# Irish Cement Ltd Limerick

## BREF Review

## Reference Document on Best Available Techniques on Energy Efficiency, February 2009

Issue | 13 February 2017

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This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 325373-47

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# 1 Introduction

A review was undertaken of the recommendations of the EU Commission's *Reference Document on Best Available Techniques for Energy Efficiency, February 2009*

The above BAT Reference Document or BREF is guidance for installations licenced under the IPPC Directive (2008/1/EC). This review is being undertaken as requested in the form

*"EPA Industrial Emissions Licensing Section 90(1)(aa) Review Form and Guidance Note for the activities covered by the Commission Implementing Decision (2013/163/EU) where it relates to the main activity of an installation. This form is for the purpose of enabling the Agency to complete a mandatory review of an Industrial Emissions licence or revised licence under Section 90(1)(aa) of the EPA Act 1992 as amended (i.e. a questionnaire for the purposes of completing the review). Ref: Commission Implementing Decision (2013/163/EU) establishing the best available techniques (BAT) conclusions under Directive 2010/75/EU on industrial emissions for the production of cement, lime and magnesium oxide"*

The installation to which this report applies is:
Irish Cement Ltd
Castlemungret
Co. Limerick

IE Licence Register Number: P0029-03

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# 2 Assessment Table

## Table 1: BREF Assessment[1,2]

| BAT Reference | BAT Statement | Applicability Assessment | State if in place or state schedule for implementation |
|---|---|---|---|
| 1 | BAT is to implement and adhere to an energy efficiency management system (ENEMS) that incorporates, as appropriate to the local circumstances, all of the following features | All installations. The scope and nature (e.g. level of detail) of applying this ENEMS will depend on the nature, scale and complexity of the installation, and the energy requirements of the component processes and systems. | Yes.<br><br>Environmental Management System (EMS) (ISO 14001 accredited) incorporates energy efficiency.<br>In accordance with the EMS the facility strives to achieve continuous improvement in energy use.<br><br>ICL also participates in the Sustainable Energy Authority of Ireland Energy Large Industry Energy Network (SEAI - LIEN). This programme has been developed under the Irish Energy Management Standard, IS 393 and provides companies with a structured approach to reducing energy costs and improving energy management through the implementation of a schedule of energy efficient measures. |
| a | commitment of top management (commitment of the top management is regarded as a<br>precondition for the successful application of energy efficiency management) | | Yes.<br><br>Energy policy, action plan and regular review have commitment of top management as part of the EMS. |
| b | definition of an energy efficiency policy for the installation by top management | | Yes. |
| c | planning and establishing objectives and targets (see BAT 2, 3 and 8) | | Yes.<br><br>Energy Efficiency objectives and targets are set as part of EMS and licence Annual Environmental Review. |

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[1] Cells shaded in grey in Table 1 are intentionally blank.
[2] Not all sections in this BREF are numbered. Additional numbering has been added in line with BREF numbering for ease of reference in this report.



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| BAT Reference | BAT Statement | Applicability Assessment | State if in place or state schedule for implementation |
|---|---|---|---|
| | | | |
| d | implementation and operation of procedures paying particular attention to:<br>i) structure and responsibility<br>ii) training, awareness and competence (see BAT 13)<br>iii) communication<br>iv) employee involvement<br>v) documentation<br>vi) effective control of processes (see BAT 14)<br>vii) maintenance (see BAT 15)<br>viii) emergency preparedness and response<br>ix) safeguarding compliance with energy efficiency-related legislation and agreements<br>(where such agreements exist). | | Yes. |
| e | benchmarking: the identification and assessment of energy efficiency indicators over time<br>(see BAT 8), and the systematic and regular comparisons with sector, national or regional<br>benchmarks for energy efficiency, where verified data are available<br>(see Sections 2.1(e),<br>2.16 and BAT 9) | | Yes.<br><br>Benchmarked against other EU Cement Plants.<br><br>The ICL Limerick Works currently produces Eco-efficient CEM II cements that have a lower carbon footprint and require less energy to produce than high clinker CEM I cements.<br><br>As part of Irish Cements participation in the SEAI- LIEN it supplied energy performance data to SEAI. |
| f | checking performance and taking corrective action paying particular attention to:<br>i) monitoring and measurement (see BAT 16)<br>ii) corrective and preventive action<br>iii) maintenance of records<br>iv) independent (where practicable) internal auditing in order to determine whether or | | Yes.<br><br>Plant performance which includes energy efficiency periodically checked and corrective action taken in accordance with EMS. |

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| BAT Reference | BAT Statement | Applicability Assessment | State if in place or state schedule for implementation |
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| | not the energy efficiency management system conforms to planned arrangements<br>and has been properly implemented and maintained (see BAT 4 and 5) | | |
| g | review of the ENEMS and its continuing suitability, adequacy and effectiveness by top<br>management | | Yes.<br><br>EMS which includes energy efficiency periodically reviewed. |
| h<br>i | For (h) and (i), see further features on an energy efficiency statement and external verification,<br>below<br>b. when designing a new unit, taking into account the environmental impact from the<br>eventual decommissioning of the unit<br>c. development of energy efficient technologies, and to follow developments in energy<br>efficiency techniques.<br>The ENEMS may be achieved by ensuring these elements form part of existing management<br>systems (such as an EMS) or by implementing a separate energy efficiency management<br>system.<br>Three further features are considered as supporting measures. Although these features have<br>advantages, systems without them can be BAT. These three additional steps are:<br>• (see Section 2.1(h)) preparation and publication (and possibly external validation) of a<br>regular energy efficiency statement describing all the significant environmental aspects of<br>the installation, allowing for year-by-year comparison against environmental objectives<br>and targets as well as with sector benchmarks as appropriate<br>• (see Section 2.1(i)) having the management system and audit procedure examined and | | Yes.<br><br>EMS which includes energy efficiency externally accredited to ISO 14001 |

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| BAT Reference | BAT Statement | Applicability Assessment | State if in place or state schedule for implementation |
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| | validated by an accredited certification body or an external ENEMS verifier<br>• (see Section 2.1, Applicability, 2) implementation and adherence to a nationally or<br>internationally accepted voluntary system such as:<br>_ DS2403, IS 393, SS627750, VDI Richtlinie No. 46, etc.<br>_ (when including energy efficiency management in an EMS) EMAS and<br>EN ISO 14001:1996. This voluntary step could give higher credibility to the<br>ENEMS. However, non-standardised systems can be equally effective provided<br>that they are properly designed and implemented. | | |
| 2 | BAT is to continuously minimise the environmental impact of an installation by<br>planning actions and investments on an integrated basis and for the short, medium<br>and long term, considering the cost-benefits and cross-media effects. | All installations. | Yes.<br><br>ICL Limerick Work's EMS is to international standard ISO 14001, which strives to achieve continuous improvement in many environmental aspects, including energy use.<br>An Environmental Management Plan (EMP) is agreed annually and provided to the Agency. The EMP sets targets and objectives for the year ahead and aims to achieve continuous improvement of the Environmental Management System. |
| 3 | BAT is to identify the aspects of an installation that influence energy efficiency by carrying out an audit. It is important that an audit is coherent with a systems approach (see BAT 7). | All existing installations and prior to planning upgrades or rebuilds. An audit may be internal or external. | Yes.<br><br>An energy audit has been completed on site and recommended energy saving opportunities have been implemented where feasible including installation of additional power metering. |
| 4 | When carrying out an audit, BAT is to ensure that the audit identifies the following<br>aspects (see Section 2.11): | All installations. | Yes.<br><br>See each item below. |

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| BAT Reference | BAT Statement | Applicability Assessment | State if in place or state schedule for implementation |
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| a | energy use and type in the installation and its component systems and processes | | Yes.<br><br>Identified as part of audit. |
| b | energy-using equipment, and the type and quantity of energy used in the installation | | Yes.<br><br>Identified as part of audit. |
| c | possibilities to minimise energy use, such as:<br>_ controlling/reducing operating times, e.g. switching off when not in use (e.g. see<br>Sections 3.6, 3.7, 3.8, 3.9, 3.11)<br>_ ensuring insulation is optimised, e.g. see Sections 3.1.7, 3.2.11 and 3.11.3.7<br>_ optimising utilities, associated systems, processes and equipment (see Chapter 3) | | Yes.<br><br>Identified as part of audit. Audit recommendations included possibilities to minimise energy use. |
| d | possibilities to use alternative sources or use of energy that is more efficient, in particular energy surplus from other processes and/or systems, see Section 3.3 | | Yes.<br><br>Reviewed as part of audit. See also BAT 11 below. |
| e | possibilities to apply energy surplus to other processes and/or systems, see Section 3.3 | | Yes.<br><br>Reviewed as part of audit. See also BAT 11 below. |
| f | possibilities to upgrade heat quality (see Section 3.3.2). | | Yes.<br><br>Reviewed as part of audit. See also BAT 11 below. |
| 5 | BAT is to use appropriate tools or methodologies to assist with identifying and<br>quantifying energy optimisation, such as:<br>_ energy models, databases and balances (see Section 2.15)<br>_ a technique such as pinch methodology (see Section 2.12) exergy or enthalpy analysis (see Section 2.13), or thermoeconomics (see Section 2.14) _ estimates and calculations (see Sections 1.5 and 2.10.2). | Applicable to every sector. | Yes.<br><br>Comprehensive system in place which sets targets, monitors consumption, identifies faults, quantifies savings and provides budget tracking. |

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| 6 | BAT is to identify opportunities to optimise energy recovery within the installation, between systems within the installation (see BAT 7) and/or with a third party (or parties), such as those described in Sections 3.2, 3.3 and 3.4. | The scope for energy recovery depends on the existence of a suitable use for the heat at the type and quantity recovered.<br><br>The cooperation and agreement of a third party may not be within the control of the operator, and therefore may not be within the scope of an IE Licence. | Yes.<br><br>Reviewed as part of audit. See also BAT 11 below. |
| 7 | BAT is to optimise energy efficiency by taking a systems approach to energy management in the installation. Systems to be considered for optimising as a whole are, for example:<br>_ process units (see sector BREFs)<br>_ heating systems such as:<br>_ steam (see Section 3.2)<br>_ hot water<br>_ cooling and vacuum (see the ICS BREF)<br>_ motor driven systems such as:<br>_ compressed air (see Section 3.7)<br>_ pumping (see Section 3.8)<br>_ lighting (see Section 3.10)<br>_ drying, separation and concentration (see Section 3.11). | All installations. | Yes.<br><br>Energy efficiency is optimised by taking a systems approach to energy management in the installation.<br><br>Comprehensive installation wide information system sets targets, monitors consumption, identifies faults, quantifies savings and provides budget tracking. |

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| 8 | BAT is to establish energy efficiency indicators by carrying out all of the following: | All installations. | |
| a | identifying suitable energy efficiency indicators for the installation, and where necessary, individual processes, systems and/or units, and measure their change over time or after the implementation of energy efficiency measures (see Sections 1.3 and 1.3.4) | | Yes.<br><br>All management, engineers and operations constantly monitor energy usage via the Key Performance Indicators (KPIs) of kWh/tonne of Clinker and kWh/tonne of cement produced. Management hold Engineers and Operations accountable should these KPIs increase above low target levels. These meetings to review the KPIs occur regularly.<br><br>The cement production controls system monitors all energy usage and tracks KPIs automatically. Deviations from KPIs are noted as potential 'faults' or a need for operations to address. This information feeds into the preventative maintenance regime on site. |
| b | identifying and recording appropriate boundaries associated with the indicators (see Sections 1.3.5 and 1.5.1) | | |
| c | identifying and recording factors that can cause variation in the energy efficiency of the relevant process, systems and/or units (see Sections 1.3.6 and 1.5.2). | | |
| 9 | BAT is to carry out systematic and regular comparisons with sector, national or regional benchmarks, where validated data are available. | All installations. | Yes.<br><br>Benchmarked against other EU Cement Plants.<br><br>As part of Irish Cements participation in the SEAI- LIEN it supplied energy performance data to SEAI. |
| 10 | BAT is to optimise energy efficiency when planning a new installation, unit or<br>system or a significant upgrade (see Section 2.3) by considering all of the following: | All new and significantly refurbished installations, major processes and systems. | Yes.<br><br>Energy Efficiency will be optimised when planning all new installations, units or systems, or a significant upgrade including the listed items. |
| a | the energy efficient design (EED) should be initiated at the early stages of the conceptual<br>design/basic design phase, even though the planned investments may not be well-defined.<br>The EED should also be taken into account in the tendering process | | |
| b | the development and/or selection of energy efficient technologies (see Sections 2.1(k) and | | |

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| | 2.3.1) | | |
| c | additional data collection may need to be carried out as part of the design project or separately to supplement existing data or fill gaps in knowledge | | |
| d | the EED work should be carried out by an energy expert | | |
| e | the initial mapping of energy consumption should also address which parties in the project organisations influence the future energy consumption, and should optimise the energy efficiency design of the future plant with them. For example, the staff in the (existing) installation who may be responsible for specifying design parameters. | | |
| 11 | BAT is to seek to optimise the use of energy between more than one process or system (see Section 2.4), within the installation or with a third party. | All installations. | Yes.<br><br>Energy efficiency measures between systems include heat recovery from the cooling clinker to preheat combustion air, application of improved and optimised kiln systems and recovery of energy from the exhaust gases of the kiln by directing the gases to dry the raw materials in the mills. |
| 12 | BAT is to maintain the impetus of the energy efficiency programme by using a variety of techniques, such as: | All installations. | |
| a | implementing a specific energy efficiency management system (see Section 2.1 and BAT 1) | | Yes.<br><br>Energy Efficiency a key element of the plants ISO 14001 accredited EMS<br><br>ICL implement energy efficiency improvements continually. The Engineering and Operations Department assess possible improvement projects from a technical and financial point of view. Where these projects are found to make financial sense ICL provide funding for their implementation. This is seen as core to achieving cost |

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| | | | savings in the business and maintaining competitive advantage. |
| b | accounting for energy usage based on real (metered) values, which places both the obligation and credit for energy efficiency on the user/bill payer (see Sections 2.5, 2.10.3 and 2.15.2) | | Yes.<br><br>The process energy usage is tightly controlled. Constant measurement of the key performance indicators (KPIs) are<br>• kWh/Tonne of Clinker Produced<br>• kWh/Tonne of Cement Produced<br>Any process with a KPI below the target KPI is immediately investigated and a preventative maintenance procedure ensures all equipment is serviced to bring the KPIs back within target values. |
| c | the creation of financial profit centres for energy efficiency (see Section 2.5) | | Yes.<br><br>ICL implement energy efficiency improvements continually. The Engineering and Operations Department assess possible improvement projects from a technical and financial point of view. Where these projects are found to make financial sense ICL provide funding for their implementation. This is seen as core to achieving cost savings in the business and maintaining competitive advantage. |
| d | benchmarking (see Section 2.16 and BAT 9) | | Yes.<br><br>Benchmarked against other EU Cement Plants.<br><br>As part of Irish Cements participation in the SEAI- LIEN it supplied energy performance data to SEAI. |
| e | a fresh look at existing management systems, such as using operational excellence (see Section 2.5) | | Yes. |

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| | | | Investments in energy efficient and green technologies where investment makes commercial sense are pursued continuously. |
| f | using change management techniques (also a feature of operational excellence, see Section 2.5). | | Yes.<br><br>ICL implement energy efficiency improvements continually. The Engineering and Operations Department assess possible improvement projects from a technical and financial point of view. Where these projects are found to make financial sense ICL provide funding for their implementation. This is seen as core to achieving cost savings in the business and maintaining competitive advantage.<br><br>All management, engineers and operations constantly monitor energy usage via the Key Performance Indicators (KPIs) of kWh/tonne of Clinker and kWh/tonne of cement produced. Management hold Engineers and Operations accountable should these KPIs increase above low target levels. These meetings to review the KPIs occur regularly.<br><br>There is a programme of staff awareness and regular publicity campaigns |
| 13 | BAT is to maintain expertise in energy efficiency and energy-using systems by using<br>techniques such as: | All installations. | |
| a | recruitment of skilled staff and/or training of staff. Training can be delivered by in-house<br>staff, by external experts, by formal courses or by self-study/development (see<br>Section 2.6) | | Yes.<br><br>Skilled in house staff in place. Appropriate training provided to all staff<br><br>External energy experts used as required and provide recommendations eg to undertake energy efficiency audits |

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| | | | |
| b | taking staff off-line periodically to perform fixed term/specific investigations (in their original installation or in others, see Section 2.5) | | Yes.<br><br>ICL implement energy efficiency improvements continually. The Engineering and Operations Department assess possible improvement projects from a technical and financial point of view. Where these projects are found to make financial sense ICL provide funding for their implementation. This is seen as core to achieving cost savings in the business and maintaining competitive advantage. |
| c | sharing in-house resources between sites (see Section 2.5) | | Yes.<br><br>ICL Limerick and Platin share technical and environmental expertise. |
| d | use of appropriately skilled consultants for fixed term investigations (e.g. see<br>Section 2.11) | | Yes.<br><br>External energy experts used as required and provide recommendations eg to undertake energy efficiency audits. |
| e | outsourcing specialist systems and/or functions (e.g. see Annex 7.12) | | Yes.<br><br>External energy experts provided cost saving recommendations as part of energy efficiency audits. |
| 14 | BAT is to ensure that the effective control of processes is implemented by techniques<br>such as: | All installations. | |
| a | having systems in place to ensure that procedures are known, understood and complied<br>with (see Sections 2.1(d)(vi) and 2.5) | | Yes.<br><br>Staff provided with regular appropriate training. |

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|---|---|---|---|
| b | ensuring that the key performance parameters are identified, optimised for energy<br>efficiency and monitored (see Sections 2.8 and 2.10) | | Yes.<br><br>All management, engineers and operations constantly monitor energy usage via the Key Performance Indicators (KPIs) of kWh/tonne of Clinker and kWh/tonne of cement produced. Management hold Engineers and Operations accountable should these KPIs increase above low target levels. These meetings to review the KPIs occur regularly. |
| c | documenting or recording these parameters (see Sections 2.1(d)(vi), 2.5, 2.10 and 2.15). | | Yes.<br><br>KPIs recorded internally within Irish Cement. |
| 15 | BAT is to carry out maintenance at installations to optimise energy efficiency by<br>applying all of the following: | All installations. | |
| a | clearly allocating responsibility for the planning and execution of maintenance | | Yes.<br><br>Responsibility for planning and execution of maintenance clearly allocated. All roles on site are documented and staff are aware of their responsibilities and role. |
| b | establishing a structured programme for maintenance based on technical descriptions of<br>the equipment, norms, etc. as well as any equipment failures and consequences. Some<br>maintenance activities may be best scheduled for plant shutdown periods | | Yes.<br><br>A structured maintenance program is documented and implemented on site<br><br>A shutdown maintenance program is also documented and implemented on site |
| c | supporting the maintenance programme by appropriate record keeping systems and<br>diagnostic testing | | Yes.<br><br>Records are kept of all maintenance and diagnostic testing. |

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| d | identifying from routine maintenance, breakdowns and/or abnormalities possible losses in energy efficiency, or where energy efficiency could be improved | | Yes.<br><br>Opportunities for energy efficiency identified during maintenance, breakdowns and or abnormalities are identified, documented and pursued on site.<br><br>The operation of the plant, including fuel delivery is controlled by a PLC based control system. Stop and start sequences are programmed in a safe manner to minimise emissions. In the event of faults or emergency situations developing during operation, the control system completes a pre-programmed stop procedure which is designed to minimise danger to the plant, employees and the environment. |
| e | identifying leaks, broken equipment, worn bearings, etc. that affect or control energy usage, and rectifying them at the earliest opportunity. | | Yes.<br><br>Leaks, broken equipment, worn bearings etc identified during scheduled periodic inspections, diagnostic testing and through plant performance measurement. All are rectified at the earliest opportunity. |
| 16 | BAT is to establish and maintain documented procedures to monitor and measure, on a regular basis, the key characteristics of operations and activities that can have a significant impact on energy efficiency. Some suitable techniques are given in Section 2.10. | All installations. | Yes.<br><br>The operation of the plant, including fuel delivery is controlled by a PLC based control system which monitors and measures the key characteristics of operations which can have a significant impact on energy efficiency.<br><br>Periodic energy efficiency audits are undertaken to monitor and measure energy efficiency. |
| 17 | BAT is to optimise the energy efficiency of combustion by relevant techniques such as: | Not applicable as part of this assessment | |

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| | _ those specific to sectors given in vertical BREFs<br>_ those given in Table 4.1. | Please refer to BATC Assessment relating to BAT Conclusion on the Production of Cement Lime and Magnesium Oxide 2013 | |
| 18 | BAT for steam systems is to optimise the energy efficiency by using techniques such<br>as:<br>_ those specific to sectors given in vertical BREFs<br>_ those given in Table 4.2 | Not applicable as part of this assessment.<br><br>Please refer to BATC Assessment relating to BAT Conclusion on the Production of Cement Lime and Magnesium Oxide 2013 | |
| 19 | BAT is to maintain the efficiency of heat exchangers by both:<br>a. monitoring the efficiency periodically, and<br>b. preventing or removing fouling<br>See Section 3.3.1.1. | Installations with heat recovery systems | Yes.<br><br>Heat exchangers efficiency is maintained by periodic monitoring and prevention and removal of fouling. |
| 20 | BAT is to seek possibilities for cogeneration, inside and/or outside the installation (with a third party). | Not applicable. This is not within the control of the operator and as such is outside the | |

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<table>
<tr><th>BAT Reference</th><th>BAT Statement</th><th>Applicability Assessment</th><th>State if in place or state schedule for implementation</th></tr>
<tr><td></td><td></td><td>scope of the IE Licence.</td><td></td></tr>
<tr><td>21</td><td>BAT is to increase the power factor according to the requirements of the local electricity distributor by using techniques such as those in Table 4.3, according to applicability (see Section 3.5.1).
<table>
<tr><th>Technique</th><th>Applicability</th></tr>
<tr><td>Installing capacitors in the AC circuits to decrease the magnitude of reactive power</td><td>All cases. Low cost and long lasting, but requires skilled application</td></tr>
<tr><td>Minimising the operation of idling or lightly loaded motors</td><td>All cases</td></tr>
<tr><td>Avoiding the operation of equipment above its rated voltage</td><td>All cases</td></tr>
<tr><td>When replacing motors, using energy efficient motors (see Section 3.6.1)</td><td>At time of replacement</td></tr>
</table>
Table 4.3: Electrical power factor correction techniques to improve energy efficiency</td><td></td><td>Yes.<br><br>Operation of idling or lightly loaded motors minimised<br><br>Operation of equipment above its rated value minimised<br><br>When replacing motors energy efficient motors used</td></tr>
<tr><td>22</td><td>BAT is to check the power supply for harmonics and apply filters if required (see Section 3.5.2)</td><td></td><td>Yes.<br><br>Check undertaken and no evidence of any harmonic feedback affecting the power supply.</td></tr>
<tr><td>23</td><td>BAT is to optimise the power supply efficiency by using techniques such as those in Table 4.4, according to applicability:</td><td></td><td>Yes.<br><br>Power cables have the correct dimensions for the power demand<br><br>High efficiency/low loss transformers used<br><br>Equipment with a high current demand placed as close as possible to the power source</td></tr>
</table>

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<table>
<tr><th>BAT Reference</th><th>BAT Statement</th><th>Applicability Assessment</th><th>State if in place or state schedule for implementation</th></tr>
<tr><td></td><td>
<table>
<tr><th>Technique</th><th>Applicability</th><th>Section in this document</th></tr>
<tr><td>Ensure power cables have the correct dimensions for the power demand</td><td>When the equipment is not in use, e.g. at shutdown or when locating or relocating equipment</td><td>3.5.3</td></tr>
<tr><td>Keep online transformer(s) operating at a load above 40 – 50 % of the rated power</td><td>• for existing plants: when the present load factor is below 40 %, and there is more than one transformer<br>• on replacement, use a low loss transformer and with a loading of 40 – 75 %</td><td>3.5.4</td></tr>
<tr><td>Use high efficiency/low loss transformers</td><td>At time of replacement, or where there is a lifetime cost benefit</td><td>3.5.4</td></tr>
<tr><td>Place equipment with a high current demand as close as possible to the power source (e.g. transformer)</td><td>When locating or relocating equipment</td><td>3.5.4</td></tr>
</table>
Table 4.4: Electrical power supply techniques to improve energy efficiency
</td><td></td><td></td></tr>
<tr><td>24</td><td>24. BAT is to optimise electric motors in the following order (see Section 3.6):<br>1. optimise the entire system the motor(s) is part of (e.g. cooling system, see Section 1.5.1)<br>2. then optimise the motor(s) in the system according to the newly-determined load requirements, by applying one or more of the techniques in Table 4.5, according to applicability</td><td></td><td>Yes.<br><br>Electric motors have been replaced by electrically efficient motors and variable speed drives (VSD) as appropriate in the context of the system the motor sits in. VSD are in place in the following locations:<br><br>- Exhaust Fan<br>- Booster Fan<br>- Primary Air Fan<br>- Coal Mill Fan<br>- Circulation fans on the separators for cement mills 6 and 7<br><br>VSD are not appropriate in locations where full flow is required at all times.<br><br>Lubrication, adjustments and tuning are undertaken periodically.</td></tr>
</table>

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<tr><td></td><td>
<table>
<tr><th>Driven system energy savings measure</th><th>Applicability</th><th>Section in this document[1]</th></tr>
<tr><td colspan="3">SYSTEM INSTALLATION or REFURBISHMENT</td></tr>
<tr><td>Using energy efficient motors (EEM)</td><td>Lifetime cost benefit</td><td>3.6.1</td></tr>
<tr><td>Proper motor sizing</td><td>Lifetime cost benefit</td><td>3.6.2</td></tr>
<tr><td>Installing variable speed drives (VSD)</td><td>Use of VSDs may be limited by security and safety requirements. According to load. Note in multi-machine systems with variable load systems (e.g. CAS) it may be optimal to use only one VSD motor</td><td>3.6.3</td></tr>
<tr><td>Installing high efficiency transmission/reducers</td><td>Lifetime cost benefit</td><td>3.6.4</td></tr>
<tr><td>Use:<br>• direct coupling where possible<br>• synchronous belts or cogged V-belts in place of V belts<br>• helical gears in place of worm gears</td><td>All</td><td>3.6.4</td></tr>
<tr><td>Energy efficient motor repair (EEMR) or replacement with an EEM</td><td>At time of repair</td><td>3.6.5</td></tr>
<tr><td>Rewinding: avoid rewinding and replace with an EEM, or use a certified rewinding contractor (EEMR)</td><td>At time of repair</td><td>3.6.6</td></tr>
<tr><td>Power quality control</td><td>Lifetime cost benefit</td><td>3.5</td></tr>
<tr><td colspan="3">SYSTEM OPERATION and MAINTENANCE</td></tr>
<tr><td>Lubrication, adjustments, tuning</td><td>All cases</td><td>2.9</td></tr>
<tr><td colspan="3">Note[1]: Cross-media effects, Applicability and Economics are given in Section 3.6.7</td></tr>
</table>
Table 4.5: Electric motor techniques to improve energy efficiency
</td><td></td><td></td></tr>
<tr><td>25</td><td>BAT is to optimise compressed air systems (CAS) using the techniques such as those in Table 4.6, according to applicability</td><td>Installations with compressed air systems</td><td>A PLC program is in place to maximise compressed air and minimise idling of compressors.<br><br>Annual leak testing is conducted and maintenance is undertaken where leaks are identified. Significant leaks which cannot be addressed during leak testing are repaired during the main overhaul.<br><br>Preventative maintenance of compressors is also undertaken.</td></tr>
</table>

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<table>
<tr><th>BAT Reference</th><th>BAT Statement</th><th>Applicability Assessment</th><th>State if in place or state schedule for implementation</th></tr>
<tr><td></td><td>
<table>
<tr><th>Technique</th><th>Applicability</th><th>Section in this document</th></tr>
<tr><td colspan="3">SYSTEM DESIGN, INSTALLATION or REFURBISHMENT</td></tr>
<tr><td>Overall system design, including multi-pressure systems</td><td>New or significant upgrade</td><td>3.7.1</td></tr>
<tr><td>Upgrade compressor</td><td>New or significant upgrade</td><td>3.7.1</td></tr>
<tr><td>Improve cooling, drying and filtering</td><td>This does not include more frequent filter replacement (see below)</td><td>3.7.1</td></tr>
<tr><td>Reduce frictional pressure losses (for example by increasing pipe diameter)</td><td>New or significant upgrade</td><td>3.7.1</td></tr>
<tr><td>Improvement of drives (high efficiency motors)</td><td>Most cost effective in small (<10 kW) systems</td><td>3.7.2, 3.7.3, 3.6.4</td></tr>
<tr><td>Improvement of drives (speed control)</td><td>Applicable to variable load systems. In multi-machine installations, only one machine should be fitted with a variable speed drive</td><td>3.7.2</td></tr>
<tr><td>Use of sophisticated control systems</td><td></td><td>3.7.4</td></tr>
<tr><td>Recover waste heat for use in other functions</td><td>Note that the gain is in terms of energy, not of electricity consumption, since electricity is converted to useful heat</td><td>3.7.5</td></tr>
<tr><td>Use external cool air as intake</td><td>Where access exists</td><td>3.7.8</td></tr>
<tr><td>Storage of compressed air near highly-fluctuating uses</td><td>All cases</td><td>3.7.10</td></tr>
<tr><td colspan="3">SYSTEM OPERATION and MAINTENANCE</td></tr>
<tr><td>Optimise certain end use devices</td><td>All cases</td><td>3.7.1</td></tr>
<tr><td>Reduce air leaks</td><td>All cases. Largest potential gain</td><td>3.7.6</td></tr>
<tr><td>More frequent filter replacement</td><td>Review in all cases</td><td>3.7.7</td></tr>
<tr><td>Optimise working pressure</td><td>All cases</td><td>3.7.9</td></tr>
</table>
Table 4.6: Compressed air system techniques to improve energy efficiency
</td><td></td><td></td></tr>
<tr><td>26</td><td>BAT is to optimise pumping systems by using the techniques in Table 4.7, according to applicability (see Section 3.8)</td><td>Installations with pumping systems</td><td>Yes.<br><br>There are pumps present on site for cement manufacture. Pumps and piping systems across the site are optimised.<br><br>Oversizing is avoided when selecting pumps.<br><br>The correct choice of pump is matched to the task required.<br><br>Unnecessary pumps are shut down.</td></tr>
</table>

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| BAT Reference | BAT Statement | Applicability Assessment | State if in place or state schedule for implementation |
|---|---|---|---|
| | | | Regular maintenance is undertaken and pumps are repaired and replaced as necessary.<br><br>Bends in the distribution system are minimised. |

| Technique | Applicability | Section in this document | Additional information |
|---|---|---|---|
| **DESIGN** | | | |
| Avoid oversizing when selecting pumps and replace oversized pumps | For new pumps: all cases<br>For existing pumps: lifetime cost benefit | 3.8.1<br>3.8.2 | Largest single source of pump energy wastage |
| Match the correct choice of pump to the correct motor for the duty | For new pumps: all cases<br>For existing pumps: lifetime cost benefit | 3.8.2<br>3.8.6 | |
| Design of pipework system (see Distribution system, below) | | 3.8.3 | |
| **CONTROL and MAINTENANCE** | | | |
| Control and regulation system | All cases | 3.8.5 | |
| Shut down unnecessary pumps | All cases | 3.8.5 | |
| Use of variable speed drives (VSDs) | Lifetime cost benefit. Not applicable where flows are constant | 3.8.5 | See BAT 24, in Section 4.3.6 |
| Use of multiple pumps (staged cut in) | When the pumping flow is less than half the maximum single capacity | 3.8.5 | |
| Regular maintenance. Where unplanned maintenance becomes excessive, check for:<br>• cavitation<br>• wear<br>• wrong type of pump | All cases. Repair or replace as necessary | 3.8.4 | |
| **DISTRIBUTION SYSTEM** | | | |
| Minimise the number of valves and bends commensurate with keeping ease of operation and maintenance | All cases at design and installation (including changes). May need qualified technical advice | 3.8.3 | |
| Avoiding using too many bends (especially tight bends) | All cases at design and installation (including changes). May need qualified technical advice | 3.8.3 | |
| Ensuring the pipework diameter is not too small (correct pipework diameter) | All cases at design and installation (including changes). May need qualified technical advice | 3.8.3 | |

**Table 4.7: Pumping system techniques to improve energy efficiency**

| | | | |
|---|---|---|---|
| 27 | BAT is to optimise heating, ventilation and air conditioning systems by using | Installations with HVAC Systems | Yes, |

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| BAT Reference | BAT Statement | Applicability Assessment | State if in place or state schedule for implementation |
|---|---|---|---|
| | techniques such as:<br>-for ventilation, space heating and cooling, techniques in Table 4.8 according to applicability<br>-for heating, see Sections 3.2 and 3.3.1, and BAT 18 and 19<br>-for pumping, see Section 3.8 and BAT 26<br>-or cooling, chilling and heat exchangers, see the ICS BREF, as well as Section 3.3 and BAT 19 (in this document). | | Air conditioning units are in place in the offices and electrical switchrooms on site.<br><br>There is a contract in place on site for the maintenance and repair of all Air Con units. This ensures the air conditioning system is working effectively and that any required repairs and replacements are undertaken. |

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| Energy savings measure | Applicability | Section in this document |
|---|---|---|
| **DESIGN and CONTROL** | | |
| Overall system design. Identify and equip areas separately for:<br>• general ventilation<br>• specific ventilation<br>• process ventilation | New or significant upgrade. Consider for retrofit on lifetime cost benefit | 3.9.1<br>3.9.2.1 |
| Optimise the number, shape and size of intakes | New or upgrade | 3.9.2.1 |
| Use fans:<br>• of high efficiency<br>• designed to operate at optimal rate | Cost effective in all cases | 3.9.2.1<br>3.9.2.2 |
| Manage airflow, including considering dual flow ventilation | New or significant upgrade | 3.9.2.1 |
| Air system design:<br>• ducts are of a sufficient size<br>• circular ducts<br>• avoid long runs and obstacles such as bends, narrow sections | New or significant upgrade | 3.9.2.1 |
| Optimise electric motors, and consider installing a VSD | All cases. Cost effective retrofit | 3.9.2.1, 3.9.2.2, 3.6, 3.6.3, 3.6.7 and BAT 24 |
| Use automatic control systems. Integrate with centralised technical management systems | All new and significant upgrades. Cost effective and easy upgrade in all cases | 3.9.2.1<br>3.9.2.2 |
| Integration of air filters into air duct system and heat recovery from exhaust air (heat exchangers) | New or significant upgrade. Consider for retrofit on lifetime cost benefit. The following issues need to be taken into account: the thermal efficiency, the pressure loss, and the need for regular cleaning | 3.9.2.1<br>3.9.2.2 |
| Reduce heating/cooling needs by:<br>• building insulation<br>• efficient glazing<br>• air infiltration reduction<br>• automatic closure of doors<br>• destratification<br>• lowering of temperature set point during non-production period (programmable regulation)<br>• reduction of the set point for heating and raising it for cooling | Consider in all cases and implement according to cost benefit | 3.9.1 |
| Improve the efficiency of heating systems through:<br>• recovery or use of wasted heat (Section 3.3.1)<br>• heat pumps<br>• radiative and local heating systems coupled with reduced temperature set points in the non occupied areas of the buildings | Consider in all cases and implement according to cost benefit | 3.9.1 |
| Improve the efficiency of cooling systems through the use of free cooling | Applicable in specific circumstances | 3.9.3 |
| **MAINTENANCE** | | |
| Stop or reduce ventilation where possible | All cases | 3.9.2.2 |
| Ensure system is airtight, check joints | All cases | 3.9.2.2 |
| Check system is balanced | All cases | 3.9.2.2 |
| Manage airflow: optimise | All cases | 3.9.2.2 |
| Air filtering, optimise:<br>• recycling efficiency<br>• pressure loss<br>• regular filter cleaning/replacement<br>• regular cleaning of system | All cases | 3.9.2.2 |

**Table 4.8: Heating, ventilation and air conditioning system techniques to improve energy efficiency**

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<table>
<tr><th>BAT Reference</th><th>BAT Statement</th><th>Applicability Assessment</th><th>State if in place or state schedule for implementation</th></tr>
<tr><td>28</td><td>BAT is to optimise artificial lighting systems by using the techniques such as those in Table 4.9 according to applicability (see Section 3.10)
<table>
<tr><th>Technique</th><th>Applicability</th></tr>
<tr><th colspan="2">ANALYSIS and DESIGN OF LIGHTING REQUIREMENTS</th></tr>
<tr><td>Identify illumination requirements in terms of both intensity and spectral content required for the intended task</td><td>All cases</td></tr>
<tr><td>Plan space and activities in order to optimise the use of natural light</td><td>Where this can be achieved by normal operational or maintenance rearrangements, consider in all cases. If structural changes, e.g. building work, is required, new or upgraded installations</td></tr>
<tr><td>Selection of fixtures and lamps according to specific requirements for the intended use</td><td>Cost benefit on lifetime basis</td></tr>
<tr><th colspan="2">OPERATION, CONTROL, and MAINTENANCE</th></tr>
<tr><td>Use of lighting management control systems including occupancy sensors, timers, etc.</td><td>All cases</td></tr>
<tr><td>Train building occupants to utilise lighting equipment in the most efficient manner</td><td>All cases</td></tr>
</table>
Table 4.9: Lighting system techniques to improve energy efficiency</td><td>Installations with applicable lighting systems.</td><td>Yes.<br><br>Appropriate illumination requirements are identified. Space and activities are planned in order to optimise the use of natural light.<br><br>Lighting management control systems are in use eg. motion detector light activation switches are in places in offices and electrical rooms being installed on site.<br><br>Old light fittings are being replaced with energy efficient light fittings.</td></tr>
<tr><td>29</td><td>BAT is to optimise drying, separation and concentration processes by using techniques such as those in Table 4.10 according to applicability, and to seek opportunities to use mechanical separation in conjunction with thermal processes</td><td>Installations with drying, separation and concentration processes.</td><td>Yes.<br><br>Energy conservation measures include:<br><br>- the preheater of the kiln system is a counter current, cyclone based heat exchanger where heat is recovered from exhaust gases to heat the kiln feed.<br><br>- the raw mill and coal mill uses a portion of the exhaust gas from the kiln, thereby available excess heat for drying of the raw materials.</td></tr>
</table>

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| BAT Reference | BAT Statement | Applicability Assessment | State if in place or state schedule for implementation |
|---|---|---|---|
| | | | |

| Technique | Applicability | Additional information | Section in this document |
|---|---|---|---|
| **DESIGN** | | | |
| Select the optimum separation technology or combination of techniques (below) to meet the specific process equipments | All cases | | 3.11.1 |
| **OPERATION** | | | |
| Use of surplus heat from other processes | Depends on the availability of surplus heat in the installation (or from third party) | Drying is a good use for surplus heat | 3.11.1 |
| Use a combination of techniques | Consider in all cases | May have production benefits, e.g. improved product quality, increased throughput | 3.11.1 |
| Mechanical processes, e.g. filtration, membrane filtration | Process dependent. To achieve high dryness at lowest energy consumption, consider these in combination with other techniques | Energy consumption can be several orders of magnitude lower, but will not achieve high % dryness | 3.11.2 |
| Thermal processes, e.g.<br>• directly heated dryers<br>• indirectly heated dryers<br>• multiple effect | Widely used, but efficiency can be improved by considering other options in this table | Convective (direct) heat dryers may be the option with the lowest energy efficiency | 3.11.3<br>3.11.3.1<br>3.11.3.2<br>3.11.3.3<br>3.11.3.6 |
| Direct drying | See thermal and radiant techniques, and superheated steam | Convective (direct) heat dryers may be the option with the lowest energy efficiency | 3.11.3.2 |
| Superheated steam | Any direct dryers can be retrofitted with superheated steam. High cost, needs lifetime cost benefit assessment. High temperature may damage product | Heat can be recovered from this process | 3.11.3.4 |
| Heat recovery (including MVR and heat pumps) | Consider for almost any continuous hot air convective dryers | 3. | 11.1<br>3.11.3.5<br>3.11.3.6 |
| Optimise insulation of the drying system | Consider for all systems. Can be retrofitted | | 3.11.3.7 |
| Radiation processes e.g.<br>• infrared (IR)<br>• high frequency (HF)<br>• microwave (MW) | Can be easily retrofitted.<br>Direct application of energy to component to be dried. They are compact and<br>Reduce the need for air extraction.<br>IR limited by substrate dimensions.<br>High cost, needs lifetime cost benefit assessment | More efficient heating.<br>Can boost production throughput coupled with convection or conduction | 3.11.4 |
| **CONTROL** | | | |
| Process automation in thermal drying processes | All cases | Savings of between 5 and 10 % can be achieved compared with using traditional empirical controllers | 3.11.5 |

**Table 4.10: Drying, separation and concentration system techniques to improve energy efficiency**

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