Matisons Toxicology Solutions
toxsolutions@outlook.com
0402 546 967

Addendum to Kwinana Sodium Cyanide Manufacturing Facility Proposed Interim Upgrade Human Health Risk Assessment: Start-Up Operations

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 air quality assessment reports and Martin Matisons of Matisons Toxicology Solutions was engaged to undertake Human Health Risk Assessments (HHRA).

Ramboll undertook an air quality assessment in 2020 (*Kwinana Sodium Cyanide Manufacturing Facility Interim Upgrade: Air Quality Impact Assessment* dated 2 November 2020) which was the basis of a Human Health Risk Assessment (HHRA) undertaken by Matisons Toxicology Solutions (Matisons 2020). DWER have asked CSBP to undertake another Air Quality Impact Assessment for a second set of start-up monitoring data taken during a start-up in November 2020. A subsequent air quality assessment was undertaken by Ramboll in 2021 (*Kwinana Sodium Cyanide Manufacturing Facility Air Quality Impact Assessment: Start-Up Operations* dated 10 June 2021) with Matisons Toxicology Solutions engaged to undertake the Human Health Risk Assessment (HHRA) of the additional data.

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 in November 2020.

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 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 HQs at the site boundary for HCN of 25.5 and 13.2 at 3-minutes and 1-hour respectively and 11.9 for HCN at Wells Park at 3-minutes, all other HQs were at or less than 6 in the AERMOD model. In the DISPMOD model 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 with the HQs for HCN and the 3-minute GLCs for NH_3 being less than 4.5.

Nitrogen dioxide HQs for predicted maximum 3-minute and 1-hour average GLCs for both models were at or less than one 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. When the newly proposed NEPM 1-hour guideline for NO_2 of 151 µg/m^3 comes into force, the majority of the HQs would remain below one with only the HQ at the site boundary and Wells Park in the AERMOD model being greater than 1 at 2.4 and 1.1 at 3 -minutes and 1-hour respectively. The HQs for NO_2 were comparable between the May 2020 and November 2020 data modeling.

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 the southwest locations of Wells Park and North Rockingham. HCN HQs did not exceed 10 except at the site boundary for both times and a 3-minutes HQ of 11.5 at Wells Park.

The DISPMOD model found that the 3-minute and 1-hour HQs for HCN were slightly higher in November 2020 compared with May 2020, but all DISPMOD HQs were less than 4.5. The largest differences for HCN were seen at the site boundary and at Wells Park. The HQ ratios (November/May) for the site boundary were 25.9/21.9 for 3-minutes and 13.2/4.9 for 1-hour. The HQ ratios (November/May) for Wells Park were 11.5/9.6 for 3-minutes and 5.8/2.1 for 1-hour.

The ammonia HQs were less than five for all receptor sites. NH_3 HQs were marginally lower in November 2020 compared with the May 2020 modelling.

The assessment of health hazard quotients from predicted emissions during start-up operations has found that all HQs for sensitive receptors were less than 12 with the only HQ exceeding 10 was the 3-minutes HCN HQ of 11.5 at Wells Park. The additional modelling of the November 2020 start-up operation can be considered as a worst-case scenario as it took 30 minutes longer than the start-up in May 2020. The current licence conditions for start-up stipulate that when the wind direction is in line with Wells Park the wind speed must be greater than 4.5 m/sec. A wind speed of 4.5m/s would ensure that any emissions produced would be dissipated and unlikely to cause significant health outcomes to sensitive receptors at Wells Park.

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.

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.

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

As part of this regulatory approval process, AGR is required to present an assessment of the air quality impacts associated with the proposed upgrade of the Facility. Consequently 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) prepared an air quality assessment report: *Kwinana Sodium Cyanide Manufacturing Facility Interim Upgrade: Air Quality Impact Assessment* dated 2 November 2020 which formed the basis of a Human Health Risk Assessment (HHRA) by Matisons Toxicology Solutions (Matisons 2020).

DWER have asked AGR to undertake another Air Quality Impact Assessment for a second set of start-up monitoring data taken during a start-up in November 2020. AGR provided the additional monitoring data to Ramboll who undertook the air dispersion modelling assessment. Matisons Toxicology Solutions was tasked with undertaking the HHRA

OBJECTIVE

The objective of this HHRA is to assess whether the emissions would adversely impact on human health during start-up events by reviewing the additional modelling data provided by Ramboll (2021) for the start-up operation of a single liquid sodium cyanide plant. The emission estimates and exhaust characteristics used in the model are based on the results of recent stack emissions monitoring campaign in November 2020, targeting average and peak emissions scenarios with the assumption that start-up events only occur subject to the meteorological conditions specified in License conditions and between the hours of 18:00 and 06:00, in line with AGR's operating practices.

METHODOLOGY

In order to be consistent with the HHRA undertaken in Matisons (2020), the same methodology has been employed in this HHRA, namely the approach of enHealth (2012) has been adopted. 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 and consistent with the previous HHRAs (Ramboll 2019b, Matisons 2019 and Matisons 2020).

GUIDELINES USED

The guidelines used by this HHRA to calculate hazard quotients are given in Table 1. 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 previous assessments.

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.

It should be noted that the NEPC, in April 2021, following public consultation, has significantly strengthened NO_2 reporting standards for 1-hour and annual average NO_2 to 80 ppb and 15 ppb respectively (NEPC 2021), The NEPC has brought forward standards initially proposed for 2025 to reflect the most recent health evidence emerging about the health impacts of NO_2 (NEPC 2021). This HHRA has not used the proposed updated guidelines for NO_2 as they are not currently applicable in Western Australia. The proposed new guideline for NO_2 would equate to 151 µg/m^3.

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

The receptors of concern used in the modelling are identical to those used in previous assessments and are given in Table 2. The receptors 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)

Table 2 highlights the spatial distribution of the receptors with the colour coding representing 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 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.

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, 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 (2021) 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.

RESULTS

START-UP OPERATIONS

The air quality impact assessment for start-up operations (Ramboll 2021) 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 6: Summary of Maximum Predicted GLCs – Start-up Operations* presented in Ramboll (2021).

Table 4: Hazard quotients (HQs) for maximum predicted GLCs at start-up operations – AERMOD modelling.

	NO_2		HCN		NH_3,	
receptor	**3-minute**	**1-hour**	**3-minute**	**1-Hour**	**3-minute**	**1-Hour**
Site boundary*	**2.4** *(2.4#)*	**1.6** *(1.9)*	**25.5** *(21.9)*	**13.2** *(4.9)*	**10.7** *(19.1)*	**4.6** *(5.1)*
Wells Park	**1.0** *(1.0)*	**< 1** (<1)	**11.5** *(9.6)*	**5.8** *(2.1)*	**4.7** *(8.2)*	**2.0** *(2.2)*
North Rockingham	< 1^	< 1	**1.2** *(< 1)*	< 1	< 1	< 1
Oval	< 1	< 1	**2.7** *(2.2)*	**1.3** *(< 1)*	**1**.1 (1.8)	< 1
Hope Valley	< 1	< 1	**2**.1 *(1.7)*	**1.0** *(< 1)*	**<**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**

* = Colour coding is based on location - see table 2

 # = Italicized numbers in parentheses are the respective HQs derived by Matisons (2020)

^ = A single entry of < 1 implies the same result for 2021 and 2020

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 HQs at the site boundary for HCN of 25.5 and 13.2 at 3-minutes and 1-hour respectively and 11.9 for HCN at Wells Park at 3-minutes, all other HQs were at or 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 with the HQs for HCN and the 3-minute GLCs for NH_3 being less than 4.5.

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.

Applying the newly proposed NEPM 1-hour guideline for NO_2 of 151 µg/m^3 would not significantly change the HQs determined. The majority of the HQs would remain below 1 with only the HQ at the site boundary and Wells Park in the AEROMOD model being greater than 1 at 2.4 and 1.1 respectively.

Table 5: Hazard quotients (HQs) for maximum predicted GLCs at start-up operations – DISPMOD modelling.

	NO_2		HCN		NH_3,	
receptor	**3-minute**	**1-hour**	**3-minute**	**1-Hour**	**3-minute**	**1-Hour**
Site boundary*	< 1[#]	< 1	**2.5** *(2.4)*	**1.6** *(< 1)*	**1.3** *(3.9)*	< 1
Wells Park	< 1^	< 1	**4.3** *(3.6)*	**2.2** *(< 1)*	**1.8** *(3.1)*	< 1
North Rockingham	< 1	< 1	**2.1** *(1.7)*	**1.0** *(< 1)*	**<1** *(1.3)*	< 1
Oval	< 1	< 1	**4.3** *(3.6)*	**2.2** *(< 1)*	**1.8** *(3.3)*	< 1
Hope Valley	< 1	< 1	**4.1** *(3.4)*	**2.1** *(< 1)*	**1.7** *(3.1)*	< 1
Golf course	< 1	< 1	**3.3** *(2.6)*	**1.6** *(< 1)*	**1.3** *(2.1)*	< 1
Nearest residence	< 1	< 1	**2.9** (2.4)	**1.4** *(< 1)*	**1.2** *(2.1)*	< 1
Thomas oval	< 1	< 1	**2.9** *(2.3)*	**1.4** *(< 1)*	**1.1** *(1.8)*	< 1
Wombat CC	< 1	< 1	**2.7** *(2.2)*	**1.3** (< 1)	**1.1** *(1.7)*	< 1
Calista PS	< 1	< 1	**2.6** *(2.0)*	**1.3** (< 1)	**1.0** *(1.6)*	< 1
Residence 3	< 1	< 1	**2.5** (2.0)	**1.2** *(< 1)*	**1.0** *(1.6)*	< 1
guideline	**2000**	**226**	**365**	**199**	**578**	**320**

* = Colour coding is based on location - see table 2

 # = Italicized numbers in parentheses are the respective HQs derived by Matisons (2020)

^ = A single entry of < 1 implies the same result for 2021 and 2020

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 the south west locations of Wells Park and North Rockingham. HCN HQs did not exceed 10 except at the site boundary for both times and Wells Park for 3-minutes where the HQ was 11.5.

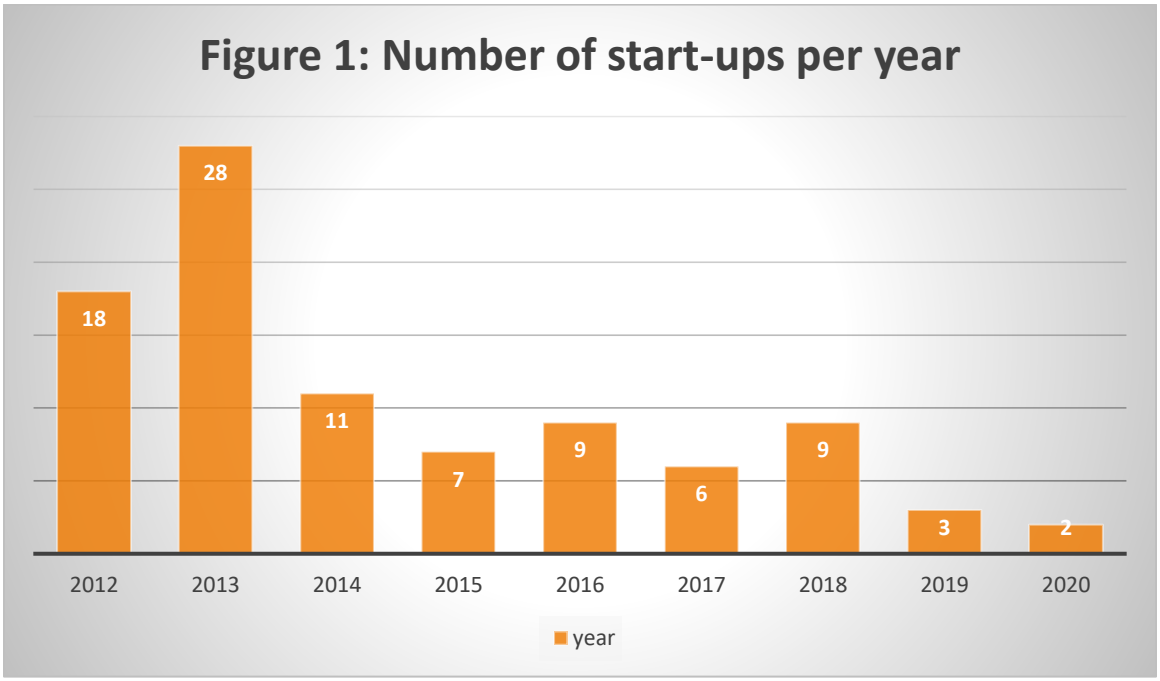
Ammonia

The ammonia HQs were only marginally greater than one for the 3-minute average GLCs in the DISPMOD model across all sites and the AERMOD model for the northern oval at 3-minutes and Wells Park for the 3-minute and 1-hour predicted GLCs.

As seen in the 2020 air quality assessment and HHRA, the 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 modeling periods.

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 with the exception of Wells Park where the 3-minute HCN HQ was 11.5.

The number of start-ups has significantly decreased over time. Figure 1 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.



Comparison with 2020 results

Tables 4 and 5 also provide the HQs from the 2020 HHRA which were based on sampling in May 2020. The majority of the results were similar between the May and November 2020 modeling.

The DISPMOD model (Table 5) found that the 3-minute and 1-hour HQs for HCN were slightly higher in the 2021 HHRA but the 3-minute HQs for NH_3 were marginally lower. All HQs however, were less than 4.5.

A similar picture was seen with the AERMOD model (Table 4) where the HQs for NO_2 were comparable between the 2020 and 2021 modeling. The HCN 2021 modelling had higher HQs but for NH_3 the HQs were lower. The largest differences were seen for HCN at the site boundary and Wells Park. The HQ ratios (November/May) for the site boundary were 25.9/21.9 for 3-minutes and 13.2/4.9 for 1-hour. The HQ ratios (November/May) for Wells Park were 11.5/9.6 for 3-minutes and 5.8/2.1 for 1-hour.

Table 6: Conditions at May and November 2020 start-ups

Start Up Phase		SCP1 May20 Time (hh:mm:ss)	SCP2 Nov20 Time (hh:mm:ss)	Time difference (hh:mm:ss)	Description
1	Pre-start	23:20	22:08:30	-	Start-up fan is pulling approximately 4000Nm3/hr air through the reactors. Incinerator is firing.
2	Ammonia ignition	23:24:15	22:15:32	START	Ammonia is introduced and ignited by hydrogen lances.
3	Ammonia gauze conditioning	23:25:00	22:16:20	+ 0:00:03	Ammonia flow is gradually increased from 500Nm3/hr up to 1250Nm3/hr while the catalyst temperature increases to approximately 850 ºC.
4	Nitrogen suppression ON	23:44:45	22:37:25	+ 0:01:20	Nitrogen is introduced at a flow of approximately 4000Nm3/hr which pushes the combined gas mixture to a point outside the Lower Explosive Limit (LEL) prior to Natural Gas addition.
5	Natural Gas addition	23:52:15	22:54:45	+ 0:09:50	Once oxygen content in the combined gas mixture is below 11%, Natural Gas is added to the gas mixture. Hydrogen cyanide begins to form.
6	Nitrogen suppression OFF	23:53:00	22:55:45	+ 0:00:15	After Natural Gas is flowing steadily to the reactors, Nitrogen suppression is removed.
7	Blower changeover start	00:02:00	23:23:30	+ 0:18:45	Following reactor start-up, absorber column pre-checks commence, the main blowers turn on and emissions are re-directed from the start-up stack to the shutdown stack.
8	Waste gas to incinerators	00:09:53	23:27:30 (start-up fan off)	-	Once the process gases are being scrubbed through the absorber column, the process of introducing waste gas to the incinerators begins.
9	Start-up complete	00:42:00	N/A	-	The start-up is complete once waste gas is being fed to the incinerators.

Predicted exceedances

The Ramboll (2021) 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. Also, it needs to be emphasised that the start-up process upon which the 2021 modelling was undertaken was not typical but a worst-case scenario and hence applying the 2021 data across an average of 6 start-ups per year would be unrealistic.

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 78, approximately 2.3 % 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 0.004 % based on the average of six start-up events since 2015.

For NH_3, the maximum predicted number of hours was 8, approximately 0.24% 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 an average of six start-up events since 2015. The predicted exceedances would be further reduced based on three start-up events as occurred in 2020.

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 start-up in November 2020. The start-up operation undertaken in November 2020 was not a typical start-up in that it took 30 minutes longer than the May 2020 start-up. This resulted in increased average data and hence some slightly increased HQs. . There were a number of issues arising which impacted the typical timeframes for the various phases. Table 6 gives an indication of the additional time taken for each phase compared to the May 2020 start-up. These factors are likely to have resulted in increased average data and hence some slightly increased HQs.

Though the majority of the results were similar between the 2020 and 2021 modeling the most notable differences were in the AERMOD model with an increase in HCN HQs at the site boundary and Wells Park with the 3-minute HCN HQ for Wells Park in November 2020 was 11.9 compared with 9.6 in May 2020.

The additional modelling of the November 2020 start-up operation can be potentially seen as a worst-case scenario.The current licence conditions for start-up stipulate that when the wind direction is in line with Wells Park the wind speed must be greater than 4.5 m/sec. A wind speed of 4.5m/s would ensure that any emissions produced would be dissipated and unlikely to cause significant health outcomes to sensitive receptors at Wells Park.

Figure 1 and Matisons (2019) indicate that the frequency of start-ups is decreasing with only three in 2020 and therefore start-ups as seen in November 2020 are not expected to be regular occurrences.

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

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. This is consistent with the finding of the 2020 HHRA (Matisons 2020).

OVERALL

The assessment of health hazard quotients from predicted emissions during start-up operations has found that all HQs for sensitive receptors were less than 12 with the only HQ exceeding 10 was the 3-minutes HCN HQ of 11.5 at Wells Park. The additional modelling of the 2021 start-up operation can be considered as a worst-case scenario and the current licence conditions for wind speed and directions at start-up would ensure that any emissions produced would be dissipated and unlikely to cause significant health outcomes to sensitive receptors at Wells Park.

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.

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