

Industrial Emissions Licence – an EU Licence

Louise Clune

Environment Coordinator

Aughinish Alumina Ltd., Askeaton, Co. Limerick, Ireland

Corresponding author: louise.clune@augh.com

Abstract

The Rusal Aughinish Alumina (AAL) refinery is located on Aughinish Island, on the southern shore of the Shannon Estuary 33 kilometres west of Limerick city in the South West of Ireland. The plant, which commenced operation in 1983, has a current production capability of 1.99mt/yr. It sources bauxite predominantly from Guinea, Brazil and Guyana and uses the Bayer process to produce Alumina. The refinery functions with an accredited Safety Management System (ISRS), Environmental Management system (ISO14001), Quality Management System (ISO9001) and Energy Management system (ISO50001). The environmental management of the AAL operation is overseen by the Irish Environment Protection Agency (EPA) through the Industrial Emissions License (IEL), in accordance with the Industrial Emissions Directive. This Directive (2010/75/EU) of the European Parliament and the Council on industrial emissions entered into force in January 2011 and was transposed into Irish Legislation in 2013. This paper outlines the stringent requirements of the Industrial Emissions Directive on the operation of an Alumina refinery in Ireland.

Keywords: Alumina refinery, Industrial Emissions Directive, Industrial Emissions Licence.

1. Introduction

Rusal Aughinish Alumina Limited (AAL) refinery is located on Aughinish Island, on the Southern shore of the Shannon Estuary in the South West of Ireland with the nearest city being 33 kilometres away. The plant commenced operation in 1983 and through debottlenecking and optimisation has achieved a current production capability of 1.99Mt/yr. It sources bauxite predominantly from Guinea, Brazil and Guyana and uses the Bayer process to produce Alumina.

The refinery is located within the Shannon Estuary Region (Rural) zone, and has been designated as being of the highest category of air quality by the Environment Protection Agency's (EPA's) Air Quality Index for Health [1].

The refinery is surrounded by conservation areas designated by the European Union's Habitats Directive (92/43/EEC), which aims to protect species and habitats which are considered to be of European interest. Figure 1 illustrates the proximity of those areas designated as special areas for birds (denoted by red lines) and habitats (blue lines) [2].

Bauxite residue generated from the Bayer process is deposited in an engineered facility called the Bauxite Residue Disposal Area (BRDA). The BRDA is a Category A facility under the Extractive Waste Directive (2006/21/EC) due to its scale and location adjacent to a special area of conservation. This classification ensures that the design and operation of the BRDA must provide the highest level of environmental protection possible.



Figure 1. Proximity of designated areas to AAL refinery and BRDA.

The operation of the BRDA is one of the key enablers in the sustainability of AAL. The deposition method employed is dry stacking of washed, filtered mud which is pumped by positive displacement pumps to the BRDA at 58% solids. Partial neutralisation of the mud by atmospheric carbonation through mud farming produces a mud with $\text{pH} < 11.5$ which is non-hazardous and is suitable for remediation and revegetation. In addition the farming process increases the percent solids to 70 – 75 %. The BRDA has been designed and is operated to ensure the long-term stability of the residue.

The refinery operates compliantly under an Industrial Emissions Licence (IEL) issued and enforced by the Irish EPA. The ISO14001 environmental management system is a key tool to ensure compliance with the conditions in the IEL and to drive continuous improvement of the environmental performance of the plant and to safeguard sustainability through a lifecycle approach.

The refinery also operates under both a Dumping at Sea permit (issued and enforced by the EPA) and a Foreshore Licence (issued and enforced by the Environment Department) to allow dredging works at the port facility. In addition, the refinery operates in compliance with a Greenhouse Gas Emissions Permit which contains requirements that must be met in respect of emissions of carbon dioxide from approved emission sources. This Greenhouse Gas Emissions Permit places an obligation on the refinery to surrender allowances annually to the European Union Emissions Trading Scheme (EU-ETS) equal to the annual reportable emissions of carbon dioxide equivalent from the installation.

The refinery functions with an accredited Safety Management System (ISRS), Environmental Management system (ISO14001:2004), Quality Management System (ISO9001:2004) and

Energy Management system (ISO50001:2011). In 2017, a goal is to achieve certification to ISO9001:2015 and ISO14001:2015 standards.

To satisfy the refinery's demand for energy, a 160 megawatt Combined Heat & Power Plant (CHP Plant) was built on the site of Rusal Aughinish in 2007. Currently, the CHP Plant generates steam and power for the refinery and supplies surplus power to the national power grid. Since 2014 all fuel requirements use natural gas at AAL. This followed a series of projects including conversion of calciners from heavy fuel oil to gas consumption, which was completed in 2012. The latest project to allow complete conversion to gas was the installation of 2 new gas boilers which was completed in 2014. These gas boilers have replaced the 3 original HFO boilers.

2. History of Environmental Licencing at AAL Refinery

The EPA has been licensing certain large-scale industrial and agriculture activities since 1994. Prior to this, the Local Authorities issued air and water discharge licences in addition to the planning permission for the activity. Originally, the licensing system was known as Integrated Pollution Control (IPC) licensing, governed by the Environmental Protection Agency Act, 1992. This Act superseded the following regulations: Air Pollution Act (1987), Water Pollution Act (1977), Fisheries (Consolidation) Act (1959) and European Communities (Toxic and Dangerous Waste) Regulations (1982). The IPC Licence took an overall approach to the control of industrial emissions to atmosphere and water as well as control of noise and waste emissions.

The 1992 Act was amended in 2003 by the Protection of the Environment Act, 2003 which gave effect to the Integrated Pollution Prevention Control (IPPC) Directive. The IPPC Directive expanded both the categories of activities regulated as well as the aspects which were controlled including energy efficiency, waste reduction and prevention or reduction of emissions to air, water and land. The IPPC Directive introduced the requirement to demonstrate how sites will be decommissioned and managed on closure.

Since 2014, the environmental management of the refinery is overseen by the EPA through the Industrial Emissions Licence (IEL), in accordance with the Industrial Emissions Directive (IED). This Directive (2010/75/EU) of the European Parliament and the Council, focussed on the reduction of industrial emissions, entered into force in January 2011 and was transposed into Irish Legislation in 2013. The primary implications of this change in legislation is the mandatory requirement to be compliant with Best Available Techniques (BAT) which are the reference for Member States in setting Licence conditions. Licence conditions must be updated within 4 years of publication of new BAT conclusions, as discussed further below in Section 4.

One of the other major changes in the IED relates to revisions of existing provisions set out under the Large Combustion Plants Directive. The history and implications of this are described in Section 5 below. In addition, the IED introduces a new requirement to monitor periodically the soil quality in order to ensure that appropriate information is available to protect these media from contamination. A soil and groundwater baseline report was submitted by the refinery to the EPA which provides quantified information on what is now considered as the baseline conditions of the site and on cessation of the activity the refinery has to take the necessary measures to return the site to that condition.

Table 1 below presents a history of the Licenses issued to the refinery by the EPA.

Table 1. History of EPA issued licences at the AAL refinery.

Licence	Year	Reason for change to licence
IPC Licence P0035-01	1998	EPA Act (1992)
IPC Licence P0035-02	2004	Inclusion of CHP
IPC Licence P0035-03	N/A	Application withdrawn
IPPC Licence P0035-04	2008	BRDA extension and production increase
IPPC Licence P0035-05	2012	Inclusion of a gas fired boiler and Calciner conversion to gas
IE Licence P0035-06	2014	Inclusion of a 2 nd gas fired boiler

The process of undertaking a licence review is difficult and can be lengthy. By way of example, in December 2012 a licence application was submitted to the EPA for the operation of a second gas boiler. This followed a previous application for the operation of a single gas boiler and gas fired calciners which led to the granting of IEL P0035-05. Installation of a second gas boiler was the final stage required to successfully convert the plant to gas combustion, replacing heavy fuel oil.

Following the 2012 application for inclusion of the second gas boiler, the final determination (P0035-06) was not issued until July 2014. This was due to changes in the application form, implementation of the Industrial Emissions Directive, requests for further information and submissions made regarding the proposed determination which is a draft licence issued by the EPA.

The annual cost of compliance with the IEL is significant and increasing, at greater than €1 million in 2015. This figure excludes costs associated with compliance with the GHG and DAS permits, internal labour, capital expenditure, public relations, safety, insurance, financial provision, equipment maintenance and treatment of bauxite residue in the BRDA via carbonation.

3. Industrial Emissions Licence Conditions

Since 2014 the refinery has been operating under IEL P0035-06 which permits the following specific activities: production of inorganic chemicals, combustion of fuels in installations with a total rated thermal input of 50MW or more and the recovery or disposal of waste. The IEL contains more than 200 conditions and sub-conditions under which the refinery operates and manages its operation. The IEL imposes Emission Limit Values (ELV's) on emissions to air, emissions to water and waste disposal. In addition the IEL also imposes conditions on site management, infrastructure and operation, interpretation of results, control and monitoring, proper storage & handling of chemicals (integrity testing), accuracy of data (instrument calibration), appropriate training of people, resource use, energy efficiency, requirement for emergency preparedness, notification of incidents & accidents, financial charges and provisions (closure plan), documentation, records and reporting.

The requirements for air, water and groundwater emissions prescribed by the IEL have been detailed previously by D. Clancy at the 2016 ICSOBA proceedings [3].

By way of example of the strict requirements of the IEL, conditions relevant to the two new gas boilers are now described.

3.1 Infrastructure and Operation

Condition 3.17 of the IEL states that the shutdown and start up conditions for the gas boilers must be defined and agreed by the EPA within 3 months of data of grant of the IEL. Start-up and shutdown conditions for stable and safe generation of steam from the gas boilers were agreed by the Agency within the prescribed timeline and have been implemented by the refinery in determining those periods where ELV's are applicable.

3.2 Interpretation

Condition 4 of the IEL details the interpretation of continuous emissions monitoring for the gas boilers. For example, no validated daily average emission value can exceed 110% of the ELV while no validated monthly average shall exceed the ELV.

3.3 Control and Monitoring

Condition 6.1 of the IEL states requirements for the testing programme of abatement equipment on the gas boilers including approval by the EPA, completed within 3 months of commencement of operation and incorporate maintenance and calibration. Performance assessment, maintenance and calibration of monitors on the abatement system is also required.

Low NO_x stage combustion burners are the primary abatement control which ensure NO_x generation is minimised during the combustion process. A flue gas recirculation system is installed on each boiler to further control emissions. Testing of the combustion burners, gas recirculation system and associated controls was completed in the commissioning phase of the gas boiler installation project. Both continuous and manual emissions monitoring was conducted during the commissioning phase to verify the effectiveness of the above controls. The relevant standard works methods (SWM's) for the gas boilers operation were revised to include operation, control and management of the gas boilers abatement systems.



Figure 2. Location of CEMS adjacent to gas boiler stack.

Continuous Emission Monitoring Systems (CEMS) have been installed on the gas boilers, supplied by Emerson. As per British Standard EN14181: Stationary Source Emissions Quality

Assurance of Automated Measuring Systems [4], 3 quality assurance levels (QAL 1-3) and an annual surveillance test (AST) have been completed. Figure 2 above provides a view of the enclosure adjacent to a gas boiler stack which houses the CEMS to monitor that boiler emissions. Figure 3 provides an internal view of the CEMS unit.



Figure 3. Emerson CEMS for gas boiler stack emissions monitoring.

3.4 Notification, Records and Reports

Condition 11.1 of the IEL states that any release of environmental significance to atmosphere from any potential emissions point including bypasses must be reported to the EPA as soon as practicable after its occurrence. There have been no reportable incidents associated with the gas boilers since their operation commenced in 2014.

3.5 Emission Limits

Schedule B of the IEL defines the emission point reference numbers for both gas boilers, the maximum hourly volume to be emitted (130,000 m³ each) and the maximum discharge height (32m above ground). The gas boiler ELV's as defined in the IEL are provided in Table 2 below along with the requirement for monitoring of each parameter. The instrument agreed with the EPA for monitoring of both NO_x and carbon monoxide is the Emerson CEMS.

Table 2. Gas boiler ELV's and monitoring requirements.

Parameter	Emission Limit Value mg/m ³	Monitoring Frequency
Nitrogen oxides (as NO ₂)	100	Continuous
Carbon Monoxide	100	Continuous

4. Application of Best Available Techniques

The Industrial Emissions Directive aims to achieve a high level of protection of human health and the environment taken as a whole by reducing harmful industrial emissions across the EU, in particular through better application of BAT [5]. It has now become mandatory that Member States set industrial emissions licence conditions and emission limit values (ELV's) which are

based on BAT. Historically, for the IPPC Directive BAT was provided in guidance documents that member states had to have regard to but were not mandatory. The intention of the Industrial Emissions Directive is that Operators should take all preventative measures against pollution to improve environmental performance, in particular through the application of BAT.

BAT reference documents (BREFs) are published by the European Commission which present the results of an exchange of information between EU Member States and Industries. In this regard, technical working groups are established to develop and review BREF's. This process ensures that BAT is determined in a consistent manner across the EU. Technical working groups are composed of industry experts (for those sectors governed by the Industrial Emissions Directive), national regulators (such as the Irish EPA) and National Government Organisations (NGO's).

BREF documents contain the following sector specific information: techniques and processes used, current emission and consumption levels, techniques to consider to determine BAT, emerging techniques, references, links to relevant legislation and standards as well as additional technical information. BAT conclusions is that section of each BREF which provides a description of relevant techniques including information to assess their applicability, emission levels associated with each technique and monitoring requirements.

In Ireland, the EPA has developed BAT guidance documents based on the equivalent EU BREFs. The achievable ELV set out in the BAT guidance note is reflected in the refineries IE Licence ELV's.

Table 3 below provides the 9 BREF's which are applicable to the refinery. The BREF for Management of Tailings and Waste Rock in Mining is applicable under the Directive (2006/21/EC) of the European Parliament on the management of waste from the extractive. The remaining 8 BREF's are applicable under the Industrial Emissions Directive.

Table 3. BREF documents relevant to the Alumina Industry.

Best available techniques Reference document (BREFs)	Publication Date <i>(previous publication date bracketed)</i>
Large Volume Inorganic Chemicals	2007
Large Combustion Plant	2006
Energy Efficiency	2009
Emissions from Storage	2006
Economic and Cross MEDIA Effects (adopted reference document)	2006
Common wastewater and waste gas treatment/management systems in the chemical sector	2016 (2003)
General Principles of Monitoring (adopted reference document)	2003
Management of Tailings and Waste Rock in Mining Activities	2009
Non Ferrous Metals Industries	2016 (2001)

As part of the submission to the EPA for the revision of the IPPC licence to the IEL in 2014, a review of the refineries implementation of relevant BAT was completed. In fact, there are over 800 relevant BAT techniques which were considered with justifications provided for those not applied on site.

The European Union review BREF's on an ongoing basis. Following issue of an updated BREF, member states have 4 years to implement revised BAT into IE licence conditions and ELV's.

In 2015, the refinery was requested to make a submission to the EPA who were part of the technical working group reviewing the BREF document for the Management of Tailings. The exercise allowed the refinery an opportunity to provide a view of what techniques should be considered BAT to prevent or reduce environmental impacts from extractive waste management. Detailed information was also provided on the following topics: general information on waste management, classification of waste, waste handling, water management, closure and after care, energy and materials consumption, control of emissions to air and water, noise and odour control, site selection, design and construction, monitoring and risk management.

In addition, a number of techniques were submitted as candidates for BAT, which have since been incorporated in the draft BREF for Management of Tailings and Waste Rock in Mining issued by the European Commission in 2016 [6]:

1. The use of mud farming machinery, namely amphirolls (Archimedes screw tractors), to densify and dry the bauxite residue layers (thereby reducing the footprint generation of the residue) and the use of that same machinery to enhance the exposure of the residue layers to atmospheric carbon dioxide (to reduce the liquid phase alkalinity in the bauxite residue and thereby reduce its pH) ensures that bauxite residue continues to remain a Non Hazardous residue (farmed red mud). This is discussed further in Section 4.1 below.
2. The use of an automated sprinkler supply and distribution network to dampen the BRDA surface quickly and efficiently to avoid surface dust emissions, as shown in Figure 4 below.



Figure 4. Automated sprinkler network operating on BRDA.

It is noteworthy that the 2009 BREF for Management of Tailings includes reference the refineries existing implementation of BAT techniques:

1. Direct vegetation of bauxite residue via reduction of pH by ploughing and weathering, application of washed sand for texture and structure, amendment with gypsum to reduce exchangeable soda and addition of an organic nutrient , This has been demonstrated in dedicated remediated areas which exhibit properties analogous to native soils taken from adjacent grasslands. It has been shown that plant nutrient contents are within typical ranges grasslands.

2. Neutralisation, clarification and sludge thickening of BRDA run-off effluent water. In a wet climate there is a surplus of BRDA run-off water to be disposed. Operation of a neutralisation and clarification system ensures that surplus water can be efficiently treated and disposed of thereby avoiding the need to accumulate a large water inventory.

4.1 Mud Farming

Mud farming is a mechanical plant technique to further process and densify bauxite residue layers following deposition in the BRDA and it also facilitates the atmospheric carbonation of the bauxite residue, reducing its alkalinity. Archimedes Screw Tractors or commonly called amphirolls (see Figure 5 below) are used to plough and densify the bauxite residue by compressing the residue layer as well as increasing the residue surface area to enhance atmospheric drying.



Figure 5. Amphirolling of bauxite residue.

The weight and dynamic movement of the scrolls through the residue squeezes out residual fluid /water thereby densifying and increasing the solids contents. The drying of the residue is enhanced by the increase in surface area of the residue resulting from the ploughed furrows and ridges. The increase in the surface area increases evaporation from the residue as well as increasing the contact area for the residual alkalinity in the residue layer with the atmospheric carbon dioxide - thereby carbonating and reducing the alkalinity and pH of the residue. In addition a low ground pressure bulldozer (see Figure 6 below) is used to grade out the ploughed furrowed surfaces of the residue prior to the placement of the next layer of fresh residue paste.



Figure 6. Bulldozing of carbonated bauxite residue.

The moisture content within the farmed red mud range from 26% to 38%, whilst the values within the non-farmed red mud range from 31% to 49%. Thus moisture content reduces. The dry density of red mud increases from 15.5kN/m³ in the unfarmed layers to 16.8kN/m³ in the farmed layers thereby increasing the density of the residue. The undrained shear strength of the residue has increased from values at 2% strain of 3kPa to 68kPa in unfarmed layers to 3kPa to 129kPa in farmed layers. Therefore the strength, density and stability of bauxite residue increases with mud farming by amphirolling. In addition the pH of farmed red mud is reduced to < 11.5.

This technique is also practised in Alumina refineries in Jamaica, Ukraine and Western Australia.

4.2 Automated Sprinkler System

A DCS (Distributed Control System) controlled sprinkling system is installed in the BRDA to control and prevent fugitive dust emissions. Treated BRDA run-off water at 1000 kPa delivery pressure (650 m³/hr) is distributed to 21 separate sprinkler rows each with up to 13 fixed point sprinkler heads. Only one row operates at a time, in sequence, on timed cycles. When pressurised the sprinkler heads rotate to deliver 360 degree water coverage. Sprinkler times can be adjusted by a Control Room Operator (CRO) by adjusting a set point within the control system. Controls are transmitted through a wireless interface. Valve and sprinkler status are visible to the CRO. Alarms on water flow and pressures are incorporated into the control system. Automated reduction of the supply pressure during valve changes to eliminate water hammer are also incorporated. Key performance data (supply quantity, pressure, locations) are automatically recorded in the Process Information (PI) database for historical reference.

The fully automated sprinkling system with instantaneous remote on/off ensures full control of sprinkling water coverage. This facilitates night-time sprinkling when evaporation is minimised which reduces the consumption of sprinkling water. The entire BRDA surface is (re)wettered within 4 hours in one complete sprinkling system sequence. During sustained high temperatures and dry windy weather continuous 24 hour sprinkling can be implemented. In the refinery, sprinkling water is recycled rainwater run-off from the BRDA surface which would otherwise have been disposed to the river under IE licence.

This technique is also practised in Western Australia.

4.3 Implementation of BAT in New Installations

The refinery is legally required to implement BAT in new projects and gradually implement BAT in existing operations. By way of example, in 2015 the refinery undertook a project to convert a heavy fuel oil (HFO) storage tank (45,000 tonne capacity) into a tank suitable for storage of caustic. Since the refinery installed 2 gas boilers in 2014 the need for this HFO storage tank no longer existed as no HFO consumption is expected on a regular basis. The conversion to a caustic storage tank facilitated the delivery of caustic from North America in high volume vessels. This was a strategic project since the European supply of caustic has reduced significantly in recent years and there is caustic soda production in North America.

The original scope of the project was to refurbish the tank by confirming integrity of floor, removing heating coils, installing insulation and supply/discharge piping, line and test bund, hydrostatically test the tank and remove redundant equipment associated with HFO. However, on review of BAT techniques the scope was altered to include the installation of a new floor which allowed the incorporation of a leak detection system. In addition a full membrane lined bund was installed. The Emissions from Storage BREF (2006) [7] outlines the BAT

requirements on storage. These include a full membrane lined bund which has 110% storage of rated capacity (overflow point) and a leak detection system under the tank floor.

Figure 7 below illustrates the caustic storage and associated membrane lined bund.

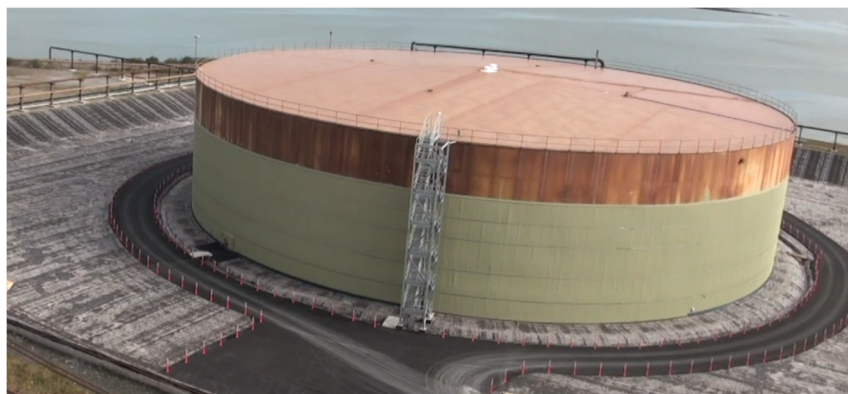


Figure 7. Caustic storage tank.

Of the total project costs, 40% of the expenditure was required to achieve compliance with BAT requirements.

4.4 Implementation of Energy Management System

BAT for energy efficiency is to implement and maintain an energy management system, identify the aspects of an installation that influence energy efficiency by carrying out an audit, identify opportunities to optimise energy recovery, establish energy efficiency indicators, optimise energy efficiency when planning a new installation, seek to optimise the use of energy between more than one process or system and carry out maintenance to optimise energy efficiency.

In 2016 the refinery achieved certification to ISO50001:2011. In doing so, the refinery has committed to the following in order to maintain the refinery as best in class in terms of energy efficiency as well as making a significant contribution to energy conservation:

- Continual improvement in energy efficiency
- Established objectives and performance targets for energy efficiency
- Established purchasing and maintenance procedures which support the purchase of energy efficient products and services
- Energy is a key consideration at the design stage of projects and modifications
- Cooperate with Government bodies to improve energy efficiency at a national level.

The total energy consumption of the refinery has continuously reduced over the past 20 years (with the exception of the 2009 global economic crisis). The best ever steam efficiency performance was achieved in 2016.

5. Combustion Plant ELV's under IED and Large Combustion Plant Directive

Three heavy fuel oil (HFO) boilers provided steam energy for the refinery from start-up. Since 2014 these HFO boilers have been predominantly offline since the plant converted to 100% gas consumption following installation of the gas boilers, installation of a combined heat and power plant (CHP) in 2007 and conversion of calciners from HFO to gas in 2011.

The 3 HFO boilers were licensed before the first Large Combustion Plant Directive came into force in 1987. This resulted in them being designated 'Existing plant' under the Directive and therefore subject to less onerous ELVs than more modern 'New' large combustion plant. Under the 2001 revised Large Combustion Plant (LCP) Directive existing boilers had three options for continued operation from 1st Jan 2008:

1. Comply with the new ELVs of 1700 mg/nm³ SO_x, 450 mg/nm³ NO_x and 50 mg/nm³ particulates
2. Maintain the pre-LCP Directive ELV's but limit operating time to <20,000 hours between Jan 1st 2008 and December 31st 2015 inclusive and then de-commission the boilers.
3. Participate in a National Emission Reduction Plan (NERP) during period 1st January 2008 to 31st December 2015.

Enabled by the CHP project AAL participated in the NERP scheme with the following annual mass emission ELV's achieved: 4,140 tpy SO_x, 1,095 tpy NO_x and 123 tpy particulates.

Under the Industrial Emissions Directive the ELVs that apply to the HFO boilers since 1st January 2016 are: 200 mg/nm³ SO_x, 150 mg/nm³ NO_x and 20 mg/nm³ particulates. However, the HFO boilers were not capable of being modified to guarantee compliance with these new ELV's. Similar to the revised LCP Directive the IE Directive also provided two other options for compliance:

1. Maintain the existing pre IED ELVs but limit operating time to 17,500 hours after 1st January 2016 and decommission the boilers after 17,500 hours of operation or by December 31st 2023 whichever comes first.
2. Enter a Transitional National Plan whereby the annual mass emissions limits would reduce linearly from 2016 to 2019.

The refinery has adopted the first option outlined above. Once the 17,500 operating hours (or December 31st 2023) derogation has been exhausted the boilers must be decommissioned or re-conditioned as new plant. If re-conditioned they will have to perform at the new EU standards that apply at that time.

6. Future of the Industrial Emissions Licence:

It is anticipated that in future years there will be greater emphasis on sustainability, in particular on the circular economy. In this regard, AAL is part of two EU funded consortia tasked with developing economic solutions for the bulk re-use of bauxite residue. Considerable interest has been expressed already by large cement manufacturers who are actively seeking ways of reducing their carbon footprint. This is a much more positive development than in times past, as now multiple industries are coming together to develop more synergistic solutions.

7. Conclusions

The EU plays a crucial role in developing policy and legislation to protect the environment, relating to such aspects as air, water, waste, resources, energy, climate change and sustainability. As a member state, the Irish Government have provided authority to the EPA, set up since 1993, to regulate key activities so they do not harm the environment, in accordance with EU legislation.

AAL have been licenced by the EPA since 1998, undergoing a number of licence revisions before issue of the IEL in 2014. This licence (P0035-06) has been recognised by the EPA as the most stringent licence in Ireland. The Industrial Emissions Directive has led to a number of significant changes for the refinery operations, including mandatory implementation of BAT and limited operation followed by decommissioning of HFO boilers.

It is the mission of the refinery to to improve continuously in the area of environment management. This is evidenced by the successful transition to energy generation from gas.

It is anticipated that there will be a greater emphasis on the circular economy in future legislation.

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