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11 May 2021

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Dear Nathan,

Air Quality Verification Study - Orica Boiler

AECOM were commissioned by Orica Ltd to prepare an air quality verification study (AQVS) in relation to the emissions from the newly constructed and now operational boiler at their plant located on Kooragang Island, NSW. The purpose of the study was to verify whether the recently measured emissions from the boiler stack differed from the emissions assessed in the 2009 Environmental Assessment (EA), and if they do, to make an assessment of whether the differences are material and whether they may result in worse impacts to those predicted in 2009.

1.0 Introduction

The requirement for the preparation of an AQVS was based on project consent condition 22 and 23, which has been reproduced below:

22. The Proponent shall undertake air emission monitoring as required by the EPL for the Project.

Air Quality Verification Study

23. The Proponent shall carry out an Air Quality Verification Study for each relevant stage of the Project to the satisfaction of the Secretary and the EPA. The study shall:

- *a) be prepared by a suitably qualified expert whose appointment has been agreed to in writing by the Secretary;*
- *b) be based on a minimum of 12 months of monitoring data and be completed during the initial 18 months of operation or as otherwise agreed to in writing by the Secretary;*
- *c) include a verification of actual monitored emissions performance against the assumptions adopted within the EIS, including:*
  - *point source pollutant concentrations;*
  - *point source pollutant mass emission rates; and*
  - *point source emission parameters as relevant to plume dispersion.*
- *d) confirm, through direct measurement, that applicable EPL air emission limits are being complied with; and*
- *e) confirm, using reasonable means, the effectiveness of the implemented emission controls in minimising air quality impacts.*

Should the air quality verification study or routine monitoring required by the EPL indicate that emissions from the Project exceed the relevant regulatory criteria, the Department may request that Orica implement all reasonable and feasible measures to minimise emissions

An analysis of the stack emissions testing data and a comparison with the 2009 EA assumptions have been provided in the following letter.

2.0 Emissions Data

Emissions data for the boiler from the 2009 EA and from emissions tests undertaken on the recently installed stack as shown in **Table 1**. Emissions testing have been undertaken on the following dates:

- May 2020; and
- April 2021.

Emissions testing has been undertaken in accordance with the Approved Methods for the Sampling and Analysis of Air Pollutants in NSW by a qualified and NATA certified stack emissions testing company. A review of the testing field sheets has verified that the data is correct and appropriate for the analysis with the 2009 EA document.

Table 1 Stack Emissions Data – 2009 EA and Recently Installed

Parameter	2009 EA Data	Boiler Emissions Data	
		May 2020 Stack Test	April 2021 Stack Test
Stack Height (m)	40	39.9	39.9
Stack Temperature (°C)	200.0	94.1	121.0
Sample Plane Diameter (m)	NA	1800	1800
Sample Plane Velocity (m/s)	NA	2.9	3.4
Stack Tip Diameter (m)	1000	1512	1512
Stack Tip Velocity (m/s)	10.1	4.1	4.8
Oxygen Conc. (%)	NA	6.9	9.0
Moisture Content (%)	NA	16.7	16.7
Flow Rate (Nm^3/s)	8.3	4.7	5.0
NO_X Emission Conc. (mg/Nm^3)[1]	NA	143	207
NOx Emission Limit (mg/Nm^3)[1]	NA	350	
NO_X Emission Conc. (mg/Nm^3)[2]	234.0	112	138
Emission Rate (g/s)	1.95	0.526	0.690

[1] Oxygen Corrected Value (corrected to 3% oxygen)
[2] Non-Oxygen Corrected Value

3.0 Comparison with 2009 EA Assumptions

When considering whether an installed emissions point may result in worse emissions than those predicted in an earlier Air Quality Impact Assessment (AQIA), a range of factors need to be examined. The factors provide an indication of how whether the overall dispersion of the emitted pollutants may be better, worse or much the same as predicted in the EA document.

For the Boiler stack, the pollutants of concern were Oxides of Nitrogen (NO, NO_2 and NO_X), with NO_X being the primary pollutant of concern as NO_X is the pollutant entered into the dispersion model for assessment against NSW EPA criteria. A comparison of the differences between the 2009 EA and the recent stack testing data considered all of the parameters listed above in **Table 1** as follows:

- **Stack Emission limit**. The stack emission limit for the newly installed boiler is 350mg/Nm3 (corrected to 3% O_2). The maximum concentration measured during the two stack testing events in 2020 and 2021 was 207mg/Nm^3, which is well below the limit imposed for the stack. On this basis, the stack is complying with its regulatory limits.
- **Stack Height**. The stack height modelled and the constructed stack height differ by only 0.071m. Stack dimensions for the new Boiler stack are shown in **Figure 1**. This difference in stack height would not result in a material difference in the ground level concentration from the stack.

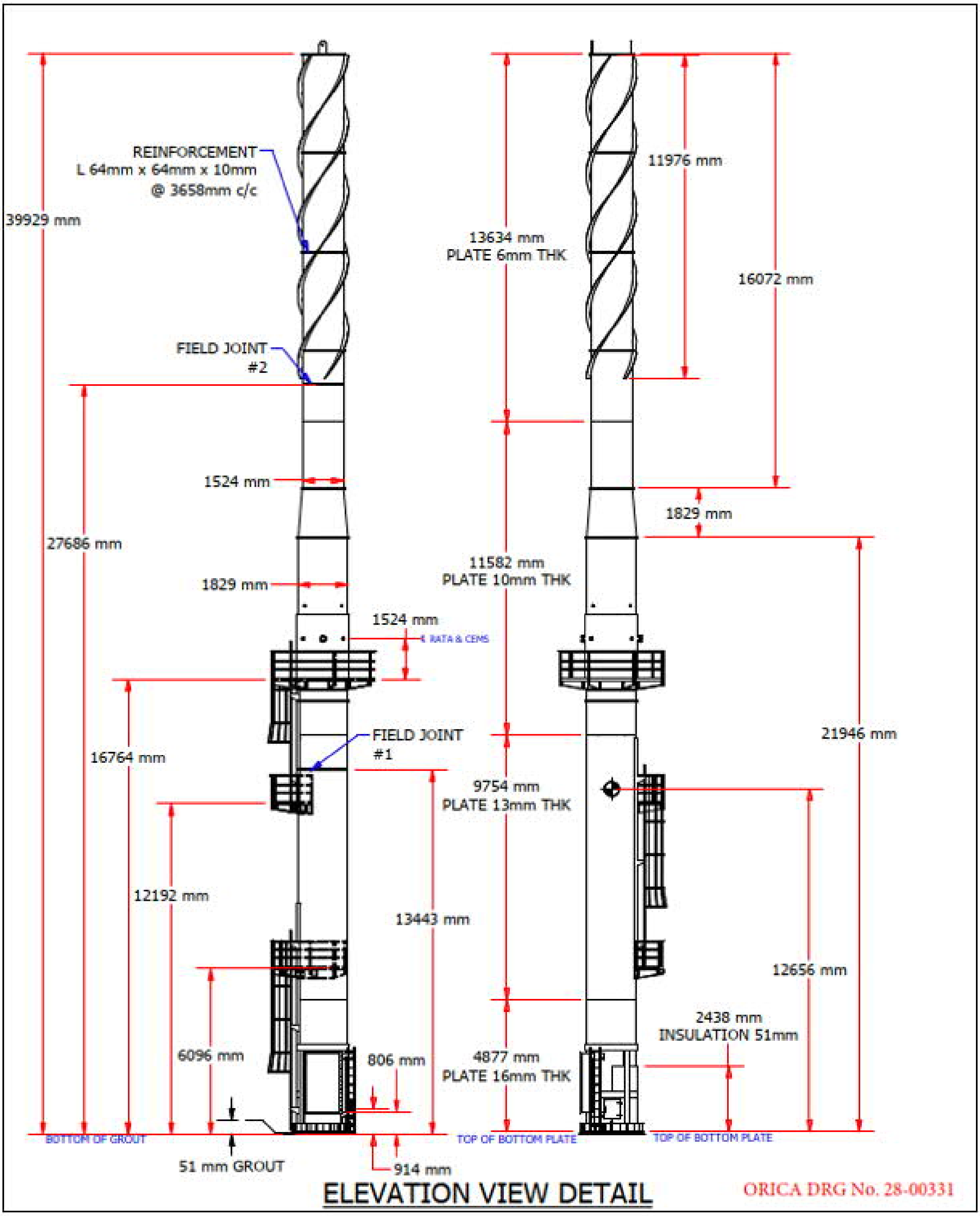

Figure 1 Boiler Stack Details

- **Stack Temperature**. The final stack temperature from the new boiler stack is approximately half of the initially modelled stack temperature (measured stack temperatures were 47% and 61% of the 2009 modelled temperature). The effect of a lower temperature on the dispersion modelling would be that the plume thermal buoyancy and hence plume rise would be reduced, which would in turn result in the plume coming to ground slightly sooner than would be expected with a higher temperature. The effect of the plume coming to ground sooner would be that the ground level concentrations may be slightly higher for the installed stack. Although this is a negative effect, the expected impact on the ground level pollutant concentration is expected to be minor and is not of major concern to the plume dispersion.

- **Diameter, Volumetric Flow Rate and Velocity**. Diameter, volumetric flow rate and velocity are interlinked and changes to any of these parameters change the other (except for diameter, which is fixed). The diameter of the stack tip was assumed to be 1m for the 2009 EA whereby the final stack diameter for the new boiler stack was 1.524m. The larger diameter results in a lower velocity, which is reduced from 10.1m/s in the 2009 EA to 4.0m/s and 4.7m/s for the 2020 and 2021 stack tests respectively. The effect of the lower velocity is similar to the lower temperature whereby the lower velocity results in a shorter stack plume which reaches the ground sooner than a higher velocity plume resulting in higher ground level concentrations. As with temperature, the effect of the lower velocity does not result in a linear increase in ground level concentration and the lower velocity, while likely to have a minor effect on the plume dispersion, is not expected to adversely affect the findings of the 2009 study ie. no adverse effects from the upgraded boiler.
- **Pollutant Concentrations and Mass Emission Rates**. The NO_X pollutant emission rate calculated for the 2009 EA was 1.95 g/s. The emission rates calculated for the 2020 and 2021 stack emissions tests were 0.53 g/s and 0.69 g/s respectively. These values represent 27% and 35% of the 2009 EA modelled emission rate respectively. The measured concentrations are substantially lower than the originally estimated NO_X concentrations and would result in a significant reduction in ground level NO_X concentrations from the boiler itself.

Some of the dispersion modelling parameters suggest that there may be a slightly higher ground level concentration due to the changes in the parameter values measured after the construction of the boiler stack. The mass emission rate of NO_X however, suggests a much lower ground level concentration as a result of the much lower emission rate. It would be expected that the degree of change to the mass emission rate would have a much higher effect on the ground level pollutant concentration. Reduction in mass emission rate results in a linear reduction in ground level concentration while velocity and temperature effects are less significant than emission rate and are not linear e.g. halving temperature or velocity does not result in a doubling of ground level concentrations. The effect of the change in temperature and velocity would be expected to be much lower.

It is also noted that the boiler has a very low relative contribution of NO_X to the atmosphere when compared with other NO_X emission sources included in the 2009 EA (the NO_X sources contributing the majority of the NO_X from the site are the Reformer Flue stack and the Acid Plant stacks, which contribute over 25g/s of NO_X to the atmosphere). This suggests that any changes to the NO_X emissions from the boiler (regardless of the degree of change) are unlikely to have a significant effect on the overall findings of the assessment.

Additional dispersion modelling is not warranted to quantify the changes as a result of the construction of the new boiler given emissions rates were substantially lower than those modelled as part of the 2009 EA i.e. 27-35%. Qualitatively, the large decrease in the emission rate for the Boiler stack would be expected to result in materially lower ground level concentrations and are not expected to be offset by the minor changes in stack velocity and gas temperature. Ground level NOx concentrations surrounding the boiler are therefore qualitatively predicted to be substantially lower than modelled in the 2009 EA for the site and the conclusions reached by the 2009 EA remain valid.

If you have any questions relating to the above analysis, please contact the undersigned.

Yours faithfully

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