REPORT

AIR QUALITY IMPACT ASSESSMENT AND MITIGATION STUDY – TPR EPL CONDITION U1.1

Transpacific Refiners

Job No: 3663

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A PEL Company

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1 INTRODUCTION

PAEHolmes have been requested by Transpacific Refiners Pty Ltd (TPR) to assist in their response to a pollution reduction program for air and odour emissions that the NSW EPA (DECCW) requires via Condition U1.1 of TPR's Environment Protection Licence.

1.1 Background

TPR operate an oil refinery that processes recycled oil feedstock. The activity is located in Kyle Street, Rutherford and is within an industrial area. There are industrial activities nearby, and a golf course separates the industrial area from residential properties.

In short, TPR have had issues with their approval and the initial operations of the facility, including meeting stack emission limits placed on the licence. The DECCW has taken legal action against TPR recently in regard to air emissions.

TPR appear to have operated with relatively stable levels of air emissions for quite some time now.

Following improvements, testing and verifications, the DECCW have reduced some of the monitoring requirements at TPR and have also placed a pollution reduction program on TPR's licence. The requirements of this PRP, and actions that arise from it appear to be the last significant air quality matters to be resolved at TPR.

1.2 Objectives of the Study

The study aims to conduct the work necessary to satisfy the objectives of the DECCW PRP, which is reproduced as follows;

U1.1

The aim of this condition is to benchmark air emission control performance and demonstrate that the current emission control[s] are performing to a level that achieves compliance with the current licence emission concentration limits and the EPA's air quality impact assessment criteria. Where current emission controls are found to be inadequate, this condition requires investigation and implementation of additional control measures that will ensure compliance with relevant criteria.

1. *The licensee must complete an air quality impact assessment and mitigation study ("the Study").*

2. *The Study must be completed in strict accordance with the methodologies set out in the following documents or as otherwise approved of in writing by the EPA:*

    a. *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (NSW DEC, August 2005)* [approved methods]*; and*
    b. *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales (NSW DEC, December 2006).*

3. *The Study must include:*

a. Identification of all emission sources of complex mixtures of odorous substances, speciated volatile organic compounds (e.g. individual air toxics and individual odorous substances), hydrogen sulphide, solid particles and sulphuric acid mist at the premises and their maximum air pollutant emission concentrations/rates determined by sampling in accordance with the methods detailed in 2b;

b. Identification of all air pollution control equipment associated with the emission sources in 3a. The operational performance of each item of control equipment must be determined based on actual performance as determined in 3a. Performance of each item of equipment must be benchmarked against best management practice;

c. Based on the results of 3a and 3b, a determination by the Licensee as to whether emissions of these air pollutants comply with the requirements of the Protection of the Environment Operations (Clean Air) Regulation 2002 ("the Regulation") and the licence. If the emission concentrations do not comply with the requirements of the Regulation and the licence, the Licensee must advise the EPA Regional Manager Hunter immediately when the results become known;

d. A dispersion modelling study which predicts the ground level concentrations of air pollutants specified in 3a. Modelling must be conducted in strict accordance with the methods detailed in 2a and using the data collected in 3a. To remove any doubt, where TAPM meteorology is used to predict atmospheric dispersion from the site, on-site wind measurements must be incorporated into the TAPM model for assimilation. Emissions modelled must be based on maximum measured emission concentrations; and

e. A comparison of the ground level concentrations predicted by the model against the appropriate impact assessment criteria detailed in 2a. Ground level concentration predictions at both nearby industrial and residential receptors must be presented in the comparison. To remove any doubt, the appropriate criteria for odour and hydrogen sulphide to be adopted by the Study are:

   i. Odour – 2OU at residential receptors and 4 OU at industrial receptors; and
   ii. Hydrogen sulfide – 1.38 µg/m^3 at residential receptors and 2.76 µg/m^3 at industrial receptors.

f. A review of the current flare design and operation and comparison with the flare design approved by the EPA in a letter dated 7 December 2006.

4. Using the results from 3, if the premises does not comply with the relevant impact assessment criteria, emission concentration limits and the approved flare design, a technical review of all practical options for mitigating or controlling the emission concentration and rate of air pollutants and improving the flare design and operation must be completed and included in the Study. The technical review must include:

a. Qualitative evaluation and modelling where appropriate of the potential reduction in the emission concentration and rate and air quality impacts associated with each mitigation option;

b. *A cost/benefit analysis of a range of air quality mitigation and flare design options must be completed;*

c. *Using the results of 3, 4a and 4b the Licensee must identify emission control and management practices that ensure that the relevant impact assessment criteria detailed in 2a above, the licence emission concentrations limits and the requirements of the Protection of the Environment Operations (Clean Air) Regulation 2002 are met;*

d. *Detail a timetable to implement all necessary emission controls and flare modifications (as necessary);*

e. *Detail a timeframe and validation framework to demonstrate compliance following the implementation of emission controls from 4c and 4d; and*

5. *By no later than 1 September 2010, the Licensee must submit the findings of 3 and 4 to the EPA's Regional Manager, Hunter in a formal report that has been prepared in strict accordance with the requirements detailed in 2a.*

The intention of the PRP is essentially a requirement for TPR to formally confirm that the emissions from the premises are reasonable, check compliance with the existing regulation and licence limits and conduct air dispersion modelling to confirm whether off-site air pollutant concentrations due to TPR meet acceptable levels.

The PRP also requires presentation of corrective actions needed to address problems that may be occurring.

2 APPROACH TO ASSESSMENT

The PRP requires assessment of the following substances:

- complex mixtures of odorous substances (i.e. odour);
- speciated volatile organic compounds VOC (i.e. individual air toxics and individual odorous substances);
- hydrogen sulphide;
- solid particles; and,
- sulphuric acid mist.

All of these substances were assessed. The individual VOC substances for which the approved methods present ground level concentration criteria were assessed. These substances are:

- Formaldehyde (toxic); and,
- PAH (toxic).

It is noted that in almost all cases, the individual VOC substances were measured at levels below the detection level for the specific test.

A site inspection was conducted to identify the potential emission sources of these substances.

The measured levels of these substances from every emission point on the premises were examined from June 2009 to present, (the last 4 rounds of quarterly sampling). The maximum emission concentration and also the maximum mass emission rate was determined for each substance.

Air dispersion modelling was conducted assuming every point was simultaneously emitting the substance at the maximum level. However, the maximum emission rates of the various substances occur at different times from the various emission points. Therefore the approach adopted is conservative as it would predict higher off site pollutant concentrations than would have occurred.

The approach has further conservatism built in as the maximum rate was modelled for all times of the year. For modelling many of the individual VOC's the detection level was used as it is not known how far below this level actual emissions may have been. This is conservative as generally 50% of the detection level is modelled.

Further details of the modelling approach, including meteorology are provided in **Section 4**.

The modelling results are presented in tables and also as ground level concentration (glc) contours for selected pollutants. Note that the majority of individual VOC substances were measured at the same detection level, thus only a single plot is necessary to represent the potential impact of any one of these substances.

3 EMISSIONS FROM THE SITE

3.1 Identification of potential emissions

Whilst there are some minor dust emissions from traffic on sealed roads, and some minor fugitive odour emissions from the oil receiving facility and also within the intrinsically safe plant process area, these sources do not have potential to cause impact off-site.

Odour from the receiving facility was somewhat like that near a typical truck refuelling area, and the oily/ distillate type odours were generally not detectable within a few meters of the facility.

Some minor oily/ chemical odour was detectable in parts of the intrinsically safe process area, however these odours could not be detected outside the security fence of the processing area.

Only stack emission points were identified as having any potential to lead to off-site impacts, and thus the rest of this study focuses on these sources.

The emission sources identified for assessment are shown in **Figure 3.1**: Identified sources of emissions

Figure 3.1: Identified sources of emissions

3.2 Pollution control equipment

The following pollution control equipment is employed at TPR:

- Emission points 2 and 3 comprise of stacks which serve to disperse emissions from gas fired boilers;
- Emission point 4 is a flare, designed to destroy VOC emissions in the event of start up, shutdown and emergency process upset conditions. Whilst the flare is a pollution control device, its primarily function is to operate as a safety device.
- Storage tank VOC emissions are controlled with a wet scrubber that vents via emission point 5, Light Ends Scrubber.
- Emission point 19 is a stack that serves two gas fired heaters.
    - The thermal oil heater operates on natural gas and exhausts directly out of Point 19 (via in-duct monitoring point 18);
    - The Fired Heater operates on natural gas and fuel gas from the process, and exhausts to a SO_X scrubber to control potential sulphur emissions. After passing though the scrubber, emissions from the Fired Heater exhaust to point 19 (via in-duct monitoring point 1).
- Emission point 20 is a stack which serves to exhaust emissions associated with operation of the reformer.

3.3 Operational performance

Plant emission compliance is outlined in Table 3.1, and is used to show operational performance. The results show that emission points 2, 3, 5 and 20 perform well below the POEO Clean Air (Plant and Equipment) Regulation limits, and current EPL limits. However Point 19 does not meet limits.

- Hydrogen sulphide emissions for the December 2009 monitoring were above the regulation and licence limit;
- Sulphuric acid mist and sulphur trioxide emissions for the July 2009 monitoring were above the regulation and licence limit; and,
- Solid particle emissions were above the licence limit (but not the Regulation limit) for the last four monitoring events.

Table 3.1: Compliance assessment of emissions (mg/m^3)

Point	Parameter	Jul-09	Sep-09	Dec-09	Mar-10	Reg limit	License limit	OK (reg/lic)
2	VOC	0.2	4.3	3.8	0.13	40	10	yes/yes
	Solid Particles	6.4	0.54	2.3	1.1	50	10	yes/yes
3	VOC	0.3	8	<0.01	6.97	40	10	yes/yes
	Solid Particles	<0.1	0.12	1.3	0.88	50	10	yes/yes
5	VOC	0.2	<0.17	1.1	7.66	40	20	yes/yes
19	VOC	<0.2	<0.2	0.3	1.34	40	10	yes/yes
	H_2S	2.1	2.1	**6.6**	4.68	5	5	no/no
	Solid Particles	**14**	**17**	**30**	**47.4**	50	10	yes/no
	Sulfuric Acid Mist	**110**	46	32	70.5	100	100	no/no
20	VOC	0.1	3.3	7.6	5.74	40	10	yes/yes
	Solid Particles	2.7	1.1	0.06	1.91	50	10	yes/yes

3.4 Benchmarking performance

The use of natural gas fired plant is consistent with best practice, and the measured emissions from these items show consistently low levels of emission.

However, emissions from Point 19 did not achieve compliance with limits on all occasions, and some closer examination is warranted.

The plant configuration for point 19 appears to be unique, and we are unable to find a comparable configuration for benchmarking purposes. However, the following discussion may assist to gauge the level of performance achieved.

Overall, the Fired Heater that exhausts via the SO_x scrubber and thence Point 19 serves as a device to destroy otherwise waste gas than might potentially be flared. The fired heater operates as a best practice measure as it destroys large quantities of potential VOC emissions, and reduces greenhouse gas emissions by capturing otherwise lost heat for use in the process.

However there is a trade off as the combustion of the fuel gas can produce sulphurous emissions which are controlled with a wet scrubber. The type used has a rapid quench and is essentially a packed column that is spray irrigated with sodium hydroxide. A demister is used to capture mists.

This is fundamentally a good scrubber design and should ensure good removal of sulphur oxides. It is however noted that sulphuric acid mist and sulphur trioxide emissions exceeded limits by 10% on one occasion . The scrubber is regularly maintained; opened to inspect and service the demister pad and sprays, checking alignment and blockages; and has sub daily condition monitoring conducted by operations staff.

Solid particle emissions achieve compliance with the regulation limit of 50 mg/m^3 but are above the license limit of 10 mg/m^3. The levels of solid particle emissions are believed to be heavily influenced by salts present in the emissions stream that confound the monitoring.

The licence limit of 10 mg/m^3 would be applicable to a natural gas fired heater or boiler but is not considered to reflect best practice levels of emission from a heater operated on fuel gas and exhausting via an SO_x scrubber. (It is noted that the natural gas fired equipment on-site would meet a level of 10 mg/m^3 for solid particle emissions.) Overall it is considered that the levels of combustion particles emitted are likely to be low and consistent with best practice, however the complicating factor of having to test for particulate matter in the outlet of an SO_X scrubber makes measurement unreliable. There appears to be a strong case to alter or remove the solid particle license limit for this emission point. This is considered further later in the report.

The H_2S level exceeded the regulation limit on one occasion. The reasons for this are not clear at this time. Whilst H_2S is a toxic gas at high concentrations, emission limits are designed to protect amenity (odour) as H_2S is highly odorous at levels that would not be toxic. This is supported by the provision in the regulation to accommodate alternative standards for H_2S emission.

Point 4 is an enclosed design type flare. Enclosed design flares provide higher combustion temperatures and longer residence time, which is important for a high level of destruction of VOC. The flare at TPR cannot be tested during operation due to the intensity of the heat produced which has obvious safety implications. The flare design specification is included at **Appendix A**.

The flare type and flare design is consistent with best practice and is specified to operate with a destruction efficiency of 99.99%, within the range of 800 to 1000 degrees centigrade with a residence time of 1.2 seconds in the high heat zone.

4 MODELLING METHODOLOGY

The modelling has been carried out in general accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales,* (**DEC, 2005**). The Approved Methods specify how assessments based on the use of air dispersion models should be undertaken. They include guidelines for the preparation of meteorological data to be used in dispersion models and the relevant air quality criteria for assessing the significance of predicted concentrations from a site.

Dispersion modelling conducted for this assessment has been based on a modelling system using TAPM, CALMET and CALPUFF.

TAPM is a prognostic meteorological model that generates gridded three-dimensional meteorological data for each hour of the model run period. CALMET, the meteorological pre-processor for the dispersion model CALPUFF, calculates three-dimensional meteorological data based upon observed ground and upper level meteorological data, as well as modelled data generated for example by TAPM. CALPUFF then calculates the dispersion of plumes within this three-dimensional meteorological field.

For this project, hourly surface data from the on-site monitoring station and cloud data from Williamtown RAAF were used. Upper air data were calculated with these data using TAPM.

4.1 Meteorology

Annual and seasonal wind roses for on-site meteorological data are presented in **Figure 4.1.** On an annual basis winds from west are predominant. To use the wind data to assess dispersion, it is necessary to also have data on atmospheric stability. The term atmospheric stability refers to the dispersive capacity of the atmosphere. The most well-known stability classification is the Pasquil-Gifford scheme, which denotes stability classes from A to F. The frequency distribution of estimated stability classes in the meteorological file is presented in **Table 4.1.** Overall the stability class F occurs for the greatest proportion of time (48%) within the surrounding area.

Table 4.1: Frequency of stability classes

Stability Class	Percentage occurrence (CALMET)
A	5%
B	24%
C	16%
D	5%
E	2%
F	48%
TOTAL	**100**

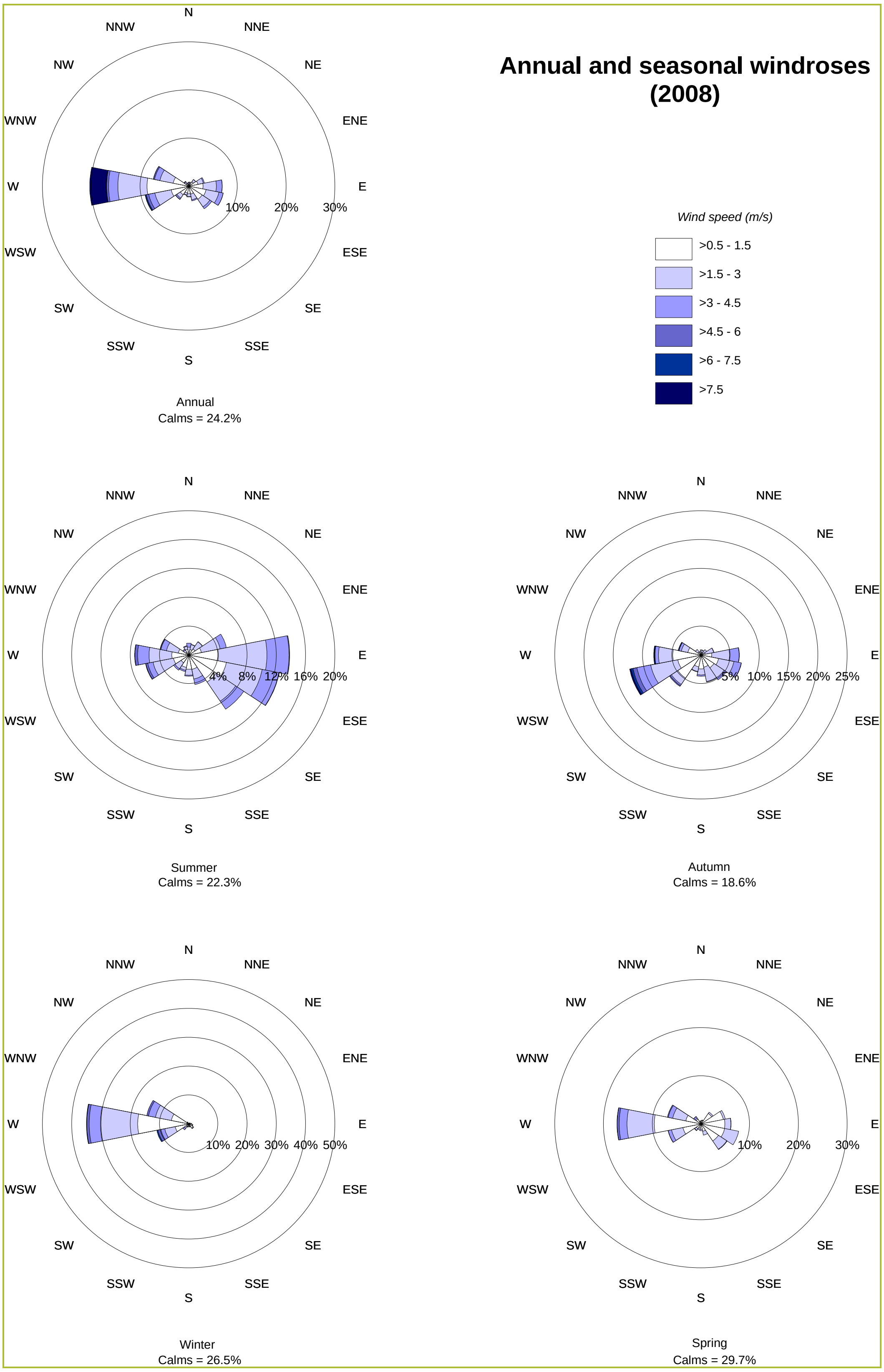

Figure 4.1: Annual and seasonal windroses for onsite meteorological data

4.2 Building Wake Effects

The dispersion of emissions released at TPR is likely to be affected by aerodynamic wakes generated by winds having to flow around the buildings or stack. Building wake effects may lead to downwash where the plume approaches the ground resulting in elevated ground level concentrations.

Significant buildings and structures on the site were included in the CALPUFF model. The Building Profile Input Program (BPIP) was applied to consider the effects of building wakes on pollutant dispersion.

5 EMISSION ESTIMATION

Emissions from each stack were estimated based on the stack measurement data for the last four quarters (March 2010, December 2009, September 2009 and July 2009). The maximum emission rates for each stack, calculated from the stack measurement data, are presented in **Table 6.1** and have been used in the dispersion modelling as detailed at **Section 2**.

Table 5.1: Emission rates and modelling parameters used in air dispersion modelling

Pollutant	Units	Point 2	Point 3	Point 4	Point 5	Point 19	Point 20
Stack Parameters							
Temperature	°C	170	238	96	11	101	833
Exit velocity	m/s	2.4	6.4	2.8	2.4	5.7	11.0
Diameter	m	0.65	0.16	0.95	0.2	0.4	0.34
Height	m	8	10	16	8	16	14
Odorous and Toxic Pollutants							
Hydrogen Sulfide	g/s	2.59E-03	1.69E-03	4.20E-04	-	2.90E-03	1.09E-03
Odour	ou-m³/s	434	444	-	423	979	262
Sulfuric Acid Mist	g/s	1.54E-03	7.80E-04	1.40E-04	-	4.84E-02	1.16E-03
Solid Particles	g/s	3.58E-03	2.87E-04	7.00E-04	-	2.21E-02	6.48E-04
Speciated Volatile Organic Compounds (VOCs)							
1,3,5 trimethylbenzene	g/s	5.70E-05	1.40E-05	-	6.00E-06	4.70E-05	2.40E-05
Acetone	g/s	5.70E-05	1.40E-05	-	6.00E-06	4.70E-05	2.40E-05
Benzene	g/s	5.70E-05	1.40E-05	-	4.80E-06	4.70E-05	2.40E-05
Chlorobenzene	g/s	5.70E-05	1.40E-05	-	6.00E-06	4.70E-05	2.40E-05
Chloroform	g/s	5.70E-05	1.40E-05	-	6.00E-06	4.70E-05	2.40E-05
Cyclohexanone	g/s	5.70E-05	1.40E-05	-	6.00E-06	4.70E-05	2.40E-05
Ethyl Benzene	g/s	5.70E-05	1.40E-05	-	6.00E-06	4.70E-05	2.40E-05
Formaldehyde	g/s	-	-	-	-	7.48E-04	-
Hexanone	g/s	5.70E-05	1.40E-05	-	6.00E-06	4.70E-05	2.40E-05
m & P Xylene	g/s	1.10E-04	2.90E-05	-	1.20E-05	9.90E-05	4.80E-05
o- xylene	g/s	5.70E-05	1.40E-05	-	6.00E-06	4.70E-05	2.40E-05
(PAH)	g/s	5.2E-09	7.74E-09	2.66E-06	2.84E-09	5.17E-09	9.27E-08
Styrene	g/s	5.70E-05	1.40E-05		6.00E-06	4.70E-05	2.40E-05
Toluene	g/s	1.50E-04	7.20E-05		1.70E-05	4.70E-05	2.80E-05
Trichloroethene	g/s	5.70E-05	1.40E-05		6.00E-06	4.70E-05	2.40E-05
Xylene (total)	g/s	2.07E-04	8.60E-05		2.30E-05	9.40E-05	5.20E-05

6 MODELLING RESULTS

Predicted ground level pollutant concentration levels due to emissions from the TPR operations are presented in **Figure B.1** to **Figure B11.** It is noted that measured stack concentrations for several VOCs including 1,3,5 trimethylbenzene, acetone, chlorobenzene, chloroform, cyclohexanone, ethyl benzene, hexanone, styrene and trichloroethene were below detection levels and have the same reported concentration values. To save unnecessary repetition therefore, the predicted off-site concentration levels for these pollutants are presented in one figure (**Figure B**.6) which is valid for each individual pollutant.

The predicted maximum off-site concentration levels for each pollutant listed in **Table 5.1**, are presented in **Table 6.1**.

Table 6.1: Predicted maximum offsite concentrations for pollutants

Pollutant	Averaging Period	Units	Maximum off site concentration	DECCW Criteria	Meets criteria	Fraction of criteria
H_2S	Nose-response	µg/m³	2.4	3.45	yes	69.6%
Odour	Nose-response	OU	0.8	4	yes	20.0%
H_2SO_4	1-hour	mg/m³	0.012	0.018	yes	66.7%
PM_{10}	24-hour	µg/m³	2	50	yes	4.0%
	Annual	µg/m³	0.21	30	yes	0.7%
Speciated VOCs						
1,3,5 trimethylbenzene	1-hour	mg/m³	3.00E-05	2.2	yes	0.0%
Acetone	1-hour	mg/m³	3.00E-05	22	yes	0.0%
Benzene	1-hour	mg/m³	3.00E-05	0.029	yes	0.1%
Chlorobenzene	1-hour	mg/m³	3.00E-05	0.1	yes	0.0%
Chloroform	1-hour	mg/m³	3.00E-05	0.9	yes	0.0%
Cyclohexanone	1-hour	mg/m³	3.00E-05	0.26	yes	0.0%
Ethyl Benzene	1-hour	mg/m³	3.00E-05	8	yes	0.0%
Formaldehyde	1-hour	mg/m³	0.00018	0.02	yes	0.9%
Hexanone	1-hour	mg/m³	3.00E-05	1.8	yes	0.0%
PAH	1-hour	mg/m³	3.40E-07	0.0004	yes	0.1%
Styrene	1-hour	mg/m³	3.00E-05	0.12	yes	0.0%
Toluene	1-hour	mg/m³	9.50E-05	0.36	yes	0.0%
Trichloroethene	1-hour	mg/m³	3.00E-05	1	yes	0.0%
Xylene (total)	1-hour	mg/m³	9.00E-05	0.19	yes	0.0%

7 ASSESSMENT OF MODELLING RESULTS

All model predictions show that the TPR operations comply with DECCW impact assessment criteria for all air emissions considered in this study.

In terms of environmental significance, the results presented in **Table 6.1** are the most relevant to consider as they compare potential impacts with criteria for environmental harm or nuisance.

In regard to potential risk of harm or nuisance, the results reveal that (if emitted at the maximum measured levels continuously over a year) off-site H_2S and sulphuric acid mist concentration levels would be at around two third of the criteria, odour levels near the site would be one fifth of the criteria and other pollutant concentration levels would be negligible.

7.1 Hydrogen sulphide and sulphuric acid mist

The pollutants with the highest off-site concentration (relative to the respective criteria) are H_2S and sulphuric acid mist, and are primarily emitted from emission point 19. These substances are most likely to originate from the sulphur contained in the Thermal Heater fuel gas, exhausted via the SO_X scrubber into the stack serving emission point 19.

Whilst, when conservatively modelled, these pollutants show a good margin of compliance with off-site impact assessment criteria, there have been occasions in the past when in-stack concentration limits were exceeded, although only by a relatively small degree.

It is noted that extensive efforts have been made to date in regard to the operation of the facility, and specifically to remove the potential for odour emissions (e.g. Point 5 light ends scrubber) and also to reduce/ resolve issues with particulate emissions from emission point 19, including the SO_X scrubber operation. Investigations have been conducted on the scrubber and issues with de-mister operation resolved. The scrubber has been benchmarked with the original equipment manufacturers specification and shown to be operating within these.

The modifications at the site have essentially brought about best practice management of odour, VOC and GHG emissions by re-directing emissions to the fired heater, and ensuring SO_X scrubber operation is as designed.

H_2S and sulphuric acid mist emissions from emission point 19 have exceeded in-stack limits on only one occasion over the past year, and only to a relatively small degree.

In this circumstance, and where it is conservatively shown that maximum measured emissions, (occurring continuously over a year) would not exceed impact criteria, it is not reasonable or feasible to undertake any major re-fit or revision to the plant operations or pollution control equipment.

However it is concerning that any exceedance at all has occurred in the last year, and it would be warranted to closely monitor the performance of emission point 19 and to evaluate the performance to see if any trend or issue arises.

The objectives are to;

- Take actions to investigate and better understand H2S an acid mist emissions from point 19 beyond that required in the EPL,
- take appropriate corrective action if issues are found to exist; and,
- provide reassure to the community and regulators if issues do not exist;

7.2 Solid particles

Solid particle emissions from the premises have been conservatively shown to have negligible off-site effect, however they have significantly exceeded the licence limit for in-stack concentration at point 19.

As discussed previously, after extensive investigation it is believed that emissions entering point 19 via the SO_X scrubber confound the monitoring results for particulate emissions. There is no reasonable basis to consider that actual combustion particulate from point 19 would be at the levels being measured, and it would appear that other material, such as salts from the SO_X scrubber lead to the high solid particulate levels recorded in measurements.

The information and studies conducted by TPR on particulate emission from point 19 support an increase to the licence limit at emission point 19 to a level of 50 mg/m^3, or removal of a particulate limit altogether.

The key reasons are that this level is commensurate with best management practice for equipment combusting fuel gas of variable calorific value, variable composition, and variable quantity. The nature of the fuel makes it impractical to operate the equipment at levels commensurate with best practice for equipment burning natural gas (which is consistent in quality). Emission point 19 also services an SO_X scrubber and a natural gas fired heater further complicating matters.

Whilst it can be shown (from the results of emission point 18, in-duct monitoring point) the natural gas fired heater produces low levels of particulate commensurate with best management practice for a natural gas fired boiler, we cannot find any examples of particulate monitoring of SO_X scrubber emissions as part of best practice management practice for Furnace emissions. We have examined furnace emissions controls commensurate with best practice plant and some examples are provided in **Table C.1.** A key observation is that these plant operate alternative controls for NO_X emissions (SCR units) and that Particulate emissions are not regulated, as the emission levels are inherently low.

This supports the current view that particulate emissions from the heaters at TPR are low, but that measurement to show this is confounded by emissions from the in-line SO_x scrubber. In light of this situation, it would not be reasonable to expect operation of the plant at TPR to achieve a particulate emission level below 10 mg/m^3.

The application of the regulation limit of 50 mg/m^3 to emission point 19, or alternatively, no particulate limit would be consistent with best practice management of emissions from this point.

8 CONCLUSIONS

The study has reviewed the potential emission sources at TPR, pollution control equipment and the concentration level of emissions.

The emission concentration levels have been compared with regulatory and licence limits. Some exceedances of these limits were found to have occurred.

The plant generally complies with best management practice for key pollutants of concern from a refining activity, such as odour and VOC, however the plant has some unique features in its design that cannot be reasonably benchmarked.

The maximum measured levels over the past 12 months have been applied in a site specific air dispersion model to predict maximum off-site ground level pollutant concentrations.

Through conservative modelling, the off-site ground level pollutant concentration levels were shown to be well below impact assessment criteria.

Overall, it is concluded that:

- Maximum plant emissions have no environmental impact beyond the boundary of the site;
- Particulate emission limits for point 19 should be revised to reflect the operation of fuel-gas fired plant, or be removed altogether; and,
- H_2S and sulphuric acid mist emissions have exceeded limits, albeit by a relatively small degree and only on one occasion in the last four rounds of testing, however this is of concern as off-site impacts of such emissions at such levels would be at around two thirds of the off-site impact assessment criteria.

In light of this, it is recommended to monitor point 19 closely over a year in regard to sulphur related emissions and parameters, with a view to revealing whether there is any underlying issue or not.

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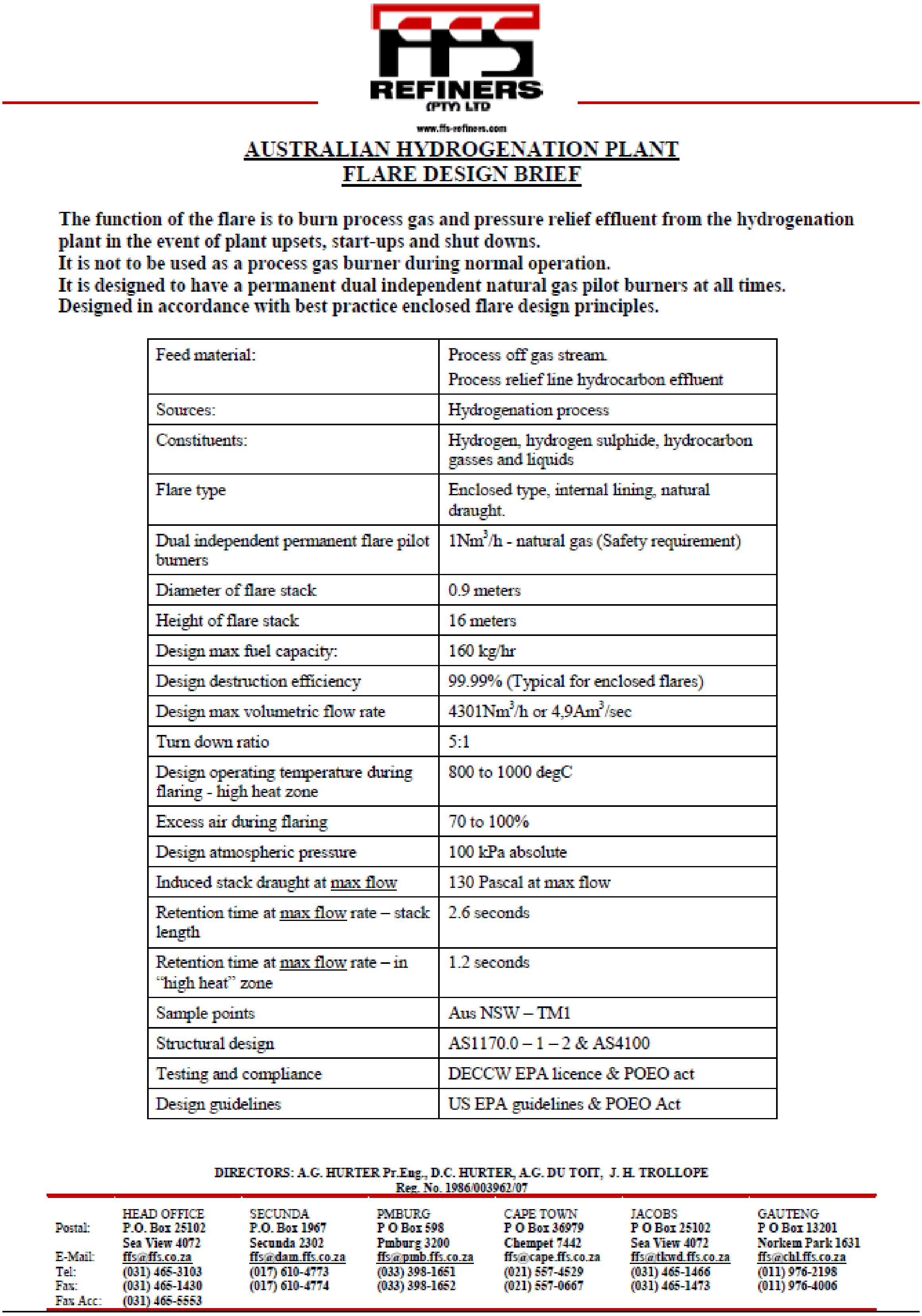
APPENDIX A

FLARE SPECIFICATIONS

A.1 FLARE SPECIFOCATIONS



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AUSTRALIAN HYDROGENATION PLANT
FLARE DESIGN BRIEF

The function of the flare is to burn process gas and pressure relief effluent from the hydrogenation plant in the event of plant upsets, start-ups and shut downs.
It is not to be used as a process gas burner during normal operation.
It is designed to have a permanent dual independent natural gas pilot burners at all times.
Designed in accordance with best practice enclosed flare design principles.

Feed material:	Process off gas stream. Process relief line hydrocarbon effluent
Sources:	Hydrogenation process
Constituents:	Hydrogen, hydrogen sulphide, hydrocarbon gasses and liquids
Flare type	Enclosed type, internal lining, natural draught.
Dual independent permanent flare pilot burners	1Nm^3/h - natural gas (Safety requirement)
Diameter of flare stack	0.9 meters
Height of flare stack	16 meters
Design max fuel capacity:	160 kg/hr
Design destruction efficiency	99.99% (Typical for enclosed flares)
Design max volumetric flow rate	4301Nm^3/h or 4,9Am^3/sec
Turn down ratio	5:1
Design operating temperature during flaring - high heat zone	800 to 1000 degC
Excess air during flaring	70 to 100%
Design atmospheric pressure	100 kPa absolute
Induced stack draught at max flow	130 Pascal at max flow
Retention time at max flow rate – stack length	2.6 seconds
Retention time at max flow rate – in "high heat" zone	1.2 seconds
Sample points	Aus NSW – TM1
Structural design	AS1170.0 – 1 – 2 & AS4100
Testing and compliance	DECCW EPA licence & POEO act
Design guidelines	US EPA guidelines & POEO Act

DIRECTORS: A.G. HURTER Pr.Eng., D.C. HURTER, A.G. DU TOIT, J. H. TROLLOPE
Reg. No. 1986/003962/07

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APPENDIX B

AIR DISPERSION MODELLING RESULTS

B.1 FIGURES

Species: H_2S	**Location:** Transpacific Rutherford	**Scenario:** PRP	**Percentile:** 99th	**Averaging Time:** Nose response
Model Used: CALPUFF v6.267	**Units:** mg/m³	**Guideline:** DECCW = 3.45 mg/m³	**Met Data:** 2008 CALMET Generated	**Plot:** F.Rahaman

Figure B.1: Predicted nose response time average H_2S concentration

Species: Odour	**Location:** Transpacific Rutherford	**Scenario:** PRP	**Percentile:** 99th	**Averaging Time:** Nose response
Model Used: CALPUFF v6.267	**Units:** Mg/m³	**Guideline:** DECCW = 2 OU	**Met Data:** 2008 CALMET Generated	**Plot:** F.Rahaman

Figure B.2: Predicted nose response time average Odour concentration

Species: H_2SO_4	**Location:** Transpacific Rutherford	**Scenario:** PRP	**Percentile:** Maximum	**Averaging Time:** 1-Hour
Model Used: CALPUFF v6.267	**Units:** mg/m³	**Guideline:** DECCW = 0.018 mg/m³	**Met Data:** 2008 CALMET Generated	**Plot:** F.Rahaman

Figure B.3: Predicted 1-hour average H_2SO_4 concentration

Species: PM$_{10}$	**Location:** Transpacific Rutherford	**Scenario:** PRP	**Percentile:** Maximum	**Averaging Time:** 24-Hour
Model Used: CALPUFF v6.267	**Units:** mg/m³	**Guideline:** DECCW = 50 µg/m³	**Met Data:** 2008 CALMET Generated	**Plot:** F.Rahaman

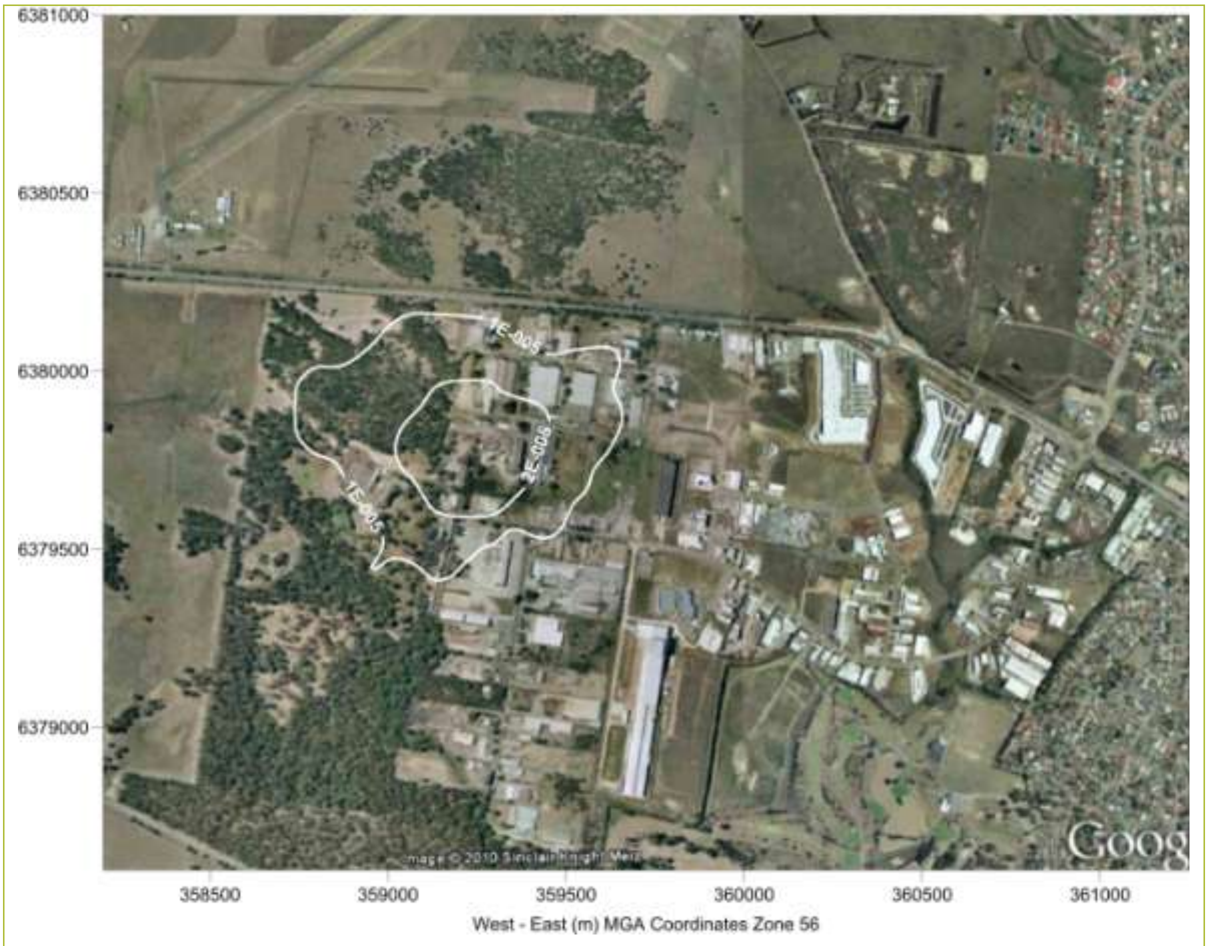
Figure B.4: Predicted 24-hour average PM$_{10}$ concentration

Species: PM_{10}	**Location:** Transpacific Rutherford	**Scenario:** PRP	**Percentile:** Maximum	**Averaging Time:** Annual
Model Used: CALPUFF v6.267	**Units:** mg/m³	**Guideline:** DECCW = 30 mg/m³	**Met Data:** 2008 CALMET Generated	**Plot:** F.Rahaman

Figure B.5: Predicted annual average PM_{10} concentration

Species: Various, see figure title	**Location:** Transpacific Rutherford	**Scenario:** PRP	**Percentile:** Maximum	**Averaging Time:** 1-hour
Model Used: CALPUFF v6.267	**Units:** mg/m³	**Guideline:** Refer to **Table 6.1**	**Met Data:** 2008 CALMET Generated	**Plot:** F.Rahaman

Figure B.6: Predicted 1-hour average for individual VOCs substances, modelled at the detection limit of measurement (valid for:123 trimethylbenzene, Acetone, Chlorobenzene, Chloroform, Cyclohexanone, Ethyl Benzene, Hexanone, Styrene and Trichloroethene)



Species:	**Location:**	**Scenario:**	**Percentile:**	**Averaging Time:**
Benzene	Transpacific Rutherford	PRP	Maximum	1-hour
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
CALPUFF v6.267	mg/m³	DECCW = 0.029 mg/m³	2008 CALMET Generated	F.Rahaman

Figure B.7: Predicted 1-hour average Benzene concentration

Species: Formaldehyde	**Location:** Transpacific Rutherford	**Scenario:** PRP	**Percentile:** Maximum	**Averaging Time:** 1-Hour
Model Used: CALPUFF v6.267	**Units:** mg/m³	**Guideline:** DECCW = 0.02 mg/m³	**Met Data:** 2008 CALMET Generated	**Plot:** F.Rahaman

Figure B.8: Predicted 1-hour average Formaldehyde concentration

Species: PAH	**Location:** Transpacific Rutherford	**Scenario:** PRP	**Percentile:** Maximum	**Averaging Time:** 1-Hour
Model Used: CALPUFF v6.267	**Units:** mg/m³	**Guideline:** DECCW = 0.0004 mg/m³	**Met Data:** 2008 CALMET Generated	**Plot:** F.Rahaman

Figure B.9: Predicted 1-hour average PAH concentration

Species: Toluene	**Location:** Transpacific Rutherford	**Scenario:** PRP	**Percentile:** Maximum	**Averaging Time:** 1-hour
Model Used: CALPUFF v6.267	**Units:** mg/m³	**Guideline:** DECCW = 0.36 mg/m³	**Met Data:** 2008 CALMET Generated	**Plot:** F.Rahaman

Figure B.10: Predicted 1-hour average Toluene concentration

Species: Xylene	**Location:** Transpacific Rutherford	**Scenario:** PRP	**Percentile:** Maximum	**Averaging Time:** 1-hour
Model Used: CALPUFF v6.267	**Units:** mg/m³	**Guideline:** DECCW = 0.19 mg/m³	**Met Data:** 2008 CALMET Generated	**Plot:** F.Rahaman

Figure B.11: Predicted 1-hour average Xylene concentration

APPENDIX C

EXAMPLES OF BEST PRACTICE FOR FURNACE CONTROL

Table C.1: Example of best practice for furnace control

Company	Plant Type	Function	Max Heat Input	Primary Secondary Fuel	Permit Limit	Control Technology Type	Description
TOSCO Refining Co.	Hydrogen reforming furnace	Included in a hydrogen plant at a refinery and heats hydrocarbon feed streams to reform them with steam to H_2 and CO_2.	460 MMBtu/Hr	Pressure swing absorption off gas (lo-Btu) & refinery gas/Natural gas.	NOx: 7 ppmv; NH3: 20 ppmv; each dry, corrected to 3% O2 and averaged over 15 minutes; SOx: 11.1 lbs/hr; fuel total sulfur content: 100 ppm as H2S. Exceptions to NOx limit: startup and shutdowns, 150 hours of refractory dry out, and when heater exhaust is < 600 degrees F (to avoid ammonium bisulphate deposits.)	Selective catalytic reduction (SCR) with aqueous ammonia injection	NOx is chemically reduced to N2 by the reducing agent NH3 in the presence of a Cormetech, Inc. catalyst.
Air Products and Chemicals, Inc.	Reforming Furnace	Included in a new hydrogen production facility and will convert compressed natural gas and steam to CO, CO2 and H.	764 MMBtu/Hr	Natural gas PSA gas mixture	NOx: 5 ppmvd at 3% O2, 3-hour ave; CO: 10 ppmvd at 3% O2, 3-hour ave, NH3: 20 ppmvd at 3% O2.	Selective Catalytic Reduction System	Aqueous ammonia is injected into the flue gas upstream of the SCR unit to allow mixing of the ammonia and the NOx in the flue gas. The SCR unit contains a proprietary catalyst that promotes the reduction reaction between NOx and ammonia. The products of the reduction reaction are nitrogen and water. The SCR unit has 42 catalyst modules and the total catalyst volume is 1490 cubic feet.
Chevron Products CO.	Reforming Furnace	Used for hydrogen production.	653 MMBtu/Hr	Refinery Gas/natural gas	NOX: 5 ppmvd corrected to 3% O2, 3-hour ave; CO: 25 ppmvd corrected to 3% O2, 3-hour ave; NH3: 20 ppmvd corrected to 3% O2, 3-hour ave.	Selective Catalytic Reduction System	Reduces NO_X emissions from combustion incl. such as heaters, boilers, and gas turbines. Chemical reaction involves:(1) injecting anhydrous ammonia (NH_3), aqueous ammonia, or aqueous urea into the flue gas;(2) mixing NH_3 with NO_X in the combustion gases upstream of a NO_X reactor; and (3) a series of chemical reactions of the mixture in the presence of oxygen and a catalyst bed (enclosed in the NO_X reactor) to form N_2 and water. This SCR system is most effective whenever the reaction occurs within a temperature envelop of 500 and 750 degree F.
Praxair	Hydrogen Reformer	Provides heat to catalyst-filled tubes in which steam-natural gas mixture is reformed to hydrogen-rich gas.	117.6 MMBtu/Hr	Reformer Waste Gas (PSA tail gas)/ natural gas (warm-up and supplement)	Ppmvd at 3%O2 (1-hr Avg.): NOx-5, CO-400, NH3-5	Selective Catalytic Reduction System	Ammonia is mixed into flue gas, and the mixture is passed through a catalyst bed, in which the ammonia reacts with NOx reducing it to N2. SCR design operating temperature is 760F, and design removal efficiency is 90%.