DESKTOP REVIEW

PINJARRA ALUMINA REFINERY EFFICIENCY UPGRADE

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CH Environmental

Stakeholder Reference Group
Pinjarra Refinery Efficiency Upgrade Project
2/99 Forrest Street
Cottesloe, WA, 6001
Attention: Roberta Mead, facilitator,

DESKTOP REVIEW - ALCOA REFINERY EFFICIENCY UPGRADE PROJECT, PINJARRA

Dear Roberta

I have been commissioned to undertake an independent review of the air quality information for the project and report to the Stakeholder Reference Group. The documents considered in the review are:

- Air Quality Data, Environmental Protection Statement, Environ Report dated 28 October, 2003
- Pinjarra Refinery Efficiency Upgrade – Draft Air Dispersion Modelling, SKM Report dated 28 October, 2003

Sections 1-4 of the Environ Report "Preliminary Draft Environmental Protection Statement, Sect 1-4, dated Oct 23 2003 were also provided as background.

The thrust of the review has been to assess whether the information provided is comprehensive and adequate for assessing the air quality impacts of the project, and whether the methods used for deriving the information are appropriate and appropriately applied.

As such, the review is not an audit of the data, or an evaluation of the process and technology. Assessment and conclusions about the environmental impacts of the project are the responsibility of the relevant approval agencies and are also beyond the scope of this review.

Enclosed is the detailed review of the project. The following overall comments can be made:

In general, the information presented in both the Environ and the SKM reports is thorough and clear. The measurements and validation processes used are well documented and suitable for the assessment of impacts. Appropriate methodology has been applied in the derivation and the analysis of data. The models used have been selected on the basis of providing conservative results, are in general use for regulatory purposes,

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have been correctly employed (based on the information provided) and are appropriate.

There are some areas where further or clearer information would be useful as indicated below.

- An assessment of impact of particle and metal emissions from stockpiles and the RDA on total ambient levels, and hence on potential exposure, is not included in the reports reviewed. Determination of emission rates from area sources such as stockpiles and modelling their dispersion are both difficult to do and any ensuing results highly uncertain. However, an assessment of their significance is necessary for a full characterisation of exposure. In the absence of emissions data and model prediction, an assessment based on monitoring information could be used, and this may have been carried out. If not already available, a program of analysis of the metal composition of ambient particles is also desirable.

- Detailed emission rate information from which ratios can be derived are provided. Provision of a separate chart or table would make the presentation clearer and allow easier assessment.

- Some assessment of the significance or otherwise of the odours from area based sources (ponds, RDA, stockpiles) which are not modelled is warranted. This does not imply that an odour problem exists or is likely, but is suggested for completeness since odour issues have arisen for other refineries.

- More explicit information on the range of model predictions for the compounds used as indicators of odour would improve the clarity and would also be useful.

Could you please forward this assessment to the stakeholder reference group.

Please contact me if you wish to discuss any aspects of this review.

Best Regards

Jack Chiodo

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PINJARRA ALUMINA REFINERY EFFICIENCY UPGRADE

1 Background

Alcoa proposed to increase alumina production capacity at the Pinjarra refinery by about 600,000 tpa to 4.2 Mtpa, which equates to a17% increase in annual production. Alcoa has in place a Community consultation program as an integral part of the process for addressing community concerns and obtaining environmental approval. Independent reviews of environmental information form part of the process.

Alcoa has commissioned CH Environmental to undertake an independent review of the air quality information and report to the Stakeholder Reference Group via the Reference Group Facilitator. The following documents are considered in the review:

- Air Quality Data, Environmental Protection Statement, Environ Report dated 28 October, 2003
- Pinjarra Refinery Efficiency Upgrade – Draft Air Dispersion Modelling, SKM Report dated 28 October, 2003

Sections 1-4 of the Environ Report "Preliminary Draft Environmental Protection Statement, Sect 1-4, dated Oct 23 2003 were provided as background information for the review:

2 Terms of Reference.

The review addresses the following terms of reference

1. Comment on the completeness of the information presented;
2. Comment on the suitability of the measurements performed for assessing the project impacts;
3. Comment on the correctness of the analysis performed on the data presented and the appropriateness of engineering calculations performed;
4. Comment on the suitability of modelling methodology used to make predictions.

The thrust of the review is therefore to assess whether the information provided is adequate for assessing the air quality impacts of the project, and whether the methods used for deriving the information are appropriate and appropriately applied. It is not intended as an audit of the information provided, an evaluation of the process and technology, or an assessment of the environmental impacts of the project.

3 Summary of Review

In general, the information presented in both the Environ and the SKM reports is thorough and clear. The measurements and validation processes used are well documented and suitable for the assessment of impacts. Appropriate methodology has been applied in the derivation and the analysis of data. The models used have been selected on the basis of providing conservative results, are in general use for regulatory purposes, have been correctly employed (based on the documents reviewed) and are appropriate.

Areas where further or clearer information would be useful are the following:

- **Particle and metal emissions from stockpiles**

An assessment of impact of particle and metal emissions from stockpiles and the RDA on total ambient levels, and hence on potential exposure, is not included in the reports reviewed. Determination of emission rates from area sources such as stockpiles and modelling their dispersion are both difficult to do and any ensuing results highly uncertain.

However, an assessment of their significance is necessary for a full characterisation of exposure. In the absence of emissions data and model prediction, an assessment based on monitoring information could be used, and this may have been carried out, but is not included in the reports reviewed. If not already available, a program of analysis of the metal composition of ambient particles is also desirable.

- **Peak to average emission ratios for VOCs**

Detailed emission rate information from which ratios can be derived is provided. Provision of a separate chart or table would make the presentation clearer and allow easier assessment.

- **Odours**

A more explicit presentation of the range of model predictions for the odour indicator compounds either in the Environ or the SKM reports would make the discussion clearer.

Some assessment of the significance or otherwise of the odours from area based sources (ponds, RDA, stockpiles) which are not modelled is warranted.

4 Detailed Comments -Environ Report

4.1 Refinery Emissions Scenarios

The scaling of emissions based on baseline production rates derived from production records, and efficiency upgrade production rates based on design is appropriate. Detailed analysis and comment on the basis used for peak to mean emission rates to reflect process variability and plant upset conditions involve detailed process and plant management considerations which are beyond the scope of this review.

Combining maximum flow rates with maximum measured flow rates as indicated in the report is appropriate for normal operations.

4.2 Consideration of pollutants

4.2.1 Criteria Pollutants

The set of criteria pollutants modelled are standard except that lead and ozone which are also standard pollutants in urban air, were not modelled. Omission of these pollutants is appropriate given the low levels emissions of lead and ozone precursors (NO_x and ROCs), and the isolation from major urban and other industrial sources.

It should be noted however that Ozone production depends on the emission rates of precursors as well as their ratio. Thus reductions in either precursor per se may not necessarily result in reduced ozone levels if the ratio changes.

4.2.2 VOCs

Emissions data were derived by combining measurements from a range of programs at Pinjarra, with emissions composition profiles derived from the comprehensive procedures used for the Wagerup emissions inventory project. The assumption that the emissions profiles for similar processes at the two refineries will be similar is supportable.

As noted in the Environ report, the effects of exposure to hazardous air pollutants on health are a function of the toxicity, and dose which is proportional to the ambient concentrations. For similar meteorology, ambient concentrations in turn vary with source emission rates, and conditions of release (temperature, height, velocity, geometry, etc).

In order to maintain the detailed atmospheric dispersion modelling task to manageable proportions, pollutants were screened using a two stage process for assessing their relative health risk potential. The first stage screening is based on emission rates; stage 2 screening is based on annual emissions reported for the NPI weighted by toxicity. Compounds identified in either screening are combined, and ambient levels are predicted by applying an atmospheric dispersion model. A simplified modelling procedure (scaling according to minimum dilution ratios from the complex modelling) is used to predict ambient levels of the remaining compounds.

The screening procedures used for assigning compounds to either detailed or simple modelling are adequate. More complex screening involving consideration of release conditions for these compounds is not warranted, given that the use of minimum dilution ratios in the simplified modelling procedure probably overestimates the ambient concentrations (and hence estimated health risks) of these compounds relative to the other compounds.

A more important consideration is whether the assumed peak to mean emission rate ratio of 2.0 is appropriate or conservative, particularly for acute (short term) ambient concentration estimates resulting from emissions during upset plant conditions. The basis for this assumption is clearly enunciated in the report. This ratio is consistent with the peak to mean ratio (2.14) for the VOCs modelled (see modelling report input data), although most of the variability here appears to arise from the combustion sources. The issue of process variability and short-term process upsets leading to

higher or lower emissions is beyond the scope of this review, but is noted for consideration.

4.2.3 Metals

A review of the health risk assessment is being undertaken by other reviewers. It is assumed that the outputs from the SKM modelling report form the basis for that review. It should however be pointed out that the treatment of metals in estimating ambient exposures is problematic.

While the difficulty in modelling area sources is well understood, a full evaluation of the potential health risks requires an exposure assessment that includes an estimate of exposure to metals from all sources, including metals in particles emitted from area sources such as stockpiles. The environ report indicates that air-borne particles from stockpiles and the RDA may be a major source of emissions of some metals. Some indication of the significance or otherwise of such exposure is therefore warranted, perhaps by reference to ambient particle monitoring and metal composition data.

4.2.4 PAHs

One PAH (naphthalene) was detected in Pinjarra emission measurement programs, but several in the more comprehensive Wagerup program. The Wagerup PAH emissions profile was assumed to apply to Pinjarra. PAHs not detected in Pinjarra were scaled from naphthalene measurement data for Pinjarra and the Wagerup PAH profile, and this approach is reasonable.

4.2.5 Odour

The difficulties in measuring odour emissions in moist discharges are well recognized, as are the difficulties in modelling odours in wet plumes. The alternative approach used in the air quality statement assumes that indicator VOCs can be used as surrogates for odour emissions. Changes in concentrations derived by model predictions for these compounds are used as an indicator of changes in odour levels at various critical receptors.

The method is well documented in an appendix to the Environ Report. The method assumes potential odour impacts are proportional to the odour emission rates and does not consider the quality of the odour (e.g. objectionable, pleasant, etc). A second issue with the method is the variability in emissions of specific compounds in plant upsets leading to potential odour “events”. These uncertainties are not immediately remediable, and would also apply to the more conventional olfactometry measurements and odour dispersion modelling.

A third issue is the problem with the very different ranges of odour thresholds reported for different compounds. For example, based on the Environ report, the ratio of highest to lowest odour threshold is 20,000 for Acetaldehyde, 2000 for methyl mercaptan, 200 for butanone, and 20 for propanal. This makes the ranking of odour potential for different compounds a tenuous exercise. Given the threshold used in the assessment for acetaldehyde (approximately half the maximum), the ranking of this compound is unlikely to have been overestimated. Acetaldehyde is seen as the dominant indicator for odour.

In the absence of detailed odour measurements and modelling, the approach seems reasonable in assessing potential changes in the odour impact from the upgrade, (higher or lower). It is less useful for quantifying impacts or for resolving current problems with odours, if these exist.

A more explicit presentation of the range of model predictions for the indicator compounds either in the Environ or the SKM reports would make the discussion clearer and is warranted. Some assessment of the significance or otherwise of the odours from area based sources (ponds, RDA, stockpiles) which are not modelled is also warranted.

4.2.6 Fugitive Dusts

The problems in measuring and modelling emissions from area based sources are recognized, as are the uncertainties in the results which would make interpretation difficult. The difficulty of assessing potential impacts of specific components from these sources remains however.

A summary and analysis of all particle monitoring data around the stock piles and the RDA would be useful in complementing the Pinjarra racecourse data. If available, particle composition data, particularly for metals and compounds, would be particularly useful.

4.3 Wagerup Refinery Independent Audit

Alcoa appear to have incorporated issues raised in the Wagerup audit in deriving the air quality data for the Environ report on Pinjarra, but verification is beyond the scope of this review.

4.4 Emission Estimates

The selection of emission sources for detailed modelling and analysis aims to include the majority of emissions (estimated at greater than 90% for VOCs) and exclude minor sources. This approach was endorsed by the Independent Audit for Wagerup and is appropriate. The procedure that has been used for assessing source emissions includes a combination of process and emissions expertise, reviews at Pinjarra and Wagerup, and visual and olfactory observations around the refinery. Adequate information is provided on sources included, those excluded, the reasons for inclusion and exclusion, and the broad source profiles for selected emission classes. Detailed emissions profiles are included in the modelling report.

As discussed earlier, emissions of particulate matter and metals from area based sources are not included.

4.5 Pollutant Emissions Monitoring

The methods used to measure emissions are adequately defined in the Environs report. In general, they are based on recognized international methods and appropriate. Variations to the methods used, and the justification and limitations are also documented. The level of monitoring is recognized as not extensive for a number of sources and pollutants, and plans for future monitoring to include sources and pollutants of potentially greatest risk based on the analysis is a logical approach to resource utilization.

A number of specific issues affecting emissions estimates for the baseline case have been adequately and appropriately addressed in the Environ report. These include setting emissions at zero (or half the detection limit for dioxins) when measurements are below the level of detection and at the quantifiable limit where measurements are below the PQL; replacing initial estimates of cadmium and nickel based on Wagerup measurements with Pinjara measurements; basing flow estimates on methods technically assessed as most appropriate or conservative (spot measurements, continuous process measurements, mass and energy balances, and fan and pump characteristic curves);estimating exhaust plume temperature and moisture content.

Emissions from the Alinta cogeneration project have been appropriately estimated using generally accepted methods and procedures.

4.6 Emissions for the Upgrade Scenario

As previously indicated detailed analysis and comment on peak to mean emission rates and the scaling of emissions are beyond the scope of this review as they require process and engineering design details and operating procedures and practices. Only general comments on the overall approach is therefore provided.

The approach taken in estimating baseline emissions for the upgraded refinery involves considering changes in emissions due to changes in process variables and changes in emissions due to improvements in emission controls (new or improved design). This is a standard engineering approach and is adequately documented in the Environ report. The removal and destruction efficiencies given for the emission control equipment are within the range expected for similar types of control equipment. Assessing the adequacy of the control equipment and whether higher or lower efficiency equipment is available or appropriate is not part of this review.

The comparison of current emission estimates with reported NPI data is interesting, but more an indication of consistency in approach than validation of either estimate.

The comparison of NOx emissions data for the current project with data used in the Alinta project is also interesting, particularly data on peak to average emissions for the calciners and the oxalate kiln indicating a range from 1.7 to 3.4. It raises the issue of appropriate ratios to be used in the modelling particularly for computing short term averages (acute health effects, and odour).

A peak to average ratio of 2 was used for non modelled VOCs (health assessment). The ratio for modelled substances can be calculated from the input data in the SKM modelling report. Peak to average emissions are stated to have been derived by dividing peak emissions (from peak flow rates and peak emissions) by average emissions (from average flow rates and emissions). A table giving peak to average ratios for emissions and flow rates, and concentrations for pollutant classes (or for key pollutants) could be helpful for indicating and assessing the variability in the data, and whether other plant upset conditions than the two that were modelled (both involving particles from calciner stacks) should be considered.

4.7 Information Sources

The Environ report provides adequate information for the derivation of source parameters and meteorological data, including validation and applicability, as required for dispersion modelling.

Summary ambient particle monitoring data and its assessment for the Pinjarra racecourse site are provided and the inconsistency in some data noted. It should be pointed out that TEOM monitors are more commonly used by control agencies for PM_{10} measurements rather than for TSP. There is a reference in the Environ report to dust measurements around the RDA and stockpiles. A summary of these data would be desirable. As previously indicated, data on the metal composition profiles of particles would also be useful.

4.8 Proposed Ambient Gaseous Monitoring

The rationale for the current 12-month continuous monitoring program for gaseous pollutants (site and pollutant selection) is adequately explained and is logical. It is presumed that the particle monitoring program will continue.

Continuous monitoring for NOx and CO is appropriate. These data and the particle monitoring data will provide an indicator of the impacts of the refinery. It is unlikely that continuous monitoring for VOC species will yield meaningful data given the predicted levels. Odour assessments provide a better assessment of impacts for most species. It is recommended that a program of analysis of particles for metals be conducted to establish a metals profile for refinery emissions if this is not already in place.

Sites selected for monitoring are based on model predictions and are generally appropriate for assessing impacts and partial model validation, although based on the SKM model comparisons (figs 7,11,18,20), a site east to south east of the refinery rather than north east would appear to give higher maxima (the precise locations of monitoring sites are not given in the report).

It should be pointed out that, given the complexity in source emissions, and the interaction of complex terrain and coastal meteorology, a full model validation would require many more sites than proposed, or other methodology. This is recognized in the SKM modelling report which refers to proposed supplementary field work for model validation, but no details of this are provided.

4.9 Quality Control

Appropriate procedures are given for selection of specialist monitoring contractors and quality control of their outputs.

5 Detailed Comments -SKM Report

5.1 Overall Approach

The overall 3-stage approach used in the assessment is sound and involves initial assessment to select a conservative model and meteorology, making predictions on this basis, and subsequently validating and refining the predictions when sufficient monitoring and field data have been obtained.

5.2 Meteorology

A good picture of the meteorology of the area including temporally and seasonally resolved wind data is provided and complex flow patterns derived from current and

previous data and analyses are described in sufficient detail for consideration in the assessment.

5.3 Modelling

The models selected for comparison are standard models which have been used in regulatory applications and investigations in Australia and overseas and cover a suitable range. The model parameterisations described are considered normal for the application.

Surface meteorology used in the models is appropriate, being the Pinjarra station data for the 12 month period corresponding to the emissions data period. Comparison with an earlier data set is provided. Model predictions for the two data sets are made in the model comparison section of the report with the conclusion drawn that the later data predicts higher levels (more conservative). This is consistent with the higher percentage of calms, justifying its use.

A variety of methods are available for deriving upper winds, temperatures, and mixing heights, and each has advantages and disadvantages and yield differences in detailed profiles. There is no a priori way of determining the most appropriate, and professional judgment is required. Comparisons of the different methods have been made in the report, and some sensitivity studies conducted. Appropriate considerations have been used in selecting the method for deriving the meteorological files for each of the 3 models.

5.4 Model Comparison and Selection

Each model is used to predict the 2nd highest 1 hour concentrations of NOx (generally high level sources) and VOCs (generally lower level sources). One summer and one winter month is modelled for NOx and one winter month only for VOCs. Period average concentrations (1 month or 2 month) are also computed. Predicted concentrations for each model are compared. Comparisons with monitoring data is proposed to be undertaken as part of the model validation stage of the assessment when monitoring and other field data are available.

The comparisons drawn indicate a mixture of results. Depending on location, and on the averaging times (1 hour average or 1 month or longer average) each model's predictions can be higher or lower than those of the others. The conclusion is drawn in the report that AUSPLUME generally predicts the highest concentrations at the nearest residences, and the highest concentrations for all averaging times at residences with the highest concentrations, and this is evident from the information presented. AUSPLUME therefore in general provides the most conservative (highest) prediction of individual exposure.

AUSPLUME has therefore been selected for the analysis on the basis of this assessed conservatism, with the intention of reviewing the selection and analysis when the model verification against field data are completed and this is appropriate.

5.5 Emission Source characteristics

Standard procedures are used to group sources and to model them as volume sources (e.g. building vents) or as a combined stack (e.g. calciner stacks). It should be pointed out that for hot plumes, combining stacks increases the buoyancy plume

rise which counteracts the effects of reduced plume spread and hence the degree of conservatism in the results.

5.6 Particulate modelling

The omission of emissions from area based sources has been discussed previously.

Appropriate consideration has been given to particle characteristics (density and size distribution), to other input parameters used in the modelling, and to the approach used for the cooling tower (modelled as a dry source). Some pollutants which are emitted as either gases or particles, have been modelled in both forms, and this is also appropriate. The recommendation to obtain better data on particle characteristics and the form of emissions (gaseous or particle) of some pollutants is noted

Two plant upset conditions, both involving particle emissions from the calciners, have been previously conservatively modelled, i.e. resulting in overprediction, and the results are summarised in the report. AUSPLUME was used in one case and CALPUFF in the other. Comparison with the outputs from the refinery upgrade modelling provides an indication of the large variation in predicted concentrations from short term excess emissions.

5.7 NO_2 to NO_X Ratio

Various approaches are generally used for estimating this ratio for use in models. Ratios used vary upwards from 5 to 10%. In some cases 100% has been used in screening studies. A ratio of 10% is commonly assumed for stationary combustion sources and higher ratios for gas turbines. The approach used in the SKM report (around 10%) is at the low end of the range used elsewhere but is supportable. A check against ambient monitoring data ratios for specific events may be useful in verifying the ratio used.

5.8 Background Levels

In the absence of better data, the use of Wagerup monitoring data provides a suitable estimate of background. Background information for particles has not been included in the model, but a summary of particle monitoring data is included in the Environ report. A more detailed presentation of the particle monitoring data as previously indicated is warranted.

5.9 Results

Comments will be limited to general comments on the information presented. Environmental assessment of the results is beyond the scope of this review.

Comprehensive information of the model outputs is provided, and a well balanced and unbiased discussion provided. The presentation of predicted changes resulting from the upgrade is also very clear.

It is accepted that the procedures used (peak to mean emission rates, and assuming emissions peak together) will result in conservative predictions normally. It is also accepted that the modelling has been generally conservative. The degree of conservatism will be reduced to an unknown extent by higher than normal emissions during plant upset conditions.

NEPM ambient air standards are intended to be used in conjunction with a defined monitoring network, and apply a performance monitoring stations. They are not intended to be used as design criteria. Comparison of model outputs with NEPM standards as has been done here goes beyond the intended scope of the standards.

The appropriateness of using the NEPM standards, and WHO guidelines for vegetation in this assessment is for the appropriate agencies to assess.

The conclusions and recommendations drawn are clear, brief and an adequate summary of the details in the report.