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1. Introduction

Austeel Pty Ltd intends to develop a Hot Briquetted Iron (HBI) project of nominally 4.35 Mtpa at Cape Preston 80 km south-west of Dampier. The project will involve:

- Iron ore mining;
- Ore concentration;
- Ore pelletising;
- Production of DRI/HBI;
- Waste dumps;
- Tailing dams;
- Conveyor transfer of product to Cape Preston;
- Product stockpiles and material handling;
- Port development and ship loading; and
- Additional infrastructure including access roads, haul roads, construction camps, villages, power distribution and desalinated water.

As part of the environmental impact assessment, Halpern Glick Maunsell have engaged Sinclair Knight Merz to undertake the air quality impact assessment. To this end this report presents an assessment of the local and regional impacts from the major point sources of pollutant for the project; the Pellet plant, DRI/HBI plant and power station.

2. Plant Emissions

2.1 Sources of Atmospheric Emissions from the Project

In terms of air quality impacts atmospheric emissions from the project will be generated from:

- Mining activities, haulage operations, wind erosion from open areas and stockpiles, and combustion products from vehicles. All emissions with the exception or particulate matter, are generally insignificant. The particulate emissions are generally difficult to quantify and model, therefore, these sources are not treated in the air quality assessment.
- The pellet plant with emissions from a main stack with pollutants of concern being oxides of nitrogen and particulate and from two de-dusting stacks emitting particulate.
- The three DRI plants with main stacks emitting combustion products (oxide of nitrogen, sulphur dioxide and particulate and 6 de-dusting stacks emitting particulate.
- Power station consisting of two open cycle gas turbines that will emit oxide of nitrogen.

Emissions from the point sources are summarised in **Appendix A**. This indicates that:

- Emissions will total 356 g/s of NO_X, being released primarily from the Pellet Plant (65% of emissions);
- Emissions will total 26.8 g/s of SO_2, released from the pellet plant and DRI plant main stacks; and
- Emissions will be a maximum of 48.7 g/s for dust.

These emissions are predicted to occur under normal operating conditions, with no upset conditions predicted to occur from the plant (Lurgi, 2000a).

2.2 Comparison to Emission Limits

Within WA, the EPA "require that all reasonable and practicable means should be used to prevent and minimise the discharge of waste" (EPA, 1999a). In the past they have used the AEC/NHMRC (1986) guidelines for new stationary sources as being indicative of what can be achieved by best practice technology as at 1985, (see **Table 2.1** for the relevant guidelines). For NO_X from sources apart from nitric acid plants and steam boilers and gas turbines, it is understood that the DEP have in the past applied the emission limit of 0.35 g/m^3 for other gaseous fired processes. This is consistent with the limits adopted in other states for gas fired fuel equipment (>150,000 MJ/hr) of 0.35 g/m^3 in Victoria for air quality control regions and in South Australia (CASANZ, 1996).

For large gas turbines burning natural gas, the EPA have recently released guidance that they now consider dry low NO_X burner technology as best practice (EPA, 1999a). As such, a level of 25 ppm by volume dry at 15% oxygen reference level is recommended. The corresponding AEC/NHMRC guideline for large gas turbines burning natural gas is 34 ppm volume dry at a 15% percent reference level at base load (which is 0.07 g/m^3).

- **Table 2-1 AEC/NHMRC Guidelines for New Stationary Sources Relevant to this Project**

Pollutant	Standard applicable to	Standard	Notes
Solid Particles	Furnaces for the heating of metals Any other trade, industry process, industrial plant or fuel burning equipment	0.1 g/m^3 0.25 g/m^3	
Sulphur dioxide	Fuel burning equipment	0.2 g/m^3 expressed as SO_2	
Nitric acid or oxides of nitrogen	Gas turbines >10 MW Gas Fired Boilers	0.07 g/m^3 0.35 g/m^3	Nitrogen oxides calculated as NO_2 at a 15% oxygen reference level. (Note the EPA guidelines for gas turbines (EPA, 1999a) are now used in WA). Generally adopted by the DEP for other gaseous fired processes (see text).

Note: Gas volumes expressed dry at zero degrees Celsius and at an absolute pressure equivalent to one atmosphere.

Comparison to emission limits provided by the AEC/NHMRC, indicate that stack emissions of particulate and sulphur dioxide will be well below the adopted guidelines. For the power station, dry low NO_X burners have been adopted such that emissions are below the recent EPA guidelines. For other stacks emitting NO_X it is seen that the DRI main stacks will be below the emission guideline, whilst the Pellet plant emission will be just above it.

3. Ambient Air Quality Criteria

The relevant ambient air quality criteria follow the National Environmental Protection Measure (NEPM) standards (NEPC, 1998). These are listed below in **Table 3.1.** These specify a maximum concentration and the goal that is to be achieved within 10 years.

- **Table 3-1 National Environmental Protection Measures – Standards and Goals**

Pollutant	Averaging Period	Maximum Concentration	Goals within 10 years Maximum allowable exceedances
Carbon Monoxide	8 hours	9.0 ppm	1 day a year
Nitrogen Dioxide	1 hour 1 year	0.12 ppm 0.03 ppm	1 day a year none
Photochemical oxidants (as ozone)	1 hour 4 hours	0.10 ppm 0.08 ppm	1 day a year a day a year
Sulfur dioxide	1 hour 1 day 1 year	0.20 ppm 0.08 ppm 0.02 ppm	1 day a year a day a year none
Lead	1 year	0.50 ug/m^3	None
Particles as PM10	1 day	50 ug/m^3	5 days a year

In Western Australia the DEP intends to implement the NEPM standards and goals through the development of a state wide Environmental Protection Policy (EPA, 1999b). As these standards are nationally acceptable ambient air quality standards which will act as a benchmark against which the quality of the air can be assessed, they are intended to be measured at sites representative of population exposure to the NEPM pollutants (EPA, 1999b). As such, the EPA proposes to "adopt the current NEPM standards in the Air EPP for general application to air quality management programs and the assessment of development proposals in Western Australia. However the Air EPP would not apply the standards within industrial areas and residence free buffer areas around industrial estates", (EPA, 1999b, pp3).

4. Modelling Methodology

4.1 Important Dispersion Processes

For the proposed plant and its location the following dispersion processes are important:

- Possible reduced plume rise and increased dispersion due to the induced flow distortion of air around the large building structures. As a result sections of the plumes may be mixed to the ground at closer distances than otherwise would occur.
- Proximity to the coast (8 km to the northwest). This will result in the presence of a temperature inversion (thermal internal boundary layer) for onshore flows. For a distance of 8 km from the coast and for relatively low stacks this will tend to act as a lid on the plume therefore leading to higher concentrations than would occur for a more inland site (see **Section 4.2**).
- There are no local sources in the immediate area though there exist a number of large NO_X emitters in the Dampier/Karratha region approximately 85 km to the northeast. Therefore for predicting local impacts no other source need be considered as the relative contribution will be insignificant. However, given that photochemical smog formation already occurs to some degree in the Dampier Karratha area it may be possible that emissions from this plant may contribute to already elevated levels of ozone.
- The presence of relatively low hills, approximately 100 m above plant base around 5 km to the east. These may lead to higher concentrations on the hills than would occur for flat terrain.

Given the above issues, the air quality assessment was undertaken using two modelling approaches; one to model local impacts and the other to address the regional issue of ozone formation.

4.2 Local Impacts - ISCPRIME

To determine local impacts around the site, ISCPRIME (the USEPA dispersion model) was used. ISCPRIME is the new US EPA's primary model for assessing impacts from complex industrial sites and has a rigorous treatment of the effects of building structures and takes into account complex terrain.

ISCPRIME can be run for a number of different model options and meteorological data formats. In this report the main model options and assumptions used are:

- Meteorological data from an annual file of hourly observations was used, ie the short term version of the model was used.
- Rural dispersion options.
- US regulatory default model options.
- Terrain included.
- Two cartesian grids, one of 1.0 km over the area and a finer 0.5 km grid over the area with discrete receptors at the top of surrounding hills.
- Average roughness length of 0.10 m, to simulate the average residue areas and the surrounding rural land.

- Building wake effects, with building dimensions determined from site and elevation plans for all significant structures.
- Maximum NO_X conversion at the point of impact of 50%. At release the percentage of NO_2 in NO_X is taken as a maximum value of 10% for all sources (Lurgi, 2000b). Upon release the NO is converted to NO_2 by chemical reactions as the plume is transported down wind. Assessment of the NO_2 percentage in NO_X at Kwinana using monitoring (Dames & Moore, 1993) and from modelling of the Pinjar gas turbine plumes (Bowman Bishaw and Gorham, 1990), indicates that a percentage of around 50% will be an upper limit.

4.2.1 Time Series Meteorological Data

A time series air quality meteorological file containing hourly averaged values of:

- Wind speed and direction;
- Air temperature;
- Mixing height;
- Stability class;
- Monin Obukhov lengths (a measure of stability); and
- Roughness length.

is required for ISC3. The meteorological data set for the modelling was obtained from the DEP for their "Karratha" meteorological station for the period 1/9/1998 to 31/8/1999. This site is located several kilometres to the south of Dampier Salt drying ponds and is a similar distance from the coast. As such the wind regime for the two sites will be similar being primarily controlled by the synoptic winds and development of the sea breeze.

Heat fluxes, mixing depths and stability classes were calculated by the DEP using standard DEP procedures as used at Hope Valley (Kwinana) and Caversham. The Monin Obukhov length was calculated from heat flux and friction velocity. Night time heat fluxes were calculated from differential temperature at 2 and 10 metres. Daytime fluxes were calculated from the heat/moisture budget. Coefficients describing soil characteristics for the Dampier/Karratha region were provided by CSIRO Division of Atmospheric Research.

Mixed-layer heights were calculated as per Rayner and Watson (1991), using the Bureau of Meteorology's Port Hedland sonde data. A monthly average profile was substituted on days where the profile was missing. The average profiles only were needed on 7 times over the 12 month period. These mixing heights provided are correct only for offshore winds.

Pasquill stability classes were derived from the Monin Obukhov length using Golder's method (Golder, 1972). The classes were modified to insure that stability did not change by more than 2 classes for light winds at sunrise or sunset. The data were also checked to ensure no unstable B and C classes occurred during night time. There were very few cases where this did occur. These times correspond to small negative delta T values during the evening. The stability classes were reclassified using wind speed to be consistent with the Solar Radiation Delta-T method outlined by USEPA (1987).

To account for the presence of a thermal internal boundary layer, all hours with unstable and neutral onshore flows were capped with a mixing depth of 300m. This value was determined following advice from Bill Physick (CSIRO, 2000) from an analysis of TIBL heights data from a similar inland distance in the Pilbara. This data indicated that the TIBL would be in the range from 300 to 500m. As a conservative estimate in this modelling a 300-m limit was adopted.

A summary of the data used in the meteorology is presented in **Appendix B**. For the data period of 1/9/1998 to 31/8/1999 100.0% data return was achieved.

4.3 Regional Impacts – Photochemical Smog

To determine regional impacts and the formation of ozone, TAPM [a prognostic, three-dimensional meteorological and air pollution model developed by CSIRO (Hurley, 1999)] was used. TAPM is a complex prognostic dispersion model (predicts the meteorology for the region of interest instead of using observations such as ISCPRIME) see, Hurley, (1999 and 2000). The model has an air pollution module that solves the gas-phase photochemistry based on the generic reaction set of Azzi et al (1993). Depending on the grid configuration, model runs to simulate an entire year may take weeks with the fine resolution grids chosen for this study. As such, model runs of an entire year are generally not practical.

TAPM has been used in two previous assessments of photochemical smog in the Pilbara region. These are:

- The assessment of the additional North West Shelf Venture LNG facilities (CSIRO, 1998) and Woodside (1998); and
- The assessment of the proposed gas to synthetic hydrocarbons plant on the Burrup Peninsula (CSIRO, 1999) and HLA- Envirosciences Pty Limited (1999).

These both used TAPM version 1 to estimate impacts for two months, August 1997 and March 1998. Two months were only used because of the large computational requirements of the modelling and followed an analysis by CSIRO (1998) that assessed that these months would lead to maximum smog concentrations on land. A new version of TAPM (v1.3) has been recently released, however to maintain consistency with the previous assessments, it was not used for this study.

In this assessment, TAPM v 1 will also be used along with the same input parameters as used in these assessments, excepting the grid size as noted below. Specific input parameters used for the modelling are:

- Two nested grids of 10 and 3-km. In the original modelling 25 grid cells were used in a north/south and east/west direction, but to encompass the larger region 40 grid cells in both directions were used.
- Topography, vegetation and soil types as supplied in the TAPM databases.
- Pollution predicted on the 3-km grid. It is noted that for NO_2 and NO_X the model will under-predict as the maximum concentrations occur close to the plants with the grid resolution being too coarse to resolve these maximums. For ozone with maximums which form further from the sources, a 3km grid was argued by CSIRO (1998) to be sufficient to resolve the maximums.
- Prognostic turbulence scheme.
- Soil moisture taken as the default 0.15.
- Hydrostatic approximation.
- 20 vertical levels.
- Chemical reactions of NO, NO_2 and Ozone with deposition.
- Background levels of NO_X and smog of 0 ppb, with background ozone levels of 20 ppb as used in the previous assessments.

For modelling the pollution impacts from the existing sources, source data as used in the gas to synthetic hydrocarbon proposal as detailed in CSIRO (1999) was used. This includes the:

- Woodside facilities with expansion;
- Hamersley Iron Power Station at Dampier;
- Proposed Plenty River ammonium nitrate plant and PEXCO ammonium nitrate plant; and
- Proposed gas to synthetic hydrocarbon (Syntroleum) plant.

5. Results - ISCPRIME – Near Field

5.1 NO_2 Levels

Predictions of NO_2 for the maximum one hour and one year average concentrations are presented in **Figures 5.1** and **5.2** and summarised in **Table 5.1**. These predictions have been based on the assumption that 50% of the NO_X is NO_2 at ground level (see **Section 4.2**)

These results indicate that the levels will be at most 54% of the NEPM standard on the Austeel site. These standards are not applicable to the site, but are applicable beyond the plant boundary and in any buffer area. As such concentrations at locations where the standards apply will be even less, indicating that levels of NO_2 from the proposed development are not an issue.

- **Table 5-1 Predicted maximum ground level concentrations (GLCs) from ISCPRIME**

Pollutant	NEPM standard ppm (ug/m^3)	Averaging Period	Highest predicted GLC (µg/m^3)	Percentage of NEPM standard (%)
Nitrogen Dioxide	0.12 (246) 0.03 (62)	1-hour 1-year	133 1.58	54 25
Sulphur Dioxide	0.20 (572) 0.08 (228) 0.02 (57)	1-hour 1-day 1-year	25.2 3.4 0.27	4.4 1.5 0.5
PM10	50 µg/m^3	1-day	37.2	74

Notes: NEPM standard has been converted to ug/m3 at 0 deg and 101.3 kPA.

5.2 Sulphur dioxide

Predicted maximum one hour, maximum 24 hour and annual average concentrations are presented in **Figures 5.3** to **5.5** and summarised in **Table 5.1**. These indicate that the sulphur dioxide levels are at most 4.4% of the NEPM standards.

5.3 PM10

Predicted maximum 24 hour average concentrations of PM10 are presented in **Figure 5.6** and summarised in **Table 5.4**. Maximum levels occur within 500 m of the plant, due to the effects of building profiles on plumes. These concentrations however are below the NEPM ambient standard applicable beyond the lease boundary and are well below occupational health levels.

6. TAPM Results - Ozone

TAPM predicted maximum one hour ozone concentrations for the existing and proposed plant on the Burrup Peninsula as modelled in CSIRO (1999) are presented in **Figures 6.1** and **6.2** for August 1997 and March 1998. The maximum ozone concentrations predicted anywhere on the grid are also summarised in **Table 6.1.** Concentrations are slightly different to that modelled in CSIRO due to the slightly different grid alignment.

Predictions with the above sources as well as the Austeel proposal are presented in **Figures 6.3** to **6.6** and summarised in **Table 6.1**.

- **Table 6.1: Maximum Ozone Concentrations predicted by TAPM**

Pollutant	Highest predicted GLC (ppm) Existing and Proposed Burrup plant (August 97 March 98)	Highest predicted GLC (ppm) With addition of Austeel (August 97 March98)	NEPM standard (ppm)	Averaging Period
Ozone	0.038 , 0.070 0.034 , 0.053	0.038 , 0.070 0.035 , 0.053	0.10 ppm 0.08 ppm	1-hour 4-hour

Note: Predictions of NO_2 and NO_X are not maximums due to the coarse 3 km grid used for the photochemical modelling

These indicate that the:

- Maximum concentrations of ozone with the existing and proposed plant on the Burrup Peninsula will be up to 70% of the standard. These maximum concentrations occur over water, probably as a result of the reduced mixing.
- The Austeel plant will make negligible difference to ozone concentrations in the Dampier/Karratha area. This would appear to be the case as the conditions under which the greatest ozone formation occurs do not correspond to those for which the NO_X plumes from the Cape Preston are advected to Dampier area in relative high concentrations.
- Maximum concentrations of ozone at Cape Preston are due to the plumes from the Dampier region, indicating the dominance of this source for photochemical smog in the region.

7. Conclusions

An assessment of the likely air quality impacts of the Austeel project has been conducted for both local and regional impacts.

Local impacts of nitrogen dioxide, sulphur dioxide and particulate matter below 10 µm (from point sources) has been assessed using the USEPA air dispersion model ISCPRIME and meteorological data from Karratha.

Results of this modelling indicate that maximum concentrations occur within 5 km of the stack and therefore are within the Austeel project lease or surrounding pastoral lease. Comparison of the predicted maximum concentrations to the NEPM standards (that is levels applicable outside the lease) indicates that the maximum concentrations would be only 54, 4.4 and 74% of the NO_2, SO_2 and PM10 standards. As such, concentrations beyond the lease boundary will be lower and it is concluded that the local impacts from these pollutants will be minimal.

Regional impacts of this proposal were assessed using TAPM developed by CSIRO. This model has recently been used to assess formation of photochemical smog from both the NWSGV LNG expansion and the Syntroleum proposal on the Burrup Peninsula. Using this model it is predicted that there will be no or negligible increase in the maximum ozone concentrations with the operation of the Austeel plant.

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Appendix A Summary of Emission Parameters for the Austeel Project

Appendix B Summary of Meteorological Parameters used in ISCPRIME Modelling

Appendix C Typical ISCPRIME Input File