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for Environment
Food & Rural Affairs

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Process Guidance Note 2/02(13)

Statutory guidance for hot dip galvanizing processes

Revised: July 2013



Llywodraeth Cymru
Welsh Government



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Revision of the guidance

The electronic version of this publication is updated from time to time with new or amended guidance. **Table 0.1** is an index to the latest changes (minor amendments are generally not listed).

Table 0.1 - Revision of the guidance		
Date of change	Section/ paragraph where change can be found	Nature of change - what paragraphs have been inserted, deleted or amended - what subject matter is covered by the change
July 2013	Throughout	Addition of colour coding to tables

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1. Introduction

Legal basis

- 1.1 This note applies to the whole of the UK. It is issued by the Secretary of State, the Welsh Government, the Scottish Government and the Department of the Environment in Northern Ireland (DoE NI) to give guidance on the conditions appropriate for the control of emissions into the air from hot dip galvanizing processes. It is published only in electronic form and can be found on the [Defra](#) website. It supersedes PG2/02(04) and NIPG2/02(04).
- 1.2 This guidance document is compliant with the [Code of Practice on Guidance on Regulation](#) page 6 of which contains the "golden rules of good guidance". If you feel this guidance breaches the code or you notice any inaccuracies within the guidance, please [contact us](#).
- 1.3 This is one of a series of statutory notes giving guidance on the Best Available Techniques (BAT). The notes are all aimed at providing a strong framework for consistent and transparent regulation of installations regulated under the statutory Local Air Pollution Prevention and Control (LAPPC) regime in [England and Wales](#), [Scotland](#) and [Northern Ireland](#). The note will be treated as one of the material considerations when determining any appeals against a decision made under this legislation. Further guidance on the meaning of BAT can be found for [England and Wales](#) (in chapter 12 of the General Guidance Manual), [Scotland](#), and [Northern Ireland](#), (in chapter 9).
- 1.4 In general terms, what are BAT for one installation in a sector are likely to be BAT for a comparable installation. Consistency is important where circumstances are the same. However, in each case it is, in practice, for regulators (subject to appeal) to decide what are BAT for each individual installation, taking into account variable factors such as the configuration, size and other individual characteristics of the installation, as well as the locality (e.g. proximity to particularly sensitive receptors).
- 1.5 The note also, where appropriate, gives details of any mandatory requirements affecting air emissions which are in force at the time of publication, such as those contained in Regulations or in Directions from the Government. In the case of this note, at the time of publication there were no such mandatory requirements.

1.6 In **Section 4** and **Section 5**, arrows are used to indicate the matters which should be considered for inclusion as permit conditions. It is important to note, however, that this should not be taken as a short cut for regulators to a proper determination of BAT or to disregard the explanatory material which accompanies the arrows. In individual cases it may be justified to:

- include additional conditions;
- include different conditions;
- not include conditions relating to some of the matters indicated.

In addition, conditions will need to be derived from other parts of the note, in particular to specify emission limits, compliance deadlines and mandatory requirements arising from directions or other legislation.

Who is the guidance for?

1.7 This guidance is for:

Regulators

- local authorities in England and Wales, who must have regard to this statutory guidance when determining applications for permits and reviewing extant permits;
- the Scottish Environment Protection Agency (SEPA) in Scotland, and district councils or the Northern Ireland Environment Agency (NIEA), in Northern Ireland;

Operators who are best advised also to have regard to it when making applications and in the subsequent operation of their installation;

Members of the public who may be interested to know what the Government considers, in accordance with the legislation, amounts to appropriate conditions for controlling air emissions for the generality of installations in this particular industry sector.

Updating the guidance

1.8 The guidance is based on the state of knowledge and understanding, at the time of writing, of what constitute BAT for this sector. The note may be amended from time to time to keep up with developments in BAT, including improvements in techniques, changes to the economic parameters, and new understanding of environmental impacts and risks. The updated version will replace the previous version on the [Defra](#) website and will include an index to the amendments.

- 1.9 Reasonable steps will be taken to keep the guidance up-to-date to ensure that those who need to know about changes to the guidance are informed of any published revisions. However, because there can be rapid changes to matters referred to in the guidance – for example to legislation – it should not be assumed that the most recent version of this note reflects the very latest legal requirements; these requirements apply.

Consultation

- 1.10 This note has been produced in consultation with relevant trade bodies, representatives of regulators including members of the Industrial Pollution Liaison Committee and other potentially-interested organisations.

Policy and procedures

- 1.11 General guidance explaining LAPPC and setting out the policy and procedures is contained in separate documents for [England and Wales](#), [Scotland](#) and [Northern Ireland](#).

2. Timetable for compliance and reviews

Existing processes or activities

- 2.1 This note contains all the provisions from previous editions which have not been removed. Some have been amended. For installations in operation at the date this note is published, the regulator should have already issued or varied the permit having regard to the previous editions. If they have not done so, this should now be done.
- 2.2 The new provisions of this note and the dates by which compliance with these provisions is expected are listed in **Table 2.1**, together with the paragraph number where the provision is to be found. Compliance with the new provisions should normally be achieved by the dates shown. Permits should be varied as necessary, having regard to the changes and the timetable.

Table 2.1 - Compliance timetable

Guidance	Relevant paragraph/row in this note	Compliance date
There are no new provisions in this note likely of themselves to result in a need to vary existing permit conditions. For a full list of changes made by this note, excluding very minor ones, see Table 6.1 .		

- 2.3 Replacement plant should normally be designed to meet the appropriate standards specified for new installations/activities.
- 2.4 Where provisions in the preceding guidance note have been deleted or relaxed, permits should be varied as necessary as soon as reasonably practicable.
- 2.5 For new activities, the permit should have regard to the full standards of this guidance from the first day of operation.
- 2.6 For substantially changed activities, the permit should normally have regard to the full standards of this guidance with respect to the parts of the activity that have been substantially changed and any part of the activity affected by the change, from the first day of operation.

Permit reviews

- 2.7 Under LAPPC, the legislation requires permits to be reviewed periodically but does not specify a frequency. It is considered for this sector that a frequency of once every eight years ought normally to be sufficient for the purposes of the appropriate Regulations. Further guidance on permit reviews is contained in the appropriate Guidance Manual for [England and Wales](#), [Scotland, Practical guide](#) section 10 and Northern Ireland [Part B Guidance](#) page 9, Northern Ireland [Part C Guidance](#) chapter 17. Regulators should use any opportunities to determine the variations to permits necessitated by paragraph 2.2 above in conjunction with these reviews.
- 2.8 Conditions should also be reviewed where complaint is attributable to the operation of the process and is, in the opinion of the regulator, justified.

3. Activity description

Regulations

- 3.1 This note applies to LAPPC installations carrying out galvanizing processes. The activities for regulation are listed in **Table 3.1**.

Table 3.1 - Regulations listing activities			
LAPPC	England and Wales	Scotland	Northern Ireland
	EPR Schedule 1 reference	PPC Schedule 1 reference	PPC Schedule 1 reference
Part B	Section 2.2 Part B	Section 2.2, Part B	Section 2.2, Part B

The links are to the original version of the Regulations. A consolidated version is not available on www.legislation.gov.uk.

- 3.2 This note refers to processes for the melting of zinc or its alloys in conjunction with hot dip galvanizing. For the purpose of this note the term galvanizing will be used to mean hot dip galvanizing.
- 3.3 Where they have an input of more than 2 tonnes of crude steel per hour, processes applying protective fused metal coatings will become Part A activities under the relevant Regulations. Separate guidance covering Part A processes is available.

General galvanizing

Pre-treatment

- 3.4 The requirement for successful galvanizing is that the item to be dipped must be free from contaminants prior to dipping. Pre-treatment to achieve the surface required for galvanizing may include cleaning, pickling and fluxing. Some items, e.g. structural steel, may arrive on site in a clean state and not require any cleaning. The cleaning of iron and steel items may include any of the following physical or chemical treatments.
- 3.5 Shot blasting removes contamination such as paint, sand or grease. It may also be used to create a greater surface area allowing a thicker zinc coating when galvanizing.

- 3.6 Degreasing removes surface oils and grease using proprietary solutions which may be alkaline, neutral or acidic. Some galvanizers use surfactant additives in the acid pickling bath for degreasing.
- 3.7 Although it is not normal practice, vapour degreasing with organic solvents may be undertaken. In this event PG6/23 (coating of metal and plastic) should be consulted for the appropriate standards of control and emission limits. Rinsing may be used after alkaline degreasing to minimise carryover of alkaline solution into the acid pickling tank.
- 3.8 Pickling is a process whereby the surfaces of the items are prepared for galvanizing. It involves removal of surface oxidation products (e.g. rust) and millscale (arising from the steel rolling process). Generally hydrochloric acid (36% or 28%) is bought in bulk and diluted on site for use in pickling baths at ambient temperature, (concentrations up to 18% acid is generally used). The acid used is co-product acid, which means it is derived from a commercial process involving chlorination of an organic compound, (if the co-product acid meets BS 3993 (1996) then the organic content is controlled. It is not a necessary requirement however.) It is possible on occasion that co-product acid may have an odour associated with its organic content. This should be acceptable provided it is not noticeable outside the process boundary (Sometimes 15% sulphuric acid is used for pickling at 40°C. In combination with a pickling inhibitor, emissions from use of sulphuric acid are not problematic).
- 3.9 The reaction in the pickling bath is slightly exothermic. Use of heated pickling solutions reduces pickling times. Stronger acids or heated acids may generate more fume and may require arrestment and control under COSHH Regulations.
- 3.10 The acid needs to be at about 10°C to start the pickling process. If the temperature falls below this it is acceptable to apply indirect heating to raise the temperature (Direct injection of steam may give rise to unacceptable fuming and should not be used).
- 3.11 An acid inhibitor may be added to the pickling bath which prevents the acid from attacking the steel itself. Fume suppressants may also be used.
- 3.12 As pickling proceeds, the iron content of the acid builds up and the acid strength decreases. When the bath liquid reaches a composition of approximately 5% acid and 150 g/l of iron it is no longer effective as a pickling solution and is described as "spent". The rate at which this occurs depends upon the work being pickled. Operators may top up an acid bath with fresh acid from time to time. There is usually a number of acid pickling baths that range in strength from fresh acid to spent acid. When a tank is spent and can no longer be used for pickling it may be used for stripping the zinc from any rejected galvanized work. Some operators have a dedicated acid bath for zinc stripping only. Waste acid is tankered off site for treatment.

- 3.13 Good practice when taking delivery of acid directly into an acid bath or when re-making acid baths is to secure the discharge hose to the bath. As delivery of acid from the tanker is usually air pressure assisted there may be an air surge caused by the release of pressure towards the end of a delivery. Good control of the delivery rate and pressure release is required. This is managed by the tanker driver. There are developments towards vehicle mounted or ground mounted pump delivery which avoids this problem and reduces fuming. The INEOS- chlor Hydrochloric Acid Bulk Storage document (Ref 7) provides guidance for acid storage and fume minimisation, which may be useful where acid is stored on site prior to use.
- 3.14 Rinsing after pickling washes off acid and prevents carryover of iron salts on the surface of the workpiece. Such carryover would cause additional dross to be formed in the zinc bath. Water is used for rinsing. Two rinse tanks may sometimes be used.

Fluxing

- 3.15 A flux is usually applied to the work surface in order to prevent any oxidation of the work piece before it is dipped. It covers the whole surface and enhances the zinc "wetting" of the steel allowing a uniform coating to be achieved.
- 3.16 Zinc chloride can be used as a flux but most fluxes consist of zinc ammonium chloride (ZAC). This is a mixture of zinc chloride and ammonium chloride salts. The proportions of each may vary. They are sometimes described as double or triple salts, where double salt is made of 55% zinc chloride 45% ammonium chloride and triple salt is made of 45% zinc chloride 55% ammonium chloride. (These salts comprise a molecular mix which is crystallised out during manufacture - "double salt" has 1 molecule of zinc chloride to 2 molecules of ammonium chloride, "triple salt" has 1 molecule of zinc chloride to 3 molecules of ammonium chloride - they store much better than a mixture of zinc chloride and ammonium chloride which goes very hard as zinc chloride is deliquescent). Ammonium chloride from the flux is one of the main components of the fume when the workpiece is dipped.
- 3.17 There are now different types of flux available. Fluxes described as "low fuming" have been developed. These are proprietary mixtures where the ammonium chloride constituent of traditional fluxes has been reduced and partially replaced with other salts. These fluxes require technical management and may not be acceptable to all operators or applicable to all types of work. Due to the technicalities of the use of low fuming flux more frequent emission monitoring may be considered if a galvanizer chooses it as a new technique. Once use of the flux has become established and it has been demonstrated that the emission limit can be consistently achieved then any increased monitoring requirement may be relaxed.

- 3.18 There are two methods of fluxing. They may be used independently or in conjunction with each other.
- 3.19 Dry fluxing is where the work is dipped into an aqueous flux solution (sometimes referred to as preflux) after rinsing and before immersion into the galvanizing bath. The properties of ZAC fluxes can be improved by adding a wetting agent which reduces the surface tension of the flux solution. After dry fluxing the work may be placed into a drying chamber prior to dipping to remove as much water from the aqueous preflux as possible. Water carryover into the zinc bath can cause spattering of molten zinc during immersion and bare patches on the finished article. A drying chamber is not essential. Heating the flux solution to 70°C helps to speed up the fluxing action as well as the drying process. When zinc chloride flux is used it is common to pre-heat the work pieces in a furnace.
- 3.20 Wet fluxing is where the dried work is immersed through a flux blanket which lies on the molten zinc surface. This technique is now less commonly used than dry fluxing as it is a slow process and usage rate of flux is high. Wet fluxing systems are more commonly used for specialist processes such as spin galvanizing and hand dipping.
- 3.21 The prepared items are then ready to be galvanized.

Galvanizing

- 3.22 The galvanizing bath contains molten zinc or zinc alloy at about 440 - 460°C. Specialist plants operate at about 555°C. Alloy formation is different at this temperature. (98.5% zinc is the lowest grade of zinc that is usually used). Metal additives in small quantities are used to enhance the characteristics of the galvanizing process. Such techniques are continually being developed world-wide within the industry.
- 3.23 The galvanizing process is a metallurgical reaction which creates zinc/iron alloy layers. The composition of the alloy layers changes. The layers closest to the base metal are iron rich with the percentage of zinc increasing through the layers until there is 100% zinc layer at the surface. The quality of the final product can be affected by the make up of the steel article.
- 3.24 Where ammonium chloride or ZAC type of fluxes are used, fume is created instantaneously at the point of dipping. The content includes ammonium chloride, zinc oxide, zinc chloride and steam. These arise from the flux and the molten zinc.
- 3.25 Containment of the fume from dipping is usually effected by the use of enclosures which may be fixed or mobile. During dipping the enclosure should be in place and the extractor fans switched on.

- 3.26 Double dipping is a technique which is sometimes used for extremely large work pieces. Where the length of the item is such that one door of the enclosure cannot be closed during dipping, then fugitive fume emissions should be contained in the building. (Note: items may be double dipped for reasons other than that the work is too large for the bath. In these cases the issue of doors being left open does not arise).
- 3.27 When semi -automatic tube galvanizing, full enclosure is impractical and a canopy is considered BAT in these circumstances, provided that there is sufficient extraction so that there is not significant escape of fume into the workplace. Tube blowing is carried out to remove zinc oxide build-up on the inner surface of the tube.
- 3.28 Dusting (also described as hand salting) - ammonium chloride is occasionally sprayed as a powder or a solution, or hand applied to work as it is withdrawn from the bath, in order to remove excess zinc or impurities that may have adhered to the work surface. This gives rise to fumes and should be avoided wherever possible. The use of a spray gun allows more control over the process and is to be preferred to hand application. The extraction should be operational during dusting.
- 3.29 The ash, which is mainly zinc oxide, forms on the surface of the molten zinc and is skimmed back before the work is withdrawn from the bath to avoid it contaminating the coating.
- 3.30 The dross is a solid consisting of about 95% zinc/5% iron alloy. It is heavier than zinc and sinks to the bottom of the zinc bath. It is removed periodically with perforated grabs or spoons.

Post treatment

- 3.31 The work may be left to air cool to room temperature but often it is quenched in water (boshed) after galvanizing.
- 3.32 "Passivation" is an optional step in the process whereby the reactivity of the surface is reduced. The choice of passivation techniques will depend upon any further process requirements or particular end uses of the product. Chromic acids or chromate salts may be added to the quench water to prevent "wet storage stain" appearing subsequently. Phosphate treatments and complex oxide treatments are also sometimes used.
- 3.33 The application of other coatings, for example paint, liable to emit volatile organic compounds or particulate matter where the process uses more than 5 tonnes of organic solvents in any 12 month period is the subject of separate guidance.

Zinc recovery

- 3.34 The recovery of zinc from dross or ash removed from the galvanizing bath by separate heat or chemical treatment methods is a refining operation and subject to control as a Part A activity under the relevant regulations and is not considered further in this note.
- 3.35 However, the removal of metallic zinc from ash produced by the galvanizing process, achieved by physical separation techniques is within the scope of this note.
- 3.36 The majority of galvanizers "rework" their ash carefully on the zinc bath surface in order to reduce zinc losses into the ash. The residual ash is then taken offsite for zinc recovery. Some galvanizers may prefer to remove the ash more quickly from the surface of the bath and later "rework" their ash. Typically the ash may either be melted in a small furnace or transferred back into the galvanizing bath below the zinc surface via a screw feed. Any zinc left in the ash will melt and the ash that remains on the surface will contain less zinc. This process is likely to give rise to substantial amounts of fume. Adequate provisions must be made to ensure compliance with the emission limits.

Spin or centrifuge galvanizing

- 3.37 The terms spin galvanizing or centrifuge galvanizing are used to describe the process for hot dipping threaded components and other small parts. They are immersed into the molten zinc in a perforated basket. After the coating has formed the basket is removed from the melt and is centrifuged at high speed to throw off the surplus zinc and ensure a clean profile. The work is normally quenched after the centrifuging operation. Flux blankets are occasionally used for this process.

Hand dip galvanizing

- 3.38 Certain pieces of work due to their intricate shape cannot be wired or jig mounted. Others due to their potential to trap air give rise to quality and/or safety issues. Such pieces may be galvanized by hand dipping. One item is dipped at a time. Hand dipping may sometimes take place through a flux blanket.

Continuous sheet galvanizing

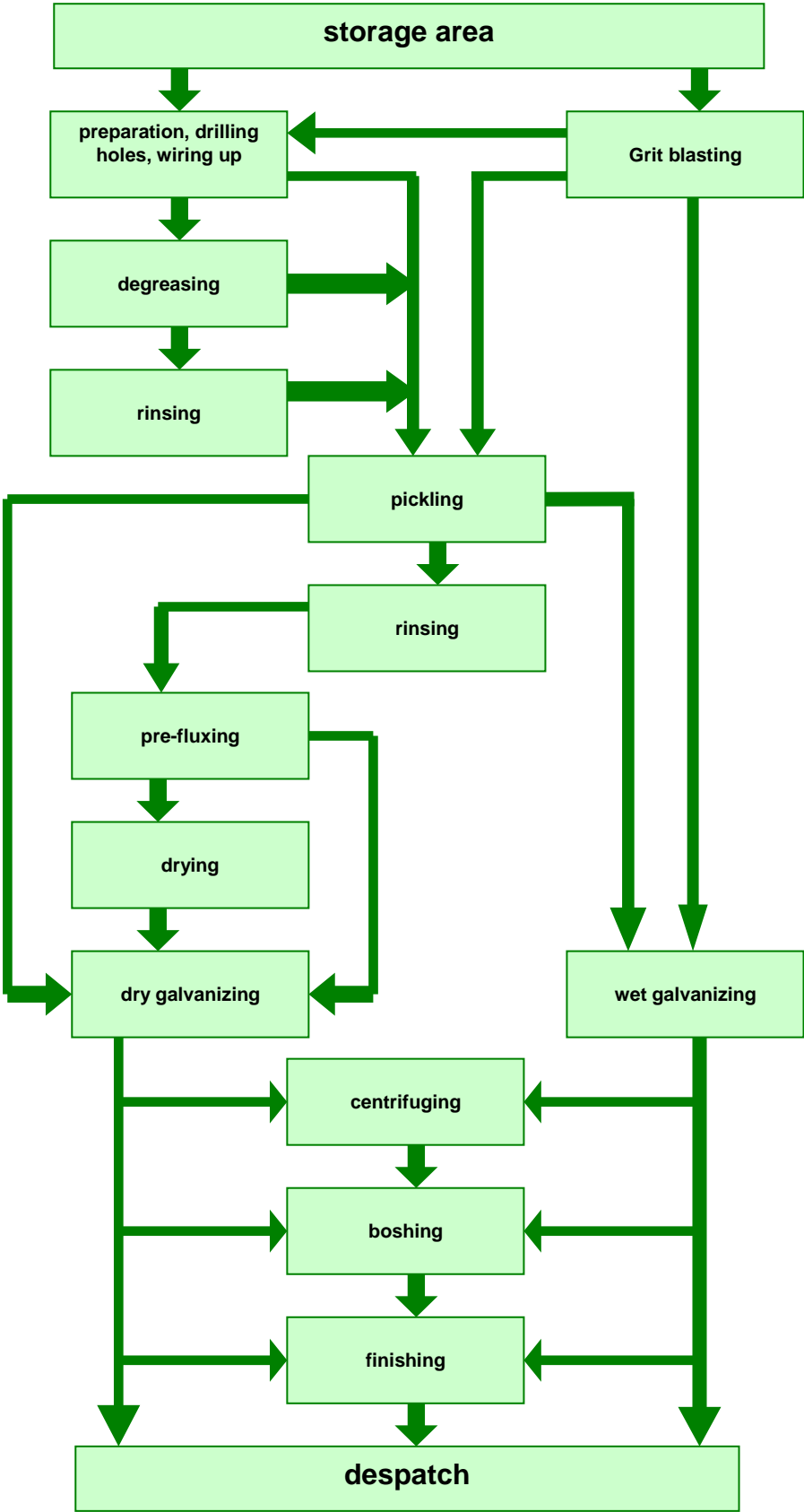
- 3.39 Continuous sheet or strip galvanizing processes are normally undertaken using an oven with a reducing atmosphere for pretreatment prior to direct immersion into a zinc bath not involving the use of fluxes.

Wire galvanizing

- 3.40 Wire galvanizing is normally a continuous process and can involve some or all of the following pre-treatment processes - annealing, degreasing, pickling, rinsing and fluxing before the actual galvanizing.
- 3.41 A similar process is used for galvanizing fabricated welded wire mesh and for hexagonal wire netting.
- 3.42 Up to 60 individual wire strands (normally 20 - 40) pass through the galvanizing process in parallel. Lines stretch for up to 500 m, of which the galvanizing bath is likely to be no more than about 8 m, with a zinc capacity of up to 100 tonnes. A lead emission limit applies to processes using lead annealing or quenching baths.
- 3.43 Galvanized wire can be divided into two types, mild steel and high carbon steel. Mild steel galvanized wire is used for the manufacture of barbed wire, hexagonal netting, field fencing etc. High carbon steel galvanized wire is used for the manufacture of springs, ropes, cables etc (items requiring its high tensile strength). The mild steel galvanizing process generally requires a soft wire, which is achieved by annealing through molten lead baths or furnaces of several different types. The high carbon steel galvanizing process requires a re-crystallised structure which is achieved by heating through a furnace and quenching in a lead bath or other medium (can be specially designed water quench) in order to freeze the re-crystallised structure and provide a ductile and workable finished product, this process is known as "patenting". Any of the above wires may be galvanized hard in which process the wire will pass through a low temperature lead bath or furnace in order to stress relieve the wire and degrease.
- 3.44 The galvanizing process itself is achieved by passing the wires through the zinc bath under a sinker. The sinker may be a roller which rotates with the wire or a solid block of ceramic or refractory concrete under which the wire skids. The wire exits the zinc normally vertically as this gives the simplest conditions for a concentric coating. It is then wiped by a range of techniques in order to achieve the required coating weight. The most common today are "jet wiping" which uses nitrogen gas to achieve heavier coat weights and "pad wiping" which uses mineral fibre pads to achieve light coating weights. The zinc bath itself will be run at about 450°C.

Pollutants and Sources

Figure 3.1 - Flow diagram of a typical galvanizing process



4. Emission limits, monitoring and other provisions

- 4.1 Emissions of the substances listed in **Table 4.1** should be controlled.
- 4.2 The emission limit values and provisions described in this section are achievable using the best available techniques described in **Section 5**. Monitoring of emissions should be carried out according to the method specified in this section or by an equivalent method agreed by the regulator. Where reference is made to a British, European, or International standard (BS, CEN or ISO) in this section, the standards referred to are correct at the date of publication. (Users of this note should bear in mind that the standards are periodically amended, updated or replaced). The latest information regarding the monitoring standards applicable can be found at the [Source Testing Association website](#). Further information on monitoring can be found in Environment Agency publications, [M1 and M2](#).
- 4.3 All activities should comply with the emission limits and provisions with regard to releases in **Table 4.1**.

The reference conditions for limits in Section 4 are: 273.1K, 101.3kPa, without correction for water vapour content, unless stated otherwise.

Table 4.1 should be considered in conjunction with the monitoring paragraphs found later in this section.

Table 4.1 - Emission limits, monitoring and other provisions

Row	Substance	Source	Emission limits/provisions	Type of monitoring	Monitoring frequency
1	Particulate matter	Galvanizing baths which do not use low fuming flux but which use arrestment plant.	15mg/m ³	Indicative	Continuous
2	Particulate matter	Galvanizing Baths	15mg/m ³	Manual Extractive Test	Annual
3	Particulate matter	Point source emissions from non galvanizing contained sources.	20mg/m ³	Indicative And Manual Extractive Test	Continuous And Annual
4	Particulate matter	All authorised emission points from low fuming flux operations operating without arrestment plant.	No persistent visible emissions	Visual	Daily
5	Chloride (expressed as HCl)	Hydrochloric acid pickling plant.	30mg/m ³	Manual Extractive Test	Annual
6	Lead	Lead annealing baths	0.25mg/m ³	Manual Extractive Test Results expressed as a 15 minute mean	Annual

Monitoring, investigating and reporting

4.4 The operator should monitor emissions, make tests and inspections of the activity. The need for and scope of testing (including the frequency and time of sampling) will depend on local circumstances.

- The operator should keep records of inspections, tests and monitoring, including all non-continuous monitoring, inspections and visual assessments. Records should be:
 - kept on site;
 - kept by the operator for at least two years; **and**
 - made available for the regulator to examine.
- If any records are kept off-site they should be made available for inspection within one working week of any request by the regulator.

Information required by the regulator

4.5 The regulator needs to be informed of monitoring to be carried out and the results. The results should include process conditions at the time of monitoring.

- The operator should notify the regulator at least 7 days before any periodic monitoring exercise to determine compliance with emission limit values. The operator should state the provisional time and date of monitoring, pollutants to be tested and the methods to be used.
- The results of non-continuous emission testing should be forwarded to the regulator within 8 weeks of completion of the sampling.
- Adverse results from any monitoring activity (both continuous and non-continuous) should be investigated by the operator as soon as the monitoring data has been obtained. The operator should:
 - identify the cause and take corrective action;
 - clearly record as much detail as possible regarding the cause and extent of the problem, and the remedial action taken;
 - re-test to demonstrate compliance as soon as possible; **and** inform the regulator of the steps taken and the re-test results.

Visible emissions

4.6 The aim should be to prevent any visible airborne emission from any part of the process. This aim includes all sites regardless of location. Monitoring to identify the origin of a visible emission should be undertaken and a variety of indicative techniques are available.

- where ambient monitoring is carried out it may also be appropriate for the regulator to specify recording of wind direction and strength;
- where combustion units are in use for dryers then the combustion process should be controlled and equipment maintained as appropriate.

4.7 Emissions from combustion processes in normal operation should be free from visible smoke. During start up and shut down the emissions should not exceed the equivalent of Ringelmann Shade 1 as described in British Standard BS 2742.

- All other releases to air, other than condensed water vapour, should be free from persistent visible emissions.
- All emissions to air should be free from droplets.

Where there are problems that, in the opinion of the regulator, may be attributable to the installation, such as local complaints of visual emissions or where dust from the installation is being detected beyond the site boundary, the operator should investigate in order to find out which part of their operation(s) is the cause.

If this inspection does not lead to correction of the problem then the operator should inform the regulator who will determine whether ambient air monitoring is necessary. Ambient monitoring may either be by a British Standard method or by a method agreed with the regulator.

Whilst problems are ongoing, a visual check should also be made at least once per day/shift, by the operator, when an installation is being operated. The time, location and result of these checks, along with weather conditions such as indicative wind direction and strength, should be recorded. Once the source of the emission is known, corrective action should be taken without delay and where appropriate the regulator may want to vary the permit in order to add a condition requiring the particular measure(s) to be undertaken.

Emissions of odour

- 4.8 The overall aim should be that all emissions are free from offensive odour outside the site boundary, as perceived by the regulator. However, the location of the installation will influence the assessment of the potential for odour impact as local meteorological conditions may lead to poor dispersion conditions. Where the site has a low odour impact due to its remoteness from sensitive receptors, the escape of offensive odour beyond the installation would be unlikely to cause harm.
- 4.9 Where there are problems that, in the opinion of the regulator, may be attributable to the installation, such as local complaints of odour or where odour from the installation is being detected beyond the site boundary, the operator should investigate in order to find out which part of their operation(s) is the cause.
- 4.10 Whilst problems are ongoing, a boundary check should also be made at least once per day/shift, by the operator, when an installation is being operated. The time, location and result of these checks, along with weather conditions such as indicative wind direction and strength, should be recorded. Once the source of the emission is known, corrective action should be taken without delay and where appropriate the regulator may want to vary the permit in order to add a condition requiring the particular measure(s) to be undertaken.

Abnormal events

- 4.11 The operator should respond to problems which may have an adverse effect on emissions to air.
- In the case of abnormal emissions, malfunction or breakdown leading to abnormal emissions the operator should:
 - investigate and undertake remedial action immediately;
 - adjust the process or activity to minimise those emissions; **and**
 - promptly record the events and actions taken.
 - The regulator should be informed without delay, whether or not there is related monitoring showing an adverse result:
 - if there is an emission that is likely to have an effect on the local community; **or**
 - in the event of the failure of key arrestment plant, for example, bag filtration plant or scrubber units.
 - The operator should provide a list of key arrestment plant and should have a written procedure for dealing with its failure, in order to minimise any adverse effects.

Continuous monitoring

4.12 Continuous monitoring can be either 'quantitative' or 'indicative'. With quantitative monitoring the discharge of the pollutant(s) of concern is measured and recorded numerically. For pollution control this measurement is normally expressed in milligrams per cubic metre of air (mg/m^3). Where discharge of the pollutant concerned is controlled by measuring an alternative parameter (the 'surrogate' measurement), this surrogate is also expressed numerically.

Continuous indicative monitoring is where a permanent device is fitted, for example, to detect leaks in a bag filter, but the output, whether expressed numerically or not, does not show the true value of the discharge. When connected to a continuous recorder it will show that emissions are gradually (or rapidly) increasing, and therefore maintenance is required. Alternatively it can trigger an alarm when there is a sudden increase in emissions, such as when arrestment plant has failed.

4.13 Where continuous indicative monitoring has been specified, the information provided should be used as a management tool. Where used, the monitor should be set up to provide a baseline output when the plant is known to be operating under the best possible conditions and emissions are complying with the requirements of the permit. Where used to trigger alarms, the instrument manufacturer should be able to set an output level which corresponds to around 75% of the emission limit. Thus the alarms are activated in response to this significant increase in pollutant loading above the baseline, so that warning of the changed state is given before an unacceptable emission occurs. The regulator may wish to agree the alarm trigger level.

4.14 Where continuous monitoring is required, it should be carried out as follows:

- All continuous monitoring readings should be on display to appropriately trained operating staff.
- Instruments should be fitted with audible and visual alarms, situated appropriately to warn the operator of arrestment plant failure or malfunction.
- The activation of alarms should be automatically recorded.
- All continuous monitors should be operated, maintained and calibrated (or referenced, in the case of indicative monitors) in accordance with the manufacturers' instructions, which should be made available for inspection by the regulator.
- The relevant maintenance and calibration (or referencing, in the case of indicative monitors) should be recorded.

- Emission concentrations may be reported as zero when the plant is off and there is no flow from the stack. If required a competent person should confirm that zero is more appropriate than the measured stack concentration if there is no flow.
- Any continuous monitor used should provide reliable data >95% of the operating time, (i.e. availability >95%). A manual or automatic procedure should be in place to detect instrument malfunction and to monitor instrument availability.

Calibration and compliance monitoring

- 4.15 Compliance monitoring can be carried out either by use of a continuous emissions monitor (CEM), or by a specific extractive test carried out at a frequency agreed with the regulator.
- 4.16 Where a CEM is used for compliance purposes it must be periodically checked, (calibrated), to ensure the readings being reported are correct. This calibration is normally done by carrying out a parallel stand-alone extractive test and comparing the results with those provided by the CEM.
- 4.17 For extractive testing the sampling should meet the following requirements:
- For batch processes, where the production operation is complete within, say, 2 hours, then the extractive sampling should take place over a complete cycle of the activity.
- 4.18 Should the activity either be continuous, or have a batch cycle that is not compatible with the time available for sampling, then the data required should be obtained over a minimum period of 2 hours in total.
- For demonstration of compliance where a CEM is used no daily mean of all 15-minute mean emission concentrations should exceed the specified emission concentration limits during normal operation (excluding start-up and shut-down); **and**
 - No 15-minute mean emission concentration should exceed twice the specified emission concentration limits during normal operation (excluding start-up and shut-down).
 - For extractive testing, no result of monitoring should exceed the emission limit concentrations specified.

4.19 Exhaust flow rates should be consistent with efficient capture of emissions, good operating practice and meeting the requirements of the legislation relating to the workplace environment.

- The introduction of dilution air to achieve emission concentration limits should not be permitted.

Dilution air may be added for waste gas cooling or improved dispersion where this is shown to be necessary because of the operational requirements of the plant, but this additional air should be discounted when determining the mass concentration of the pollutant in the waste gases.

Varying of monitoring frequency

4.20 Where non-continuous quantitative monitoring is required, the frequency may be varied. Where there is consistent compliance with emission limits, regulators may consider reducing the frequency. However, any significant process changes that might have affected the monitored emission should be taken into account in making the decision.

4.21 When determining “consistent compliance” the following are cases which might not qualify for a reduction in monitoring:

- a) variability of results: cases where monitoring results vary widely and include results in the range 30-45mg/m³ (when the emission limit is 50mg/m³)
- b) the margin between the results and the emission limit: cases where results over a period are 45mg/m³ or more (when the emission limit is 50mg/m³).

Consistent compliance should be demonstrated using the results from at least;

- three or more consecutive annual monitoring campaigns; **or**
- two or more consecutive annual monitoring campaigns supported by continuous monitoring.

Where a new or substantially changed process is being commissioned, or where emission levels are near to or approach the emission concentration limits, regulators should consider increasing the frequency of testing.

4.22 A reduction in monitoring frequency should not be permitted where continuous quantitative or indicative monitoring is required. These types of monitoring are needed to demonstrate at all times when the plant is operating, that either the emission limits are being complied with or that the arrestment equipment is functioning correctly.

Monitoring of unabated releases

- 4.23 Where emission limit values are consistently met without the use of abatement equipment, the monitoring requirement for those pollutants should be dispensed with subject to the “Varying of monitoring frequency” paragraphs above.

Where monitoring is not in accordance with the main procedural requirements of the relevant standard, deviations should be reported.

Representative sampling

- 4.24 Whether sampling on a continuous or non-continuous basis, care is needed in the design and location of sampling systems, in order to obtain representative samples for all release points.
- Sampling points on new plant should be designed to comply with the British or equivalent standards (see **paragraph 4.2**).
 - The operator should ensure that relevant stacks or ducts are fitted with facilities for sampling which allow compliance with the sampling standards.

Where monitoring is not in accordance with the main procedural requirements of the relevant standard, deviations should be reported.

5. Control techniques

Summary of best available techniques

- 5.1 **Table 5.1** provides a summary of the best available techniques that can be used to control the process in order to meet the emission limits and provisions in **Section 4**. Provided that it is demonstrated to the satisfaction of the regulator that an equivalent level of control will be achieved, then other techniques may be used.

Table 5.1 - Summary of control techniques	
Sources of emission	Control techniques
Galvanizing bath	Enclosures and extraction, followed by arrestment plant where necessary
Ash reworking	Enclosures and extraction, followed by arrestment plant where necessary
Tube blowing	Enclosures and extraction, followed by arrestment plant where necessary
Storage of ash and other dusty wastes	Within enclosed building or covered containers
Abrasive blasting Particulate matter	Bag filtration
Where there is extraction from pickling areas	Chloride Scrubbing of acidic content
Sulphuric Acid	Use of a pickling inhibitor
Annealing or quenching in lead bath (wire galvanizing)	Temperature control Anthracite covering

Techniques to control emissions from contained sources

Techniques to control fugitive emissions

- 5.2 The control techniques described below address the sources of pollutants listed in **Table 4.1**.

Pre-cleaning and acid pickling

- 5.3 Abrasive blasting should be carried out in a specially designed booth and exhausts should be vented to suitable dust arrestment plant.
- 5.4 Where heated hydrochloric acid baths are used and mist or fume is emitted, emissions should be contained and vented to suitable arrestment plant, for example a scrubber.
- 5.5 Direct injection of steam into hydrochloric acid pickling baths should not be permitted.

Fluxing and hot-dip galvanizing

- 5.6 The use of solid flux should be reduced by prefluxing with zinc ammonium chloride solution where practicable in relation to the process characteristics. The application of flux for both blanket replenishment and dusting should be reduced to a minimum consistent with good operational practice and should be applied carefully in order to minimise emissions to air (The emission is due mainly to the sublimation of ammonium chloride which occurs at the temperature of the molten metal).
- 5.7 It should be noted that full fume enclosures will not achieve 100 percent fume capture but when used correctly provide adequate capture. In the event that full fume enclosures are not able to be used, for example some spin galvanizing or hand dipping processes, lip extraction may achieve sufficient fume capture provided the work is handled appropriately. Lip extraction is not suitable where galvanizing leads to fume being generated outside of the zone of influence of the extraction. When double dipping it may be necessary for the end door at one end of the bath to remain open. Where semi-continuous tube galvanizing the canopy is considered sufficient provided the extraction system ensures there is no significant escape of fume into the workplace.
- 5.8 Emissions from the galvanizing process should be adequately contained and extracted to prevent fugitive emissions from the building.

- 5.9 Full fume containment enclosure should be provided. There are exceptions which include, for example, small hand dipped items and spin galvanizing, provided adequate lip extraction is used; also semi -automatic tube galvanizing where a canopy is used.
- 5.10 If the fume containment enclosure is mobile, it should be in place above the galvanizing bath prior to making up or replenishing flux blankets and when articles are being immersed. The enclosure should also be in place above the galvanizing bath during flux dusting and should remain in place until the fume produced subsides.
- 5.11 Sufficient fume containment measures should be provided to collect fume produced when working the ash; for example by working ash with the enclosure in place or by the use of peripheral extraction.
- 5.12 All doors to fume enclosures should be closed during immersion of articles into the galvanizing bath.

Materials handling

- 5.13 Ash, and any other potentially dusty materials, should be stored in such a manner as to prevent wind whipping. All such materials should be stored in covered containers or within an enclosed area, and handled in a manner that avoids emissions of dust.
- 5.14 Ashes from the zinc bath should be kept dry at all times.
- 5.15 The method of collection of waste from dry arrestment plant should be such that dust emissions are minimised.
- 5.16 A high standard of housekeeping should be maintained.
- 5.17 Lorries transporting ash or other potentially dusty materials should be sheeted immediately after loading.

Techniques to control emissions from contained sources

- 5.18 Best available techniques are required to control emissions. The main principles for preventing emissions are the use of operational controls to minimise emissions, then containment and arrestment of emissions. Filtered particulate emissions can be expected to be below 10 mg/m³ if modern plant designed for the purpose is used.

Air quality

Dispersion & dilution

- 5.19 Pollutants that are emitted via a stack require sufficient dispersion and dilution in the atmosphere to ensure that they ground at concentrations that are deemed harmless. This is the basis upon which stack heights are calculated using HMIP Technical Guidance Note (Dispersion) D1. The stack height so obtained is adjusted to take into account local meteorological data, local topography, nearby emissions and the influence of plant structure.

The calculation procedure of D1 is usually used to calculate the required stack height but alternative dispersion models may be used in agreement with the regulator. An operator may choose to meet tighter emission limits in order to reduce the required stack height.

- 5.20 Where an emission consists purely of air and particulate matter, (i.e. no products of combustion or any other gaseous pollutants are emitted) the above provisions relating to stack height calculation for the purpose of dispersion and dilution should not normally be applied. Revised stack height calculations should not be required as a result of publication of this revision of the PG note, unless it is considered necessary because of a breach or serious risk of breach of an EC Directive limit value or because it is clear from the detailed review and assessment work that the permitted process itself is a significant contributor to the problem.

Ambient air quality management

- 5.21 In areas where air quality standards or objectives are being breached or are in serious risk of breach and it is clear from the detailed review and assessment work under Local Air Quality Management that the permitted process itself is a significant contributor to the problem, it may be necessary to impose tighter emission limits. If the standard that is in danger of being exceeded is not an EC Directive requirement, then industry is not expected to go beyond BAT to meet it. Decisions should be taken in the context of a local authority's Local Air Quality Management action plan. For example, where a permitted process is only responsible to a very small extent for an air quality problem, the authority should not unduly penalise the operator of the process by requiring disproportionate emissions reductions. Paragraph 59 of the [Air Quality Strategy 2007 \[Volume 1\]](#) gives the following advice:

“...In drawing up action plans, local authority environmental health/pollution teams are expected to engage local authority officers across different departments, particularly, land-use and transport planners to ensure the actions are supported by all parts of the authority. In addition, engagement with the wider panorama of relevant stakeholders, including the public, is required to ensure action plans are fit-for-purpose in addressing air quality issues. It is vital that all those organisations, groups and individuals that have an impact upon local air quality, buy-in and work towards objectives of an adopted action plan.”

Stacks, vents and process exhausts

- 5.22 Liquid condensation on internal surfaces of stacks and exhaust ducts might lead to corrosion and ductwork failure or to droplet emission. Adequate insulation will minimise the cooling of waste gases and prevent liquid condensation by keeping the temperature of the exhaust gases above the dewpoint. A leak in a stack/vent and the associated ductwork, or a build up of material on the internal surfaces may affect dispersion:
- Flues and ductwork should be cleaned to prevent accumulation of materials, as part of the routine maintenance programme.
- 5.23 When dispersion of pollutants discharged from the stack (or vent) is necessary, the target exit velocity should be 15m/s under normal operating conditions, (but see paragraph below regarding wet plumes). In order to ensure dispersion is not impaired by either low exit velocity at the point of discharge, or deflection of the discharge, a cap, or other restriction, should not be used at the stack exit. However, a cone may sometimes be useful to increase the exit velocity to achieve greater dispersion.
- 5.24 An exception to the previous paragraph is where wet arrestment is used as the abatement. Unacceptable emissions of droplets could occur from such plant where the linear velocity in the stack exceeds 9m/s.
- 5.25 To reduce the potential of droplet emissions a mist eliminator should be used. Where a linear velocity of 9m/s is exceeded in existing plant consideration should be given to reducing this velocity as far as practicable to ensure such droplet entrainment and fall out does not happen.

Management

Management techniques

5.26 Important elements for effective control of emissions include:

- proper management, supervision and training for process operations;
- proper use of equipment;
- effective preventative maintenance on all plant and equipment concerned with the control of emissions to the air; **and**
- ensuring that spares and consumables - in particular, those subject to continual wear – are held on site, or available at short notice from guaranteed local suppliers, so that plant breakdowns can be rectified rapidly. This is important with respect to arrestment plant and other necessary environmental controls. It is useful to have an audited list of essential items.

Appropriate management systems

5.27 Effective management is central to environmental performance; it is an important component of BAT and of achieving compliance with permit conditions. It requires a commitment to establishing objectives, setting targets, measuring progress and revising the objectives according to results. This includes managing risks under normal operating conditions and in accidents and emergencies.

It is therefore desirable that installations put in place some form of structured environmental management approach, whether by adopting published standards (ISO 14001 or the EU Eco Management and Audit Scheme [EMAS]) or by setting up an environmental management system (EMS) tailored to the nature and size of the particular process. Operators may also find that an EMS will help identify business savings.

5.28 Regulators should use their discretion, in consultation with individual operators, in agreeing the appropriate level of environmental management. Simple systems which ensure that LAPPC considerations are taken account of in the day-to-day running of a process may well suffice, especially for small and medium-sized enterprises. Regulators are urged to encourage operators to have an EMS for all their activities, but it is outside the legal scope of an LAPPC permit to require an EMS for purposes other than LAPPC compliance. For further information/advice on EMS refer to the appropriate chapter of the appropriate Guidance Manual for [England and Wales](#), [Scotland](#) and [Northern Ireland](#).

Training

- 5.29 Staff at all levels need the necessary training and instruction in their duties relating to control of the process and emissions to air. In order to minimise risk of emissions, particular emphasis should be given to control procedures during start-up, shut down and abnormal conditions. Training may often sensibly be addressed in the EMS referred to above.
- All staff whose functions could impact on air emissions from the activity should receive appropriate training on those functions. This should include:
 - awareness of their responsibilities under the permit;
 - steps that are necessary to minimise emissions during start-up and shutdown;
 - actions to take when there are abnormal conditions, or accidents or spillages that could, if not controlled, result in emissions.
 - The operator should maintain a statement of training requirements for each post with the above mentioned functions and keep a record of the training received by each person. These documents should be made available to the regulator on request.

Maintenance

- 5.30 Effective preventative maintenance plays a key part in achieving compliance with emission limits and other provisions. All aspects of the process including all plant, buildings and the equipment concerned with the control of emissions to air should be properly maintained. In particular:
- The operator should have the following available for inspection by the regulator:
 - a written maintenance programme for all pollution control equipment; **and**
 - a record of maintenance that has been undertaken.

6. Summary of changes

The main changes to this note, with the reasons for the change, are summarised in **Table 6.1**. Minor changes that will not impact on the permit conditions e.g. slight alterations to the Process Description have not been recorded.

Table 6.1 - Summary of changes			
Section/ paragraph/ row	Change	Reason	Comment
Introduction			
	Simplification of text	Make Note clearer	
	Addition of links	Change to electronic format	Removes need for extensive footnotes/references

7. Further information

Sustainable consumption and production (SCP)

Both business and the environment can benefit from adopting sustainable consumption and production practices. Estimates of potential business savings include:

- £6.4 billion a year UK business savings from resource efficiency measures that cost little or nothing;
- 2% of annual profit lost through inefficient management of energy, water and waste;
- 4% of turnover is spent on waste.

When making arrangement to comply with permit conditions, operators are strongly advised to use the opportunity to look into what other steps they may be able to take. Regulators may be willing to provide assistance and ideas, although cannot be expected to act as unpaid consultants.

Health and safety

Operators of processes and installations must protect people at work as well as the environment:

- requirements of a permit should not put at risk the health, safety or welfare of people at work or those who may be harmed by the work activity;
- equally, the permit must not contain conditions whose only purpose is to secure the health of people at work. That is the job of the health and safety enforcing authorities.

Where emission limits quoted in this guidance conflict with health and safety limits, the tighter limit should prevail because:

- emission limits under the relevant environmental legislation relate to the concentration of pollutant released into the air from prescribed activities;
- exposure limits under health and safety legislation relate to the concentration of pollutant in the air breathed by workers;
- these limits may differ since they are set according to different criteria. It will normally be quite appropriate to have different standards for the same pollutant, but in some cases they may be in conflict (for example, where air discharged from a process is breathed by workers). In such cases, the tighter limit should be applied to prevent a relaxation of control.

Further advice on responding to incidents

The UK Environment Agencies have published [guidance](#) on producing an incident response plan to deal with environmental incidents. Only those aspects relating to air emissions can be subject to regulation via a Part B (Part C in NI) permit, but regulators may nonetheless wish to informally draw the attention of all appropriate operators to the guidance.

It is not envisaged that regulators will often want to include conditions, in addition to those advised in this PG note, specifying particular incident response arrangements aimed at minimising air emissions. Regulators should decide this on a case-by-case basis. In accordance with BAT, any such conditions should be proportionate to the risk, including the potential for harm from air emissions if an incident were to occur. Account should therefore be taken of matters such as the amount and type of materials held on site which might be affected by an incident, the likelihood of an incident occurring, the sensitivity of the location of the installation, and the cost of producing any plans and taking any additional measures.