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Task 12: Provide comment on the progress of the Botany Groundwater Cleanup Project to date

My role with the Botany Clean Up Project has focused on dioxin emissions from the Groundwater Treatment Plant (GTP) stack. Dioxin test results over the last 6 months have shown a vast improvement over those recorded during the initial 6 months of operation. Dioxin emissions have been consistently below the limit of 0.1 ng/m^3 I-TEQ at 11% O_2, although a minor exceedance was recorded in December last year (0.115 ng/m^3 I-TEQ at 11% O_2).

All testing undertaken to date indicates that the dioxins are forming or being desorbed between the quench outlet and the stack. Dioxin formation mechanisms in combustion processes are still not properly understood due to their complexity. Dioxin formation in combustion systems can potentially be explained by the following three principal mechanisms, which should not be regarded as being mutually exclusive:

- Pyrosynthesis (high temperature gas phase formation)
- *De novo* synthesis (formation from macromolecular carbon and other elements in a specific temperature range).
- Precursor synthesis (formation from various organic precursors).

It is generally accepted that the dominant dioxin formation mechanism in combustion systems is *de novo* synthesis. This actually occurs in the post-combustion zone, as the combustion gases are cooled, in the temperature range 200-450°C. Significant *de novo* formation (ie, 95%) is found in the temperature range 250-400°C, with maximum formation occurring at 300-350°C.

The temperature of combustion gases leaving the GTP heat exchanger is in the range 400-450°C. As expected, the concentration of dioxins at this point is extremely low, with test results similar to those found

with analytical blanks. This excludes pyrosynthesis as a significant dioxin formation mechanism.

If *de novo* synthesis is the dominant mechanism, a dramatic increase in dioxin concentration would be observed between the heat exchanger outlet and the quench outlet, where the temperature of combustion gases falls to 65-70°C. Although an increase in dioxin concentration is generally noted, the most dramatic increase occurs between the quench outlet and the stack, where the combustion gas temperature is maintained at 65-70°C. This is highly unusual.

Desorption of dioxins from surfaces such as scrubber packing materials has been suggested as a possible explanation, but this phenomenon (known as the 'memory effect') generally decreases over time, and is not expected to be a continuing problem after 72 hours of continuous operation.

On-going testing is focusing on precursor synthesis of dioxins as the exhaust gases pass through the acid absorber (after the quench outlet). The term 'dioxins' actually refers to the 210 possible chlorinated dioxin and furan compounds, of which only 17 are considered to be toxic. This toxicity is due to the location of the chlorine atoms on the dioxin or furan molecule. The 17 toxic dioxin compounds represent less than 10% of the 210 types of dioxins present. It is hypothesised that in the acid absorber a number of 'non-toxic' dioxins are converted to the toxic form due to chlorination. For testing conducted in late February the hydrochloric acid strength in the acid absorber was reduced from the normal 5% down to 0.2-0.3%, minimising the amount of available chlorine present. Due to a lack of data the results to date are inconclusive. However, it is still believed that once the specific dioxin formation pathway has been identified this plant will be capable of consistently achieving a dioxin concentration of 0.02 ng/m^3 I-TEQ at 11% O_2 in the stack exhaust.

One very positive development over the past 6 months is that tests indicate that the temperature in the thermal oxidiser can be reduced from 1,000°C to 900°C without significantly increasing the dioxin

concentration in the GTP stack. Apart from the obvious cost savings to Orica, this has the very important benefit of substantially reducing Greenhouse gas emissions from the GTP.

Task 13: Advise of the specific questions that IMC members think the CLC should be asking about the Project.

From my perspective, the most exciting developments in this project are the on-going investigation into dioxin formation between the quench outlet and the stack and the potential to dramatically reduce Greenhouse gas emissions by lowering the incinerator temperature without increasing dioxin levels.

As such, I believe that the CLC should ask Orica what plans it has in place to further investigate the potential for dioxin and Greenhouse gas reduction.