**DeNOx systems optimisation trials report**

Site name:

Operator:

Permit number:

Date:

Version:

**Purpose of the Document**

This document has been prepared by [*Insert ERF Operator*] in fulfilment of Improvement Condition [*X*] of Permit [*insert permit number*]. The text of the improvement condition can be found below.

[*Please check that the text below matches the text of the improvement condition in your permit, and modify if necessary*]

The operator shall perform a study to determine the extent to which the operation of the systems in place at the plant to minimise NOx emissions (including the NOx abatement installed to meet the new emission limit value for NOx of 180 mg/m3 as a daily average) can be optimised. A written report of the study shall be submitted to the Environment Agency which shall include but not necessarily be limited to the following:

* A brief description of the measures installed measures at the installation to minimise NOx emissions, including details of how the reagent dosing system responds to emissions monitoring.
* The results the optimisation study including:
	+ a description of the parameters that were varied during the optimisation e.g. ammonia or urea feed rates, physical form of urea injected, air flows, and the range over which they were varied
	+ the levels of NOx achieved and associated levels of ammonia and nitrous oxide emissions and reagent consumption
	+ observed effects and predicted long-term impacts on plant operation, reliability and maintenance regime
	+ any changes to the composition of the bottom ash and boiler ash and the implications of those changes for the ability to process and use the ash, as well as for the pollution potential of the ash both during processing and its subsequent use as a secondary aggregate (if relevant)
	+ any other relevant cross-media effects
	+ a description of how the plant will be operated on an ongoing basis to minimise NOx emissions, including target emission limit values for NOx and NH3

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# **Description of currently installed measures for NOx reduction and associated maintenance**

### System description:

* Plant description (e.g. number of lines, MW capacity, annual waste throughput, overall FGT system)
* SCR/SNCR and overall description of the deNOx system including primary techniques for NOx reduction i.e. primary and secondary air control, flue gas recirculation (FGR) where applicable, and identification of the OEM
* Confirmation that primary NOx reduction techniques have been optimised (if not, any further optimisation of primary measures should be included as part of the trial)
* Ammonia or urea specification (including dilution when appropriate)
* If urea, solid or liquid and form of solid urea i.e. prills or granules
* On-site reagent storage capacity (quantity and corresponding operational period which this is sufficient for)
* Number of reagent injection points
* Number of reagent injection levels (including conceptual diagram where possible)
* Reagent delivery rates/pressures if available
* How the injection system works including control parameters
* PPMs and routines including blockage inspection, calibration of relevant sensors, boiler repair
* Any other relevant information relating to the de-NOx system e.g. historical performance tests, optimisations or upgrades

# **Optimisation Trial Description**

### Procedure and arrangements

* **Notification of IBA and APCR processors of the trial dates:** This will allow operators of the processing plants to monitor the residues for changes in composition (namely increased ammonia content) and manage any impacts on their process which could arise as a result.
* **Number of lines to be tested**: The strong expectation is for multi-line plants is that a trial will be performed on each line, unless it can be confidently demonstrated that a trial carried out on one line only will be sufficiently representative of the other lines (i.e. identical design and current de-NOx performance between the lines). This will probably only apply to newer plants, and operators should be mindful of limitations as a result of common equipment on one line e.g. can a common dosing system deliver to all 3 lines at the same time, is there sufficient reagent supply capacity etc? Please note that it is at the operator’s risk if they wish to trial only one line.
* **Whether primary techniques will also be optimised in addition to SNCR systems**
* **Trial duration:** Minimum 1 week at each emission level/set point is recommended, but operators can exercise their judgement depending on the set point being tested and initial results being obtained.
* **Target emission levels and associated setpoints:** It is up to the operator to decide suitable steps between NOx set points and to ensure that the lowest set point trialled is fully justified (i.e. why it was deemed unsuitable to trial a lower set point beyond this).
* **Main parameters to be controlled during the trials**
* **Main parameters to be recorded during the trials**
* **Trial termination conditions**: These are likely to be related to e.g. excessive ammonia slip and/or, excessive ammonia identified in residues (IBA/APCR), failure of dosing system including nozzle blockages, diminishing returns on ammonia dosing, excessive ammonia consumption leading to risk of supply shortage/running out of reagent, excessive differential pressure, formation of ammonia salts downstream (this is a non-exhaustive list).
* **Use of abnormal operation for short term determination of raw NOx levels**: It is permissible to use the abnormal operation provisions within permits to operate without the SNCR system for up to 4 hours at a time, should this be necessary to optimise primary measures and/or establish a non-SNCR abated baseline. In so doing, the Environment Agency will accept this as a technically unavoidable stoppage of the plant. Note however that this facility is available for use at the operator's discretion and it is not a requirement of the improvement condition.
* **Data to be collected**
* **Sample number for IBA/APCR:** The sampling frequency should ensure sufficient confidence in the results which demonstrate any increased ammonia concentration in the IBA/APCR within the range of emission levels targeted during the trial. The sampling is likely to focus on IBA/APCR produced when trialling the lower NOx set-point values, and baseline samples should be taken before the trials begin to act as a comparator.

### Normal Operating Conditions

#### Key Operating Parameters

These are required to demonstrate that the plant was operating within normal design or operational ranges for the majority of the trial periods.

Table 1. Design range parameters vs data obtained during trial

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | **Design or current operating value (setpoints)** | **Line 1 Trial Indicative Data (percentile or average)**  | **Line … Trial Indicative Data (percentile or average)**  |
| Steam Flow (t/h) |  |  |  |
| Normal operating range of MCR (%) |  |  |  |
| Oxygen setpoint (at boiler exit) (%) |  |  |  |
| Roof temperature (at top of first pass), °C |  |  |  |
| Baghouse differential pressure (mbar) |  |  |  |
| NOx daily emission value guarantee (mg/Nm3) (corrected value as per permit requirements including confidence interval subtraction) |  |  |  |

#### Waste Composition and NCV

* Include the list of waste codes received and volumes during trial
* Include calculated NCV ranges if available
* Include plant firing diagram if available
* Include any additional composition/CV data e.g. fuel sampling or Bioma software, if relevant and available
* Summary of most recent DeNOx system and/or combustion optimisation reports prior to start of trials if available

# **Optimisation Trial Results**

### Key Plant Parameters

* Present the daily average results in the form of a one chart per incineration line (covering the full trial period) which includes:
	+ Indication of target emission values/ setpoints
	+ Daily average NOx emission values (corrected values with confidence intervals subtracted)
	+ Daily average of ammonia slip at the stack (corrected values with confidence intervals subtracted)
	+ Daily average of reagent consumption (presented as kg or l per t of waste)
	+ Daily average nitrous oxide emissions from trial period if continuously measured (or alternatively example levels from recent operating period)
* Please paste relevant charts into this section from data template
* Include comment on graphs

### Cross Media Effects (IBA, APCR test results)

* Table of results and short description of results for residue reagent content. Typical parameters include **total Kjeldahl nitrogen** (which includes nitrogen from organic nitrogen, urea, ammoniacal nitrogen, and volatile nitrogen) and**ammoniacal nitrogen** (which includes fee or volatile ammonia species eg. ammonium sulphate, chloride and nitrate, but not urea).
* Unavoidable plant deviations during normal operations and their impacts
* Any other observations e.g. increases in differential pressure across bag filters, increased ID fan levels etc.
* Discussion of key deviations from trial log and evaluation of impact (as necessary)

### Reagent Consumption

* Estimated increase in reagent consumption per tonne of waste by emission level or setpoint (use delivery information and/or changes in storage tank level where possible to validate plant measurements)

# **Conclusions**

* Confirmation of compliance with new BAT-AEL's of 180mg/m3 for NOx and 15mg/m3 for ammonia (or other limits specified in the permit)
* Commentary on:
	+ the main findings of the trial e.g.
		- large reduction in NOx concentrations possible for small additional of extra reagent and small increase in ammonia slip; or
		- small reduction in NOx with large increase in reagent and large increase in ammonia slip; or
		- other (please describe)
	+ the likely reasons for the results observed e.g. plant age and sophistication of the SNCR system, original plant design parameters, urea vs ammonia, available residence time etc
	+ limitations of the trials (including the impact of any deviations from the trial protocol) and further work which would be needed to establish achievable performance on a longer-term basis
* If applicable, an implementation plan for any short-term improvements identified to the current operation of the SNCR system which will have minimum impact on ammonia slip, reagent consumption, IBA quality and plant maintenance requirements
* Initial conclusions on potential alternative emission level suitable for the system for the majority of operating time (e.g. percentile-based target NOx emission value range that may be possible to achieve) taking into account the limitations of the system and the short-term nature of the data available from the trials, along with an estimate of the corresponding ammonia slip and reagent consumption ranges; or otherwise justification of why no further improvements below 180 are likely to be feasible with current set-up.
* Views on potential further optimisation improvements which could be considered within financial and technical constraints (beyond carrying out a longer-term trial with existing set-up) e.g. conversion from urea to ammonia, upgraded control systems, flue gas recirculation, retrofit of SNCR system based on acoustic gas temperature measurement (AGAM) etc.