Our Ref. BL3838_0793

Mrs F Devine
National Permitting Service
Environment Agency
Sapphire East
550 Streetsbrook Road
Solihull
West Midlands
B91 1QT

11th August 2014

Sent by email

Dear Fiona

Re: BL3838 Regulation 60 Notice. Justification of delay in meeting BAT-AELs for coke oven effluent treatment at Scunthorpe integrated steelworks

The Environment Agency is currently reviewing the Environmental Permit for Scunthorpe steelworks in order to ensure that the new permits comply with the requirements of the Industrial Emissions Directive (IED). A formal notice served under Regulation 60 of the Environmental Permitting Regulations, requesting information required for this review, was received in June 2013 and Tata Steel submitted a response in September and provided supplementary information in April 2014. This response compared the techniques employed at Scunthorpe with those in the BAT conclusions for Iron and Steel Production published in March 2012, and highlighted some areas where the relevant BAT-associated emission levels (BAT-AELs) would not be achieved before the default deadline of March 2016.

BAT Conclusion 56 states that the use of biological waste water treatment with integrated nitrification and denitrification stages is the Best Available Technique for reducing pollution from coke oven effluent. Tata Steel is now seeking that the Environment Agency agrees a delay in meeting the associated BAT-AELs on the basis that the technique is <u>not available</u> currently at Scunthorpe. Further information is provided herein for the Environment Agency's consideration.

Please do not hesitate if you require anything further.

Katherine Haigh
Long Products Environment Manager

cc. Peter Quinn, Neil Haines, Chris Jackson, Stuart Cadzow, Hamid Rasool, John Spooner – Tata Steel
Steve Proffitt – Environment Agency

TATA STEEL

Long Products Europe
PO Box 1 Brigg Road Scunthorpe Lincolnshire DN16 1BP United Kingdom
T: +44 (0) 1724 404 040 T: +44 (0) 1742 401 721 (direct) Katherine.Haigh@tatasteel.com

Justification of delay in meeting BAT-AELs for coke oven effluent treatment at Scunthorpe integrated steelworks

The 2012 Iron and Steel BREF and the associated BAT conclusions document state that the use of biological waste water treatment with integrated nitrification and denitrification stages is the Best Available Technique for reducing pollution from coke oven effluent. However, in contrast to purely physical or chemical abatement techniques, which can be precisely characterised, there is still a lack of in-depth understanding of the fundamentals of the different biological processes that occur during coke oven effluent treatment and how they may interact. The effluent characteristics and sludge characteristics at each treatment plant are unique and "best practice" evolves in an empirical manner such that experience from one plant is not always directly transferrable to a different plant.

For these reasons, this technique is not immediately available for implementation at the plant treating the effluent from the two coke plants at Scunthorpe without adequate research trials to ensure that improving treatment for some pollutants will not have a detrimental impact on the treatment of other species. The duration of the required research programme and the subsequent lead time to modify the effluent treatment plant mean that it will not be possible to achieve all the BAT-AELs stipulated in the BAT conclusions document before March 2016.

1. Current emission levels

The combined waste waters from Appleby and Dawes Lane coke plants at Scunthorpe, along with drainage waters from both operating plants and the demolished Redbourn coke plant, are treated in a single biological effluent treatment plant. However this plant does not currently incorporate denitrification and nitrification stages and hence the BAT-AEL for nitrogenous species is not achieved, though the performance is consistently better than the current emission limit value (200 mg/l for ammonia).

Treatment efficiencies for a wide range of organic compounds are generally good, all current discharge limits are met and the BAT-AELs for most species are already achieved most of the time. However, the dependence on living organisms means that there is some variability in treatment, and it is not possible to guarantee consistent compliance with all the BAT-AELs at the present time.

A summary of effluent characteristics measured over the period January 2011 to June 2014 is shown in the table below, along with the current discharge limits and the BAT-AELs from the 2012 BAT conclusions document. The percentage compliance with both the current limits and the BAT-AELs is also shown in the table.

			Measured values (Jan 2011 to Jun 2014)		Compliance with	
Parameter	Current limit (mg/l)	BAT-AEL (mg/l)	No.	Average and Range (mg/l)	Current limit	BAT-AEL
pH	5-9	-	115	Range 6.5 - 7.8	100%	-
Suspended solids	150	-	115	Average = 21; Range 5 - 69	100%	-
Nitrogenous species [a]	200	< 15 - 50	115	Average = 103; Range 60 - 133	100%	0%
Biological oxygen demand (BOD_5)	100	< 20	82	Average = 4.4; Range 1.0 - 19	100%	100%
Phenols [b]	5	< 0.5	115	Average = 0.51; Range 0.01 - 2.3	100%	48%
Thiocyanate	10	< 4	115	Average = 1.1; Range 0.5 - 6.7	100%	97%
Cyanide, easily released	0.3	< 0.1	115	Average = 0.08; Range 0.02 - 0.17	100%	82%
Polycyclic aromatic hydrocarbons [c]	-	< 0.05	34	Average = 0.027; Range 0.002 - 0.087	-	91%
Chemical oxygen demand (COD)	-	< 220	Not routinely measured, but 100% compliance with BAT-AEL			
Sulphides, easily released	-	< 0.1	Not routinely measured			

a Current limit and measured results are for ammonia only; BAT-AEL is the sum of ammonia, nitrate and nitrite (all expressed as nitrogen)
b Current limit and measured results are for total monohydric phenols; BAT-AEL does not specify the type of phenol
c Sum of fluoranthene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene, indeno[1,2,3-cd]pyrene and benzo[g,h,i]perylene

It should be noted that the measured concentrations refer to spot samples, whereas the BAT-AELs are based on qualified random samples or 24-hour composite samples.

2. Differences between reference plants and Scunthorpe

At Scunthorpe there are some significant differences from more common practices across Europe:

- Primary cooling of the coke oven gas at both Scunthorpe coke plants is effected by spraying water directly into the gas stream, rather than the more commonly used indirect cooling
- Coke oven gas is currently not desulphurised at Scunthorpe; desulphurisation plants will be installed in the next few years and the effluent characteristics will then change
- At Scunthorpe, coke oven effluent is treated several kilometres from the coke plants themselves, which means that the temperature of the waste water entering the biological effluent treatment plant is significantly lower than would normally be expected

The emission levels associated with BAT are based on experience at a number of reference plants across Europe that use biological waste water treatment with integrated nitrification and denitrification stages. However, there are many alternative options for waste water flows from coke oven plants (as acknowledged in sections 5.1.5 and 5.2.2.2 of the BREF), and the characteristics of the effluent to be treated will therefore differ from one location to another.

One of the reference plants for coke oven effluent treatment discussed in the BREF is at Tata Steel's IJmuiden site. At IJmuiden, the treatment plant receives waste waters from the blast furnaces (and until recently waste water from the AIRFINE scrubber at the sinter plant) as well as the coke ovens and so this situation is not comparable to that at Scunthorpe.

The other reference plants have specific effluent flow rates (see Table 5.24 of the BREF) ranging from 0.44 to 0.69 m^3 per tonne coke, whereas at Scunthorpe the volume of effluent treated is around 1 m^3 per tonne coke. The higher volume at Scunthorpe arises from inclusion of drainage waters from both the operational coke plants and the demolished Redbourn coke plant and means that the process waters make up only around 50% of the total flow and hence the effluent received at the treatment plant is more dilute than would normally be expected. This changes some of the effluent characteristics, such as the ratio of COD to total Kjeldahl nitrogen, in such a way as to make incorporating nitrification and denitrification stages more challenging at Scunthorpe than at the reference plants quoted in the BREF.

It should also be noted that the effluent treatment plant at Scunthorpe was originally designed to treat waste waters from coke plants at the nearby Normanby Park works, Redbourn and Appleby and effluent from a chemical plant and a tar distilling plant. Current effluent characteristics and volumes are not the same as were envisaged when the plant was designed, which impacts on the efficiency of the plant.

Furthermore, the quality of the final effluent is affected not only by the performance of the effluent treatment plant, but also by the way in which the coke oven by-products plant is operated (particularly the ammonia stills and deacidifier). Currently, by-products operations at Scunthorpe have been optimised to allow the complete system (by-products plant plus effluent treatment plant) to achieve the current discharge limits, but to improve performance to achieve the BAT-AELs stipulated in the BAT conclusions document may also require changes to the way the by-products plant is operated.

The reliance on biological processes also means that apparently minor differences in effluent and sludge composition from one site to another can have a significant impact on treatment efficiencies. This is particularly the case for nitrifying bacteria, which are susceptible to a variety of inhibiting effects that are not always well understood, but will be critical to the success of implementing an integrated nitrification and denitrification system at Scunthorpe.

Overall, the differences between the situation at Scunthorpe and those at the quoted reference plants mean that the BAT-AELs cannot be achieved by simply copying the design and operating procedures of one of the reference effluent treatment plants to Scunthorpe and so the nominal Best <u>Available</u> Technique is not immediately <u>available</u> for implementation at Scunthorpe. An extensive research programme is required to ensure that improving treatment for some pollutants (particularly nitrogenous species through the introduction of integrated nitrification and denitrification stages) will not have a detrimental impact on the treatment of other species.

3. Research programme

Tata Steel is committed to improving the performance of the current biological effluent treatment plant to fully achieve the relevant BAT-AELs, but no immediate enhancement of the existing biological waste water treatment plant can be defined pending the outcome of ongoing research.

Many different microbial communities are present in the sludge in a biological treatment plant; the functions of some species are well understood, but others are not, and apparently small changes in the sludge composition can have a profound impact on treatment efficiency. Tata Steel is supporting research at the University of Sheffield to study the microbial communities in coke oven biosludges and their interactions using molecular biology.

Reducing outlet concentrations of ammonia and other nitrogenous species will require implementation of a new treatment regime including both nitrification and denitrification stages. Several different parameters will have to be investigated in order to optimise this regime, including:

- Determine the optimum COD:TKN ratio for complete denitrification to occur and establish whether there will be a need for addition of a supplemental organic carbon source
- Establish the impact of nitrification on the stability of thiocyanate and phenol treatment during start-up
- Determine the optimum recycle ratio and anoxic/aerobic basin volumes (individual and overall hydraulic retention times)
- Study the synchronisation of the nitritification and nitratification stages
- Determine the long-term stability of the denitrification process
- Determine the temperature sensitivity of treatment
- Determine the optimum sludge age

A pilot-scale biological treatment cell, previously used to investigate means of enhancing PAH degradation, is available at Scunthorpe and will be used to investigate the impact of changing operating practices without the risk of the final effluent quality from the BETP deteriorating if the changes adversely impact on treatment efficiencies. The pilot plant currently has only one aerobic treatment cell, and in order to investigate different means of reducing nitrogenous species, one or even two additional cells will need to be built. The pilot plant trials are necessary to ensure that any changes implemented to improve treatment of one pollutant do not have an unforeseen negative impact on treatment of other species. This is particularly important for biological treatment plants, since a disturbance to the complex microbial communities in the sludge may have unintended consequences that cannot be immediately reversed due to the dependence on living organisms.

4. Timetable for research programme

A research programme to test and optimise the introduction of separate nitrification and denitrification stages and other improvements into the existing biological waste water treatment plant at Scunthorpe has been developed, but there is intrinsically some uncertainty over the outline timetable as the success of the trials cannot be predicted beforehand.

- June to September 2014 – add a separate anoxic tank, with associated pumps and pipework, to the existing pilot plant
- September 2014 to April 2015 – optimise pilot plant operation employing separate nitrification and denitrification stages to reduce total nitrogen concentration in the final effluent, whilst maintaining or enhancing treatment of other species
- May to September 2015 – demonstrate the long-term treatment stability of the pilot plant under the optimum conditions
- October 2015 to February 2016 – assess the effectiveness of bioaugmentation to improve treatment stability, assist with recovery from any loss of treatment and further reduce PAH concentrations

5. Implementation at full scale

Only after successfully demonstrating the long-term stability of pilot plant operation can the required modifications to the full-scale plant be specified. It is expected that these modifications will include new pumps and pipework to allow for recycling between aerobic and anoxic stages, the provision of additional heating and possibly the provision of an additional carbon source (e.g. methanol) to ensure the correct COD:TKN ratio for effective denitrification. Furthermore, we have served notice on a third party that we wish to termintate the lease for three cells in the existing plant in order to use them for coke oven effluent treatment. The terms of the lease requires twelve months notice to provide reasonable time for them to make alternative provisions for the treatment of their own effluent. Consequently the three cells will not be available until June 2015.

As stipulated above the timescales for implementation are dependant on completion of the research programme, though a considered view is outlined below:

- August – October 2015 - Finalise the modification designs and specification for any associated infrastructure
- November 2015 – February 2016 – Preparation (including tender process) and submission of a capital expenditure scheme for approval following the Tata Steel Europe protocol
- March – August 2016 – Contract placement and installation on site
- August – January 2017 - Commissioing and optimisation of the system on a staged basis stream by stream allowing for growth of the nitryifying bacteria until the fullscale of the facility is available

6. Impact of current emissions

The cleaned waste waters from the biological effluent treatment plant are discharged into the River Trent, and the environmental impact of the discharge can be assessed for comparison with relevant water quality standards to determine the acceptability of the current discharge levels, even where the BAT-AEL is not achieved.

No measurements of the river flow at the discharge location are available, but a conservative estimate can be made using measurements taken at a non-tidal gauging station at North Muskham near Newark, over 50 km upstream from Scunthorpe. Between Newark and Scunthorpe a number of other rivers feed into the Trent, the most significant of which are the Torne, the Idle and Foss Dyke (all of which are artificial discharges, rather than naturally flowing watercourses). Only data for the Trent, the Idle and its tributary the Ryton are available from the National River Flow Archive[1], maintained by the Centre for Ecology and Hydrology:

		River flow data (m^3/s)	
River	**Gauging Station**	**Mean**	**Q_{95}**
Trent	28022 – North Muskham	89.3	28.6
Idle	28015 – Mattersey	2.39	0.85
Ryton	28016 – Serlby Park	1.75	0.45

The additional flow from the Idle/Ryton is thus relatively small compared to the Trent's flow at North Muskham; a conservative assumption would be that the additional flow from other rivers between Newark and Scunthorpe is insignificant and hence the mean flow of the Trent at Scunthorpe, ignoring tidal effects, would be 93 m^3/s and the Q_{95} flow (i.e. the flow that is exceeded for 95% of the time) 30 m^3/s.

The tidal nature of the Trent at Scunthorpe and the fact that effluent is only discharged on the ebb tide, when the fluvial flow is augmented by the receding tidal flow, further complicate an assessment of the relevant flow parameters. Effluent is discharged over a period of up to four hours commencing an hour after each high tide and hence during discharge the actual flow in the Trent will be significantly greater than the flows estimated above. Without further information it is not possible to estimate the actual flow, and so the above parameters will be used to assess impacts of the discharge from the BETP, which will result in a conservative assessment of short-term impacts.

The Environment Agency's RQP (River Quality Planning) software has been used to estimate the impact of the BETP discharge. It is assumed in the software that the discharge is continuous and into a non-tidal river, so the facts that the discharge only takes place for up to eight hours each day and that the tidal flow will enhance dispersion mean that this assessment will be conservative.

For ammonia, the following parameters were input to the model:

- Mean river flow = 93 m^3/s
- Q95 river flow = 30 m^3/s
- Mean upstream ammonia concentration = 0.093 mg/l 2
- Standard deviation of upstream ammonia concentration = 0.089 mg/l [2]
- Mean discharge flow = 0.1 m^3/s (average flow whilst discharging – does not account for the fact that discharge takes place for no more than 8 hours each day)

[1] www.ceh.ac.uk/data/nrfa/data/search.html
[2] Data for River Trent between Gainsborough and Keadby (2009 data, which is the latest available), from Environment Agency

- Standard deviation of discharge flow = 0.01 m³/s (nominal value - discharge is pumped, so not expected to vary significantly)
- Mean ammonia concentration in discharge = 102.8 mg/l
- Standard deviation of ammonia concentration in discharge = 15.3 mg/l

A Monte Carlo simulation was run with the RQP software, using the default parameters to give an estimate of the impact of the discharge. The mean downstream ammonia concentration was calculated to be 0.25 mg/l and the 90th percentile 0.4 mg/l. The Environment Agency's guidance on assessment of complex surface water discharges[3] suggests that the 90th percentile ammonia concentration in lowland, non-acidic rivers should not exceed 0.3 mg/l for the highest quality and 0.6 mg/l for good quality, so it would be expected that taking into account the environmental impact of current discharges from the BETP, the River Trent would still achieve good quality in terms of downstream ammonia concentrations.

For cyanide, the flow data are the same as for the ammonia example, the mean discharge concentration is 0.077 mg/l, the standard deviation of the cyanide concentration is 0.031 mg/l and it is assumed that there is negligible cyanide upstream of the discharge point. Again, a Monte Carlo simulation has been run and the calculated mean downstream cyanide concentration is 0.12 µg/l and the 95th percentile 0.28 µg/l. The Environment Agency's guidance on assessment of surface water discharges[4] suggests that to achieve good status, the annual mean cyanide concentration in rivers should not exceed 1 µg/l and the 95th percentile concentration should not exceed 5 µg/l, so it would not be expected that current discharges from the BETP would lead to a breach of these standards.

Thus even though the discharges of ammonia and cyanide do not achieve the BAT-AELs at present, the current BETP discharge would not be expected to prevent the attainment of good river quality downstream of the discharge.

7. Conclusions

Overall, the differences between the situation at Scunthorpe and those at the quoted reference plants mean that the nominal Best Available Technique is not immediately available for implementation at Scunthorpe. An extensive research programme is required to ensure that improving treatment for some pollutants (particularly nitrogenous species through the introduction of integrated nitrification and denitrification stages) will not have a detrimental impact on the treatment of other species. The duration of the required research programme and the subsequent lead time to modify the effluent treatment plant mean that it will not be possible to achieve all the BAT-AELs stipulated in the BAT conclusions document before March 2016.

Furthermore, even though the discharges of ammonia and cyanide do not achieve the BAT-AELs at present, the current BETP discharge would not be expected to prevent the attainment of good river quality downstream of the discharge

[3] "H1 Annex E – Surface water discharges (complex)", Issue 2.1, December 2011, page 19
[4] "H1 Annex D – Basic surface water discharges", Issue 2.2, December 2011, page 31