Matisons Toxicology Solutions
toxsolutions@outlook.com
0402 546 967

# *Kwinana Sodium Cyanide Manufacturing Facility Proposed Interim Upgrade Human Health Risk Assessment*

Martin Matisons
Principal Toxicologist

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# SUMMARY

CSBP forms the Chemicals and Fertilisers business units of Wesfarmers Chemicals, Energy & Fertilisers and operates the Kwinana Sodium Cyanide Manufacturing Facility (the Facility) on behalf of Australian Gold Reagents (AGR). The Facility is located within the Kwinana Industrial Area (KIA) and consists of two liquid sodium cyanide plants and a downstream sodium cyanide Solids Plant. The two liquid plants are currently licensed to produce a combined output of 91,000 tonnes per annum (tpa) of pure (100%) sodium cyanide and the Solid Plant is licensed to produce 45,000 tpa of solid sodium cyanide briquettes.

Australian Gold Reagents (AGR) is proposing to increase the combined production capacity of their two liquid sodium cyanide plants from 91,000 tpa up to 110,000 tpa, and their solid production from 45,000 tpa up to 60,000 tpa. To support the proposed increases AGR was required to present an assessment of the air quality impacts and CSBP, on behalf of AGR, engaged Ramboll Australia Pty. Ltd to prepare an air quality assessment report and Martin Matisons of Matisons Toxicology Solutions was engaged to undertake a Human Health Risk Assessment (HHRA). The Ramboll report *Kwinana Sodium Cyanide Manufacturing Facility Interim Upgrade: Air Quality Impact Assessment* dated 2 November 2020 was the basis of this Human Health Risk Assessment (HHRA) by Matisons Toxicology Solutions.

During normal operations the cyanide plants comply with the Environmental Protection Act licence conditions and predicted averages for the baseline and upgrade scenarios are below guidelines for all sensitive receptors. The cumulative averages are also below guidelines and the proposed upgrade is not expected to produce any significant change.

Start-up processes considered emissions of $NO_2$, $NH_3$, and HCN and were based on the results of AGR's stack emissions monitoring undertaken during the start-up of sodium cyanide liquid plant 1 (SCP1) in May 2020. This provided actual real time monitored emission data compared to modelled emissions which were used in the Air Quality Impact Assessment undertaken by Ramboll in August 2019. The real time monitoring data produced lower predicted ground level concentrations (GLCs) when compared to the modelling undertaken in 2019 using modelled emissions.

At start-up the hazard quotients (HQs) for the predicted GLCs in the AERMOD model were generally at or less than 1, except at the site boundary and at Wells Park for HCN and $NH_3$ and 3-minute GLCs for $NH_3$ and HCN at Hope Valley and the oval near the Motorplex. All HQs for sensitive receptors outside the facility were less than 10 in the AERMOD model. In the DISPMOD model HQs were less than 1 for $NO_2$ 3-minute and 1-hour and the 1-hour $NH_3$ and HCN predicted GLCs with the HQs for 3-minute $NH_3$ and HCN predicted GLCs for all receptors being less than 4.0.

Nitrogen dioxide HQs were at or less than 1 for all neighbouring receptors of concern. Hydrogen cyanide HQs were less than 1 for receptors of concern except for the 3-minute average GLCs in the DISPMOD model across all sites and the AERMOD model for Wells Park and

the northern industrial sites. None of the HCN HQs exceeded 10. Ammonia HQs showed a similar pattern with only the 3-minute average GLCs in the DISPMOD model across all sites and the AERMOD model for Wells Park and the northern industrial sites being greater than 1. None of the ammonia HQs exceeded 10. The highest HQs were seen at the nearest receptor of Wells Park followed by the northern industrial area. The most eastern and most southern locations had the lowest predicted GLCs.

No significant health issues are expected from start-up processes since the HQs for maximum predicted GLCs at start-up operations in the AERMOD and DISPMOD models were all less than 10 for neighbouring receptors of concern with the majority less than 1 and the remainder with the exception of an 8.2 for $NH_3$ at Wells Park, less than 4.

The frequency of start-ups has significantly decreased over the last decade or so with only two this year to date. This has significantly reduced the likelihood of guideline exceedances over time with the probability of an exceedance of the 1-hour guideline occurring during 2019, with 4 start-up events, at the nearest sensitive receptor location of Wells Park being less than 3 in $10^6$ hours for both HCN and $NH_3$. Based on the 2 start-up events for 2020, this probability reduces to 1 in $10^6$ and 2 in $10^6$ hours for HCN and $NH_3$ respectively.

In relation to waste gas venting the maximum HCN HQs for the single and two plant venting scenarios were well below the relevant air quality criteria. For ammonia, the HQs were less than 10 for all sensitive receptors under the 2-plant scenario in both models and under the 1 plant scenario were less than 5.

Based on a 2-plant simultaneous waste gas venting scenario using the conservative assumption of venting for 943 hours the probability of an exceedance of the 1-hour average $NH_3$ guideline 0.3% at the closest sensitive receptor and no more than 0.1% at the other receptor sites. It is important to note that these are overestimates as simultaneous venting of the two liquid plants is unlikely to be occur frequently. Also, the predicted 1-hour average GLCs will be reduced significantly by the proposed interconnection of the waste gas lines as part of the Facility upgrade.

The proposed interconnection of the waste gas lines from both cyanide production plants will enable waste gas to be directed to the alternate incinerator in the event of a trip. This will substantially reduce the duration of waste gas venting in the event of an incinerator trip from potentially hours to minutes and therefore substantially reducing emissions.

The proposed upgrade is unlikely to produce untoward health concerns based on planned shutdowns and plant trips based on the projected maximum GLCs during plant shutdown with the majority of HQs well below 1 and the closest sensitive receptor at Wells Park less than 4.

Overall, the proposed increase in production in conjunction with the proposed upgrades to the cyanide plants is not expected to produce untoward health effects in the nearby community

based on predicted emissions from start-up, waste gas venting and planned shutdowns or plant trips.

# INTRODUCTION

Australian Gold Reagents (AGR) is proposing to increase the combined production capacity of its two liquid sodium cyanide plants from 91,000 tpa up to 110,000 tpa, and their solid production from 45,000 tpa up to 60,000 tpa. The atmospheric emissions of oxides of nitrogen (NOx), ammonia (NH3) and total cyanide from the Facility will remain within the current emission limits and targets under normal operations, as specified in AGR's Environmental Licence for the Facility (Licence number L6110/1990/13), following the proposed upgrade.

As part of the regulatory approval process, AGR is required to present an assessment of the air quality impacts associated with the proposed upgrade of the Facility. As part of this process CSBP, on behalf of AGR, has engaged Ramboll Australia Pty Ltd undertake an assessment of the air quality impacts associated with the proposed upgrade of the Facility's liquid and solids sodium cyanide plants and Martin Matisons of Matisons Toxicology Solutions to undertake a Human Health Risk Assessment.

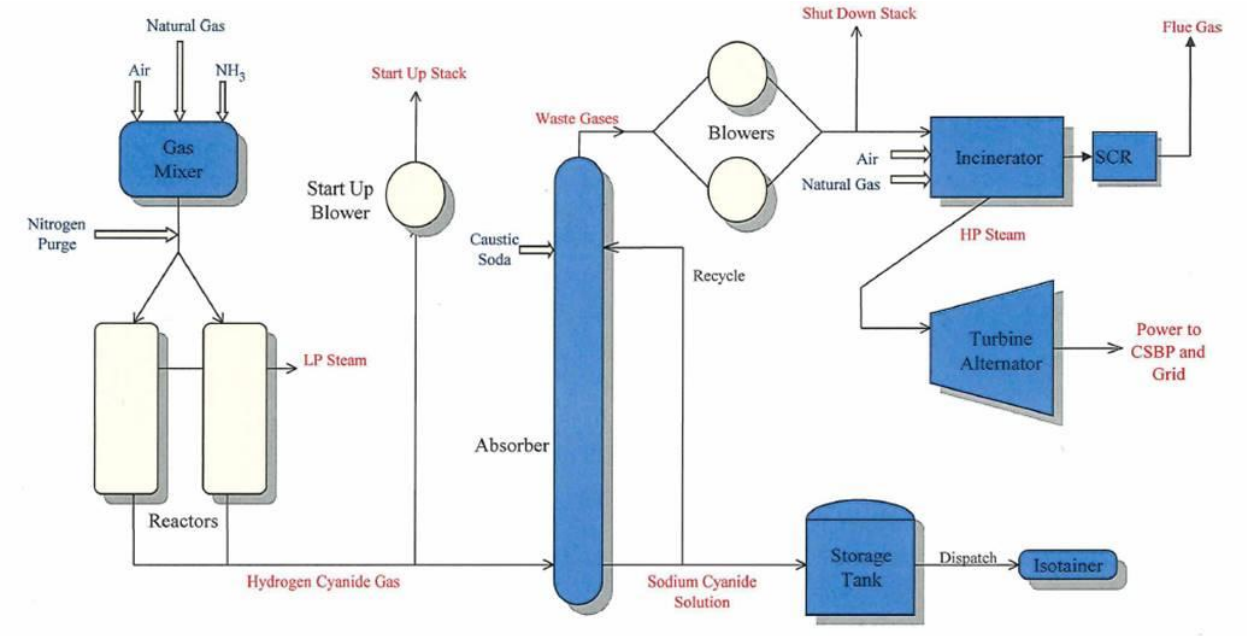
Ramboll Australia Pty. Ltd (Ramboll 2020) has prepared an air quality assessment report: *Kwinana Sodium Cyanide Manufacturing Facility Interim Upgrade: Air Quality Impact Assessment* dated 2 November 2020. This report is the basis of this Human Health Risk Assessment (HHRA) by Matisons Toxicology Solutions.

The increased liquid plant production up to a combined total of 110,000 tpa sodium cyanide (expressed as 100% sodium cyanide) is proposed by CSBP to be achieved by improved yield (efficiency of raw materials usage), improved equipment reliability and optimisation of existing plant resulting in operation at higher production rates over longer durations. The increased solids production up to 60,000 tpa is proposed to be achieved by increasing liquid feed strengths, improved equipment reliability and optimisation of existing plant resulting in operation at higher production rates over longer durations.

## PROCESS DESCRIPTION – START-UPS AND WASTE GAS VENTING

The upset operating conditions of interest in this HHRA are plant start-ups, planned shutdown or plant trip and waste gas venting. The process for start-up and waste gas venting is illustrated in Figure 1.

## Figure 1: Start-Up and Waste Gas Venting Process Flow Diagram




Plant start-up events occur prior to the incinerators being online and accepting waste gas. During plant start-up events emissions from the two liquid plants are first released via dedicated start-up stacks, located downstream of the reactors but prior to the absorber column. Once the reactors are online, waste gases are then pulled through the absorber towers and fed through to the John Zink (SCP1) and Maxitherm (SCP2) incinerators for combustion. There are several phases in the start-up, each with their own emission profile. From the first feedstock flow through to the waste gas being accepted to the incinerator it typically takes approximately 1 hour to complete though can vary depending on process conditions at the time.

The waste gases from the liquid plants are low in calorific value so natural gas is used to assist in the oxidisation of residual $NH_3$, HCN and other inert gases into $N_2$, $H_2O$, $CO_2$ and NOx. The incinerators are not 100% efficient so small amounts of $NH_3$ and HCN typically well below compliance requirements are also emitted. The two incinerators employ different methods to control NOx emissions prior to discharge to the atmosphere via the incinerator stacks. SCP1 waste gases are fed to a dual-stage incinerator where the front end produces reducing agents in an oxygen deprived environment followed by an oxygen rich environment which completes the combustion process. SCP2 waste gases are fed to a single stage incinerator combined with a selective catalytic reduction (SCR) unit. A continuous emission monitoring system is used to measure NOx emissions from each incinerator.

There are periods of time when the individual incinerators are not operational. Planned shutdowns of the incinerators are normally scheduled to coincide with the corresponding NaCN plant shutdown, however there are occasions where the incinerator can be unavailable while

the plant is running. These include planned emergency maintenance requirements or unplanned incinerator failures (i.e. incinerator trips). This results in the scrubbed gases downstream of the absorber column being vented to atmosphere via the shutdown stack and is known as 'waste gas venting'.

Management processes during these events include automated control system reductions in plant throughput, notification to nearby industries and downwind monitoring, which are implemented to minimise emissions and impact to people and the environment. The duration of the incinerator trips is variable between a few minutes up to a few hours.

To reduce the variability of time spent waste gas venting, CSBP have commenced design and engineering for a new crossover pipe that will connect the waste gas streams between SCP1 and SCP2. This crossover will essentially create a common header for waste gases from the liquid production plants enabling the waste gases from either plant to be fed to either incinerator. This will result in a significant improvement to the existing environmental impact of waste gas venting as emission duration will no longer be coupled to the offline incinerator.

Instead, following a waste gas venting transition period, the waste gases from the venting plant will be fed through the crossover and into the running incinerator. This transition is expected to take approximately 10 minutes and accounts for reducing rates in both plants, opening the crossover valve and balancing the waste gas flowrates in a steady and controlled manner to ensure no additional impact to the production plants and the running incinerator. Once the offline incinerator is operational again, the above process will essentially occur in reverse to reinstate "normal running" conditions.

Emissions during start-ups and waste gas venting are not impacted by production rate as production rate is reduced during a waste gas venting event.

CSBP is also undertaking an engineering study to determine how to reduce emissions during upset conditions from the two liquid sodium cyanide plants and has proposed to implement the outcomes in two stages (overview of stage 2 has not been provided).

The first stage (which forms the basis for this proposal) consists of interconnecting the waste gas lines from both production plants, enabling operational flexibility for waste gas processing. This will result in a significant reduction in time, from potentially hours to minutes, spent venting as it will no longer be coupled to the offline incinerator. Instead, following a transition period, the waste gases from the venting plant will be fed through a combined header to the running incinerator. To achieve this, both plants will have to reduce production rates by approximately half to avoid exceeding the combustion capacity of the running incinerator. Emissions during start-up and shutdown are not affected by the increase in production and will remain unchanged during this first phase.[1]

[1] The second stage consists of the procurement of a new combustion unit which will provide greater control, improve response and additional capacity to reduce the extent of rate reduction required. The improved response

The air quality assessment was to consider the potential air quality impacts arising from emissions of nitrogen dioxide ($NO_2$), ammonia ($NH_3$) and hydrogen cyanide (HCN) associated with the proposed upgrade of the liquid and solids sodium cyanide plants. The following scenarios were considered in the air quality assessment by Ramboll (2020):

- Normal operations
- Start-up operations
- Waste gas venting
- Planned shutdown or plant trip

DWER have also requested a toxicology report be undertaken by a qualified expert to demonstrate that emissions would not adversely impact on human health during start-up, planned shutdown or plant trip and waste gas venting events.

## OBJECTIVE

The objective of this HHRA is to assess whether the emissions would adversely impact on human health during start-up, waste gas venting and shutdown events by reviewing the data provided by Ramboll (2020) for each of the following five modelled scenarios:

1. Start-up operations: – Start-up of a single liquids plant (assuming start-up events only occur subject to the meteorological conditions specified in the Licence and between the hours of 18:00 and 06:00, in line with CSBP operating practices) operating at both average and peak emissions scenarios;
2. Waste gas venting: – Waste gas venting for a single liquids plant, assuming the production rates for SCP1 and SCP2 are reduced by 50%, upgraded solids plant remains operating under normal conditions and with the process to interconnect the incinerators taking up to 10 minutes;
3. Simultaneous waste gas venting for both liquid plants SCP1 and SCP2 and upgraded solids plant remains operating under normal conditions;
4. Planned shutdown or plant trip: – Shutdown/trip of a single liquids plant operating at both average and peak emissions scenarios assuming the other upgraded liquids plant and upgraded solids plant remain operating under normal conditions; and
5. Simultaneous shutdown/trip: - shutdown of both liquid plants operating at both average and peak emissions scenarios and upgraded solids plant remains operating under normal conditions.

will result in another iterative improvement to the time spent waste gas venting (from minutes to seconds, in some cases). In addition to processing waste gas, the new combustion unit will be designed for processing of start-up emissions through the various phases. Completion of the second stage enables complete abatement of upset conditions and will be the subject of another HHRA.

## BACKGROUND – 2019 ASSESSMENT

In 2019 an air quality impact assessment (Ramboll 2019a) with HHRA (Ramboll 2019b) and a peer review of the HHRA (Matisons 2019) was used "to assess modelled air concentrations of emitted compounds from the AGR site and determine if exposure may cause any unacceptable risks to identified human receptors in the area" in support of a Section 45C request by CSBP to increase sodium cyanide liquids production from 85,000 tpa up to 91,000 tpa.

The 2019 HHRA found that $NO_2$, $NH_3$, and HCN emissions from the start-up of the liquid sodium cyanide plants are the emissions of concern with the receptors of concern being the sensitive recreational users at Wells Park.

Risk estimates for waste gas venting from the two liquid cyanide plants and shutdowns/trips from both these plants were low and posed no health risk.

The start-up for a single plant was identified as the source of emissions that could pose some health concerns. Risk estimates for start-up from a single plant for the majority of receptors were low and acceptable (HQs of 4 or less). However, Wells Park was identified by the HHRA as the only area of concern with a HQ of 12 for $NO_2$ only.

The HHRA however did have some deficiencies, the major ones highlighted by DWER. This required some recalculation of HQs for off-site occupational receptors and provision of additional data to support arguments for varied exposure scenarios.

The recalculated HQ for $NO_2$ for off-site workers did raise potential for some health concerns. Industrial workers however, were highly unlikely to be as sensitive when compared with the most sensitive members of the general population, particularly when the significant health effect of $NO_2$ on the respiratory system and asthma were taken into account.

Additional data presented in the Peer Review demonstrated that for 2016 to 2019 the wind direction was not in the direction of Wells Park when start-ups occurred thus resulting in no exposure to $NO_2$, $NH_3$, and HCN emissions. The most recent start-up that occurred when the wind direction was in the arc to Wells Park was in 2015 when the wind speed was recorded at 8.21 m/sec ensuring good dissipation of emissions. Therefore, over the last five years the prevailing winds have been such that no significant exposure to $NO_2$, $NH_3$, and HCN from start-ups would have been expected at Wells Park.

In addition, the recommendation of the HHRA of adjusting the arc to 70 degrees for wind speeds greater than 4.5 m/sec (which was subsequently implemented) would provide further reassurance that if maximum emissions were produced, they would be dissipated by stronger winds and unlikely to cause significant health outcomes to sensitive receptors at Wells Park.

# METHODOLOGY

The HHRA adopted the approach of enHealth (2012). The enHealth (2012) guidance is the accepted Australian guideline.

## CHEMICALS OF CONCERN

The chemicals of concern (CoC) were $NO_2$, $NH_3$, and HCN. These were considered appropriate in the previous HHRA (Ramboll 2019b and Matisons 2019) assessed by DWER.

Ammonia is an acute toxicant and produces irritant effects on mucous membranes. Nitrogen dioxide on the other hand acts systemically on the respiratory system affecting lung function, exacerbating respiratory disease and exacerbates and triggers asthma. Hydrogen cyanide is a systemic toxicant that affects the central nervous, cardiovascular and respiratory systems. The National Environmental Protection Council (NEPC) has found there is considerable evidence on the health effects of $NO_2$, and that these effects are independent of other pollutants, including particulate matter (NEPC 2019).

## GUIDELINES USED

The HHRA adopted the guidelines used in the Air Quality Impact Assessment (Ramboll 2020) to calculate hazard quotients. The 1-hour guidelines were based on the NEPM for $NO_2$ and $NH_3$ (NEPC 2015) and the NSW EPA for HCN (NSW EPA 2016). The 3-minute guidelines were based on the Victorian EPA guidelines for $NH_3$, and HCN (EPA Victoria 2001) and the odour threshold for $NO_2$ established in the review by Ruth (Ruth 1986). These guidelines were also used in the assessments undertaken in 2019. The annual guidelines used were the NEPM for $NO_2$ and as no suitable Australian based annual guidelines for $NH_3$ and HCN were available the US Agency for Toxic Substances and Disease Registry (ATSDR) and the Californian Office of Environmental Health and Hazard Assessment (OEHHA) were used. The ATSDR and OEHHA references were updated to the most recent citation compared with those used by Ramboll (2020). The annual guideline did not change except for HCN where the guideline given by the OEHHA was 9 instead of 8.8 as used by Ramboll (2020). The guidelines are represented in Table 1.

**Table 1: Guidelines for Chemicals of Concern.**

| Chemical | Exposure Time | Guideline µg/m$^3$ | Reference |
|---|---|---|---|
| Nitrogen dioxide $NO_2$ | 3 minutes | 2,000 | Ruth (1986) |
| | 1-hour | 226 | NEPC (2015) |
| | annual | 56 | NEPC (2015) |
| Ammonia $NH_3$ | 3 minutes | 578 | EPA Victoria (2001) |
| | 1-hour | 320 | NSW EPA (2016) |
| | annual | 70 | ATSDR (2020) |
| Hydrogen cyanide HCN | 3 minutes | 365 | EPA Victoria (2001) |
| | 1-hour | 199 | NSW EPA (2016) |
| | annual | 9 | California OEHHA (2019) |

## RECEPTORS OF CONCERN

Discrete receptors were used in the modelling to represent residential areas (nearest residence 2.1 km due east from the cyanide plant, North Rockingham, Residence 3 to the south east adjacent to Sloan's Reserve, Hope Valley, Calista Primary School and Wombat Wallow Childcare Centre), recreational locations (Wells Park, Kwinana Golf Course and Thomas Oval) and the northern industrial area (Hope Valley and the oval by the Kwinana Motorplex)

The spatial distribution of the receptors is shown in Table 2. Colour coding represents broad location area. The listed order within the location/direction column is based on the nearest to most distant from the cyanide plants.

**Table 2: Receptors of Concern.**

| Receptor | Distance from facility (km) | Location/direction | Type of receptor |
|---|---|---|---|
| *Wells Park* | 1.4 | South west | recreation |
| *North Rockingham* | 3.2 | South west | residential |
| *Oval by Motorplex* | 2.8 | North east | industrial |
| *Hope Valley* | 4.2 | North east | industrial |
| *Kwinana Golf Course* | 2.0 | East | recreation |
| *Nearest residence* | 2.1 | East | residential |
| *Thomas Oval* | 2.1 | East | recreation |
| *Wombat Wallow Childcare Centre* | 2.9 | East | residential |
| *Calista Primary School* | 3.3 | East | residential |
| *Residence 3* | 3.0 | South east | residential |

Wells Park is the closest receptor located in the coastal fringe, 1.4 km south-west from the cyanide plants. The nearest residence in approximately 2.1 km due east from the cyanide plants.

DWER conducts ongoing ambient air quality monitoring within the Kwinana region for criteria pollutants including $NO_2$ and also undertakes campaign monitoring programs to measure ambient concentrations of other compounds such as $NH_3$. Some of the monitoring sites namely: Hope Valley, North Rockingham, Calista Primary School for $NO_2$ and Wells Park, Kwinana Golf Course, Thomas Oval for $NH_3$ are also sites considered as receptors of concern in the current HHRA.

Historical DWER monitoring undertaken in the Kwinana found that the maximum 1-hour and annual average $NO_2$ concentrations did not exceed the NEPM guidelines and were less than 70% and less than 30% of the 1-hour and annual guidelines respectively. The monitored ambient $NH_3$ concentrations were significantly less than the 1-hour and annual guidelines adopted by Ramboll (2020).

## HAZARD QUOTIENTS (HQ)

Acute (non-cancer) HQs were derived by combining the applicable short-term exposure concentration (EC) and acute dose response guideline value (GV), namely:

$$HQ = EC/GV$$

The exposure concentration used was the predicted GLCs from each model as a surrogate for the inhalation exposure concentration for the population at the receptor sites. The default assumption is that the population of interest is breathing outdoor air continuously at the modelled location. This is a conservative assumption but applicable for acute exposures over minutes to an hour as in the case for the start-up operations.

HQs less than or equal to 1 can be considered as having negligible risk. HQs less than 10 were considered to have acceptable risk in line with previous assessments (Ramboll 2019b and Matisons 2019). HQ greater than 10 would require further evaluations/investigations to assess potential for adverse effects. Generally, a HQs of 10 or more constitute a higher level of exceedance.

## LICENCE LIMITS AND TARGETS

Under the Environmental Protection Act the liquids and solids plants have had emission limits and/or targets established for $NO_2$, $NH_3$, and HCN. These are given in Table 3 and were used to assess compliance with the Environmental Protection Act Licence conditions.

**Table 3: Environmental Protection Act Licence limits and targets** (values in grams/second [g/s]).

| Parameter | Licensed Emissions g/s | | | |
|---|---|---|---|---|
| | SCP1 & SCP2 Incinerators | | Solids Plant | |
| | Limit | Target | Limit | Target |
| NOx equal to or more than 95% operating time over the previous 12 months | 5.0 | n/a | n/a | n/a |
| NOx equal to or less than 5% of operating time over the previous 12 months | 12.0 | n/a | n/a | n/a |
| Ammonia | n/a | 0.60 | n/a | 1.5 |
| Total Cyanide | 0.58 | 0.35 | 0.58 | 0.35 |

## AIR DISPERSION MODELLING

DISPMOD (Version 2005) and AERMOD (Version 16216) were both used in the air quality impact assessment by Ramboll (2020) to predict the air quality impacts from the liquid cyanide plants.

DISPMOD is a Gaussian air dispersion model developed by the DWER. DISPMOD is considered to be an appropriate model to predict dispersion characteristics from elevated emission sources located on the Kwinana coastline.

AERMOD is one of the current United States Environment Protection Agency (USEPA) recommended air dispersion models and was designed to support the USEPA's regulatory modelling programs. AERMOD incorporates advanced methods for handling complex terrain

and is the USEPA's preferred model for most local scale regulatory applications and provides a more realistic handling of building downwash effects.

The DISPMOD air dispersion model has a limited capacity for considering the influence of building wake effects on plume dispersion, while AERMOD can account for building wakes but does not include an algorithm for coastal fumigation. These two models were chosen in order to ensure the modelling results account for coastal dispersion influences and building wake effects.

The GLCs have been predicted assuming start-up events only occur subject to the meteorological conditions specified in the licence (see text box) and between the hours of 18:00 and 06:00, in line with AGR operating practices.

AGR provided Ramboll with 16-second stack monitoring data recorded during a start-up event in May 2020. The average emission rates were used to determine the predicted 1-hour average GLCs, while the peak emission rates were used to determine the 3-minute average GLCs.

# RESULTS

## NORMAL OPERATIONS

Ramboll (2020) found that the predicted maximum 1-hour and annual average $NO_2$, HCN and $NH_3$ GLCs beyond the site boundary were below the corresponding guidelines, for both the baseline and upgrade operating scenarios. The maximum off-site $NO_2$ averages approached 55% of the 1-hour and 20% of the annual NEPM guidelines. The maximum off-site HCN GLCs predicted for normal operations were at or below 15% of the corresponding guidelines for the existing and upgrade scenarios based on the licensed emissions limit and less than 10% based on the licensed emissions target. The maximum average $NH_3$ GLCs were below 30% of the short-term guideline and less than 3% of the annual guideline.

For all three chemicals of concern, the maximum off-site GLCs predicted for the upgrade scenario is similar to and in some cases slightly lower than those predicted for the existing scenario. Ramboll (2020) have attributed this to the increased flowrate and exit velocity for liquid plants under the upgraded scenario, while mass emission limits have remained unchanged which lowers the concentrations of pollutants being emitted from the stack.

## START-UP OPERATIONS

The air quality impact assessment for start-up operations (Ramboll 2020) has predicted maximum 3-minute and 1-hour averages for $NO_2$, HCN and $NH_3$ GLCs using the AERMOD and DISPMOD models. Hazard quotients (HQs) were calculated for the maximum predicted GLCs

from the AERMOD and DISPMOD modelling and are presented in Tables 4 and 5 respectively. They were based on Table 13: *Summary of Maximum Predicted GLCs – Start-up Operations* presented in Ramboll (2020).

**Table 4: Hazard quotients (HQs) for maximum predicted GLCs at start-up operations – AERMOD modelling.** (Colour coding is based on location - see table 2)

| | $NO_2$ | | HCN | | $NH_3$, | |
|---|---|---|---|---|---|---|
| **receptor** | **3-minute** | **1-hour** | **3-minute** | **1-Hour** | **3-minute** | **1-Hour** |
| **Site boundary** | 2.4 | 1.9 | 21.9 | 4.9 | 19.1 | 5.1 |
| **Wells Park** | 1.0 | < 1 | 9.6 | 2.1 | 8.2 | 2.2 |
| **North Rockingham** | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| **Oval** | < 1 | < 1 | 2.2 | < 1 | 1.8 | < 1 |
| **Hope Valley** | < 1 | < 1 | 1.7 | < 1 | 1.3 | < 1 |
| **Golf course** | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| **Nearest residence** | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| **Thomas oval** | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| **Wombat CC** | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| **Calista PS** | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| **Residence 3** | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| **guideline** | **2000** | **226** | **365** | **199** | **578** | **320** |

The AERMOD model (Table 4) found the HQs for maximum predicted GLCs at start-up operations were generally at or less than 1, except at the site boundary of the cyanide plants and at Wells Park for $NH_3$ and HCN and 3-minute GLCs for $NH_3$ and HCN at Hope Valley and the oval near the Motorplex (the northern industrial area). With the exception of the 3-minute HQs at the site boundary for $NH_3$ and HCN of 19.1 and 21.9 respectively all other HQs were less than 10 in the AERMOD model.

The DISPMOD model (Table 5) found that the 3-minute and 1-hour HQs for maximum predicted GLCs at start-up operations were less than 1 for $NO_2$ and the 1-hour HQs for $NH_3$ and HCN with the HQs for the 3-minute GLCs for $NH_3$ and HCN being less than 4.0.

**Table 5: Hazard quotients (HQs) for maximum predicted GLCs at start-up operations – DISPMOD modelling.** (Colour coding is based on location - see table 2)

| | $NO_2$ | | HCN | | $NH_3$, | |
|---|---|---|---|---|---|---|
| **receptor** | **3-minute** | **1-hour** | **3-minute** | **1-Hour** | **3-minute** | **1-Hour** |
| **Site boundary** | < 1 | < 1 | 2.4 | < 1 | 3.9 | < 1 |
| **Wells Park** | < 1 | < 1 | 3.6 | < 1 | 3.1 | < 1 |
| **North Rockingham** | < 1 | < 1 | 1.7 | < 1 | 1.3 | < 1 |
| **Oval** | < 1 | < 1 | 3.6 | < 1 | 3.3 | < 1 |
| **Hope Valley** | < 1 | < 1 | 3.4 | < 1 | 3.1 | < 1 |
| **Golf course** | < 1 | < 1 | 2.6 | < 1 | 2.1 | < 1 |
| **Nearest residence** | < 1 | < 1 | 2.4 | < 1 | 2.1 | < 1 |
| **Thomas oval** | < 1 | < 1 | 2.3 | < 1 | 1.8 | < 1 |
| **Wombat CC** | < 1 | < 1 | 2.2 | < 1 | 1.7 | < 1 |
| **Calista PS** | < 1 | < 1 | 2.0 | < 1 | 1.6 | < 1 |
| **Residence 3** | < 1 | < 1 | 2.0 | < 1 | 1.6 | < 1 |
| **guideline** | **2000** | **226** | **365** | **199** | **578** | **320** |

Nitrogen Dioxide

Overall, for nitrogen dioxide, the HQs for predicted maximum 3-minute and 1-hour average GLCs for both models were at or less than 1 for all neighbouring receptors of concern. The only HQs greater than 1 were at the site boundary in the AERMOD model but were less than 2.5.

Hydrogen Cyanide

For hydrogen cyanide the only HQs greater than 1 were for the 3-minute average GLCs in the DISPMOD model across all sites and the AERMOD model for the northern industrial sites and at Wells Park with HQs of 9.6 and 7.1 at 3-minutes and 1-hour respectively. Except at the site boundary, HCN HQs did not exceed 10.

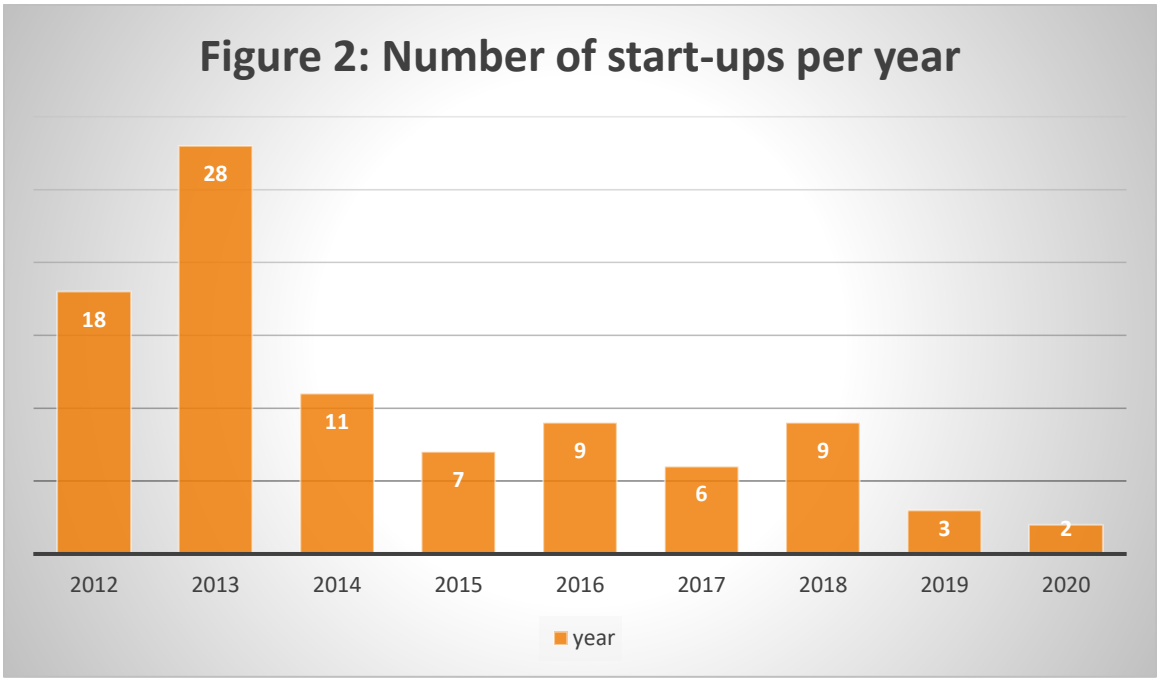
Ammonia

The ammonia HQs showed a similar pattern to that of HCN with the 3-minute average GLCs in the DISPMOD model across all sites and the AERMOD model for the northern industrial sites being greater than 1. In addition, Wells Park had ammonia HQs of 8.2 and 2.2 for the 3-minute and 1-hour predicted GLCs.

Direction and distance from the cyanide plants influenced the predicted GLCs and subsequent HQs. Besides the site boundary, the highest predicted GLCs and HQs were seen at the nearest receptor (Wells Park) and then in the northern industrial area. The most eastern and most southern locations had the lowest predicted GLCs. These findings were consistent across both models.

Overall, the HQs for maximum predicted GLCs at start-up operations in the AERMOD and DISPMOD models were all less than 10 for the neighbouring receptors of concern outside of the cyanide plants.

The number of start-ups has significantly decreased over time. Figure 2 indicates that the number of start-ups required in the last 9 years with the number below 10 and averaging 6 per year since 2015. Between 2007 and 2013 there were 143 start-ups required averaging just above 17 per year (see Matisons 2019). These data indicate that the exposure to $NO_2$, $NH_3$, and HCN from plant start-ups is decreasing and will be intermittent.




Current licence conditions for start-up (see text box) stipulate that when wind direction is between 70° and 215°, the wind speed must be greater than 2.0 m/s. Wells Park is within this arc and a wind speed of 4.5m/s would ensure that any emissions produced would be dissipated by the stronger winds and unlikely to cause significant health outcomes to sensitive receptors at Wells Park.

**Cyanide liquid plants start-ups restrictions**

The Licensee shall ensure that start-ups of SCP1 and SCP2 shall only be initiated subject to the following conditions:

a. when wind speed is less than one (1) meters per second. the Licensee shall not initiate a start-up of SCP1 or SCP2;

b. when wind speed is between one (1) and two (2) meters per second, start-up of SCP1 or SCP2 can only be initiated when wind direction originates within the true compass arc between 50° and 120°;

c. when the wind speed is greater than two (2) metres per second, start-up of SCP1 or SCP2 can only be initiated when the wind direction originates within the true compass arc between 70° and 215°;

d. when wind speed is greater than four and a half (4.5) metres per second; start-up of SCP1 or SCP2 can be imitated for any wind direction

Predicted exceedances

The Ramboll (2020) air quality impact assessment for the start-up operations estimated the frequency of predicted exceedances of the 1-hour guideline for the three CoC. This was done by using the contours of the number of hours where the 1-hour average GLC is predicted to exceed the corresponding 1-hour guideline. It is emphasized that the predicted frequencies are very conservative since they are based on the assumption that emissions will be continuous between the hours of 18:00 and 06:00 and subject to the meteorological conditions specified in the operating licence.

There were no predicted exceedances of the 1-hour $NO_2$ guideline at sensitive receptors. The maximum predicted number of hours where the 1-hour average GLC exceeded the guideline for HCN and $NH_3$ was predicted by AERMOD to occur at Wells Park. For HCN, the maximum predicted number of hours was 8, approximately 0.2% of the time. Considering the frequency of start-up events, the probability of an exceedance of the HCN 1-hour guideline occurring at Wells Park was approximately 0.0003% based on the four start-up events that occurred in 2019. This would be further reduced to 0.0001% based on the two anticipated start-up events for 2020. For $NH_3$, the maximum predicted number of hours was 9, approximately 0.3% of the time. Considering the frequency of start-up events, the probability of an exceedance of the $NH_3$ 1-hour guideline was approximately 0.0003% based on four start-up events occurring in 2019, with the probability further reduced to 0.0002% based on two start-up events for 2020.

## WASTE GAS VENTING

The air quality impact assessment (Ramboll 2020) has predicted maximum 3-minute and 1-hour averages GLCs for the waste gases, HCN and $NH_3$, using the AERMOD and DISPMOD models. Hazard quotients (HQs) were calculated for the maximum predicted GLCs from the AERMOD and DISPMOD modelling and are presented in Tables 6 and 7 respectively. They were based on Table 14: *Summary of Maximum Predicted GLCs – Waste-Gas Venting* presented in Ramboll (2020).

**Table 6: Hazard quotients (HQs) for maximum predicted GLCs during waste gas venting – AERMOD modelling.** (Colour coding is based on location - see table 2)

| | 1 plant venting | | | | 2 plant venting | | | |
|---|---|---|---|---|---|---|---|---|
| | HCN | | $NH_3$, | | HCN | | $NH_3$, | |
| **receptor** | **3-min** | **1-hr** | **3-min** | **1-hr** | **3-min** | **1-hr** | **3-min** | **1-hr** |
| **Site boundary** | <1 | <1 | 15.2 | 2.6 | <1 | <1 | 19.1 | 19.0 |
| **Wells Park** | <1 | <1 | 5.0 | <1 | <1 | <1 | 8.7 | 8.6 |
| **North Rockingham** | < 1 | < 1 | 1.3 | <1 | < 1 | < 1 | 2.7 | 2.6 |
| **Oval** | < 1 | < 1 | 1.1 | < 1 | < 1 | < 1 | 2.3 | 2.3 |
| **Hope Valley** | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | 1.5 | 1.5 |
| **Golf course** | < 1 | < 1 | 1.1 | < 1 | < 1 | < 1 | 2.3 | 2.3 |
| **Nearest residence** | < 1 | < 1 | 1.4 | < 1 | < 1 | < 1 | 2.8 | 2.7 |
| **Thomas oval** | < 1 | < 1 | 1.1 | < 1 | < 1 | < 1 | 2.2 | 2.1 |
| **Wombat CC** | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | 1.7 | 2.3 |
| **Calista PS** | < 1 | < 1 | 1.2 | < 1 | < 1 | < 1 | 2.3 | 1.5 |
| **Residence 3** | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | 1.2 | 1.2 |
| **guideline** | **365** | **199** | **578** | **320** | **365** | **199** | **578** | **320** |

For hydrogen cyanide all HQs were less than 1 in both models.

For ammonia the AERMOD model (Table 6) found the highest HQs for maximum predicted GLCs for waste gas venting were at the site boundary in both models ranging up to 19 in the 2-plant shutdown scenario. Wells Park had the next highest HQs ranging up to 9 in the 2-plant shutdown scenario. All other sensitive receptor locations had HQs less than 3.

The DISPMOD model (Table 7) found that the 3-minute and 1-hour HQs for maximum predicted GLCs for waste gas venting were less than 1 for HCN for both the one plant and two plant shutdown scenarios and the 1-hour HQs for $NH_3$ 1 plant shutdown scenario. For $NH_3$ the HQs for the 3-minute 1 plant scenario were less than 1.5 with the exception of the site boundary which was 4.9. The $NH_3$ HQs for the 2-plant shutdown scenario were less than 10 for the site boundary with the HQs for the remaining locations all less than 3.

**Table 7: Hazard quotients (HQs) for maximum predicted GLCs during waste gas venting – DISPMOD modelling.** (Colour coding is based on location - see table 2)

| | 1 plant venting | | | | 2 plant venting | | | |
|---|---|---|---|---|---|---|---|---|
| | HCN | | $NH_3$, | | HCN | | $NH_3$, | |
| **receptor** | **3-min** | **1-hr** | **3-min** | **1-hr** | **3-min** | **1-hr** | **3-min** | **1-hr** |
| **Site boundary** | <1 | <1 | 4.9 | 0.9 | <1 | <1 | 9.2 | 9.1 |
| **Wells Park** | <1 | <1 | 1.5 | <1 | <1 | <1 | 2.9 | 2.9 |
| **North Rockingham** | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | 1.6 | 1.7 |
| **Oval** | < 1 | < 1 | 1.0 | < 1 | < 1 | < 1 | 2.0 | 2.0 |
| **Hope Valley** | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | 1.9 | 1.9 |
| **Golf course** | < 1 | < 1 | 1.4 | < 1 | < 1 | < 1 | 2.9 | 2.9 |
| **Nearest residence** | < 1 | < 1 | 1.4 | < 1 | < 1 | < 1 | 2.8 | 2.7 |
| **Thomas oval** | < 1 | < 1 | 1.2 | < 1 | < 1 | < 1 | 2.3 | 2.3 |
| **Wombat CC** | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | 1.9 | 1.9 |
| **Calista PS** | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | 1.9 | 1.8 |
| **Residence 3** | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | 1.6 | 1.6 |
| **guideline** | **365** | **199** | **578** | **320** | **365** | **199** | **578** | **320** |

## PLANNED SHUTDOWN AND PLANT TRIPS

The air quality impact assessment (Ramboll 2020) has predicted maximum 3-minute and 1-hour averages GLCs for the waste gases, HCN and $NH_3$, using the AERMOD and DISPMOD models during planned shutdowns and trip events. Hazard quotients (HQs) were calculated for the maximum predicted GLCs from the AERMOD and DISPMOD modelling and are presented in Table 8. They were based on Table 15: *Summary of Maximum Predicted GLCs – Planned Shutdown/Plant Trip* presented in Ramboll (2020). The majority of the HQs were well below 0.6 with the only HQs >1 seen for the site boundary and Wells Park and hence only the HQs for the site boundary and Wells Park were included in Table 8.

All HQs for ammonia were less than 1 except for a HQ of 1.7 (AERMOD, 3-minute 2-plant shutdown). The only HQ greater than 1 seen for Wells Park was at the 3-minute average for HCN in the 2-plant shutdown scenario in the AERMOD model.

Site boundary HQs for both the AERMOD and DISPMOD models for the one plant shutdown scenario were at one or less except for a 1.9 for HCN (3-minute, 1 plant shutdown). HCN 3-minute HQs for the site boundary ranged from to 1.7 to 3.8.

**Table 8: Hazard quotients (HQs) for maximum predicted GLCs during plant shutdowns/trips for the site boundary and Wells Park.** (Highlighted values indicate HQ >1).

| Model | shutdown | Chemical | Time | Guideline | *Site Boundary* | *Wells Park* |
|---|---|---|---|---|---|---|
| AERMOD | 1 plant | HCN | 3-min | 365 | 1.9 | 0.9 |
| AERMOD | 1 plant | HCN | 1-hr | 199 | 0.8 | 0.3 |
| AERMOD | 1 plant | $NH_3$ | 3-min | 578 | 1.0 | 0.4 |
| AERMOD | 1 plant | $NH_3$ | 1-hr | 320 | 0.5 | 0.1 |
| AERMOD | 2 plant | HCN | 3-min | 365 | 3.8 | 1.7 |
| AERMOD | 2 plant | HCN | 1-hr | 199 | 1.4 | 0.6 |
| AERMOD | 2 plant | $NH_3$ | 3-min | 578 | 1.7 | 0.7 |
| AERMOD | 2 plant | $NH_3$ | 1-hr | 320 | 0.6 | 0.3 |
| DISPMOD | 1 plant | HCN | 3-min | 365 | 0.9 | 0.3 |
| DISPMOD | 1 plant | HCN | 1-hr | 199 | 0.4 | 0.1 |
| DISPMOD | 1 plant | $NH_3$ | 3-min | 578 | 0.5 | 0.2 |
| DISPMOD | 1 plant | $NH_3$ | 1-hr | 320 | 0.2 | <0.1 |
| D ISPMOD | 2 plant | HCN | 3-min | 365 | 1.9 | 0.6 |
| DISPMOD | 2 plant | HCN | 1-hr | 199 | 0.7 | 0.2 |
| DISPMOD | 2 plant | $NH_3$ | 3-min | 578 | 0.9 | 0.3 |
| DISPMOD | 2 plant | $NH_3$ | 1-hr | 320 | 0.4 | 0.1 |

# DISCUSSION

The emission estimates and exhaust characteristics used in the models were based on the results of AGR's recent stack testing undertaken during the SCP1 start-up in May 2020. This provided actual real time emission data compared to modelled emissions which were used in the Air Quality Impact Assessment undertaken by Ramboll in August 2019. The real time monitoring data produced lower predicted ground level concentrations (GLCs) when compared to the modelling undertaken in 2019 using modelled emissions.

The predicted GLCs were significantly less than those predicted by both AERMOD and DISPMOD models in 2019. The 2019 air quality assessments (Ramboll, 2019a) calculated $NO_2$ concentrations from predicted NOx concentrations under normal operations using the Ozone Limiting Method (OLM) to predict ground level concentrations of $NO_2$ as specified by NSW EPA (2016). This method assumes that all the available ozone in the atmosphere will react with nitrogen oxide in the plume until either all the ozone or all the NO is used up. This is a conservative approach since it assumes that the atmospheric reaction is instant rather the reaction takes place over a number of hours.

However, measured $NO_2$ emissions data were provided for a monitored start-up event and the modelling undertaken for this scenario has used the $NO_2$ emissions data directly. It is assumed that there will be negligible oxidation of NO to $NO_2$ as the start-up events occur at night-time and the OLM was not applied for the start-up scenario in the 2020 air quality impact assessment for start-up operations.

The 2019 air quality impact assessment (Ramboll 2019a) found that the predicted maximum 3-minute and 1-hour average $NO_2$, HCN and $NH_3$ GLCs exceeded the applicable air quality guidelines at the site boundary and nearby Wells Park receptor. The AERMOD model predicted GLC s complied with the 3-minute and 1- hour average $NO_2$ guideline values at the residential receptors to the east of the cyanide plants, although exceedances were predicted to occur within the industrial zone to the north of the site and along the coastal boundary south-west of the site. The DISPMOD model predicted 3-minute and 1- hour average $NO_2$ GLCs exceeded the respective guidelines throughout the majority of the model domain.

In contrast, the current air quality impact assessment (Ramboll 2020) found that the predicted 3-minute and 1- hour average $NO_2$ GLCs in both models were significantly less than the guidelines except at the site boundary in the AERMOD model where there was a slight exceedance. The predicted HCN and $NH_3$ GLCs in the AERMOD model were less than ten times the guideline except at the site boundary. In the DISPMOD model the predicted HCN and $NH_3$ GLCs were below the guideline at 1-hour but above the guideline for all receptors at 3-minutes.

AERMOD predicted slightly higher GLCs than the DISPMOD model, suggesting that building wake effects on plume dispersion from the liquid plants and solids plant have a greater influence on the maximum GLCs than coastal fumigation effects Ramboll (2020).

Like the predicted GLCs, HQs from the 2020 modelling, were significantly reduced compared with the 2019 modelling. The degree of decrease equates to that seen with the predicted GLCs but of significance is that the 2020 HQs were all well below 10 at the receptors of concern.

START-UP OPERATIONS

Nitrogen dioxide HQs were at or less than 1 for all neighbouring receptors of concern. Hydrogen cyanide HQs were less than 1 for receptors of concern except for the 3-minute average GLCs in the DISPMOD model across all sites and the AERMOD model for the northern industrial sites and Wells Park but the HQs did not exceed 10. Ammonia HQs showed a similar pattern with the 3-minute average GLCs in the DISPMOD model across all sites and the AERMOD model for the northern industrial sites being greater than 1 but in addition, Wells Park had ammonia HQs of 8.2 and 2.2 for the 3-minute and 1-hour predicted GLCs.

The highest HQs were seen at the nearest receptor of Wells Park followed by the northern industrial area. The most eastern and most southern locations had the lowest predicted GLCs.

Direction and distance from the cyanide plants influenced the predicted GLCs and subsequent HQs. Besides the site boundary, the highest predicted GLCs and HQs were seen at the nearest receptor (Wells Park) and then in the northern industrial area. The most eastern and most southern locations had the lowest predicted GLCs. These findings were consistent across both models.

Overall, the HQs for maximum predicted GLCs at start-up operations in the AERMOD and DISPMOD models were all less than 10 for the neighbouring receptors of concern outside of the cyanide plants and hence no significant health issues are expected from start-up processes.

Figure 2 and Matisons (2019) indicate that the frequency of start-ups is decreasing with only one in the year to date with a second planned shutdown scheduled for November 2020.

Taking into account the 4 start-ups in 2019 together with the number of predicted exceedances, Ramboll estimated the probability of an exceedance of the 1-hour guideline occurring at the nearest sensitive receptor of Wells Park to be less than 0.0003% (i.e. 3 in $10^6$ hours) for both HCN and $NH_3$. As the number of start-up events for 2020 is even further reduced to 2, the likelihood of guideline exceedances, based on two start-ups, is reduced to 0.0001% for HCN and 0.0002% for $NH_3$.

### WASTE GAS VENTING

All HQs for hydrogen cyanide were less than 1 in both models. The maximum HCN HQs for the single and two plant venting scenarios were well below the relevant air quality criteria.

For ammonia, the HQs were greater than 1 for all sensitive receptors under the 2-plant scenario in both models and under the 1 plant scenario were less than 1 for the 1-hour average but greater than 1 for the 3-minute average for all sensitive receptors except for the two most eastern sites. The DISPMOD model for waste gas venting under did not highlight any significant health issues for sensitive community receptors with the 1 plant scenario having HQs less than 1.5 and the 2-plant shutdown scenario having HQs less than 3. The AERMOD model predicted slightly higher HQs but were less than 9 for the nearest receptor of Wells Park with all other sensitive receptors having HQs less than 3 for the 2-plant scenario. The site boundary HQs did peak at just under 20 under the same conditions. Both models have similar HQs for the sensitive receptor sites for the 3-minute and 1-hour averages.

The Ramboll (2020), taking into account the frequency of waste gas venting conjunction and the frequency of the predicted exceedances estimated the probability of an exceedance event occurring at the site boundary to be no more than 0.15% for the single plant venting scenario with no further exceedances of the 1-hour average $NH_3$ guideline predicted at the offsite receptor sites. One plant waste gas venting is unlikely to result in untoward health issues for the sensitive receptors surrounding the Facility.

In considering a 2-plant simultaneous waste gas venting scenario Ramboll (2020) determined the probability of an exceedance of the 1-hour average $NH_3$ guideline over 900 and 300 hours in recent years. In 2019 there were 943 hours of waste gas venting and the probabilities of exceeding the guideline were approximately 0.8% at the site boundary, 0.3% at Wells Park and no more than 0.1% at the other receptor sites. In 2018 there were for 303 hours of waste gas venting and the probabilities of exceeding the guideline were approximately 0.3% at the site boundary, 0.1% at the Wells Park receptor and no more than 0.03% at the other receptor sites. It is important to note that these are overestimates as simultaneous venting of the two liquid plants is unlikely to be occur frequently. Also, the predicted 1-hour average GLCs are will be reduced significantly by the proposed interconnection of the waste gas lines as part of the Facility upgrade producing a reduction in time spent venting following diversion of the waste gas to the running incinerator.

During normal running, the waste gas from each liquid cyanide plant is directed to a specific incinerator for combustion and when one incinerator trips, the waste gases are vented to the atmosphere. Previous modelling has shown that $NH_3$ emissions could exceed the 1-hour guideline when either one or both plants are venting waste gas but the risk estimates were low and posed no health risk (Ramboll 2019b). However, the interconnection of the waste gas lines will enable waste gas to be directed to the alternate incinerator in the event of a trip. This process is expected to take approximately 10 minutes which will substantially reduce the duration of waste gas venting in the event of an incinerator trip from potentially hours to minutes. Therefore, the predicted emissions shown in Table 14 of Ramboll (2020) will be substantially reduced due to the significant decrease in venting time.

CSBP is undertaking an engineering study as to how to better manage emissions from the two liquid sodium cyanide plants at its Kwinana facility and has proposed to do this in two stages.

The first stage (which forms the basis for this HHRA) consists of interconnecting the waste gas lines from both production plants, enabling operational flexibility for waste gas processing. This will result in a significant reduction in time spent venting as it will no longer be coupled to the offline incinerator (from potentially hours to minutes). Instead, following a transition period, the waste gases from the venting plant will be fed through to the running incinerator, traditionally only available to the alternate production plant. To achieve this, both plants will have to reduce production rates by approximately half so as to not exceed the combustion capacity of the running incinerator.

The second stage consists of the procurement of a new combustion unit which will provide greater control, improve response and additional capacity to reduce the extent of rate reduction required. The improved response will result in another iterative improvement to the time spent waste gas venting (from minutes to seconds, in some cases). In addition to processing waste gas, the new combustion unit will be designed for processing of start-up emissions through the various phases. Completion of the second stage enables complete abatement of upset conditions and will be the subject of another HRRA.

## PLANNED SHUTDOWN AND PLANT TRIPS

There were only 6 HQs that were greater than one for the planned shutdown scenarios modelled by Ramboll (2020) and all were less than 4. Five of these were associated with the site boundary (all HQs <4) and one at Wells Park (HQ of 1.7 for HCN/3-minute/2-plant). Five were associated with the 2-plant scenario and five were related to HCN and one $NH_3$. There were no HQs greater than one for the 1-hour averaging period predicted for any of the receptors of concern with the only HQ greater than one (HQ = 1.7) was predicted for the site boundary. The other five HQs exceeding 1 were for the 3-minute averaging period.

Based on an average of two to four shutdown events per year, in conjunction with the frequency of the predicted exceedances for the 2-plant shutdown, Rambo (2020) estimated the probability of an exceedance of the 1-hour average HCN guideline at the site boundary is 0.00008% to 0.00004%. respectively. These counts are based on a total exceedance of the guideline of 15 hours for the two-plant shutdown and assume continuous operation for the whole hour under shutdown conditions. The likelihood of exceedances is therefore very low even under conservative assumptions.

The projected maximum GLCs during plant shutdown or trips indicated minimal health impact with the majority of HQs well below 1 and a few at the site boundary and Wells Park less than 4. Therefore, the proposed upgrade is therefore unlikely to produce untoward health concerns based on planned shutdowns and plant trips.

## OVERALL

The assessment of health hazard quotients from predicted emissions during start-up, waste gas venting and planed shutdowns or plant trips operations has found that all HQs for sensitive receptors were less than 10. Therefore, untoward health effects in the nearby community are not anticipated with the proposed increase in production in conjunction with the proposed upgrades to the cyanide plants. The proposed upgrades, particularly the interconnection of waste gas lines diverting waste gas to the alternate incinerator in the event of a trip will significantly reduce expected emissions from the two liquid cyanide plants.

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