

## **Pollution Prevention and Control (Scotland) Regulations 2012 Systematic Assessment of Resource Use and Efficiency – Supporting Guidance**

- **This guidance is to be used when carrying out the systematic assessment of resource use and efficiency as required by your PPC permit.**
- **The intention of this process is to provide a practical approach, which if followed will enable you to demonstrate that you have carried out your systematic assessment effectively rather than replacing or duplicating the statutory guidance that is relevant to your activity.**
- **The questions in the template have been designed to help lead you through a structured process. This guidance provides supporting information that should be considered when answering each question.**
- **This supporting information will help you to determine opportunities to investigate and to implement good practice and / or change your process to reduce your emissions.**

### **Introduction**

In the context of activities permitted under the Pollution Prevention and Control (Scotland) Regulations 2012 (PPC), the purpose of carrying out a systematic assessment of resource use and efficiency is to continuously review and implement any potential opportunities to reduce gaseous, liquid and solid emissions. In addition to reducing the impact on the environment, you will also benefit because resource efficiency is also about:

- reducing costs (raw material and waste disposal);
- maximising output of product or service from a given level of materials and energy (competitive advantage);
- finding an outlet for surplus materials therefore removing them from the waste chain;
- helping Scotland achieve its goal of becoming a zero waste society;
- reducing pollution risks, and avoiding reputational impacts.

There are two sections to the systematic assessment:

### **Section A - Data reporting:**

- provides a good understanding of the amounts of raw materials, water and energy used and the waste and losses associated with any of these;
- collating four years of data in one document allows for an efficient review of any associated trends. It also demonstrates the effect that variation in processing has on resource use and resource losses.

### **Section B – Reviewing the process:**

- understanding where materials, water and energy are used and where there are losses;
- identifying opportunities to reduce resource use and / or losses;
- identifying opportunities to reduce emissions and discharges which may mean that less or no abatement / treatment is required.

### **Section A Data Reporting (Parts 1 - 3 of the systematic assessment template)**

For energy, water and the materials listed in your permit and the waste produced and / or losses you should record the amounts for each year:

- In principle the materials to be included in each of these data tables are those materials as specified in your permit as a minimum. We also recommend that you review other materials on site to maximise the cost benefits of improved resource efficiency.
- If a category is not listed or you have additional materials please insert a row into the relevant table.
- Ensure the reporting units are noted in each table. Use either kWh or MWh for energy; otherwise these should be as agreed in your permit.
- Calculate the amount used per unit of production so that performance can be monitored.
  - when recording annual production use the gross tonnage not net tonnage;
  - in the event you have different consumption requirements / targets for different products or different production lines for example, please adapt the tables to suit your particular circumstances and insert additional rows as required. This will ensure these values are meaningful.
- For each successive year, record the reason for any change in performance / efficiency e.g. raw material used per unit of production.
- Retain the template to demonstrate you are complying with the reporting requirements of your permit.
- The site officer will review this data with you periodically.

### **Part 1 - Raw material and waste data**

- Note that data for both raw material inputs and waste losses are recorded in this table.
- Where data might fit in 2 categories agree with your site officer where best to record the data and do the same for successive years. We are aiming for a consistent approach to enable changes to be monitored. We also want to avoid any double-counting:
  - If you are a landfill or incinerator or other waste facility the waste coming onto your site is classed as a raw material for the purposes of this template.
    - If you take in a range of waste materials, for the purposes of the raw materials table you should categorise the incoming waste materials as either hazardous or non-hazardous.
- A secondary raw material is a raw material recovered from a waste or a production residue and which is used as a substitute for virgin raw materials. A secondary raw material can be derived from a completely different process.
- Recording the amount of production residues allows you to investigate the potential to prevent or reduce its production. Reusing or reprocessing off-spec material is unnecessarily using valuable resources such as power and water.
- N.B. The waste and material losses section does not replace the need to submit an annual Waste Data return, where required by us, but you can use that data to populate this section.
- This data is required to:
  - understand the reasons for changes in the use of raw materials;
  - monitor progress towards zero waste;
  - monitor material recovery.

### **Part 2 - Identify all sources of water, how much you use and how much water is disposed of and where to**

- Note that data for both water inputs and water losses are recorded in this table:
  - It is important to note whether your data is measured and / or estimated.
  - To support the efficient use of water, we encourage the routine monitoring and recording of water inputs and outflows.
- In the water losses section, a quantitative split is not required for the question asking where water / effluent is lost or disposed to. A description will suffice. However, if data is available it can be entered here.
- It is important that you indicate in the water data table whether the data includes non PPC activities – this may be determined by the level of metering you have. You need only report resource efficiency for those activities covered by the PPC regulations. However you, as a company, may wish to include non PPC activities to achieve the greatest benefits.
- This water input and losses data enables you to, for example:
  - identify opportunities to minimise / optimise water consumption;
  - understand your outlay costs and uses with a view to changing to a more cost effective and environmentally beneficial option. E.g. using grey or harvested water and / or reusing water discharges with / without treatment where the process can function perfectly well with these substitutions;
  - identify any issues such as leakage e.g. a leaking water wash system, which may increase the amount of water going to sewer rather than recirculating into the wash system.

### Part 3 – Energy consumption

The energy consumption data here relates to the assessment of current efficiencies and losses against the relevant sector guidance as noted in Part 7.

- This data is required to monitor energy efficiency:
  - It is important to note whether your data is measured and / or estimated.
- This section does not replace the detail required in heat and power plans, where required by SEPA.
- Energy data collected for this table may, in part, be useful in the development of energy data for other statutory submissions but this will depend on the scope of each requirement. E.g. for the Carbon Reduction Commitment, EU Emissions Trading Scheme (EU ETS) or for an Energy Savings Opportunity Scheme (ESOS) reference period. See the [ESOS guidance](#) for more detail.
- The EU ETS Regulations only excludes operators from submitting energy efficiency data for PPC purposes with respect to combustion units or other units emitting carbon dioxide. If you participate in EU ETS then you are still required to consider energy efficiency of other PPC activities on site that are not combustion units or units emitting carbon dioxide.
- If your installation is covered by ESOS this does not affect the requirements you need to meet under the Industrial Emissions Directive / PPC.
- It is important that you indicate in the energy data table whether the data includes non PPC activities – this may be determined by the level of metering you have. You need only consider resource efficiency for those activities covered by the PPC regulations; however you may wish to include non PPC activities to achieve the greatest benefits.

For sites other than energy producing sites:

- For energy produced on-site e.g. from gas, enter the amount of energy generated and not the amount of gas used. The amount should be entered in the raw materials table.

For energy producing sites:

- This Part 3 and the related Part 7 are not looking at energy efficiency in terms of raw material consumed per energy unit created. For the purposes of this systematic assessment, both the energy used and the performance indicator in this Part 3 relate to the efficiency of the actual generation process rather than for example the efficient use of the input material e.g. fuel gas or chicken litter. In this example these are both raw materials and should be captured in Part 1 for raw materials.
- The aim of this Part 3 and the related Part 7 is to understand how much energy is used to operate the generation process; if this energy is being used efficiently and then to identify opportunities to reduce it. Essentially this is about tackling basic energy efficiency measures of the actual generation process e.g. is kit running unnecessarily; is the turbine operating at the most efficient level.

## **Section B Systematic assessment of raw material, water, energy and fuel consumption (Parts 4 – 9 of the systematic assessment template)**

The process of carrying out the assessment should result in a thorough understanding of the processes so that changes can be made to prevent and reduce gaseous, liquid and solid emissions without compromising product quality or customer requirements. Whilst some permitted activities have achieved significant reductions, others are less clear about how best to do this. The questions below provide a structured approach to understanding your process so that you can identify and realise opportunities to reduce the unnecessary use of materials and natural resources.

In some of the systematic assessment questions we use the term 'good practice' e.g. are you operating your process in line with good practice? Essentially this means operating in line with Best Available Techniques (BAT). But if no BAT is identified then good practice may be identified in a range of documents available from Resource Efficient Scotland and their predecessor bodies such as Envirowise, Carbon Trust etc. Contact details can be found in Appendix 1.

### **Part 4 General Management**

#### **1. Have you read the sections relating to resource efficiency in both the sector guidance and Best Available Techniques (BAT) Reference documents (BREF) relevant to your activity?**

In the relevant sector guidance, Section 2 describes the techniques for pollution control:

- These provide additional methods for optimising your process.
- They also identify management techniques to optimise your operation.

N.B. Please also refer to relevant sections in the sector specific and horizontal BREF documents and associated BAT Conclusions for further information.

#### **2. Are there any resource efficiency benchmarks available and applicable e.g. BREF or sector specific?**

The BREF and sector guidance will explain what can / cannot be achieved in certain circumstances:

- A review will / should have been carried out at the permit application stage to assess where the site sits against benchmarks in the BREF and the sector guidance.
- This review is to assess the current status of your site against the benchmarks.
- This review is to also identify any subsequent changes to the original benchmarks and their applicability to your site.

### 3. Have you undertaken a review of technologies and technique advances?

Whilst these are identified in the relevant BREF, advances since its publication will be available through industry fora, trade bodies and trade magazines.

- Even if there have been no technology / technique advances in your sector, carrying out this systematic assessment provides you with the opportunity to review the effectiveness of existing technologies / techniques and to demonstrate that you are operating your process efficiently.
- Doing this will ensure that your business is benefitting from being resource efficient.

### 4. Are your Staff aware of and engaged in process efficiency

Achieving a successful outcome requires the active participation and commitment of staff at all levels. Staff need to understand what the issues are and why they need to support the process. Without staff buy-in, longer term success will be limited. In addition, experienced staff may already have simple and (cost) effective ways to improve efficiency:

- Do your staff / operators understand their role in conserving resources?
- Can staff / operators participate in the identification of waste prevention opportunities?
- Are staff / operators involved in developing and reviewing procedures?

### 5. Do you monitor / assess basic housekeeping measures to minimise your use of raw materials?

Poor housekeeping can be connected to poor resource management and unnecessary wastage of raw materials:

- Is housekeeping monitored in all areas of the process?
- Housekeeping standards and checks ensure that poor operator practices or process faults / leaks are identified and improvements made before too much raw materials is lost / waste generated.
- Good housekeeping also helps to reduce the risk to the environment.
- How effectively are materials managed e.g. by purchasing and during storage?

## Part 5 How well do you manage the use of raw materials and waste across your installation?

In the table below you will be asked to consider a series of measures that in addition to ensuring permit compliance will cut your resource use. By not embracing any of the following ideas you may be wasting money.

### 1. Have you reviewed the selection of your materials to reduce your overall environmental impact?

- Your permit provides a list of raw materials which must be considered; it is advised good practice to expand this list on a site specific basis. Do you consider ALL\* materials used within the installation (For the purpose of PPC this does not include domestic areas i.e. office and accommodation, but you may wish to address materials used in these areas to achieve further business benefits).
- Have you evaluated the environmental impact of these materials?
- Can you substitute less harmful materials or materials that can be more easily abated / treated?
- Have you considered the source of your materials – how sustainable is this source compared to other sources?
- Have you identified your key components and built resilience into Purchase Ordering to ensure business continuity should the supply become unavailable?

#### Notes

ALL\* materials used in the installation includes categories such as: main process chemicals / ingredients; emission treatment chemicals; process consumables; solvents; maintenance materials; additives; cleaning product; catalysts; and packaging.

### 2. Are you tracking losses of materials and generation of waste or defective materials? (See Part 6 for guidance on water)

The generation of defective materials needs to be analysed and tracked so that where possible its generation can be prevented or minimised. Understanding how, why and when defective material is generated will allow you to ascertain, for example, if: adjustments to operating procedures are required; operators require retraining; maintenance programmes need to be adjusted or if the process equipment needs to be replaced or modified. To provide a good understanding of where materials are used / lost, we encourage you to prepare process flow diagrams / mapping and / or a materials mass balance:

- Do you only monitor the usage of raw materials in your permit or do you monitor ALL\* materials used within the installation?
- Have you calculated the theoretical demand for your raw materials?
- Do you routinely monitor the actual consumption of your raw materials?
- Do you routinely report the differences between theoretical and actual to management on a weekly basis?
- If there is a difference between theoretical demand and actual consumption; have you identified where material is lost in the process?
- Do you routinely record and report to management the quantities of waste at each stage in the process, including end product?

**3. To avoid, reduce or reuse materials, have you implemented any in-house or any formal process efficiency programmes such as LEAN or Six Sigma etc?**

- Have you identified the reasons\*\* why materials are either lost from the process or end up as waste?
- Do you have in place an ongoing programme of work to reduce the raw materials wasted?
- Can you avoid the use of any material or packaging? E.g. have abatement systems been optimised to prevent unnecessary use of chemicals, catalysts, solvents etc.
- Can you reduce your use of raw materials? E.g. have you evaluated your process formulations to see if the use of a chemical or other material can be reduced?
- Can you increase raw material efficiency? For example:
  - by introducing recycling / re-use loops within the process;
  - by optimising programme planning to reduce product / grade changes;
  - using Lean Management techniques, such as the Product Wheel, to identify the optimum sequence, thereby reducing material losses and costs and gaining additional processing time;
- Have you developed any Key Performance Indicators to increase the efficiency of raw material use and to reduce waste generation?

Notes

\*\*Reasons why materials can be lost across the installation include categories such as:

- |                               |   |
|-------------------------------|---|
| - incorrect process controls; | - poorly maintained kit;                  |
| - poor process control;       | - poor stock control;                     |
| - un-calibrated equipment;    | - poor housekeeping;                      |
| - poor operator competence;   | - handling damage;                        |
| - incorrect procedures;       | - spillages / leaks / fugitive emissions; |
| - faulty equipment;           | - short product runs / grade changes.     |

**4. Do you have a process to review the substitution of any of the virgin materials you use / purchase with secondary raw materials or production residues?**

- Are you able to internally recycle production residues e.g. for glass manufacturing, in most cases dust collected from the waste gas streams can be internally recycled to the process. Recycled filter dust acts as a substitution for sulphur-containing virgin raw materials in glass productions using sulphate as a fining agent. Where acid gas absorbents are used, they can usually be chosen to be compatible with raw materials to enable recycling although the batch composition may have to be adjusted.
- Have you contacted other manufacturers to see if there are opportunities to use each other's materials or residues (industrial symbiosis) in place of virgin materials?



## 5. Provide a demonstration of how you are managing your waste in line with the waste hierarchy.

What opportunities have you to move your waste management approach up the waste hierarchy?



- How close are you to sending zero waste to landfill?
- Have you set 'zero waste' targets?
- Are you using competent and licensed waste management carriers and contractors?
- Have you audited how your waste management contractor actually treats your waste?

## Part 6 How well do you manage the use of water across your installation?

There is growing pressure on this natural resource as a result of population and economic growth, climate change and pollution / water quality. This is leading to increased demand, security of supply issues and rising costs and as a consequence businesses are increasingly citing the availability of water as a risk to their business.

The costs benefits of saving water are two-fold: reducing the cost to buy and the cost to treat / dispose water not consumed in the process. For sites that have not previously tried to save water, significant reductions in water consumption are usually achievable at little or no cost through simple changes in operating practices or maintenance procedures. The series of questions in the table below provide a range of fundamental ideas to understand better how you can reduce your reliance on this natural resource.

N.B. Water abstracted from a borehole or from a river and any impoundment it is likely to be regulated via the Controlled Activity Regulations (CAR) and not under PPC. However, if it is utilised directly or indirectly at the PPC installation it is a resource. As such you are required to include in this assessment possible reduction and / or efficiency measures of its use within the PPC process.

### **Please Note:**

When answering the questions below you should consider all of your processes that utilise water. E.g. effluent treatment plant, washing systems, emergency response systems, cooling systems, hydraulic systems, boilers /heating/power systems etc.

### **1. Can the use of water be avoided / eliminated?**

To help you identify opportunities to save water, we encourage you to produce flow diagrams and water mass balances for your activities.

- Have you done a water audit to identify where you use water?
- Have you assessed the need to use water at each stage?
- Are there opportunities to remove the use of water by replacing it with another system e.g. dry cleaning instead of using water cleaning?
  - Have you already stopped using water for a specific purpose?
- Do you have a detailed understanding of the water supply and distribution system on site?
- Do you carry out routine inspections of water transport and storage systems to identify and repair leaks?

For guidance, checklists and spreadsheets on water minimisation, which includes: tracking water usage and costs; conducting a water mass balance, project implementation follow the link: [www.resourceefficientscotland.com/content/key-task/implement-a-water-minimisation-programme](http://www.resourceefficientscotland.com/content/key-task/implement-a-water-minimisation-programme)

## 2. Can you reduce water use?

- Is water considered as part of good housekeeping?
  - For example leak management and / or not leaving water running unnecessarily.
- Do you read your water meters frequently, at least once per month? (If you detect an unexpected increase in water flow it is probably a leak)
- Has water use been optimised for each stage of the process?
- Have you set water efficiency objectives and have you related these to any benchmarks that might apply to your activity?
- Where water is lost e.g. as steam, could you reduce this by optimising the process?
  - Remember that any loss of hot water / steam from the process is both a loss of water and a loss of heat / energy.
- Is there an alternative system or plant that is more water efficient? For example:
  - Fitting trigger controls on all hoses and fitting automatic shut-off valves where water is not required continuously
  - Using spray or jet washing systems or formalising clean down procedures to eliminate discretionary additional clean downs
  - Could you install an alternative technology e.g. membrane technology to replace traditional effluent treatment systems?
- Do you train staff in the need to save water and the ways to do this?

## 3. Can you reuse and / or recycle water used within your processes (i.e. closed loop)?

- Have you identified the water quality requirements at each stage and evaluated the scope for reusing water?
- Can you recycle water within the process from which it arises?
- If not can you reuse the water / effluent in another part of the process?
- Can recycled or grey water / less contaminated process water be used in place of mains etc?
- Have you evaluated the scope for reusing wash water?
- If not practicable, can you recycle wash water to another part of the process that has a lower water quality requirement?

## 4. Where water is disposed to sewer, the water environment, or other, could this be reused / re-circulated? If not why not?

- If you answered no to the above question, are you able to demonstrate that a thorough assessment has been carried out?
- If you produce different effluent streams, have you optimised their segregation to enable reuse / recycling?
- Are there any opportunities to collect clean rainwater and use it?

## Estimate how much you pay for water

You do not need to present this information to SEPA however it should illustrate to you how saving water will save you money. Use the table below (amend as appropriate) to calculate the cost of your water consumption and discharge. If you compare your water costs with those for gas or electricity bills, it is unlikely that water will be the most expensive. However, water prices have risen steadily over the last 10 years. This trend looks set to continue as more capital is required to secure sustainable infrastructure and supplies, and to reduce leakage. In addition, the energy costs related to pumping and treatment are also increasing significantly.

It is important to include not just the cost of the water, but also the operating costs associated with pumping and distributing water around the installation and disposing of dirty water. If you have to treat or heat water prior to using it, then the savings potential is increased in line with these additional costs.

Things to factor in:

- The volume and cost of your water supply
- Any water consumed in onsite processes i.e. within product, through evaporation.
- The volume and cost of wastewater disposal, onsite-treatment and / or trade effluent charges
- Energy to pump and heat water
- Labour input
- Distillation / softening / pre-treatment / cost of any chemicals added

**Here is an example of the format you could use**

		Total Volume (m <sup>3</sup> )	Cost (£/m <sup>3</sup> )	Total cost (£)	Comparison
Water in	Mains water used (and any additional treatment costs)				Total Cost Water in (£)
	Abstracted water (and any treatment costs)				
	Rainwater (and any treatment costs)				
Water Consumed? (If applicable)					
Water out	Treatment of process water	---			Total Cost Water out (£)
	Energy costs from pumps (£)	---			
	Disposal of final wastewater / effluent (£)				
		Useful to highlight difference between water in and out (m3) here. Can any discrepancies be explained?			<b>Total Cost of Water in and Out</b>

For sites that hold a trade effluent consent, charges are based on the volume and strength of effluent. Therefore any measures to reduce the volume of trade effluent or improve its quality i.e. removal of suspended solids, fats and chemicals, reduction in Chemical Oxygen Demand may result in cost savings. Minimising wastewater by addressing the cause at the earliest stage i.e. production methods, cleaning activities, could even eliminate the need for expensive secondary or tertiary treatment.

## Part 7 How well do you manage the use of energy across your installation?

The techniques available for energy efficiency are strongly dependent on the particular site, activity and industrial process. There is a vast array of information and advice concerning energy efficiency available commercially. It is the aim of this Guidance not to attempt to summarise and reproduce this mass of information here, but to ensure that you have considered all relevant techniques for energy efficiency within the installation and identified those that are most effective.

In many cases, the most appropriate energy efficiency techniques will be described in the sector BREFs, the horizontal BREF for Energy Efficiency and the sector guidance.

### **Please Note:**

When answering the questions below you should consider all of your processes that utilise energy directly / indirectly e.g. combustion plant, ovens, furnaces, other thermal treatment processes, compressed air systems, steam distribution systems, refrigeration condensers and evaporators, motors/drives, filtration equipment, lighting, building heating/cooling/ventilation systems.

### **1. Is your activity covered by a Climate Change Agreement (CCA) or are you a participant in the EU Emissions Trading Scheme (EU ETS) or both?**

If you are covered by EU ETS or a CCA then you are only required to do basic energy efficiency requirements.

### **2. Can you demonstrate that your process is operating in line with good practice?**

#### **2a. Monitoring and understanding your energy usage**

- Do you routinely monitor your energy consumption?
  - Do you have on-site metering / sub-metering?
  - If not, your energy bills are a primary source of information – do they provide you with sufficiently detailed information to understand where energy is used. Are they meter readings or estimates?
- Considering the installation of further meters or data logging devices will enhance energy management and could bring energy savings.
- Have you carried out an energy audit?
  - Resource Efficient Scotland provides practical free guidance about how to conduct [an energy audit](#).
- It is useful to supplement energy consumption information with energy balances (e.g. “Sankey” diagrams, other flow diagrams or descriptions) to illustrate how energy is used throughout the process.

## Continued - 2. Can you demonstrate that your process is operating in line with good practice?

### 2b. Energy management techniques

- If your site is certified to ISO 50001 – Energy Management, you will have set standards for energy efficiency. These can be incorporated here to demonstrate how you are tackling energy efficiency.
  - If you are an SME then you may find this handbook useful: [ISO 50001 – a practical guide for SMEs](#). This provides examples of how to plan and implement energy efficiency measures, often without the need for investment in new technology or systems.
- If you are an SME you may also find the following guidance useful: [SME Guide to Energy Efficiency](#). This is designed to give you the knowledge, ideas and tips you will need to start reducing your energy use and bills, even if you have never done this before.

### 2c. Operating and maintenance procedures

The way you operate the individual processes and services at your site can have a significant impact on energy consumption. Have you optimised operating procedures and equipment schedules, as well as maintenance and general housekeeping procedures? For example (but not limited too):

- Do you switch off equipment when not in use?
- Do you minimise compressed air leakage through regular checks and maintenance? **See Checklist Energy 1**
- Do you maintain steam distribution systems to reduce leaks and heat losses? **See Checklist Energy 2**
- Do you undertake regular servicing of refrigeration condensers and evaporators? **See Checklist Energy 3**
- Do you undertake regular cleaning of heat transfer surfaces prone to fouling?
- Do undertake basic maintenance of motors and drives? **See Checklist Energy 4**
- Have you optimised cleaning of filtration equipment?
- Have you optimised warm-up procedures to reduce supplementary energy use?
- Do you manage and schedule furnaces and heated vessels to reduce holding time?

### 2d. Basic, low cost physical measures for heating or cooling losses

- Have you identified and eliminated all excessive heating or cooling losses from steam systems, hot water pipes, heated vessels, ovens, chillers and other temperature-controlled zones or equipment through implementation of basic insulation and containment methods?
  - Have you insulated all your steam and condensate pipework and fittings sufficiently – this includes flanges on a steam line?
  - Have you provided hoods, lids, air-tight seals and self-closing doors to maintain temperature?
  - Have you fitted simple timers or sensors to avoid unnecessary discharge of heated water or air?

**Continued - 2. Can you demonstrate that your process is operating in line with good practice?**

**2e. Energy-efficient building services**

This section applies to the buildings that are included in your permitted activities e.g. process buildings, control rooms etc. Often overlooked, energy-consuming building services include: space heating, cooling and hot water, ventilation, air-conditioning, associated pumps and fans, lighting and office equipment. For energy intensive industries, energy used for building services may have a relatively minor impact and should not distract effort from more major energy issues. However, these services can be a significant proportion of overall consumption in the less energy-intensive installations.

- Have you reviewed the efficiency of the services in your industrial buildings?
- Have you undertaken an assessment of the efficiency of lighting, including estimation of lighting level and a comparison with appropriate benchmarks?
- Have you considered or implemented the following measures:
  - use of efficient lighting systems, lamps and luminaires;
  - installing lighting systems to provide appropriate lighting density;
  - using effective controls so that lighting is only used when required;
  - installing roof lighting to reduce or remove the need for lighting during daylight hours.
- Have you considered measures to improve energy efficiency in the design and operation of climate control systems, including use of the following techniques:
  - use of waste process heat for space heating;
  - selection of high-efficiency heating equipment;
  - selection of point-of-use water heaters;
  - temperature control: use of thermostats, time switches, etc.
  - use of natural ventilation;
  - draught-proofing measures.

**3. Can you optimise your energy consumption using the options provided including those in the Energy Efficiency Checklists 1-4 located in Appendix 2 of this document?**

Refer to the Checklists in Appendix 2.



**4. Please describe here proposals for further, process related energy efficiency measures, which go beyond the low-cost basic physical measures above. N.B. The following is not required for activities covered by installations covered by CCA or EU ETS**

The energy efficiency measures described in this section go beyond the low-cost basic physical measures described in Question 2 and 3 above, to consider the full range of energy efficiency techniques available to industrial installations. Such techniques include design considerations, the selection of energy-efficient equipment, the use of process optimisation and integrated techniques and options for energy supply.

**4a. Design and / or procurement considerations**

The design stage is the optimum time to make the most effective energy efficiency improvements.

- Do you incorporate energy efficiency improvements when designing new installations and refurbishments?
- Do you include energy efficiency requirements in the specification for procurement of equipment and buildings?
- Do you optimise integrated energy efficiency techniques such as heat recovery, water minimisation, heat and power demand by considering the energy consumption and recovery opportunities for the installation as a whole?

**4b. Energy efficient equipment**

Have you considered the following energy efficiency techniques, where applicable:

- Motors and Drives
  - installation of high efficiencies motors;
  - installation of variable speed drives on fans and pumps;
  - phase optimisation of electronic control motors.
- Heat recovery
  - recovery of waste heat from gaseous and liquid effluent streams for use in applications such as direct process heat exchange, pre-heating of combustion and drying air, flue gas re-heating, etc.
- Water minimisation
  - use of mechanical dewatering equipment (i.e. presses and centrifuges);
  - use of closed circulating water systems.
- Low-energy technology
  - use of process routes or equipment with inherently low energy consumption, i.e. electro-technologies (microwave heating, induction heating, ultraviolet curing, air-knife drying, desiccant drying, infrared heating, radio frequency heating etc.)

**Continued - 4. Please describe here proposals for further, process related energy efficiency measures, which go beyond the low-cost basic physical measures above. N.B. The following is not required for activities covered by installations covered by CCA or EU ETS**

**4c. Process optimisation**

- Optimised design and layout
  - For example, reduced pipe runs, minimised pressure losses, location of buildings, etc.
- Process control and instrumentation
  - For example, the use of control and instrumentation to optimise process conditions such as temperature, pressure, flow-rate and humidity.

**4d. Energy supply techniques**

All energy use constitutes an environmental burden. Questions 4a – 4c above help to ensure energy is consumed efficiently at point of use. This question is about how efficiently the energy is produced:

- Have you considered alternative, more efficient forms of the supply of electricity and heat?
  - import of steam or “waste heat” from neighbouring installations;
  - installation of a combined heat and power supply system for the installation;
  - use of on-site renewable energy sources or purchasing energy generated from renewable sources (e.g. biomass conversion, use of land fill derived gas, use fuel gas derived from anaerobic digestion of sewage treatment work sludges, use of fuel cells, wind power, hydropower etc.)
- Have you considered incineration or co-incineration (or other thermal conversion) of your process wastes to provide heat and power?

## Part 8 Identifying opportunities as part of your assessment

### What is the benefit of using the Opportunities Table?

The Opportunities table provides a simple mechanism by which you can:

- simply and effectively manage each of the improvement opportunities that you identified in Parts 4 – 7 of the Template;
- demonstrate continuous improvement throughout the 4 year assessment period.

You may also have identified other opportunities to save resources which are not highlighted in Section B.

You can use the table to:

- record your assessment justifying whether each of the Improvement Opportunities identified in Parts 4 – 7 of the Template will be approved for trials / implementation;
- record on a routine basis the status or progress of approved Improvement Opportunities, including:
  - any issues or challenges that have caused a change in direction; prevented the desired benefits from being achieved or prevented the project from going ahead;
  - any other environmental outcome priorities identified elsewhere in your permit management which mean these projects have to be slowed down, postponed or cancelled;
- record the environmental and cost benefits on successful completion of a project – and any additional benefits such as health and safety, cultural etc.

Whilst the cost for some options may be low or negligible e.g. employee time, the implementation of others may require capital investment and these should be included in the business planning process. Or some opportunities may be dealt with under forthcoming maintenance programmes or process improvements. This information will enable you to prioritise implementation over the next 4 year period..

### **Continued - What is the benefit of using the Opportunities Table?**

To some extent the number of improvement opportunities that you have identified may depend on how long you have been addressing resource efficiency successfully. You may have identified more improvement opportunities than can be tackled during the next assessment period because of complexity, size of site, available resource and / or capital. If so, you should rank the opportunities with the aim of prioritising those that will result in the greatest environmental benefit.

If the greatest environmental impact is in one area of your site or relates to a particular resource it may be appropriate for you to focus your assessment on that. If this is the case, you should record your reasoning in the relevant systematic assessment and / or Opportunities Tables as appropriate.

If you have an environmental management system you can:

- use this and your environmental impacts register to achieve appropriate project ranking, whereby the most significant issues are selected for action within a specified period;
- use the site ranking to demonstrate how resource efficiency / waste minimisation projects have been or will be selected each year.

You may wish to discuss the priorities with SEPA before submission of the assessment.

You may find the Opportunities Table useful for other business purposes:

- to justify an internal application for money (although many improvements can be achieved with no or low cost or by using staff time);
- to request support from other teams / departments e.g. maintenance planning;
- to raise on-site awareness of an issue;
- as a record in an environmental management system, demonstrating how an environmental impact is being managed.

## Part 9 Reviewing progress and next steps

### What is the purpose of the Tables in the Reviewing Progress Section?

This section enables you to record both a high level summary of the progress over the 4 year period and a more detailed summary for each of the improvement opportunities. We require only enough detail to convey the success, or otherwise, of the project and we include below the type of information that will allow you to demonstrate the effective management of your resources on a continuing basis.

These tables enable you:

- To summarise the approach and work you have undertaken in the previous systematic assessment period
- To summarise the benefits, whether these be environmental, cost or health and safety related
- To record any challenges that may have caused a change in direction or prevented the opportunity from being realised
- To record any lessons learnt that could inform other work
- To manage continuity from one assessment period to the next by recording any projects that will either continue or be carried forward into the next period
- To use the learning and experience to inform or identify future improvement opportunities.

## Appendix 1 Other support

The Scottish Business Sustainability Partnership organisations provide a wide range of support and information on resource efficiency for businesses, most of the support available is free. To identify which organisation you should refer to, the type of support has been split into 'themed' areas. A summary is provided in the following table:

Resource Efficient Scotland (RES)	Raw materials, waste, energy and water guidance e.g. <a href="#">Measuring to manage resources and waste – an Introduction.</a>  Staff awareness, engagement and training	Tel: 0808 808 2268 <a href="mailto:enquiries@resourceefficientscotland.com">enquiries@resourceefficientscotland.com</a> <a href="http://www.resourceefficientscotland.com">www.resourceefficientscotland.com</a>
Energy Saving Trust (EST)	Transport Employee Engagement focussing on low carbon behaviours at home	Tel: 0800 931 669 (Local Transport Advisor) <a href="http://www.energysavingtrust.org.uk/scotland/businesses">www.energysavingtrust.org.uk/scotland/businesses</a>
Scottish Enterprise (SE)	Funding and support for sustainable growth opportunities	Tel 0300 013 3385 (ask for local Sustainability Specialist) <a href="http://www.scottish-enterprise.com/services/improve-your-business-practices/sustainability-development-service/overview">www.scottish-enterprise.com/services/improve-your-business-practices/sustainability-development-service/overview</a>
Highlands and Islands Enterprise (HIE)	Business efficiency support Innovation	Tel: 01463 234 171 <a href="http://www.hie.co.uk/business-support">www.hie.co.uk/business-support</a>
Scottish Manufacturing Advisory Service (SMAS) (An SE / HIE service)	Process improvement, lean manufacturing. Resource efficiencies and innovation	Tel: 0300 013 3385 (ask for local Sustainability Specialist) <a href="http://www.scottish-enterprise.com/industry-support/manufacturing">www.scottish-enterprise.com/industry-support/manufacturing</a> <i>N.B. Eligibility for this service is any business that has a process.</i>
SEPA	Advice and guidance on environmental regulation NetRegs – free online environmental guidance	Tel 03000 99 66 99 or your local office <a href="http://www.sepa.org.uk">www.sepa.org.uk</a> <a href="http://www.netregs.org.uk">www.netregs.org.uk</a>

## Appendix 2 – Energy Checklists

### Checklist 1 – Compressed air<sup>1</sup>

#### 1. Good housekeeping

- Consider turning off compressors during non-productive hours.
- Review the level to which air is pressurised. You may be able to reduce it, which reduces consumption and leakage.
- Related to the previous two points, if there are applications which require higher pressures or have longer operating hours than the rest of the system, investigate whether it might be worth installing a dedicated compressor.
- Check that the air inlet to the compressor is not taken from inside the building. Compressors operate more efficiently using cool air.
- Control/sequence compressors to operate on a “demand-controlled” basis. Compressors use as much as 70% of on-load power when they are idling. Seek professional advice.
- Initiate an effective system for reporting leaks. Carry out an “out of hours” survey, to listen for leaks, locate them and tag.
- Make sure all redundant piping is isolated – it is often a source of leaks.
- Check that the condensate collection system is working correctly, and that there is no constant bleed of air. Condensate traps may be jammed open or have been bypassed. Consider fitting electronically operated condensate traps, which are more reliable.

#### 2. Treatment

- Investigate treating the bulk of the air to the minimum level possible, then improving the quality for specific appliances.
- Regularly inspect and maintain the air treatment system. Check the pressure drop across the pre- and after-filters. If it is above 0.4 bar the filter may need replacing. It is cheaper to replace the filters than to pay for the loss in air pressure when they become clogged.
- Measure the dryer inlet temperature. This should not exceed 35°C with the compressors on full load.
- Measure the temperature of the dryer room. It should be within 5°C of the outside ambient temperature. If the room is too hot, there is a loss of performance.

#### 3. Use of compressed air

- Over 90% of energy used by a compressor is turned into heat, so consider whether you can fit a heat recovery system to the compressor(s) and use this heat elsewhere in your buildings.
- Use of higher efficiency nozzles (which entrain free air) can maintain performance, yet reduce the distribution pressure and hence energy consumption.

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<sup>1</sup> The British Compressed Air Society Ltd provides a range of guidance about compressed air audits and energy efficiency: <http://www.bcas.org.uk/compressed-air-energy-savings.php>

- Make sure that air tools are not left running when not in use.
- Check that compressed air is not used for ventilation or cleaning purposes, such as blowing off swarf.
- Look at alternatives to compressed air tools. Electrically powered tools are much cheaper.
- When purchasing a new compressor, take into account its energy efficiency, since electricity will be the major running cost.

#### 4. Calculating compressed air leakage

The best way to establish the amount of leakage in a system is by measurement. In the absence of suitable measuring devices, a no-load test should be carried out to establish the percentage leakage from the system. Two possible methods are as follows.

##### (a) For compressors in on/off mode

This applies to compressors that are operated in an on/off load, i.e. when the compressor is on-load it produces a known amount of air.

- Close down all the air-operated equipment.
- Start the compressor and operate it to full line pressure, when it will off-load. Air leaks will cause the pressure to fall and the compressor will come on-load again.
- Over a number of cycles, make a note of the average on-load time ( $T$ ) and average off-load time ( $t$ ).
- Total leakage can then be calculated as follows:

Leakage (litres/second) =  $(Q \times T) / (T + t)$  where  $Q$  = air capacity of the compressor (litres/second),  $T$  is the average on-load time (s) and  $t$  is the average off-load time (s).

##### (b) For modulating compressors

This test is more difficult, as the compressor output is unknown. The following method can be used if you have a pressure gauge downstream of the receiver.

- Calculate the system volume of air ( $V$ ) in litres. This can be estimated as the volume of air mains downstream of the receiver isolating valve, including all the pipework (25 mm and above) and the receivers.
- Pump up the system to operating pressure ( $P1$ ) and then close the isolating valve.
- Record the time ( $T$ ) for pressure to drop to  $P2$ .
- Leakage can then be calculated as follows:

Leakage (litres/second) =  $(V \times (P1 - P2)) / T$   
where  $V$  is in litres,  $P1$  and  $P2$  are in bar<sub>g</sub>, and  $T$  is in seconds.



## Checklist 2 – Steam Systems

### 1. Maximise condensate return

- Hot condensate that is not returned to the boiler house has to be replaced by treated cold make-up water and wastes some 20% of the energy absorbed in the generation of the steam from which the condensate is derived. This may be the greatest single energy loss in steam utilisation. The additional make-up water also adds to water treatment costs.
- If condensate is being discharged to drain because of the risk of contamination, it may be possible to return the condensate to a break tank via an analyser to detect the presence of any contaminant. Alternatively, recover useful heat from contaminated condensate before discharging it to drain.
- The energy in any steam used for direct injection to process may be considered to be fully utilised.

### 2. Avoid loss of flash steam from condensate return

- When condensate is discharged from steam traps and flows along the return piping, some flash steam is formed.
- Try to find a new use for the flash steam – it will typically contain some 40% of the energy in the original pressurised condensate. All too often flash steam is simply vented to atmosphere.
- If the condensate and associated steam cannot be accommodated in the boiler house hot well, flash the collected condensate down to a low or atmospheric pressure local to the point of use of the steam and pump the residual condensate back to the hot well. This practice is also preferred where there are long runs of condensate piping.

### 3. Isolate unused piping

- Check all pipework is used. There may be branches of the steam distribution system that are no longer used and can be removed from the system.
- Use valves or slip-plates to isolate piping that supplies steam to infrequently used items of plant. Such piping imposes a disproportionate standing loss on the system and is likely to receive less maintenance attention.
- If you remove part of a redundant section of piping and fit a blank flange, check that the remaining piping is adequately supported.

### 4. Improve steam trapping

- Inspect steam traps routinely.
- Make sure that the replacement of defective traps is given high priority.

### 5. Repair steam leaks

- Consider keeping a documented system for reporting and rectifying steam leaks.
- Make sure that the repair of steam leaks is given high priority. Costs can soon mount up with only a few leaking valve glands.

### Checklist 3 – Air conditioning and refrigeration

#### 1. Around the refrigeration plant

- Keep the condensers clean. Blocked condensers increase the condensing temperature, and a 1°C increase in condensing temperature increases running costs by 2–4%. The cooling capacity also drops and the required temperature may not be achieved. Get the condensers cleaned regularly and budget to replace badly corroded ones.
- Make sure air entering the condensers is as cold as possible. The warmer the air onto the condenser, the higher the condensing temperature. Shade the condensers if necessary and ensure warm air is not recirculated – remove anything obstructing the airflow.
- Check the refrigerant sight glass for bubbles. Bubbles in the sight glass usually mean a system is leaking. (NB: it is illegal to knowingly vent certain refrigerants.) Find the leaks and repair them before the system is recharged with refrigerant.
- Check that the oil in the compressor sight glass(es) is at the right level. The compressor will be more likely to fail if the oil level is too low (or too high).
- Report and repair any pipework that is vibrating. Vibrating pipework is more likely to fracture, causing a major refrigerant leak. Get the pipework fixed more securely, but make sure it is not too rigid.
- Keep the plant room as cool as possible. Otherwise, the plant will be running hotter than necessary, reducing reliability and performance. Ventilate the plant room, preferably with an extractor fan that is switched on when the temperature gets too high. Make sure air can get in as well as out of the plant room.

#### 2. In cooled rooms

- Keep the door closed as much as possible. Ice around the door indicates poor sealing, with a consequent increase in the heat load. Avoid loading product in the doorway and improve the sealing on the door. If the door has to be used regularly, fit a strip curtain.
- Do not stack product directly under the evaporators. This impedes the airflow over the cold store.
- Check your evaporators defrost properly. Evaporators that operate below 0°C should be completely defrosted when the ice starts to cover the fins – this may be every few hours or every few days. If the frost does not clear, or if the drain pan/lines are blocked, then the frost build-up on the evaporator will get worse.
- Report ice on the floor and walls of the store. This indicates that a lot of air is entering the room, bringing with it moisture, which is condensing on the evaporator and the structure. It could also indicate a defrost problem.
- Do not keep the store colder than necessary. Cold stores are often held at lower temperatures than necessary because of worries about failure. In fact, having a cold store at a lower temperature than necessary makes it more likely that failure will occur.

### 3. In other areas

Refrigeration systems have to remove the heat from many places other than the product or space you are cooling. Most of these heat gains are unavoidable, but they should always be minimised.

Common examples are:

- *Pumps and fans* that circulate cold air, chilled water, or an antifreeze solution generate heat, contributing most of the power they consume to the cooling load – switch them off when not required.
- *Lights in a cold store or cooled room* also contribute most of the power they consume to the cooling load – switch them off when not required.
- *Cold refrigerant pipes (particularly the larger gas pipes)* will pick up heat from their surroundings – they should be insulated, and avoid hot areas.

## **Checklist 4 – Motors and drives**

### **1. Is the equipment still needed?**

- Check that changing operational requirements have not eliminated the need for the equipment altogether.

### **2. Switching the motor off**

- Time the switching according to a fixed programme or schedule.
- Monitor system conditions, e.g. high or low temperatures, and switch off the motor when it is not needed.
- Sense the motor load so that the motor is switched off when idling.

### **3. Reducing the load on the motor**

- There is no point in optimising the drive if what the motor is driving is fundamentally inefficient.
- Is the system doing a useful and necessary job?
- Is the transmission between motor and driven equipment efficient?
- Is the driven machine efficient?
- Are maintenance programmes adequate?
- Have losses due to the pipework, ducting, insulation, etc. been minimised?
- Is the control system effective?

### **4. Minimising motor losses**

- Always specify higher efficiency motors where feasible.
- When a motor fails, ensure that proper care and attention are given in the repair process so as to minimise energy losses.
- Avoid using greatly oversized motors.
- Consider permanent reconnection of the motor electrical supply in star-phase, as a no-cost way of reducing losses from lightly loaded motors.
- Check that voltage imbalance, low or high supply voltages, harmonic distortion or a poor power factor is not causing excessive losses.

### **5. Slowing down the load**

- In pump or fan applications where the cube law applies, even a small reduction in speed can produce substantial energy savings.
- For belt drives only, a low-cost option is to change the pulley ratio.