Environmental Permitting (England and Wales) Regulations 2010
Regulation 60(1)

SCHEDULE 1

DESCRIPTION OF INFORMATION REQUIRED

The information required by this notice relates to permitted activities at Castle Cement's Padeswood Cement Works, Padeswood, Mold, Flintshire, CH7 4HB (Environmental Permit number EPR/ BL1096IB).

1.0 <u>Kiln ID Fan Trips</u>

1.1 What is a kiln ID fan trip and what are the specific causes?

The kiln ID (induced draught) is used to draw gas through kiln system. A kiln ID Fan trip is an event when the power supply to the kiln ID fan motor is stopped to protect the fan, drive or other parts of the kiln system from damage. There are a number of specific events that will trip the ID Fan. These include both safety and operational interlocks (an interlock is part of the control philosophy and software whereby an operation is stopped, started or prevented from happening because a set of control parameters have not been met). Examples of these include motor bearing temperature too high, fan bearing temperature too high, cyclone 1 exit gas temperature too high, fan vibration (as measured at the pedestal bearings) too high, main bag filter inlet temperature too high.

1.2 Explain in detail what happens to the preheater/calciner, kiln and cooler operations when the kiln ID fan trips.

When the ID Fan trips, the kiln system is automatically brought to a controlled stop in the same way as when the kiln is stopped for a planned shutdown.

Preheater

The ID Fan ceases to be driven but continues to spin for approximately 5 minutes as it comes to a near stop. At the same time, a damper between the exit of cyclone 1 and the ID Fan closes to a shut, reducing the airflow through the kiln system. At the same time the kiln feed elevator stops dead thus stopping the feed of meal to the preheater and all fuels cease being burnt. As the gas flow in the preheater cyclones ceases the raw meal drop out of suspension and move down the tower into the kiln.

Kiln

The tertiary air damper closes (preventing air from the cooler travelling to the calciner), the kiln speed automatically defaults to 0.3rpm, thus retaining meal and clinker in the kiln. These actions help to prevent damage to the kiln shell and refractory lining which would occur if the kiln stopped turning. The kiln hood suction set point automatically defaults to -1mbar.

Cooler

The cooler under grate fans default to 50% reducing the air flow into the cooler, and the cooler grate speed defaults to 4.5 strokes/min. The movement of clinker through the cooler continues albeit at a reduced speed, the heat exchanger and cooler filter continue to operate normally.

Raw Mill and Coal mill operation is also stopped automatically should they be running.

1.3 What are the potential environmental impacts arising from a kiln ID fan trip and how are these managed?

The potential environmental impacts arising from a kiln ID fan trip are minimal as all the feed and fuel is stopped and the material already in the kiln system is retained in the kiln tube and cooler.

On stopping, the length of time taken for the ID fan to spin to a halt (whilst maintaining some suction in the kiln and preheater) greatly exceeds the time taken for the meal remaining in the tower to travel through the tower into the kiln in a controlled fashion. The suction is further aided by the automatic slowing of the kiln and grate cooler and the continuing operation of the cooler exhaust fan. Any potential environmental impact is minimised by the actions that automatically occur as specified in 1.2 above. The overall impact of the combined changes is to reduce the volume of air blown in to the system and to safely maximise the suction or negative pressure within the system thus minimising the potential for gasses to be emitted through seals such as the kiln inlet.

1.4 What is the cause of the kiln ID fan vibration referred to in the shift manager's logs during December 2014?

In December the primary cause of the trips was coating building up and shedding unevenly from the fan combined with wear on the fan blades exacerbated by slight wear on the shaft and bearing. In the January 2015 shutdown the fan impeller, shaft and bearings were replaced as part of the annual shutdown work.

1.5 How many times did the kiln ID fan trip in December and what were the specific causes?

The ID fan tripped 18 times in December, the causes were as described above in 1.4

1.6 Did the kiln trips during December cause a release of dust? If so what was the scale and severity of the release(s)?

We do not consider that trips on the ID fan reported in the shift managers' log will have contributed to dust releases from the process. Brief periods of slight positive pressure within the kiln system will have occurred as with any kiln stop. Whilst there will have been a small amount of dust present in the gasses emitted, the scale and severity of the releases will have been minimal, localised and have no impact off-site.

1.7 What maintenance regime is in place to ensure smooth and trouble free operation of the kiln ID fan?

The kiln ID fan is critical to the operation of the plant. Preventative maintenance includes regular inspection of fan assembly including blades, shaft and bearing during periods of kiln shutdown. Continuous condition monitoring is provided by online vibration sensors. Further condition monitoring is carried out twice yearly using thermography whilst the kiln is in operation, augmented by 'Shock Pulse Method' vibration analysis when required. Oil levels are checked frequently as part of the lubrication schedule. Blade cleaning and balancing (the addition of weights to the fan blades to counteract wear, similar to wheel balancing on cars) occurs as and when needed.

2.0 <u>Holes in Calciner/Cyclones</u>

2.1 The shift manager's log of 18/12/15 states *'be aware of holes in top of calciner level 6*' and '*Cyclone 5 cyclone level 6 hole plated over and back tomorrow to box in*'.

2.2 Explain the nature and cause of the holes and the frequency of their occurrence.

The kiln, cooler calciner and preheater cyclones are lined with refractory. There are many mechanisms that cause degradation of the refractory including chemical attack, mechanical failure, general abrasion, damage due to excessive heat and thermal shock. Any of these mechanisms may cause the refractory *to crack and allow hot gas from the process to reach the steel shell of the cyclone or calciner. These wear processes can also cause the refractory thickness to reduce leading to the potential exposure of parts of the shell to high temperatures such that the steel will burn through causing a hole. The extent of the failure and the size of subsequent hole may vary and therefore the course of remedial action will vary. In a normal year's operation there may be 5 or 6 holes of varying size found in the calciner and preheater cyclones.*

2.3 What was the cause of these holes, how were they detected and how long had they been present before repair?

The cause of these holes was a combination of chemical and mechanical attack on the refractory. The tower is once per 12 hour shift and the holes were detected during these routine inspections. The length of time to complete a repair is dependent on the extent of the failure, the access requirements and the nature of the corrective work. As indicated in the Shift Manager's report, repairs will generally require 12 – 24 hours of work and will be actioned immediately.

2.4 What is the normal corrective action to repair such holes?

The nature of the corrective action will vary depending on the nature of the failure. Some repairs are made with 'rammable' material. That is material with refractory properties that is pliant and able to be shaped (like putty but capable of working at high temperatures). Other repairs require that the hole is plated over initially with steel then a specially manufactured box with integral anchors is attached to the vessel. The box is then filled with refractory to protect the steel.

During the annual kiln shutdown, a full refractory lining inspection and assessment is carried out by in-house and third party experts with the purpose of identifying all refractory that is reaching the end of its life span or will not maintain a cohesive and effective lining for a further 12 months. This refractory is then replaced. Replacement where required is carried out by specialist contractors. In Jan/Feb 2015 approximately 250m^2 of refractory was replaced at a cost of £1.1m. This is a typical annual cost for refractory repairs for a kiln system of this size.

2.5 Did the holes in the calciner and cyclone 5 give rise to a dust release and what is the likelihood of an offsite impact?

The calciner and cyclone 5 are under suction during kiln operation so air is drawn into the kiln system rather than gases being released from it. There will be a brief period during any kiln stop where there will be slight positive pressure in the kiln system and gasses and dust may be emitted. The calciner and cyclone 5 are situated on the preheater tower, which is clad. The likelihood of an off-site impact is negligible.

3.0 <u>Heat Exchanger (Part A & B Notification)</u>

3.1 What heat exchanger/heat exchanger tubes were found to be damaged as referenced in your Part B notification received by Natural Resources Wales 04/03/15?

The air to air heat exchanger which is used to cool hot air from the clinker cooler before it enters the cooler bag filter because the filter bags cannot handle gas temperatures higher than 240°C for long periods.

3.2 Describe the normal mode of operation of the heat exchanger and how you identify tube failure?

The physical arrangement of the heat exchanger assembly is best visualised as being similar to drinking straws tightly packed, vertically in a box, with the straws being 6 meters in length, 120mm in diameter and 726 in number. The heat exchanger operates under negative pressure with hot gasses being drawn *from the process by the cooler exhaust fan. Gasses enter from the top of the tubes, exit through the bottom and go to the cooler bag filter. Three fans blow ambient air across the tubes to cool the gas to a temperature within operable range for the cooler bag filter.*

The 'bundle' of tubes is surrounded by baffles and there is no way that the integrity of the tubes can be assessed whilst the kiln is in operation and therefore tube failure can only be identified by internal inspection during kiln shutdowns.

3.3 When was the damage to the heat exchanger tubes first identified?

Some damage to the wear inserts in the top of the heat exchanger tubes was first identified during the shutdown of January 2014. All of the wear inserts were changed at this time. During the kiln shutdown in January 2015 a further inspection was carried out and more wear damage was identified and rectified.

3.4 What was the nature of the damage to the heat exchanger tubes?

Abrasion by clinker dust has caused the steel to wear through mainly at the top of the tubes as the hot air changes direction and enters the tube bundle. During the 2015 shutdown holes approximately 5cm long by 2cm wide were found in a number of the tubes.

3.5 What was the root cause of the damage and what were the findings of the internal inspection?

Abrasion of the steel by clinker dust inherent in the clinker making process caused the holes. These holes tend to occur in the upper part of the tubes where the gas stream changes direction and is more turbulent as it enters the tubes.

3.6 Prior to the inspection of the heat exchanger tubes referred to in the Part B notification, when was the heat exchanger last inspected, what did the inspection consist of and what were the findings?

The last inspection was carried out in Jan 2014, consisting of a visual check on the top and bottom of the tubes. The findings were that wear was occurring at the tops of some of the tubes. Remedial action was to replace the wear inserts in the existing tubes. These inserts protected the top 300mm of the tubes. Tubes showing more extensive wear were blanked off to prevent gas flow through them.

3.7 What is the maintenance regime for the heat exchanger to ensure smooth and trouble free operation?

The heat exchange itself has no moving parts. It is subject to annual inspection of the tube bundle, inlet and outlet manifolds for wear and then repair of damaged tubes. There is also annual routine maintenance at shutdowns on the heat exchanger fans, bearings and drives.

3.8 The Part A notification received 21/01/15 refers to data analysis. What data analysis was completed and what were the associated findings?

The data analysis included the trending of a number of temperature and pressure readings in the kiln system alongside kiln torque, power data and CEMS data. The findings of this analysis were that there were no disruptions that may have caused significant off-site impact from other sources.

3.9 On what date(s) was dust released from the damaged heat exchanger tubes? If the exact dates are not known what is the approximate period dust releases may have occurred?

Significant dust release from the heat exchanger would only occur when the heat exchanger was operating at a positive pressure. The process data from 15th to 31st December 2014 has been reviewed. In this period there were 9 minutes of positive pressure at the kiln hood recorded out of 19,401 (less than

0.05%) operational minutes during this period. The dates when these positive pressure events were recorded were 22/12/15 (1 minute) 23/12/15 (5 minutes not consecutive) and 27/12/15 (3 minutes consecutive 0758-0800)

3.10 How was the dust release estimation completed to quantify the release as being less than 50kg?

This figure was estimated on the basis of a visualisation of how a handful of dust thrown in the air would look or a bag of cement dropped from height following discussions with previous site inspectors. Having reviewed the data in 3.9 above a worst case emission can be calculated based on cooler air flow (4300Nm^3/min), dust loading (10g/Nm^3) and assuming all air entering a damaged tube will be release thorough the hole irrespective of its size and any suction from the cooler fan. The estimated mass emission is 37kg.

3.11 What repairs were made to the heat exchanger tubes following the identification of the damage?

Longer inserts measuring 600mm, with an increased wall thickness from 3.0mm to 3.5mm were fitted to all of the 726 tubes that have not been blanked off. In addition the inserts have been designed such that there is 100mm of tube that sits above the heat exchanger tubes within the ducting. This has the effect of moving the point of wear such that should the tubes wear through then there will be no external effect. Tubes showing more excessive wear have been blanked off.

3.12 What is the likelihood of the tubes becoming damaged before the intended replacement is installed in 2016?

The tubes will inevitably wear as a result of abrasion by clinker dust. However, based on the findings in January 2015 inspection of the wear inserts fitted in Jan 2014 all of the inserts fitted in 2015 are of the longer length and increased wall thickness to increase wear life and have a modified design, thus reducing the likelihood of the tubes wearing through. A further internal inspection is planned in Q3 of 2015 to assess the effectiveness of the redesigned inserts.