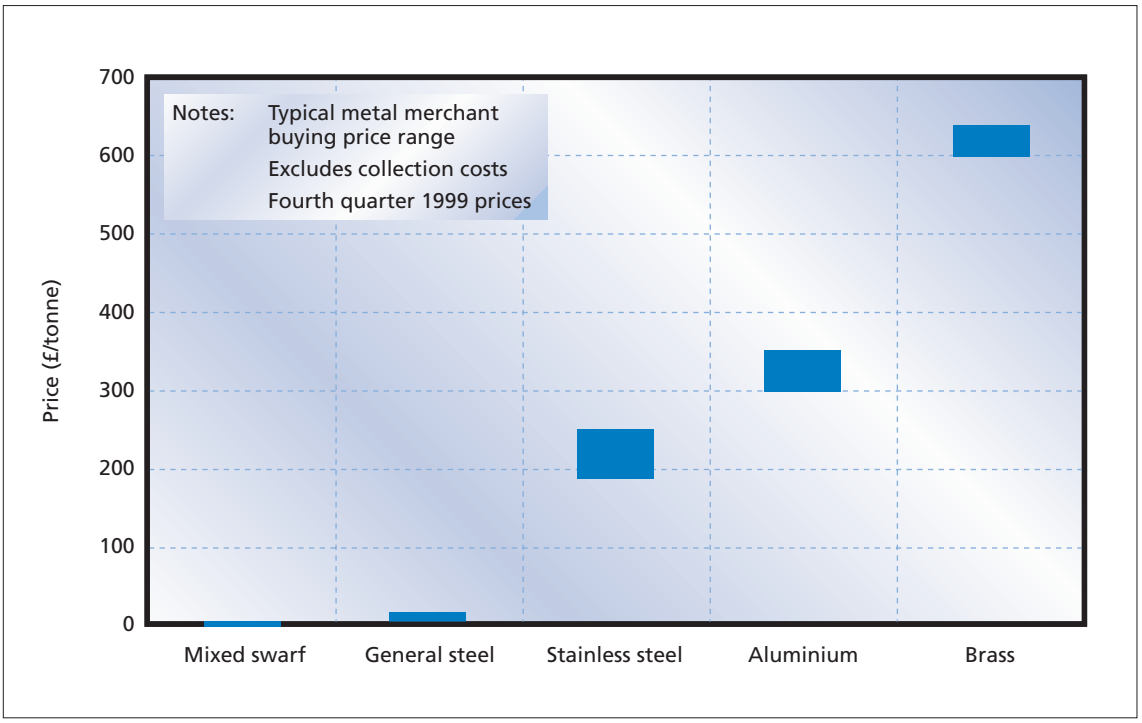

Fig 2 Typical prices paid for swarf

Mixed metal swarf has little or no resale value. The products produced by metal processors have to meet certain quality and purity specifications. In most cases, these specifications cannot be achieved by simply melting down and recasting mixed swarf in the same way as pure swarf. To ensure that product specifications are met, mixed swarf has to be ground into fine chips and then blended with purer swarf. This makes reprocessing mixed swarf more expensive and thus reduces the value of the swarf.

The price paid for swarf is also affected by its moisture content and how much it is contaminated with cutting fluid. Swarf typically contains 20 - 30% cutting fluid. Scrap metal dealers that bulk up swarf from various sources before sending it for recycling generally build a cost into the price to account for any drying needed. If the quantities produced are large enough, swarf can be sold direct to a recycler. Recyclers often demand swarf with a moisture content of less than 5 - 10%, but such swarf can yield a premium of around 25%.

section 3

3.2 INCREASING THE VALUE OF YOUR SWARF

The main way of increasing the value of swarf is to minimise contamination with other metals, cutting fluids and/or rainwater. Table 3 summarises techniques to increase swarf value by reducing contamination. These are described in more detail in Section 4.

Issue	Problem	Technique
Contamination	Other metals	■ Segregate different types of swarf. ■ Provide separate bins that are clearly labelled or colour-coded.
	Cutting fluids	■ Drain and/or centrifuge.
	Rain/snow	■ Store in a covered area.

Table 3 Techniques to increase swarf value by reducing contamination

3.2.1 Why minimise contamination with other metals?

As shown in Fig 2, individual non-ferrous metals and stainless steel can command a significant premium. Returns on carbon steel are currently small and mixed metals may have no value or even require payment for their removal. To meet specifications for individual metals, contamination of swarf with other metals needs to be avoided.

Segregation of swarf from different metals will maximise returns from swarf disposal. Cleaning down machines between production runs on different metals and storing swarf in separate, labelled bins are vital actions.

3.2.2 Why minimise contamination with cutting fluids?

Swarf is frequently contaminated with cutting fluids, either neat oil or soluble oil (generally 90 - 95% water). Even well-drained swarf still typically contains 5 - 10% contamination. With viscous cutting fluids, 30 - 40% of the weight of some types of curly swarf is due to the presence of these fluids.

Wet swarf has to be dewatered by the scrap metal dealer or recycler. This typically involves drainage under gravity, followed by centrifuging, before the swarf is dried in a rotary kiln or similar device (see Fig 3). Once the swarf is dry, it can be remelted to form ingots of recycled metal. The drier the swarf supplied by the producer, the lower the cost of drying it at the recycler. Some recyclers only accept swarf with minimal cutting oil contamination (generally less than 4 - 10%). Swarf with a higher oil content is usually sold at a lower price to a scrap metal merchant. Swarf recycling is discussed in more detail in Section 5.

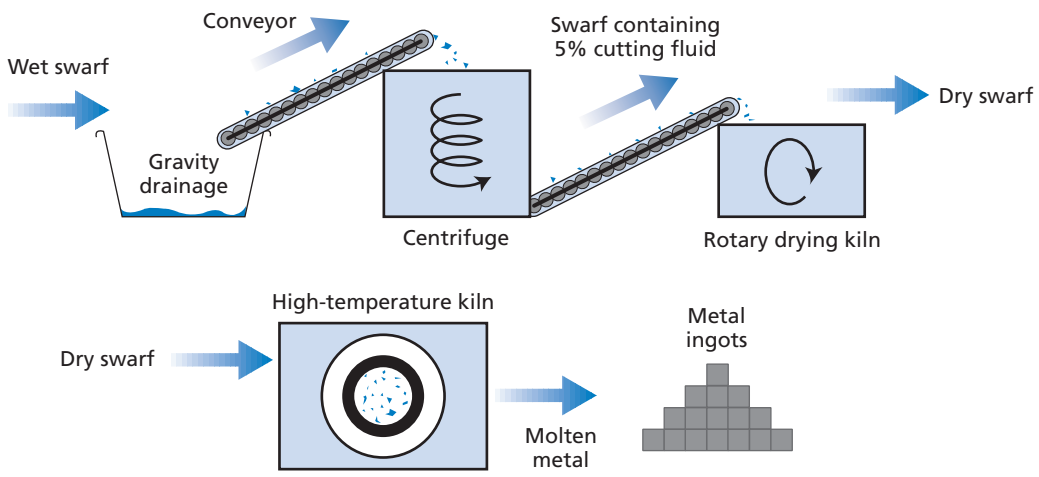

Fig 3 Swarf processing at a recycler's premises

The cutting fluids separated out from the wet swarf at a recycler's premises are mixed and, therefore, cannot be re-used. However, they may be suitable for use as power station fuel.

If you separate your cutting fluids on-site, you may be able to re-use them yourself and thus reduce your purchase costs for cutting fluids. See Good Practice Guide (GG199) *Optimising the Use of Metalworking Fluids* available free of charge through the Environment and Energy Helpline on 0800 585794.

3.2.3 Why minimise contamination with rainwater?

Skips of swarf left out in the rain will become contaminated with rainwater, leading to a need to dewater and dry the swarf before it can be processed. This will reduce the price paid for the swarf.

Rainwater can also cause oil sumps linked to bunded storage areas (see Section 4.7) to overflow, leading to contamination of soil and water sources with oils. Any land or groundwater contamination can lead to prosecution of the company involved. The company will also be required to pay for any remedial work.

Remember:

- Mixed swarf has no value.
- Carbon steel swarf has a very low value.
- Segregated non-ferrous swarf has a significant value.
- Drier swarf with a low cutting fluid content may attract a premium.
- Larger quantities may be sold direct to a recycler for a higher price.

4 MANAGING SWARF TO INCREASE ITS VALUE

This Section describes how to improve your swarf handling and thus increase its value by enabling it to be re-used or recycled. The benefits to larger companies of a partnership with a specialist waste management company are illustrated with an Industry Example (see Section 4.8).

As explained in Section 3.2, segregating swarf from different types of metal and reducing the cutting fluid content will increase the value you obtain for your swarf.

Producing **pure and dry swarf** is the key. This can be achieved by:

- removing swarf promptly from machines;
- conveying appropriately to swarf storage;
- drying if appropriate;
- suitable swarf storage.

section 4

Practical advice on how to carry out these stages is given below, together with tips on how to improve your current performance. Many of the practical measures suggested are no-cost or low-cost.

4.1 POTENTIAL COST SAVINGS FROM IMPROVED SWARF MANAGEMENT

Direct cost savings will result from reduced production of swarf and metal segregation at the point of production. Better management and reduced swarf production will lead to indirect savings through reduced machining time, swarf handling time and swarf storage capacity.

A typical machine shop using a range of ferrous and non-ferrous materials and generating around 10 tonnes/year of non-ferrous swarf could easily save an estimated £1 200/year by implementing best practice techniques. Fig 4 shows a breakdown of how these savings are achieved. Remember, these are only the direct cost savings - the company would also benefit from significant indirect savings.

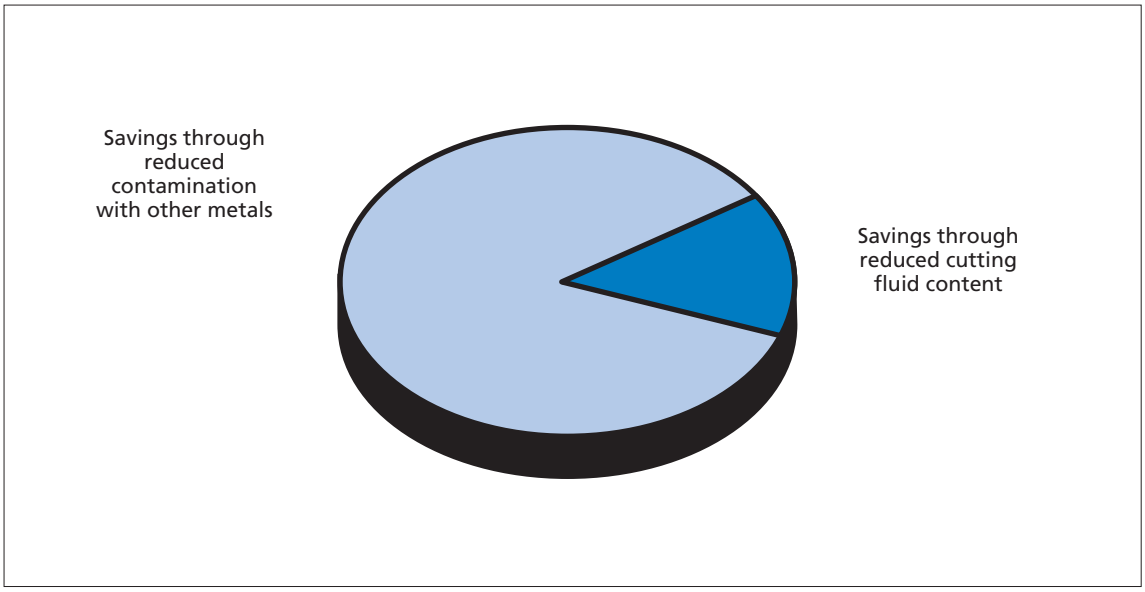

Fig 4 Breakdown of typical saving of £1 200/year

- Further savings can be achieved by improved fluid management and recycling your cutting fluids. Contact the Environment and Energy Helpline on freephone 0800 585794 for details of free publications and advice on how to reduce the costs associated with metalworking fluids.

4.2 ENCOURAGING AWARENESS

In smaller companies, the workshop manager responsible for the production, recovery, handling and segregation of swarf frequently has no information on the value of the swarf and possible effects of contamination on its value.

Making the producer of the swarf aware of the full costs/values will encourage:

- appropriate waste reduction;
- segregation (improving the ability of the swarf to be recycled);
- appropriate storage.

For example, shop-floor operators are more likely to employ appropriate storage techniques if they know the reason. This is not just the financial benefits to the company but also the environmental benefits: cutting fluid draining from poorly stored swarf may contaminate surface water or groundwater, causing damage to plants or fish and creating a contaminated land liability for your company.

Making swarf producers, eg machine operators and workshop managers, responsible for the financial returns from swarf will help to ensure the continued use of good practice. Introducing an incentive scheme, eg involving staff benefits or donations to a chosen charity, will help to motivate staff to achieve cost savings and improve the revenue obtained from swarf.

- Make swarf producers responsible for the financial returns from swarf.

4.3 REMOVING SWARF

Swarf can be recovered from machining operations either manually or automatically. The method used usually depends on the scale of operations and the size of the equipment used. Typically, swarf is removed manually from a small bench lathe, while automatic swarf removal is possible for a large CNC lathe machining only one metal.

- To ensure segregation of metals, clean swarf from the machine each time production changes to a different metal.

4.3.1 Manual swarf recovery

This is the most common form of swarf recovery, especially in small companies. Swarf is removed from the machine at the end of each production run using 'dustpan and brush' technology (see Fig 5 overleaf). This technique is applicable to drills and areas where small quantities of swarf are generated. An alternative is to use a portable vacuum cleaner designed to remove swarf and cutting fluid. To ensure segregation, the swarf basket needs to be emptied before the cleaner is used for a different metal.

Fig 5 Manual swarf removal

section 4

Care must be taken to avoid contact with oils and when handling sharp edges. Detailed information on safety issues is given in the following Health and Safety Executive (HSE) publications:

- *Health Risks from Metalworking Fluids*, INDG 167;
- *Preventing Injuries from the Manual Handling of Sharp Edges in the Engineering Industry*, EIS 16.

Both are available free from HSE Books, PO Box 1999, Sudbury, Suffolk CO10 2WA. Tel: 01787 881165. http://www.hsebooks.co.uk

For further information about health and safety issues relating to swarf, contact the HSE InfoLine on 0541 545500 or the HSE Information Centre, Broad Lane, Sheffield S3 7HQ.

4.3.2 Automatic swarf recovery

Typical methods are:

- **Belt conveyor.** As the swarf is carried on a steel conveyor, the cutting fluid drops out and is returned to the machine. Such systems are generally highly reliable and can form part of a modular system with crushers and centrifuges.
- **Screw conveyor** (see Fig 6). This is generally part of the machine.
- **Pneumatic conveyor.** An Archimedes screw is normally used to feed the conveyor, which involves a suction system with a centrifugal fan. Such systems are flexible in their positioning and can transport swarf up to

Fig 6 Swarf leaving a screw conveyor

100 metres. The swarf is removed from the air by a cyclone and dropped into a swarf silo. A swarf crusher is needed to handle bushy swarf.

- **Transfer in the cutting fluid.** In large workshops, the swarf is carried to a central swarf removal system by cutting fluid running through a piped system. The swarf is removed from the cutting fluid using basket capture or a similar method.

Table 4 shows the applicability of these four systems.

Application	Steel belt conveyor	Screw conveyor	Pneumatic conveyor	Transfer in cutting fluid
Chipped swarf	✓	✓	✓	✓
Bushy swarf	✓	✓	✘	✓
Long distance	✘	✘	✓	✓
Short distance	✓	✓	✓	✓

Table 4 Applications of automatic swarf recovery systems

4.4 CONVEYING SWARF

Generally, swarf is stored temporarily in bins adjacent to machines. These bins are then emptied into the main swarf storage containers. This system allows flexibility in the siting of machines, which can be useful. Some swarf transfer systems, eg pneumatic conveyors or fluid transfer systems, transfer the swarf directly to final storage.

There are two main types of swarf bin, these are outlined below.

4.4.1 Small wheeled bins

These are often preferable where small amounts of swarf are produced. Small wheeled bins (see Fig 7) are easy for operators to move around manually, thus eliminating the need for machinery. They can then be emptied quickly and efficiently into a larger storage skip, allowing immediate re-use of the bin.

To help separate cutting fluid from the swarf, the bins should:

- have a mesh layer above the base and a tap to drain off cutting fluid;
- be emptied with a shovel rather than by tipping to ensure the fluid remains separate.

Fig 7 Typical small wheeled bin

4.4.2 Larger bins for fork-lift trucks

Fork-lift bins are large bins that are not suitable for manual handling, but can be moved and tipped using a fork-lift truck. They have a much larger storage capacity and are, therefore, more appropriate for applications that produce significant quantities of swarf. The main disadvantage of this type of bin is that, as it is tipped, any liquid that has separated out mixes back in with the swarf.

- Always empty your swarf bins before changing the type of metal being machined.

4.5 CRUSHING SWARF

Bushy swarf requires crushing for:

- pneumatic conveying;
- drying using a centrifuge;
- more compact storage (to reduce transport costs).

A number of different methods are available that generate chipped swarf instead of bushy swarf. Some suppliers sell 'chipping' bits or inserts (see Fig 8) that can be fitted to standard machinery and are specifically designed to break up the swarf as it is drilled or machined. However, they are not applicable to all metal machining.

The benefits of producing chipped swarf rather than bushy swarf include:

- about 75% less volume occupied by the swarf;
- a safer work area (no bushy swarf swirling around);
- a cleaner work area - this can improve the machine's performance.

Fig 8 Self-chipping insert

A swarf crusher can be used to break up much larger pieces of swarf into chipped swarf. These generally grind down the swarf in the same way as a large coffee grinder crushes coffee beans. In some circumstances, swarf crushers require frequent servicing and can be unreliable. However, they generally operate reliably as part of an integrated swarf drying or conveying system installed in consultation with a recognised supplier.

4.6 DRYING SWARF

Various ways of reducing the cutting fluid content of swarf are outlined below. Reducing the amount of cutting fluid present in swarf has a number of advantages, including:

- the possibility of direct sale to a foundry or recycler (with associated 25% increase in value);
- a greater likelihood of being able to re-use the swarf in-house;
- easier and safer swarf storage;
- less environmental risk.

More cost savings may be achieved if the cutting fluid can also be recycled[1].

4.6.1 Dry machining

Dry machining techniques have been developed that eliminate the need for cutting oils in many applications. Such methods are extensively used by the German automotive industry. Dry swarf is produced and the potential hazards associated with handling cutting fluids are removed.

A carbide insert is generally used. It is important not to exceed the recommended machining speed as overheating can lead to the insert disintegrating. Inserts with special low-friction coatings, a few microns thick, are available; these can triple the maximum machining speed. For some machining operations with steel, dry machining can give a longer insert life than if coolant is used.

Dry machining is particularly suited to general steels, cast iron, brass and bronze. Some stainless steels and aluminium are unsuitable for dry machining and dust can be a problem with cast iron.

4.6.2 Gravity drainage

When swarf is left in a bin or a skip, some of the excess cutting fluid will drain down naturally under gravity.

- Use a bin with a mesh layer above the base and a tap to drain off the cutting fluid.
- Shovelling the swarf out of the bin instead of tipping it will keep the swarf drier (the fluid is left in the bottom of the bin).
- Use a skip with drainage holes, taking care to ensure the skip is standing within a bunded area to avoid polluting the soil or nearby water sources with cutting fluid.

4.6.3 Centrifugation

In a centrifuge, the liquid separates from the swarf as the swarf/coolant mixture is spun round. Automatic machines have a continuous feed from a conveyor and generally deliver the swarf directly to a bin or a skip. The coolant can then be sent for cleaning and recycling. Bushy swarf needs to be crushed before it can be centrifuged (see Section 4.5).

When switched off, the centrifuge empties by gravity. This clears out the metal chips before the centrifuge is used again. Most centrifuges are used only for one metal, so segregation is not normally a problem.

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[1] See Good Practice Guide (GG199) *Optimising the Use of Metalworking Fluids,* available free of charge through the Environment and Energy Helpline on freephone 0800 585794.

Centrifuges are only appropriate for larger machining shops. The smallest size treats 70 - 135 kg/hour of aluminium chips or 300 - 600 kg/hour of steel chips.

An automatic handling and centrifuge system costs around £60 000 for a small system processing 100 kg/hour of aluminium or 500 kg/hour of steel, and up to £180 000 for a large system processing 1 200 kg/hour of aluminium or around 5 000 kg/hour of steel. The payback period on the equipment is generally good, but leasing is an option if capital expenditure is a problem.

Drying allows direct sale to a mill

Most of the swarf produced in the machine shop at BICCGeneral UK Components Division is contaminated with 20 - 25% soluble oil. The best financial return available for the swarf is to sell it direct to a mill, but this requires a cutting fluid content of less than 4%.

The ISO 9001 and ISO 14001 certified Company has invested in a swarf processing system that grinds down any bushy swarf and then removes the cutting fluid in a centrifuge. An oil content of approximately 2% is generally achieved.

The system's advantages include:

- drier swarf that can be sold direct to a mill;
- maximised returns on swarf;
- elimination of storage problems with wet swarf;
- reduced environmental risk from fluid drainage;
- cutting fluid can be recycled.

Chipping and centrifuge plant at BICCGeneral UK Components Division

4.6.4 Magnetic separation

This method, which is applicable only to steel swarf, is used for systems where the swarf is transported by flowing cutting fluid. The swarf is removed from the cutting fluid by a strong magnet and then scraped mechanically from the magnet. As steel swarf has little value, the technique is used mainly to allow the cutting fluid to be recycled.

4.6.5 Drying in a kiln

Swarf can be dried in a kiln to reduce the cutting fluid contamination still further. Waste heat, eg from a compressor, can be used as the source of energy. This technique is normally only worthwhile for a company re-using the swarf itself in a kiln (see Section 5.1), as the price differential between the dried swarf and swarf containing 5% cutting fluid is likely to be minimal.

4.7 STORING SWARF

The type of final swarf container depends on the quantity of swarf produced (see Table 5).

Container	Use
Sacks or bags	Small quantities of valuable metals.
Skips	Larger quantities of swarf.
Heaps	Very large quantities of swarf awaiting bulk transport.

Table 5 Swarf containers

Storage in bags is particularly applicable to small quantities of titanium, brass or aluminium. Typical bags contain approximately 50 kg of brass or 10 kg of aluminium.

Skips are frequently provided by scrap metal merchants, and range in size from small, modular units to vast containers. Provided the skips are stored in properly designed and maintained bunded areas, drainage holes in the skips will allow cutting fluid to flow away under gravity and be collected.

Stored swarf needs to be:

- **Clearly labelled or colour-coded.** Segregation of the various metals is essential to obtain maximum financial returns on swarf.
- **Covered.** A covered area (a corrugated iron roof will suffice) keeps out the rain, thus reducing rainwater contamination. This is vital if the swarf has been dewatered! Skip covers are also available; if necessary, weighted tarpaulins can be used.
- **In a bunded area.** Unless appropriate protection measures are taken, storing swarf contaminated with metalworking fluids can lead to ground or surface water contamination with cutting oils. Only dry swarf contains no cutting fluids.
  - As a minimum, the storage area should be contained within a bund (a small, leak-proof wall surrounding the area).
  - The bunded area should preferably slope down to a sump, where oils can collect. Oil levels should be checked frequently and the sump emptied regularly. The collected oil is classed as a special waste and must, therefore, be taken away by a company licensed to remove and dispose of special waste.
  - Alternatively, skips can be sited on a portable skip sump. Such sumps can accommodate about 2 000 litres.

Segregation maximises returns

Kidde Graviner Limited, near Slough, manufactures fire detection and suppression equipment. Its machine shop employs about 15 people and machines various metals including stainless steel, aluminium, brass and carbon steel. Between runs the machines are brushed down manually and the swarf is taken in wheeled bins to a covered swarf storage area. The swarf is moved by shovel to a labelled skip, thus keeping the main metals separate. Cutting fluids drain through holes in the bottom of the skips, which are sited in a bunded area. Rainwater contamination is eliminated by a roof.

These measures have reduced fluid contamination to less than 10% and enabled the Company to obtain a market price for each material as opposed to nothing or a minimal return for mixed swarf.

Covered and bunded swarf storage area at Kidde Graviner

4.8 USING A SPECIALIST WASTE MANAGEMENT COMPANY

Larger companies can benefit from employing a waste management company operating in-house to manage all their wastes, including swarf. The specialist input leads to maximised prices for swarf and enables the company to concentrate on its core business.

Waste management partnership simplifies operation and gets results

British Timken Limited machines steel alloys during the manufacture of highly engineered tapered roller bearings. The Company employs some 1 200 people at its Northampton site and has about 80 turning machines. Approximately 120 tonnes of alloy steel swarf are produced each week. Small quantities of aluminium and brass swarf are also generated, together with a variety of other wastes such as office waste, pallets, drums and special waste.

In 1996, the Company was dealing with over ten different waste contractors. Liaising with this number of contractors did not result in the best utilisation of resources and it was difficult to ensure that the best value was being obtained for a particular waste. British Timken, therefore, decided to set up a total waste management contract with one company with the objective of:

"Introducing a sustainable waste management programme which will establish the best practicable and environmental option, whilst ensuring maximum return on these assets."

The aim of the contract was to:

- deal with one company instead of many;
- make use of the specialist knowledge of the waste management company;
- operate as a partnership with British Timken Limited;
- ensure continuous improvement in waste management.

The contract leaves British Timken free to concentrate on its core business of making bearings, while its chosen partner manages waste re-use, recycling and disposal to ensure maximum value. Waste minimisation principles are now integrated into Company policy and procedures.

The waste management company's expertise in the waste industry has enabled it to find suitable receptors for segregating and handling wastes and to ensure continual improved value for segregated waste, including the steel turnings. Three of its employees and a driver are based full-time at the Northampton site.

The partnership arrangement has helped British Timken to implement a new site waste management policy. The waste management company monitors the amounts of waste produced by the various departments. The reports provided for British Timken have enabled the Company to target cost-effective waste minimisation opportunities and feed back the results to its associates.

A purpose-built facility was designed and constructed as part of the integrated waste management programme. This facility allows on-going segregation of waste streams while ensuring they remain dry and secure. Site safety has improved due to fewer fork-lift truck movements on-site, while bulk loading and improved routing between British Timken sites have reduced off-site transport. An additional benefit is reduced noise.

The partnership allows:

- British Timken to concentrate on its core business;
- mutual support to continuously improve waste minimisation and management practices;
- waste management to be a sustainable self-financing enterprise;
- access to specialist expertise on market opportunities;
- a single contact point for all waste management/disposal requirements;
- assistance in identifying wastes that can be profitably recycled;
- possibilities to bulk up wastes with the waste management company's other customers.

- Segregate all non-ferrous metals (mixed swarf has no value).
- Label storage bins clearly to avoid contamination with other metals.
- Drain off cutting fluids to increase the swarf's value for recycling.
- Consider dry machining to produce dry swarf and eliminate the use of cutting fluids.
- Store small quantities of segregated swarf until you have enough for collection.
- Store swarf skips in covered, bunded areas to avoid contamination with rainwater and to avoid cutting fluids present in the stored swarf polluting the ground or water sources.

5 RECYCLING SWARF

This Section describes the methods available for recycling swarf. They include:

- re-use within the company, ie closed-loop recycling;
- sale to a scrap metal merchant;
- direct sale to a recycler or a foundry.

5.1 CLOSED-LOOP RECYCLING

Some companies use swarf recovery systems to recycle metal waste in-house. This is useful when high value metals such as brass are involved or when a large amount of material is lost as swarf from the machining processes. Such methods are limited to companies with the furnace facilities to recast the metal.

Feeding small particles of swarf to a furnace can be difficult, leading to significant losses to the atmosphere or oxidation of the metal (particularly iron). This problem can be overcome by compressing the swarf under high pressures of around 300 tonnes/cm^2 (500 tons/inch^2) into briquettes. These dense blocks of metal are more suitable than the original swarf for feeding directly to a furnace.

It may not be economical for a small company to purchase and operate a briquetter. An alternative is to use an external company to produce the briquettes for you.

Swarf recycled as briquettes

Biwater Industries in Derbyshire manufactures 120 000 tonnes/year of ductile iron pipes and fittings for the international water industry. Some 8 - 10 tonnes of swarf (known as iron borings) are produced each week. The site's melting furnace cannot use iron borings directly, so the Company sells them to a briquetting company and then buys back the briquettes. The briquettes can be fed directly into the melting furnace, thus enabling the swarf to be recycled and producing a cost saving for the Company, as this arrangement costs less than buying steel scrap.

Briquetting plant

5.2 SALE TO A SCRAP METAL MERCHANT

This method is preferred by companies that either produce relatively small amounts of swarf or generate swarf that is not acceptable to a reprocessor.

A scrap metal merchant will often provide a skip in which to collect your swarf as part of the contract. When the skip is full, the skip is collected and replaced with an empty one.

Merchants are able to take much smaller loads of swarf than a recycler as they combine swarf from a number of companies before selling it to a recycler. They will also normally collect all types of metal swarf at the same time. Merchants are frequently able to dry the swarf and, in some cases, process it further, eg compressing it into blocks, before sending it for recycling.

The cost of swarf storage or processing means that the price paid by a scrap metal merchant for your swarf is lower than that for direct sale to a recycler.

5.3 DIRECT SALE TO A RECYCLER

Large quantities of reasonably dry swarf can be sold directly to a recycler in bulk loads. This can maximise the return on the swarf, particularly for low value materials such as steel. Some recyclers will collect skip loads from customers' premises. This method maximises the return for large producers of one particular metal.

Company benefits from direct sale to a foundry

During the production of highly engineered tapered roller bearings, British Timken Limited at Northampton produces large quantities of alloy steel turnings. The Company had previously used 27 m^3 skips to store and transport this swarf. The skips, which held approximately 11 tonnes of turnings, were collected by a local scrap metal merchant, where they were bulked up for onward transfer to a foundry.

Modifying the swarf handling process and introducing a specially adapted 20 tonne lorry with an in-built bund allowed the Company to send loads for recycling directly to a foundry at Sheffield. The swarf produced by British Timken is a high-grade alloy steel and is used to cushion the electrodes of the foundry's furnace during start-up.

Even after deducting the transport costs, British Timken has achieved a significantly better return on the value of its swarf. Transport movements off-site have also halved. The additional value compared with sale to a scrap metal merchant is believed to be at least 25%.

- Could you re-use your swarf within the company?
- Would briquetting help?
- Could you bulk up large quantities and sell direct to a recycler or foundry?
- Do you have any valuable metals that could be recycled in small quantities? For example, used tungsten carbide tool tips can fetch over £2 000/tonne.

6.1 CHECKLIST FOR EFFECTIVE SWARF MANAGEMENT

Use the checklist below to help you save money by adopting a systematic approach to swarf management based on the waste hierarchy, ie prevention, reduction, re-use, recycling and finally disposal as a last resort.

Have you:

- ☐ Identified opportunities to reduce swarf by changing stock?
- ☐ Identified where swarf can be reduced?
- ☐ Identified the types of swarf produced by your company?
- ☐ Measured the quantities of each type of swarf?
- ☐ Provided separate bins for each type of swarf?
- ☐ Clearly labelled or colour-coded these bins?
- ☐ Ensured the bins will be emptied when metals are changed?
- ☐ Examined procedures for clean-down when the metal is changed?
- ☐ Drained the cutting fluids from your swarf?
- ☐ Ensured skips are covered to prevent rainwater contamination?
- ☐ Provided staff training on swarf management?
- ☐ Made staff aware of the value of segregated swarf?
- ☐ Ensured the skip storage area is bunded?
- ☐ Checked for contamination in the storage area?
- ☐ Checked whether you can sell your swarf directly to a recycler?

6.2 FREE ADVICE AND PUBLICATIONS FROM THE ENVIRONMENT AND ENERGY HELPLINE

Free publications with practical advice to help engineering companies reduce waste and thus increase their profits include:

- *Optimising the Use of Metalworking Fluids* (GG199);
- *Cost-effective Management of Lubricating and Hydraulic Oils* (GG227);
- *Environmental Management Systems Workbook for Engineering Manufacturers* (GG205);
- *Benchmarking the Consumption of Metal Cutting Oils* (EG179);
- *Automatic Recycling of Metalworking Fluid* (GC197) - a Good Practice Case Study at Dana Spicer Europe Ltd;
- *Driving Down Waste Puts the Brakes on Costs* (GC236) - a Good Practice Case Study at Continental Teves UK Ltd.

All of these publications and others on general aspects of waste minimisation (eg packaging) are available free of charge through the Environment and Energy Helpline on freephone 0800 585794.

The Environment and Energy Helpline can also:

- Provide further advice and suggest other sources of information about the techniques described in this Guide.
- Tell you about relevant environmental and other regulations that could affect your operations.
- 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).

6.3 USEFUL ADDRESSES

A list of useful contacts is given below. This listing is not exhaustive and has been compiled from the information currently available to the Environmental Technology Best Practice Programme. The listing of an organisation should not be regarded as an endorsement of its products or services by the Programme. Similarly, the Programme makes no claim for the competence or otherwise of any organisation not listed.

6.3.1 Swarf handling equipment

Arboga-Darenth Ltd
Ray Lamb Way, Erith, Kent DA8 2LA
Tel: 01322 341451

Factory Fluid Services Ltd
Falcon Business Centre, Hawkins Lane, Burton-on-Trent DE14 1PW
Tel: 01283 546515

Freddy Vacair, Freddy Products Ltd
Racecourse Road, Pershore, Worcestershire WC10 2EY
Tel: 01386 561113

6.3.2 Metal recyclers/metal merchants

Bernhard Metals (UK) Ltd
Litchurch Lane, Derby DE24 8AA
Tel: 01332 297788
(handles aluminium only)

Bishop Metal Recycling
Lake Avenue, Slough SL1 3BZ
Tel: 01753 525206

ELG Haniel Metals Ltd
Templeborough Works, Sheffield Road, Tinsley, Sheffield S9 1RT
Tel: 0114 244 3333

European Metal Recycling
Irwell Park Wharf, Lankro Way, Eccles, Manchester M30 0SA
Tel: 0161 745 7555
(also branches throughout the UK)

Smith & Co Ltd
Cauldwell Walk, Bedford MK42 9DT
Tel: 01234 272572

W N Thomas & Sons Ltd
Stoke Gardens, Slough SL1 3QA
Tel: 01753 524575

6.3.3 Briquetting

South Yorkshire Briquetting Ltd
Stevenson Road, Sheffield S9 3XG
Tel: 0114 243 5123

The Environmental Technology Best Practice Programme is a Government programme managed by AEA Technology plc.

The Programme offers free advice and information for UK businesses and promotes environmental practices that:

- **increase profits for UK industry and commerce;**
- **reduce waste and pollution at source.**

To find out more about the Programme please call the Environment and Energy Helpline on freephone 0800 585794. As well as giving information about the Programme, the Helpline has access to a wide range of environmental information. It offers free advice to UK businesses on technical matters, environmental legislation, conferences and promotional seminars. For smaller companies, a free counselling service may be offered at the discretion of the Helpline Manager.

FOR FURTHER INFORMATION, PLEASE CONTACT THE ENVIRONMENT AND ENERGY HELPLINE

0800 585794

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

e-mail address: etbppenvhelp@aeat.co.uk