Lhoist : Steetley Dolomite Ltd

Part of Lhoist Western Europe

IED Derogation Request Application Document :

W1 Kiln : Sintered Dolime : Permit – BL3269IH/V007

Version: 02

A.Graham
Senior Manager Environment & Quality – LWE
February 2020

INDEX:

1.0 Site Details 3
1.1 Commercially Sensitive Information 3
2.0 Introduction. 3
3.0 Background 3
3.1 Market 4
3.2 Products 4
3.2.1 Criteria for Group III Derogation. 5
3.2.2 Criteria for SO_2 Derogation. 5
3.2.3 Criteria for HCl Derogation. 7
3.3 Original Derogation 8
4.0 Technical Characteristics & Comparison with BAT ELV's 9
4.1 Technical Characteristics 9
4.2 BAT Requirements BAT:45 SO2 11
4.2.1 BAT:45 SO_2 11
4.2.2 SO_2 Current Performance 11
4.2.3 SO_2 Primary Techniques 12
4.3 BAT Requirements BAT: 51 HCl 16
4.3.1 CLM BATC Permit Issues 16
4.3.2 HCl Performance 17
4.3.3 HCL Primary Techniques 17
5.0 Current Risks for Allowing the Derogation 18
5.1 Current Emission Levels. 18
5.2 Impact on the Environment 19
6.0 Time Line for Expected Compliance 20
7.0 Options View 21
8.0 CBA Review 21
8.1 CBA Key Input Data 21
8.2 CCBA Conclusions 22
9.0 Dispersion / Impact Comparison 22
10.0 Summary 22

APPENDICES INDEX:

01 – W1 Kiln Abatement Trials 2018/19 24
02 – W1 Kiln SLS45 HCl Reduction Trials 2018 24
03 – W1 Kiln Caustic Soda Trials 2016/17 24
04 – HCl Abatement Sorbacal SP 2015/16 24
05 – Air Impact Assessment 2019 24
06 – Compliance Time Line / Plan 25
07 – CBA Summary File (LSDL_CBA_3269_11_v1) also attached. 26

1. **Site Details:**

Lhoist Steetley Dolomite Ltd
South field Lane, Whitwell,
Worksop, Nottinghamshire,
S80 3LJ
Companies House Reg: 4071554
Permit Ref: BL3269IH/V007

1.1 Commercially Sensitive Information:

The only part of our Derogation request that we believe to be commercially sensitive is the details within the CBA assessment attached to this request. As these detail the investment levels and operational costs of our Sintered Dolime business could be made available to our competitors within the European Union and could gain important commercial and market advantage by obtaining the sensitive investment data within the CBA.

2. **Introduction:**

Steetley Dolomite Ltd (SDL) is a Lhoist owned business and is seeking to vary its current environmental permit for its Whitwell Plant operation (BL3269IH/V007). Which currently has a derogation approval that expires on 31st December 2019. The business is currently conducting trials on flue gas emission reductions to achieve the IED BAT limit values for producing Sintered Dolime when burning a waste derived fuel (WDF).

The trials so far have shown some improvements, but more time is needed in order to determine which technique will bring the kiln emissions back within the IED BAT limits for HCl, SO_2 and Group III metals.

The business has focused on reducing the most problematic emission of HCl, as all techniques for reducing HCl have been shown to have a direct impact on the SO_2 emissions. The Group III metals mainly come from the dolomite feed stone and therefore are part of the natural level of metals within this product. Keeping in mind that the IED ELV does not take this in to consideration. As has previously been discussed and agreed with the UK Environment Agency.

Therefore, the business is now requesting a derogation be considered for the production of Sintered Dolime production to allow time to develop the final environmental solution, for the W1 kiln, when producing Sintered Dolime products with waste derived fuels (WDF).

3. **Background:**

The production of burnt stone dolomite products has been undertaken at Whitwell Works since 1959. The dolomite used in the process is quarried at the adjacent Whitwell Quarry, which is operated by a third party.

SDL currently operates two kilns; one Long Rotary Kiln (LRK) and one Preheater Rotary Kiln (PRK) at its Whitwell plant. The kilns are fuelled using a combination of common solid fuels and waste derived fuels (WDF); Coal, Pet coke, Solvent Derived Fuel (SDF) and Rubber Crumb (TDF). In 2018 the

business substituted up to 55% of all fuel requirements with WDF and reduced its overall CO_2 emissions by 21% in 2019 by using waste derived fuels.

The kiln exit gas currently goes through abatement equipment, on each kiln, before being emitted to atmosphere via the 96m stack. Emissions of Particulates, SO_2, NOx, TOC, CO, HCl and HF are monitored continuously during the process operation and more extensive emission testing is conducted every six months, in accordance with the current environmental permit. This is the focus of the business currently, as we aim to reduce all emissions to within the BATC limits for the Cement and Lime Industry.

The business has also operated under the ISO14001 Environmental standard since 2006 (BSI - EMS91946) and has been operating under the ISO 50001 Energy Management System since 2018 (BSI-ENMS677693).

3.1 Market:

SDL is the sole UK supplier of burnt dolomite products for the British steel and refractory industries, along with other specialist burnt dolomite products which are used in the production of refractories for cement kilns. No other UK company supplies these vital products. The closest alternative sources are in Europe, which would have to be imported at a higher cost. In 2018, the Whitwell plant exported 61% of all burnt production to businesses outside of the UK (26 different countries in total) but remained the key supplier to the steel production within the UK for Sintered Dolomite.

3.2 The Products:

The SDL kilns calcine / Fuse Dolomite limestone to produce three different types of Dolomite;

- Ultra Low Carbon Dolime (ULCD) – referred to internally as Dolomet.
- Sintered Dolime – referred to internally as Dolofrit.
- Dead Burnt Dolime (DBD) – referred to internally as Dolopel.

The kiln identified as W1 produces three products for the business; ULCD (Dolomet), Sintered Dolime (Dolofrit) and a hard-burnt form of Sintered Dolime referred to as Dead Burnt Dolime (Dolopel).

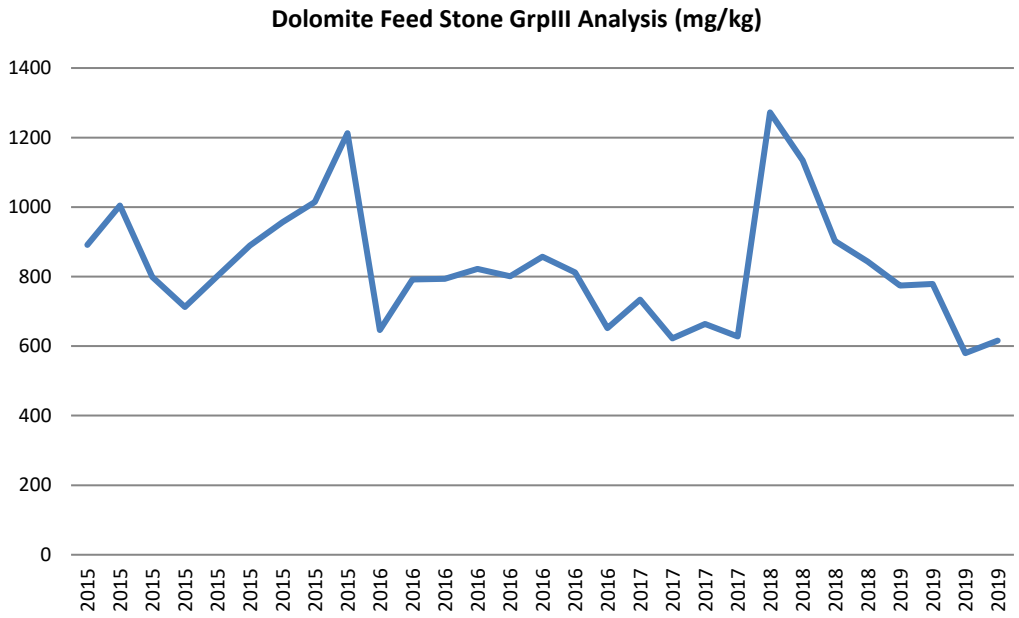
The Dolofrit and Dolopel products require higher temperatures and residence time within the kiln than the ULCD material and are produced on W1 kiln.

The demand for high quality dolomitic lime products is currently very high, with both kilns producing at high rates to achieve customer demand requirements.

The derogation request focuses on the Sintered Dolime product, as this is covered by the current IED BAT conclusions and was the focus of the original derogation issued in 2018.

3.2.1 Criteria for the Derogation: Group III Metals;

In June 2013 the business made a variation application, for permit BL3269IH, to the Environment Agency, which justified why an elevated Group III metals emission ELV was required for the Dolime kilns. This variation was based on the fact that the natural raw feed stone had a natural level of metals within it, which meant that the BAT ELV of 0.5mg/Nm3 was not achievable for Dolime production. As can be seen from the data below, the GrpIII metals content of the feed stone is consistently between 600 – 1200 mg/kg.



The feed stone required by the Dolomitic lime process is unique to the Whitwell area, not all the feed stone is suitable and therefore a selection process is conducted to ensure that only the highest quality feed stone is used. The business is currently looking for a new feed stone supply, but this process will take several years (7-10) on order for it to start producing as new feed stone source. The dolomite deposit is high in Group III metals and there is no other current source of raw Dolomite feed stone available within the UK.

3.2.2 Criteria for the Derogation: Sulphur Dioxide;

The BREF/BAT conclusions require the SO_2 emissions, from the kiln, to be below the ELV of 400mg/Nm^3 (pg364, BAT47).

This derogation is based on the geographical and technical characteristics of the kiln. The fuels required to produce the calcining / sintering energy needed to produce high quality sintered products, also determine the type of fuels used. The temperature required to produce a Sintered Dolime product is in excess of 1600°C and for a double pass Sintered Product the temperature can be as high as 2100°C, dependant on the customer's specific quality requirements.

Therefore, Natural Gas is not an option for this type of production on this type of kiln. Firstly, due to the high sintering temperatures required and secondly, an industrial supply of Natural Gas is not available for these kilns due to their location.

When producing the Sintered Dolime (single pass) material, which is referred to as Dolofrit, the kiln has a typical SO_2 emission level of; a Daily Maximum Average = 640mg/Nm^3 and a Half Hourly Maximum Average = 1600mg/Nm^3 during the 2019 production period.
The current permit ELVs, for the single pass Sintered Dolime; Daily Avg = 1200mg/Nm^3 and the Half Hourly ELV = 2400mg/Nm^3 – which is significantly different from the new limit required by the CLMBREF/BAT conclusions - a daily average of 400mg/Nm^3.

In order to assess and implement a suitable SO_2 abatement / reduction method, the plant would like to apply for a time-limited derogation for a period of 24 months.

The fuels used have the following, average, Sulphur content;

Fuel Sulphur content limits ;

	Current Permit Limit	Internal Target
Coal	2%	1%
Pet coke	4%	2%
SDF	2%	1%
TDF	2%	<1%

We are also looking in to the use of a biomass-based fuel to replace one of the current waste derived fuels. The aim is to source a high energy low sulphur, low chlorine fuel. One option current being considered is the use of Olive stone waste materials. These fuels are to be trialled during the 2020 operating period.

The reduction in SO_2 is closely linked to the reduction in HCl - the end method to be adopted by the business would be aimed at reducing both emissions simultaneously.
As failure to reduce either SO_2 or HCl will result in the same long-term business decision being taken – Switch off the WDF's when producing Sintered Dolime products.

Therefore, we would propose to continue to reduce the Sulphur levels within the current fuels used and continue to trial the different absorbent injection materials (as is the industry standard) for the duration of the derogation period, so that a final decision can be made with regards to the fuels used for this product.

This derogation is based on the technical characteristics of the kiln. The fuels required to produce the calcining / sintering energy needed to produce high quality sintered products, also determine the type of fuels used.

The temperature required to produce a Sintered Dolime product is in excess of 1600°C and for a double pass Sintered Product the temperature can be as high as 2100°C, dependant on the customer's specific quality requirements. i.e. For some specific customers this means that only certain fuels can be used, due to tight quality specific requirements of our customer.

3.2.3 Criteria for the Derogation: Hydrogen Chloride;

This derogation is based on the geographical characteristics of the inputs in to the kiln system to produce this specific product – Sintered Dolime.

- Kiln feed stone – the stone has a natural level of chlorides within it (*see table:1 below for chloride inputs*), which, even when burning coal only gives an HCl emission greater than 10mg/Nm^3.

Table:1

Dolofrit (Sintered Dolime) Production.

Avg Chloride content analysis from monthly samples.

	mg/kg:	tph:	mg/hr	Input %:
Feed Stone	299	40	11.96	96.6%
Coal	21.3	2	0.04	0.3%
Pet coke	22.9	0	0.00	0%
RC	65	2	0.13	1.1%
SDF	98	2.5	0.25	2.0%

The kiln feed stone is supplied by a third party (CRH/Tarmac) from the quarry located next to the Dolime kilns. The quality of the feed stone quarried and subsequently supplied to the kiln is checked daily for quality. The dolomitic feed stone quality is comparable from other quarries within Europe.

The plant has no ability to change the feed stone supply at the Whitwell site is limited due to the long term contractual agreements with the land owner. However, as discussed previously in this document, the business is now looking for a new feed stone supply for the Whitwell site, but this will take between 7-10 years to fully develop.

- Kiln Type – Long Rotary Kiln (LRK) allows a full range of feed stone fractions to be used (0-75), allows for a very high sintering temperature (>2100°C) to be achieved consistently and at the correct residence time for the required quality parameters to be achieved. However, due to the high sintering temperatures, the kiln has a very high flue gas exit temperature (>350°C) which does not support the use of a bag filter system without some other form of gas conditioning process.

- Fuel - The fuels required to produce the calcining / sintering energy needed to produce high quality sintered products, also determine the type of fuels used. The temperature required to produce a Sintered Dolime product is in excess of 1600°C and for a double pass Sintered product the temperature can be in excess of 2100°C, dependant on the customer's specific quality requirements.

  Therefore, Natural Gas is not an option for this type of production on this type of kiln. Firstly, the high sintering temperatures required and secondly, due to their being no availability for Natural Gas supply in this geographical area.

The chloride content of the fuels is shown in table 2 below, the target spec and the actual performance in 2019 are shown.

Chlorine Targets for Fuels.

	Target	Actual
Coal	<0.5%	0.12%
Pet Coke	<1%	1%
SDF	<1%	0.41%
TDF	<1%	0.4%

Table: 2

The permit allows maximum chlorine content of the SDF to be 2% by weight.

When producing the Sintered Dolime (single pass) material, which is referred to as Dolofrit, the kiln has a typical HCl emission level of; a Daily Maximum Average = 108mg/Nm^3 and a Half Hourly Maximum Average = 159mg/Nm^3 during the 2019 production period.

The current permit ELVs, for the single pass Sintered Dolime; Daily Avg = 200mg/Nm^3 and the Half Hourly ELV = 400mg/Nm^3 – which is significantly different from the new limit required by the CLMBREF/BAT conclusions - a daily average of 10mg/Nm^3.

Due to the chloride within the feed stone it is not technically possible for the kilns to achieve the HCl BAT emission limit and due to the geographical location of the plant there is currently no other feed stone option available. The plant is requesting a geographical variation which takes this in to account.

3.3 Original Derogation (2018).

During the last IED permit review for the Lime industry, the SDL plant applied for derogation when producing Sintered Dolime on its W1 kiln. The derogation covered HCl, SO_2 and Group III metals.

The derogation was approved and is now part of the IED permit we have (BL3269IH/V007). The derogation allows for higher limits during the derogation period but re-instates the IED limits once the derogation comes to an end. The end date for the current derogation was the 31st December 2019.
Work on reducing the emissions continued throughout 2018/19 to determine what technology would reduce the emission levels and then to identify the level of capital investment that was required to become compliant.
The initial trials have been positive but did not give the results that the business was expecting. Possibly due to these techniques have not been used on reducing emissions during sintered Dolime production previously, or at any other plant within Europe (*there are only 3 plants within Europe producing Sintered Dolime products*) or on the long rotary kiln technology used to produce Sintered Dolime.

The issues which have been encountered during the injection trials in 2018/19 have mainly been associated with achieving the maximum potential coverage of the kiln exit gas stream. Historically

within the Lime and Cement industries the absorbent emission reduction materials are used in conjunction with a bag filter, therefore maximising the coverage of the kiln emission gas stream.

As has already been mentioned, the kiln exit gas temperature, to produce Sintered Dolime, is greater than (>370°C) and is not suitable for filtration through a bag filter unit without the inclusion of a gas conditioning process. There is no room physically to install a gas conditioning process and therefore the injection of absorbent is being modified, tested, using different nozzles, locations and volumes to determine the best possible performance.

The engineers want to conduct several more trials before a final decision is made during Q2 2022 with the Lhoist senior managers on the long-term future of the Sintered Dolime production within the UK. The aim of the extension is to ensure that the injection point questions have been fully answered and determine which material reacts best during the trials when being injected at different parts of the process. i.e. Injecting in the smoke chamber as well as at the front of the kiln at the fuel input stage. We are also looking at the performance of the product once these absorbent materials have been injected, as this could also influence the final decision made in 2022.

Ultimately, the business will decide to invest in the kilns or shut the waste derived fuels off and/or possibly move the production of Sintered Dolime outside of the UK. Which will impact the UK directly, as Lhoist is the only producer of Sintered Dolomite products within the UK, and if production stops the UK would have to import this material from other producers outside of the UK.

4. Technical Characteristics & Comparison with the BAT ELV's

4.1 Technical Characteristics;

The technical characteristics of the sintering process, its geographical location and the specific quality requirements of the Sintered Dolime product, mean that the W1 kiln cannot currently achieve the CLM BATC limits for SO_2 , HCl and Grp III Metals due to technical characteristics of the Sintered Dolime process and specific quality requirements.

There are two key issues; the geographical location of the current supply of dolomitic lime feed stone, which comes from the adjacent quarry and is low in Sulphur content, but it is high in Group III metals and Chlorides *(see tables 1 & 2)*. However, this is the only source of high-quality Dolomite in the UK (MgO between 30-40% and a low residual CO_2).

As has been discussed previously within this document, the results from operating on a Coal only kiln fuel, still produces HCl / SO_2 / GrpIII emissions higher than the waste burning limits currently determined within the industry BREF document. The 2018 emission data, recorded during Coal only production, gave an average HCl result of 128 mg/m^3. In 2019 the average level of Chloride within the feed stone was 335 mg/kg. Although the business is looking for a new supply of dolomitic lime stone, this option will not be available for several more years at this time, due to the ongoing geological investigations and then the acquiring of the subsequent planning permissions to open the new feed stone source. Therefore, the Lhoist process at Whitwell is limited geographically to the supply of feed stone from the current Whitwell quarry.

The technical characteristics of the Sintered Dolime product requires a very high 'sintering' temperature (>1600°C) and a fast kiln process time (<6 hours) in order not to 'fuse' the stone *(see the morphology of lime stone Figure 2.17, Page 195 in the CLM BREF)* in to a Dead Burnt Dolime product (which is characterised by a Bulk Density greater than 3.15g/cm^2) and is outside of the specific customer requirements for Sintered Dolime.

Therefore, the movement of the product through the high temperature range does not suit the vertical kiln designs used by standard Lime producers, which can take up to 24 hours to process, but the rotary kiln allows for the controlled movement of the product through this temperature zone, within 6 hours to pass through the kiln. Currently, all Sintered Dolime production within Europe is produced on rotary kilns.

A negative aspect of using the long rotary kiln technology is that it does not propagate a good interaction between flue-gas and absorbent materials, and therefore the maximum absorption ability is currently not achievable, without further modification of the kiln process.

To improve the long rotary kiln process further, then a bag filter would need to be installed to ensure that the contact between absorbents and the kiln exit gas are maximised.
However, the current kiln process is not suitable for the installation of a bag filter without further modification to kiln exit gas temperatures.
This would require a gas cooling / conditioning tower to be installed. The kiln exit gas could them be cooled from >350°C to the required bag filter inlet temperature of <250°C for the safe operation of the bag filter house.

A further complexity with the installation of gas cooling / conditioning tower is that the current plant layout / design does not have any spare areas available for the installation of a gas conditioning system. Therefore the back end of the current kiln systems, both kilns, would have to be modified to make room for the installation of the conditioning tower. There are areas where space can be created but will require a major change to the current kiln layout.

With regards to the availability of cleaner fuels; due to its geological location there is currently no industrial supply of Natural Gas to this area.

The option of Natural Gas has been considered several times over the last few revisions of the permits and ELVs. However, the closest industrial fuel source is over 4km away from the site, so the core fuel used by the kilns to maintain stability is Coal.

The coal supplied to the plant is low in sulphur <0.9% and chlorine <0.2%. Alternative fuels available are waste derived and have sulphur levels of between 0.1% and 1% and Chloride levels of between 0.1% and 1.0%. These are self-imposed limits which have developed as we have introduced actions to continually reduce the emissions of Sulphur and Hydrogen Chloride.

The business is always looking to develop a new fuel source and has several trials planned for the 2020/2021 period. Current fuels being looked at are Olive process waste, wood pellets and E-Coal (which is a coal derivative which is supplemented with a low emission biomass-based fuel) specific dates for these trials still need to be agreed with the Environment Agency.

We have also started to engage with the Humber project to deliver industrial supply of Hydrogen gas. This project is in its early days, but long term may be an alternative fuel solution?

In summary, when the kiln is producing Sintered Dolime products it cannot comply with the BATC emission limits for Sulphur Dioxide and Hydrogen Chloride. This is based on the Geographical Location and Technical Characteristics of the Sintered Dolime process.

A time limited derogation is required until the development of techniques and investment in the required kiln technology can be made or a decision taken to stop the production of this product within the UK, can only be made once the absorbent trials have been concluded.

4.2 BAT Requirements

4.2.1 BAT 45 SOx Emissions: W1 LRK

Table 10

BAT-associated emission levels for SO_x from flue-gases of kiln firing processes in the lime industry

Kiln type	Unit	BAT-AEL (1) (2) (daily average value or average over the sampling period (spot measurements for at least half an hour), SO_x expressed as SO_2)
PFRK, ASK, MFSK, OSK, PRK	mg/Nm^3	< 50 – 200
LRK	mg/Nm^3	< 50 – 400

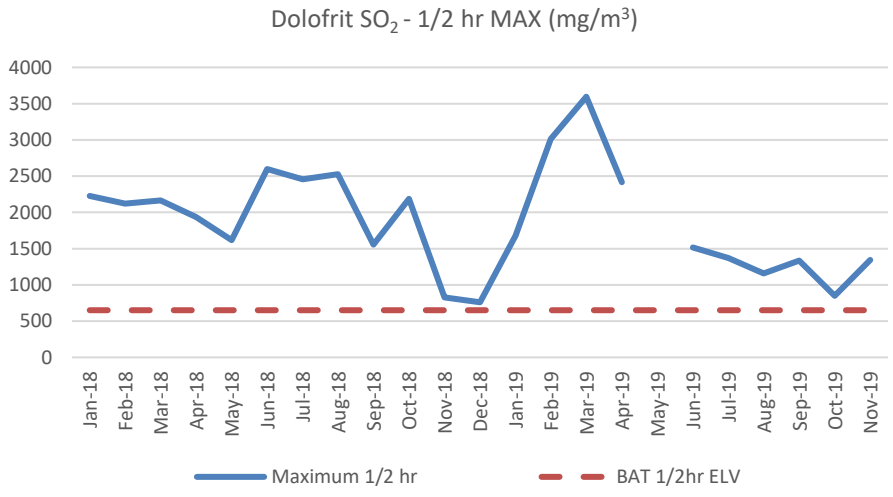
(1) The level depends on the initial SO_x level in the flue-gas and on the reduction technique used.
(2) For the production of sintered dolime using the 'double- pass process', SO_x emissions might be higher than the upper end of the range.

IED Permit Limit – Detailed within permit BL3269IH/V007

During the assessment against the IED regulations and working with the Environment Agency. The WID mixing rule was applied to determine the IED BAT limit for Sintered Dolime. This process gave the following results, which is documented within the current IED permit BL3269IH/V007.

	½ hr ELV	24 hr ELV	
SO_2	650	325	mg/m^3

4.2.2 SO_2 Current Performance:



Graph:01 – SO_2 Performance.

The graph above shows the maximum half hourly readings. The business has managed to reduce the SO_2 through process optimisation on fuel delivery, along with reduced sulphur loading from the fuels used. The results have been mainly positive. Unfortunately, due to product mix and the lack of availability of fuels during Q1 & Q2 2019, the Sulphur emissions increased until the lower Sulphur fuels and product mix allowed the actions to reduce the SO_2 emissions could continue.

One of the biggest issues with reducing the half hour emissions is the fluctuations experienced within the kiln system, which is caused by several factors related to the kiln technology used. The nature of the Long Rotary Kiln is to flush the uncalcined feed stone down the kiln slowly as the heat energy traverses back up the kiln towards the kiln exit. This movement is created by rotating the kiln at an angle. The result of which is material flushes within the tube which causes short periods of instability. The effect of ash ring build-ups within the kiln system can also have an impact on half hourly emissions. Any potential ash build-up is managed daily, but during the clearing process there can be instability with CO, which leads to fluctuations in the automated fuel delivery system – which ultimately leads to higher half hourly maximum figures but is not a true representative of the kiln performance.

This is recognised within the current IED Permit BL3269IH/V007 with increased half-hourly average emission limit values.

Reducing the amount of instability during product and fuel changes is a key focus of the site's continuous improvement team as well as a key objective of the business to aid in reducing the SO_2 emissions to within the IED ELV.

The business also recognises that by reducing the HCl emissions has a direct impact on reducing the SO_2 emissions. In fact, the greater the reduction in HCl, the greater reduction can be seen in SO_2, when using absorbents as an emission abatement technique.

4.2.3 SOx Emission Reduction Techniques :

Primary Techniques ;

a) **<u>Process optimisation</u>** to ensure efficient absorption of Sulphur Dioxide (e.g. efficient contact between the kiln gases and the quicklime).
The dolomite material has always given good absorption when interacting with the kiln flue gases. The current setup of the W1 kiln (LRK with an ESP) does not give the best interaction between gas and dolomitic dust. A way of improving the interaction / absorption between flu gas and dolomitic dust would be to introduce a bag filter unit. However, the temperature required achieving the calcination / sintering of the dolime material gives a flue gas exit temperature (>370°C), which is not suitable for a bag filter unit. This temperature is even higher (>450°C) when producing the Dead Burnt Sintered Dolime product on this kiln. Therefore, the exit gas temperature is too high for the use of a bag filter unit without some form of gas conditioning taking place first. The engineering team have attempted to cool the gas down uniformly and quickly but have not been successful and the trials increased the possibility of reformation of dioxin emissions within the flue-gas.

The gas flow within the exit ducting has been checked for homogeneity and conforms to the requirements of the MCERTS guidance on emissions monitoring.
The kiln fuel delivery systems have been improved to give a more consistent delivery of several fuels to the kiln system, this includes some new automation and back stop limits to control any adverse situations which may occur due to equipment failures. The next phase on the kiln automation is to introduce on-line flow meters, so that the volume and mass data can be used in conjunction with the other parameters we use, to control the calcining / sintering process.
Ultimately, these techniques all create a more stable and consistent kiln performance, which enables the good interaction of absorption to take place naturally within the dolime kiln system.

b) <u>Selecting fuels with a low sulphur content</u>.

As the plant has no access to natural gas, the closest supply line being over 4km away, the plant has originally been fuelled with Pet coke and Coal. The waste derived fuels were introduced at a later date, starting with the SDF and eventually the TDF.

The environment permit defines maximum limits for the sulphur content of the fuels. Shown below are the current limits next to the internal limits set by the plant, which have helped to reduce the overall sulphur loading of the kilns;

	Permit Limits	Internal Limits
Coal	2%	1.20%
Pet coke	6%	4%
SDF	2%	1.50%
TDF	2%	1.50%

Coal; when available to purchase, the coal sulphur level is set at 1%. Availability and cost of Coal supplies below this level are not commonly available on the UK market. The business is also planning to trial a new fuel referred to as E Coal in 2020. Which has a lower sulphur level (<1%) along with a biomass content for reduced CO_2 emissions.

Pet coke; this fuel is mainly used due to the customer specific quality requirements of the Sintered Dolime products. The main use of Petcoke was to produce the Dead Burnt Dolime (DBD) product – Dolopel. However, this product is only ever produced in low volumes and has not been produced since 2018. Year to date in 2019, there has been no demand for this product. Pet coke is being phased out of use for the other sintered products and is not used at all on W2 kiln. The business wants to phase out all use of Petcoke as a kiln fuel by 2023.

Solvent Derived Fuel (SDF); Waste derived fuels are more susceptible to change in sulphur levels due to the nature of the source material / waste that the fuel is generated from. However, the business now has agreement with the SDF supplier, setting a maximum limit for sulphur content at 1%. The business therefore took the decision to change SDF supplier to Veolia at the start of 2018, who offered a much lower sulphur content than the previous supplier. In 2018/19 the average sulphur level of the SDF was 0.5%.

Tyre Derived Fuel (TDF); Due to the nature of the TDF, vehicle tyres stripped of the metal banding and fractioned in to 1 – 10mm size pieces, has a sulphur content of between 1.5 – 2% on average. An internal limit of 1.5% has been set; any deliveries of fuel which have a sulphur content elevated above this limit can only be delivered under concession.

New Alternative Fuels; The focus of the business, with regards to fuel selections, is in identifying new alternatives to the current selection available to the kilns. We are currently looking to trial a biomass fuel in Q1 2020, which is derived waste from production olive oil processing. The fuel has a Sulphur content of 0.05%, significantly lower than the current fuel selections.

The aim of the trials is to identify two key performance factors; one – does it impact on product quality? and two, which fuel should be replaced to develop the reduction in SO_2 emissions we are trying to achieve?
Initial trials with a waste derived fuel referred to as SRF, was also considered during 2018/19. However, due to its variable sulphur content (0.5 – 2.0%), this fuel has been rejected and no further action will be taken.

The business is also looking in to replacing its Coal input with a lower sulphur base coal. The coal we are currently looking to trial in Q1 2020 is referred to as ECoal and is currently being tested in our laboratories for key parameters, prior to a trial date being set.

C) **Using absorbent addition techniques** (eg. Absorbent addition, dry flue-gas cleaning with a filter, wet scrubber, or activated carbon injection.

Absorbent injection techniques are currently being trialled on the W1 kiln. This action has been ongoing over the last 24 months with the results giving a mixed set of results. The main issue encountered with this technique, when incorporated on to a long rotary kiln, is the less efficient way in which the long rotary flue-gases interact with the particulates within the kiln. This is partially to do with the exit temperature of the kiln flue gas is >370 °C, which is not suitable for a bag filter unit which has a maximum inlet temperature of circa 250 °C and therefore an Electrostatic Precipitator (EP) is used to capture the dust.

Due to the inefficient way in which the flue gases within the EP interact with the absorbent, the injection systems have focused on the injection of the absorbent material within the ducting prior to the EP. This has meant that a lot of time and money has been spent on developing nozzles which give the correct spray pattern to cover the required gas stream, don't block due to dirty flue gases and can withstand long periods of time at high temperatures. This development has taken a lot more time than was originally expected, with an average cost of £8k / each nozzle designed. We are currently using 8 nozzles and are now looking at injecting in new locations within the kiln process, away from the traditional locations prescribed by the absorbent suppliers.

The injection trials have concentrated on the HCl reduction, as the abatement of HCl has a positive impact on the SO_2 emissions. Therefore, the business has focused on two areas to identify which process will enable the business to achieve IED compliance;

1) Firstly, continue with the trials of absorbent injection. In 2015/16 trials using an absorbent material (caustic soda) were conducted but were not very successful, the greatest reduction seen during the trials was around a 5 % reduction in emissions levels. The poor performance was due to the ineffective way in which the material was injected and its lack of interaction with the flue-gas within the ESP. Further trials using caustic soda were conducted in 2016/17. The previous trials of the caustic soda material had shown positive results on reducing the emissions. However, the improvement was minimal and only reduced the emission by a small percentage – *see appendix:03 for detailed report.*

A further trial using the Sorbacal material was also conducted in 2017/18. This gave far better reduction results but did not reduce the emissions down to the AEL level – *see appendix: 02 for further details.*

During 2018/19 several more trials using the absorbent material, Sorbacal, Sorbacal SP and Sorbacal SPS were trialled on the kiln. The results were positive but also raised several questions over techniques and secondary equipment used in the first set of trials? – *see appendix:01 for further details.*
This has led to a third set of absorbent trials being planned for Q1 & Q2 2020.

2) Secondly, if the trials of absorbent injection are not successful, then the business will need a capital investment to install a gas conditioning tower, a bag filter unit along with a new kiln ID fan.
This would ultimately enable the plant to reduce SO_2 and HCl emissions by significantly increasing the contact between flue-gas and the dolime particulates. This investment would be circa £4.6 million and would require a two-week kiln shutdown to complete. This figure has already been included in the Lhoist 5-year capital business plan. If the absorbent trials are not successful, then the capital project would be expected to be started in 2021/22. – *see appendix:06 (timing plan)*

In order to complete the remaining absorbent injection trials, agree on the improvement action and raise the relevant capital funding, the business needs to apply to the Environment Agency for a derogation against the current IED limits for a 36-month period, ending in December 2022.

This would give the business more time to determine the best option for ensuring IED compliance in the long term, along with securing the continued production of the key steel making additive, Sintered Dolime, within the UK.

Ultimately, if by Q3 2022 the business does not have a viable solution for the UK operation, then one of two options will be taken; business will stop using WDFs and/or phase out the production of Sintered Dolime in the UK by the end of December 2022.

4.3 BAT Requirements: BAT 51 HCl Emissions: W1 LRK

1.3.7.6 Hydrogen chloride (HCl) and hydrogen fluoride (HF) emissions

51. In order to reduce the emissions of HCl and the emissions of HF from the flue-gas of kiln firing processes, when using waste, BAT is to use the following primary techniques:

	Technique
a	Using conventional fuels with a low chlorine and fluorine content
b	Limiting the amount of chlorine and fluorine content for any waste that is to be used as fuel in a lime kiln

Applicability

The techniques are generally applicable in the lime industry but subject to local availability of suitable fuel.

BAT-associated emission levels

See Table 13.

Table 13

BAT-associated emission levels for HCl and HF emissions from the flue-gas of kiln firing processes, when using wastes

Emission	Unit	BAT-AEL (daily average value or the average value over the sampling period (spot measurements, for at least half an hour))
HCl	mg/Nm^3	< 10

4.3.1 CLM BATC Permit Limit Issues:

The CLM BATC document is clear in its determination of when emission limits are required. As is clearly stated above the HCl limit only applies to those processes which are burning WDF's. However, when the Whitwell kilns are tested during periods of no waste being burnt, the HCl levels are still very elevated compared to the BATC limit of $10mg/m^3$ for waste burning.

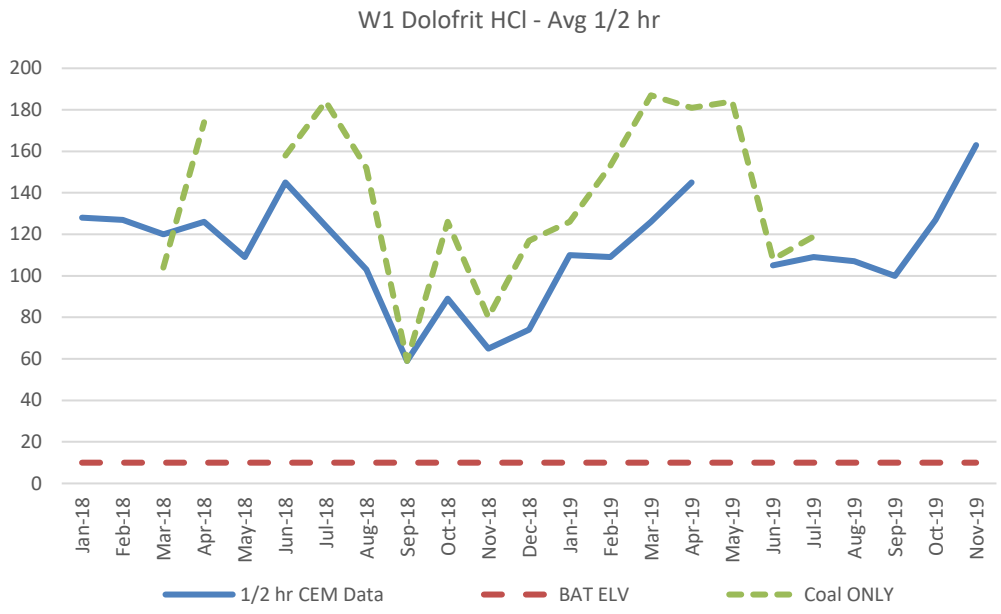
The dolomite feed stone has a high level of chlorides within it compared to standard lime stone. The dolomite stone comes from ancient sea corrals which have been fossilised over time to create the mineral Dolomite. Therefore, have a high level of chlorides naturally within the stone. The table below *(table:02)* demonstrates the potential impact on kiln loading when compared with the fuel inputs;

	Average Cl inputs 2019 YTD (mg/kg)	Hourly Kiln Input (t)	Cl Impact on Kiln (kg)
Feed Stone	155	60	9
SDF	2263	1.5	3
TDF	19	0.5	0.01
Coal	27	2.5	0.1
Pet coke	22	1	0.04

Table:02

4.3.2 HCl Current Performance:

The graph on the following page *(Graph:02)* shows the current HCl performance with and without WDF fuels being used. As the table above would suggest, the difference in the two operational scenarios is not significant.



Graph:02 – HCl Performance.

4.3.3 Primary Techniques;

a) Using conventional fuels with a low chlorine and fluorine content

The Whitwell kilns use two conventional fuels, 90% of which is Coal and 10% is Petcoke, which is used to achieve certain specific customer quality requirements.

The chloride input is always maintained at a low level for the Coal and Pet Coke purchased. The main objective is to identify alternative, biomass-based fuels, which will allow the business to phase out the use of Petcoke and Coal in the long term.

However, there are several issues which need to be addressed prior to this change being implemented; The supply of the alternative fuel must be in a volume which supports the replacement of one of the 'mainstay' fuels. As these fuels give the kiln stability during 'other' fuel and product changes. And secondly, it must be low in chloride inputs along with Copper inputs. This work is ongoing and taking longer than expected due to the contract side of supply agreements, which cannot be upheld currently.

b) Limiting the amount of chlorine and fluorine content for any waste that is to be used as fuel in a lime kiln;

The business has been reducing the input of the chlorine content of its WDF fuels, as can be seen in table:02 above. However, as has also been discussed the high level of chlorides within the feed stone also require managing along with the WDF inputs.

The plant is currently looking at two, low chlorine content fuels. The plant intends on testing the kiln with both fuels during Q1 2020, once approval has been given by the Environment Agency for the alternative fuel trials using Olive pellets and afterwards with ECoal.
Actions have also been taken to increase the use of the TDF fuel, currently the main issue with using TDF is its availability on the market. The main action is to now identify several suppliers so that the weekly required amount of TDF can be purchased and used to replace the SDF input on the kilns. This will have a direct, positive, impact on the HCl emission level when producing Sintered Dolime.

It is believed that by implementing the low chlorine fuels along with sorbent injection will deliver the correct level of emissions abatement required for the plant to achieve the CLM BATC limit for HCl of 10mg/m^3 when burning waste derived fuels.

5.0 Current Risks for allowing the derogation

5.1 The current SO_2 and HCl emission levels, emitted during the production of the Sintered Dolime product, are shown in graphs 01 & 02 discussed previously above.

	SO_2 Over 36 Months (t)	
Mass Emissions at BAT Level =	2375	
Mass Emissions at Derogation Level =	8767	
Mass Emission based on ACTUAL performance =	2237	This is based on the actual emissions form the kiln in 2018/19

Table:03

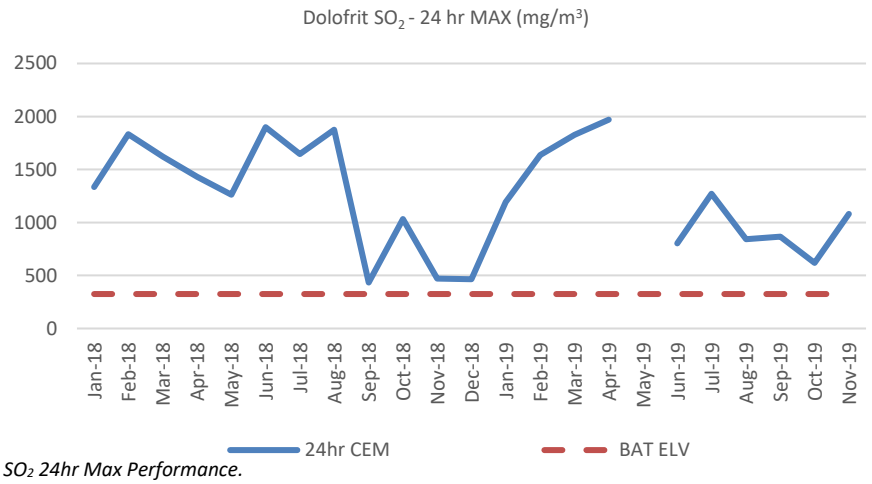
The above table shows the possible mass emission based on the derogation ELV (2400mg/m^3) compared with the BATC ELV (650mg/m^3). However, we have also highlighted the actual emission in 2018 based on the PIR report and extractive emission testing, which demonstrates that over a period of 12 months the actual current emission is lower that then BATC limit result for the same time period. This is due to the limit is high due to the fluctuations in emissions but the average emission over a longer period is significantly lower than the permitted emission limit.

The SO_2 emissions have reduced and are still reducing. In 2019 the business had an Air Quality Impact Assessment conducted independently on its behalf, *see Appendix:05.*

The assessment considered two scenarios; Scenraio:1 considers the impacts of the process based on the emission concentrations set in the environment permit; and Scenraio:2 – the effects of the process emissions based on the worst-case emission test measurements reported over the last two years.

Pages 5,6 & 7 of the report show the summary of the findings. The report has determined that there are no significant impacts on air pollution operating at the current emissions levels (which were higher during the assessment period than they are today) changes in fuel sulphur levels have had a positive impact on reducing the emission of SO_2.

The emission was identified as being a ‘minor’ significance on the long-term assessment and a ‘insignificant’ impact on the short-term assessment.



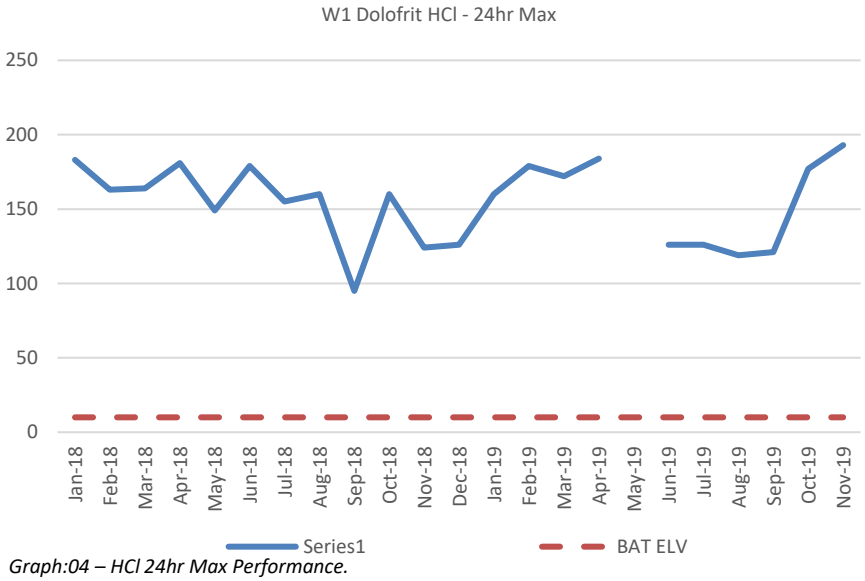
Graph:03 – SO_2 24hr Max Performance.

The graph above shows the 24hr Maximum emission on SO_2 recorded over the last 23 months. As can be seen the maximum ELV is not achieved during this period. In fact, the fuel changes have reduced the SO_2 emissions down to an daily average on 851 mg/m^3 when producing Sintered Dolime.

Also, for completeness, the original Air Dispersion Model for the kilns, which was initiated by the introduction of the IED regulations and the new ELV limits in the updated permit. It has been included in the appendices, so that the two scenarios can be compared if required.

5.2 The HCl emissions are also stated as being 'insignificant' with regards to its impact on the environmental receptors considered. Which was not unexpected considering the gas concentrations within the kiln exit gas are; 10% Oxygen, 80% Nitrogen and 10% pollutants, of which 98% of the pollutants is made up of CO_2. The SO_2 accounts for 0.25% of the actual gas emission and HCl only accounts for 0.025% of the actual gas emitted from the kilns.

As has been previously agreed, former applications on this issue, the impact of the emissions is very low and not thought to have any significance in impacting on the long-term environment.



Graph:04 – HCl 24hr Max Performance.

The graph above shows the 24hr Maximum emission on HCl recorded over the last 23 months. The HCl emission level remains constant throughout the period.

Some reductions during trial months, but overall the emission remained constant. The impact of the increased emissions, above the ELV, have been deemed to be insignificant due to the mass of the emission released. See air impact assessment in *Appendix:05.* This summary is also supported by the outcome of the CBA tool used and a copy of which has been supplied with this application (*see appendix:07 for a summary*).

6.0 Time Line for Expected Compliance;

The business is requesting a Derogation against the current IED permit (BL3269IH/v007). The business would like to have an extended time period in order to conduct the final abatement trials and summarise the results in order to enable the business to make a final decision on the Sintered Dolime production at this facility. The requested derogation would have an end date of the 31st December 2022.

As previously discussed, the reason for the derogation is to allow the business to determine which combination of techniques is effective in reducing the HCl emissions down to the required 10mg/m^3. Once this method or combination methods have been clearly identified the business will make an investment in capital to install the required equipment(s) / techniques / fuels. Or, if unsuccessful, then the business will clearly define its exit strategy and stop the production of Sintered Dolime, within UK, by December 2022.

The table below shows the summary of planned tests / trials along with expected completion dates;

A more detailed version of the compliance plan can be found in *Appendix:06*.

Trial	Description	Comp date
1	Fuel Trial - Olive stones	2020 - Q1
2	Sorbacal dosing with low S fuel	2020 - Q2
3	Standard Hydrate @ 375C	2020 - Q2
4	NaCl with kiln feed	2020 - Q3
5	Fuel Trial - E Coal	2020 - Q3
6	Dolomite fines burner	2020 - Q4
7	Dolime fines burner	2020 - Q4
8	Dolomite fines with kiln feed	2020 - Q4
9	Dolomite fines with kiln feed	2020 - Q4
10	Fuel Trial - Husks/wood	2021 - February
11	Green feed with kiln feed	2021 - March
12	Water injection to reduce O2	2021 - May
	Final Assessment Reports and agree on a final solution.	2021 - September
A	Raise Capital Investment Request with Lhoist Europe.	2021 - December
B	Order and install equipment.	2022 – March
C	Install, Commission and obtain permits for the new process.	2022 - September

Table:04

Once the trials of fuel and techniques have been completed, the business will have to make one of three options which may be available;

1) If a suitable abatement technique is identified via the trials, the business will raise the capital and make the changes to the process in line with the schedule above in Table:04.

2) If, at the end of the trials period, if no suitable technique or equipment change has been identified! Then the business will take one of two options;

   A) Stop the use of Waste Derived Fuels and Petcoke to produce the Sintered Dolime product. Follow the CLMBREF guidance on using Coal only – decision / action by November 2022.

   B) Cease all production of Sintered Dolime products in the UK – decision / action by December 2022.

Based on the predicted timings above of the trials and subsequent investment decisions, the business aims to be IED compliant on the emissions of SO_2 and HCl by the end of Q4 2022.

7.0 Options Overview;

All BAT AEL options have been considered for the reduction of HCl and SO_2 emissions, and as previously stated (in sections 4/5 of this report) are being acted upon.

Ultimately, lowering the content in the fuels will only help to achieve a percentage of the reduction required. Abatement of the emissions is the ultimate solution if a capable technique can be implemented on the current process for the production of Sintered Dolime, which does not make the product quality unsuitable for our customers. However, as is also stated above, the ultimate action will be to stop producing this product in the UK.

In order to ensure that the business has all of the relevant, possible, abatement improvement possibilities assessed and has come to a long-term conclusion, the business has requested that the derogation deadline date, for full IED compliance, is 31st December 2022.

8.0 CBA Assessment;

To prove disproportionate costs, you must supply a fully completed cost benefit assessment of your options and preferred solution. This has been completed using the Environment Agency's CBA tool and methodology, downloaded from the EA website.

8.1 Provide an explanation for all key input data.

The data used within the CBA tool comes from the business accounts and capital assessments completed in 2018/19. All specific data is available upon request and the estimates used for the new equipment are based on our investments made in 2015 to install bag filters and preheaters to the rotary kilns. The impact data is set by the tool and based on national data. The CBA is in *Appendix:07* of this application.

8.2 Confirm the conclusions that can be drawn from the CBA.

The CBA summary sheet clearly shows that the impact of the proposed derogation is minimal compared with the other options discussed – BAT-AEL and Waste Off. The most favourable option would be to achieve the BAT-AEL, with minimal negative impact raised/highlighted by the derogation. The environmental costs of issuing the proposed derogation ELV do not outweigh the potential costs of issuing the derogation for a three-year period prior to kiln achieving full IED compliance. See the CBA assessment for full details.

9.0 Dispersion / Impact / PI Data comparison;

The attached air impact assessment *(appendix:05)* does not show any long term or short-term environmental impacts due to the low level of emissions being evaluated. The assessment did not raise any issues with regards to the dispersion of the emissions within the assessment.

The pollution inventory reporting over the last 5 years have shown a drop in the mass of SO_2 & HCl, released from the Sintered Dolime production, since 2015.

Of the emissions released from the kiln process in 2018; 0.025% were attributed to HCl emissions and 0.26% came from SO_2 emissions. This amounted to 71 tonnes of HCL and 754 tonnes of SO_2 being released against the potential releases of 198t HCl and 2374t SO_2 based on the actual allowable limits within the current permit.

This position is confirmed when reviewed with the air dispersion models 2013,2018 and air impact assessment conducted in 2019 and the outcome of the latest CBA assessment appears to support this position / view.

10.0 Summary;

The business had hoped to have identified and made the required investment by this time, however, other issues have delayed the progress of the business with regards to identifying the best technique / method for abating the Sintered Dolime emissions.

The issues encountered have been around; the resulting product quality from the abatement trials, the inconsistent performance of the absorbent materials which have been trialled, fuel availability falling in line with kiln availability to trial any new potential fuels and the underlying issues with chloride levels within the feed stone. These have all been very challenging. However, the final set of actions and milestones, to identify which method and equipment are required for full compliance, is clear.

The finale aim of the remaining trials is to optimise the injection point locations and spray patterns to ensure that the best possible interaction between gas and absorbent is achieved. Identify the impact on product quality (free lime content >10%) once we have determined the injection rate of the sorbent and to identify the process required to maximise the emission reduction ability of the materials used.

Once complete the business will make its final decision about the future operation of this plant and product. A final decision will be made on Capital Investment, reduced production with no WDFs or the final solution, which will be to stop producing this product at this location.

The business has committed to a final date of 31st December 2022 (if in agreement with the EA) to have resolved the IED compliance issue one way or another. i.e. the business intends to be fully compliant by this date – 31st December 2022.

The air impact assessments and CBA assessment appear to support the business request for a derogation, as the environmental impact is deemed to be low / insignificant.

The business would once again like to ask for the assistance of the EA to approve the derogation request and allow the business the time it needs to resolve the IED ELV issues, and more specifically to keep the production of Sintered Dolime within the UK.

If you have any further questions or want further clarity on the details of this application, then please feel free to contact myself direct via one of the methods below.

Kind regards,

Andy Graham

Senior Manager Environment and Quality
Lhoist Western Europe (North)
Southfield Lane,
Whitwell,
Worksop,
Nottinghamshire, S80 3LJ

Mobile - +44 (0)7841 985388
andrew.graham@lhoist.com

APPENDIX:01

- W1 Kiln Abatement Trials 2018/19
  See attached test report ref: LSDL_App_01_v1.pdf

APPENDIX:02

- W1 Kiln SLS45 HCl Reduction Trials 2018
  See attached test report ref: LSDL_App_02_v1.pdf

APPENDIX:03

- W1 Kiln Caustic Soda Trials 2016/17
  See attached test report ref: LSDL_App_03_v1.pdf

APPENDIX:04

- HCl Abatement Sorbacal SP 2015/16
  See attached test report ref: LSDL_App_04_v1.pdf

APPENDIX:05

- Air Dispersion Model 2019
  See attached Assessment report ref: LSDL_App_AIR_05_v1.pdf

APPENDIX:06

- COMPLIANCE PLAN / DATES AND IED COMPLAINCE DATE;

Fuel Trials: 01	Olive Seed/skin waste -100% Biomass	March 2020
Trial 1 – Sorbacal abatement during no-petcoke Dolofrit run	There is a theory that the SPS reacts preferentially with SO2 before abating the HCl. This theory could be evaluated by repeating the trial with coal instead of petcoke to reduce the sulphur input to the kiln	Q2 2020
Trial 2 – Standard hydrate @375C	• Blow standard hydrated lime into EP ducting @ 500kg/hr • Maintain EP at 375C 30 minutes	Q2 2020
Trial 3 – Dosing of NaCl with kiln feed stone	Dose salt onto the kiln feed belt to reduce the resistivity of the dust in the ESP. This should result in superior dust collection	Q3 2020
Fuel Trials: 02	E-Coal, part biomass, low sulphur fuel.	Q3 2020
Trial 4 – Front end dolomite fines	• Blow dolomite fines into the rubber crumb channel of the burner pipe. • Use 500kg/hr. • Maintain EP @ 375C	Q4 2020
Trial 5 – Front end dolime fines	• Blow dolime fines into the rubber crumb channel of the burner pipe • Use 500kg/hr • Use -2mm F or fully calcined dust from a bag filter? • Maintain EP @ 375C	Q4 2020
Trial 6 – Back end dolomite fines	• Blow dolomite fines into the kiln inlet or introduce on top of kiln feed • How much? • Where can we get these from? Tarmac bag-filter, W2 Fines Screen, or ask Tarmac to make some unscreened LKF into Silo 1 or 4 • Maintain EP @ 375C	Q4 2020
Trial 7 – Back end dolime fines	• Blow dolime fines into the kiln inlet or feed onto kiln feed belt • Use 500kg/hr • Use -2mm F or fully calcined dust from a bag filter? • Maintain EP @ 375C	Q4 2020
Fuel Trials: 03	Biofuel trial, 'husks' and 'wood' (volume still to be developed).	February 2021
Trial 8 – Green feed pellets	Make some green feed pellets (pelletised dolime fines) to be added to the kiln feed. This has the advantage over Trial 4 in that the pellets carry the dolime dust further into the kiln before the tumbling action turns them back into dust.Note that this trial will only be possible if some pellets are made. It is a similar trial to Trial 7, other than the dolime fines are “released” further into the kiln (the pellets become crushed by the stone).	March 2021
Trial 9 – Use water injection to close air dilution damper	Put a control loop in place to inject enough water to keep the air dilution damper closed, but not so much water that the EP temperature goes below 375C. The control loop could be by manual intervention. Run the trial for 5 days preceding a shutdown to determine the effect on the ESP and ducting. Output of trial is to quantify the reduction of the reported HCl/SOx, and to quantify the reduction in ID fan power.	May 2021
Raise Capital Request	Once agreed, raise the capital required for the equipment or agree on the removal of the SD production.	December 2021
Install Abatement Equipment	Order and organise the installation of the equipment during a kiln shutdown. Aiming for IED compliance by the end of Q4 2022	March 2022
IED Compliance Date	All Sintered Dolime emission compliance issues will have been resolved by this date - 31/12/2022	

APPENDIX:07

- Environment Agency Cost Benefit Analysis Summary / form.
  See attached Assessment report ref:
  LSDL_CBA_3269_11_v1.pdf

---- Summary Results ----

<< MAIN MENU

< PREVIOUS | DETAILED RESULTS >

What is this worksheet for?
Fill this in after the appraisal has been completed

1.1 Please state the grounds on which the application for IED derogation is made: Technical (Select from dropdown)

1.2 Name of applicant's proposed option: Technical derogation for 36 months.

Outcome of CBA

Are the environmental benefits of meeting the BAT-AEL(s) higher than the costs of doing so in comparison to the proposed derogation option?

		Proposed derogation	BAT-AEL	Waste off		
Central	£millions	0.00	-17.45	-3.01	✓	✓
Sensitivity Analysis						
Lowest NPV for BAT-AEL is caused by: High upfront investment costs	£millions	0.00	-22.53	-3.33	✓	✓
Highest NPV for BAT-AEL is caused by: Low upfront investment costs	£millions	0.00	-12.38	-2.73	✓	✓
Scenario Analysis						
Lowest NPV for each option using highest costs and lowest benefits	£millions	0.00	-23.56	-7.61	✓	✓
Highest NPV for each option using lowest costs and highest benefits	£millions	0.00	-11.76	-12.14	✓	✓