Pinjarra Alumina Refinery Efficiency Upgrade

Alcoa World Alumina Australia

Dust Management Plan for the Alcoa Pinjarra Bauxite Residue Disposal Area
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EXECUTIVE SUMMARY

The purpose of this Dust Management Plan is to document the dust control mechanisms that are in place and the Pinjarra Refinery’s plans to minimise fugitive dust emissions from the residue storage area. Specifically, this plan will address the upgrade of the existing sprinkler system and a review of operational controls. The intention of this plan is to complement the Pinjarra Refinery Long Term Residue Management Strategy.

The material remaining after the alumina has been extracted from the bauxite ore is commonly termed “bauxite residue”. Due to the relatively low grade of Darling Range Bauxite, Bauxite residue is produced at a rate of approximately two dry tonnes per tonne of alumina. This material is stored in an area known as the Residue Drying Area (RDA) located to the west of the refinery.

The nature of the Bauxite residue and the deposition and drying process results in a range of differing materials and surface textures that have the potential to generate dust under windy conditions. As such, the dust management systems are detailed and consist of a range of proactive and reactive strategies. A significant effort in planning, implementation and monitoring is undertaken to ensure effective dust control is achieved for all components of the RDA including the embankments, stockpiles, roads, verges and drains. Specific dust controls employed by Alcoa to minimise dust generation include:

- Turning over the mud in the residue area;
- The use of sprinklers and water carts;
- Spraying exposed banks with bitumen;
- Applying aggregate to large areas that are not required in the short term;
- Road management through application of emulsified waste oil as a dust suppressant and restricting access, and;
- Planting grasses or native vegetation.
1 INTRODUCTION

1.1 BACKGROUND

The Pinjarra Refinery is located within the Shire of Murray in the Peel region south of Perth, Western Australia and approximately 6 km east of the Pinjarra town site within industrial-zoned land owned by Alcoa. The refinery is sited at the foot of the Darling Scarp and incorporates the refinery footprint, the residue drying areas (RDAs) and surrounding cattle grazing areas encompassing an area of 6,086 ha of freehold property.

Currently, the refinery has a production capacity of approximately 3.5 million tonnes per annum of alumina. As with the majority of other commercial alumina refineries throughout the world, the Bayer process is used. Commencing in late 2004, the efficiency of the refinery is being upgraded to increase alumina production capacity to 4.2 million tonnes per annum. This is known as the Pinjarra Efficiency Upgrade Project. The production increase will be achieved primarily by increasing the rate of alumina yield from the Bayer Liquor circuit by improving the precipitation process.

Bauxite is supplied to the refinery from the Huntly Mine, situated in state forest east of the refinery. The bauxite is low grade by world standards, requiring three tonnes of bauxite to produce one tonne of alumina. An aerial photograph of the refinery showing the RDA to the west is presented in Figure 1.

1.2 DUST EMISSIONS

One of the community concerns discussed by the Pinjarra Bauxite Residue Stakeholder Reference group (SRG) related to control of dust emissions from the residue drying area. Dust was perceived to be a general issue within the Pinjarra community.

Dust generated from the residue drying area mostly consists of fine clay particles and a small fraction of sodium carbonate crystals. The sodium carbonate is precipitated on the surface of residue as entrained moisture evaporates. If dry residue surfaces are not carefully managed, wind speeds in excess of 6.5 m/s (23 km/h) can pick up and transport the fine particles. The distance over which these particles are transported depends on a variety of factors including atmospheric conditions, the size, shape and mass of the particles and the surrounding infrastructure such as roads, embankments and drains.
The months from October to April are considered to be the time of the year when there is the greatest risk of airborne dust generation. The usual pattern at this time of the year is for strong and gusty easterly winds to start around midnight, peaking between 2 am and 5 am and abating around mid-morning. Under these wind conditions, and when the relevant control mechanisms are not in place, fugitive dust can be released.

Alcoa has implemented a dust monitoring network that can quantify the contribution that Alcoa WA Refineries makes to regional dust particle levels. (Air Assessments, 2004).

1.3 PURPOSE AND SCOPE OF PLAN

The purpose of this Dust Management Plan is to document the dust control mechanisms that are in place and the refinery’s plans to minimise fugitive dust emissions from the residue drying area. The scope of this management plan includes:

- An upgrade of the existing sprinkler system; and
- A review of operational controls.

This plan also provides a summary of the ambient air quality monitoring undertaken in the area surrounding the Pinjarra Refinery and related operations. This includes details of sampling locations, methods and receptor locations.

Alcoa is committed to ensuring sustainability principles are applied to the management of bauxite residue. These principles are summarised in Appendix A. Long term residue management strategies are addressed in a separate plan titled “Pinjarra Refinery Long Term Residue Management Strategy”. 
2 OBJECTIVES & TARGETS

The objective of this plan is to document the Pinjarra Refinery’s dust control mechanisms and the plans that are in place to minimise fugitive dust emissions from the residue storage area.

2.1 TARGETS

(a) Test the latest sprinkler design layout under a range of wind conditions;

and

(b) A key residue research and development project aimed at use of residue as a resource is the development of the Carbonation processes. Research to date has shown that Carbonation can reduce the pH of residue to <10.5 as well as aid in the control of sodium carbonate, a significant source of dust.
3 RESIDUE OVERVIEW

3.1 RESIDUE DISPOSAL

The material remaining after the alumina has been extracted from the bauxite ore is commonly termed “Bauxite residue”. Due to the relatively low grade of Darling Range Bauxite, Bauxite residue is produced at a rate of approximately two dry tonnes per tonne of alumina. This material is stored in an area known as the Residue Drying Area (RDA) located to the west of the refinery.

The residue consists of coarse sand fraction (termed “red sand”) and a fine silt fraction (termed “red mud”). These size fractions are separated as part of the refinery process, resulting in an approximate 40% red mud to 60% red sand split. They are subsequently recombined for pumping to the residue area in a single pipeline and then separated again and managed separately within the storage operation (SKM, 2004).

Included within the RDA are cooling facilities for the plant process waters. Initially a plant storm water pond provides temporary storage. The process water is then pumped to the cooling pond to reduce excess heat prior to being recycled back to the refinery.

The red sand fraction is used to construct the dyke walls for the red mud impoundments and also for the construction of road ways. The red mud is then stored via a “dry stacking” process in the red mud impoundments. This process involves pre-thickening the red mud to approximately 50% solid slurry and then depositing it in layers that are approximately 0.4-0.7 meters thick. After initial drying the mud is turned by bulldozers or Amphirohs which turn the dry top surface in and places the wet mud on the surface. This assists in the drying process and reduces dust emissions. Consecutive layers are then placed on top allowing the area to increase in height which subsequently reduces the overall residue footprint.

Dry stacking is now being adopted by other mineral industries as best practice (SKM, 2004).

3.2 RESIDUE DUST CHARACTERISTICS

Residue mud and sand consist primarily of alumina, silica and iron oxides (Air Assessments, 2004). The residue mud also contains a higher percentage of trace metals than the sand and can form particles of sodium carbonate on the surface during drying. These can result in a dust source in uncontrolled conditions. (Air Assessments, 2004).
3.3 FACTORS AFFECTING DUST EMISSIONS AT THE RESIDUE DISPOSAL AREA

3.3.1 Wind speeds

Dust emission data and wind data from the residue area have been evaluated by SKM (1997). These studies indicate that in uncontrolled conditions, dust emissions from the residue area initiate at approximately 6.5 m/sec (~20 km/h). Above 11 m/s (40 km/h), dust emissions from the residue area can increase rapidly and for wind speeds above 14.5 m/s (50 km/h) are predicted to be the largest source of dust from the refinery (Air Assessments, 2004).

Using the wind assessment model WAsP (the Wind Atlas Analysis and Application Program used commonly in wind energy studies for siting wind turbines), the following general statements were made with regard to the effect of the shape and height of residue areas on wind speeds and dust emissions (Air Assessments, 2004)

- Increasing the height of the residue area will increase the wind speed across the residue area and therefore could lead to a higher potential for dust emissions.
- This increase in wind speed is higher for narrower elevated areas that have a cross-section of a hill than a broader plateau.

As stated in the Alcoa Pinjarra Long Term Residue Management Strategy, (LTRMS 2005) Alcoa is committed to improving dust control well before the final height of residue is reached.

Analysis of wind data from the residue area at Pinjarra support the conclusion of higher wind speeds on the residue area than surrounding area (Air Assessments, 2004). Apart from the variation of the wind speed with height and shape, the wind speed for easterly winds also varies with distance from the scarp. Generally, the frequency and maximum wind speed of the easterly foothill winds decrease with distance from the foot of the scarp. This would imply there is generally more potential for dust emissions from sources located closer to the scarp. However, the impact of sources further from the scarp may be greater as there is less time for the dispersion of the plume and removal of particles before they reach sensitive receptors (Air Assessments, 2004).
3.3.2 Effect of Shelter Belts

The influence of vegetation on removing sub 10 µm particles from the air has been the subject of much study in the US recently (see Etyemezian et al, 2003). It has been found that the effect of vegetation can be significant in trapping particles. Dense vegetation of uniform height will be less successful in trapping airborne dust than belts of trees as the air will tend to flow over the top. Open grassland with very few trees will also have a low entrapment potential. Belts of trees that are porous and sited near the initial dust source are particularly effective. This is dependent on the porosity of the shelter belt i.e. gaps in the tree belts. Shelter belts with a porosity greater than 50% performing better at filtering the dust (Air Assessments, 2004). Vegetation over which the plume travels can also be effective in increasing dust deposition with rougher surface (e.g. tree belts) leading to higher deposition than grasslands. It is considered that design of down wind shelter belts will be important in capturing dust. Thin belts of trees that are semi porous to the wind, separated by grassland may be quite effective in removing particles.
4 DUST MANAGEMENT STRATEGIES

The nature of the residue and the deposition and drying process results in a range of differing materials and surface textures that have the potential to become dusty under windy conditions. As such the dust management systems in place are complex and consist of a range of both proactive and reactive strategies.

Alcoa employs specific dust controls to minimise dust generation. These include:

- Turning over the red mud;
- The use of sprinklers and water carts;
- Spraying exposed banks with bitumen;
- Applying aggregate to large areas that are not required in the short term;
- Road management through application of emulsified waste oil as a dust suppressant and restricting access;
- Planting grasses or other vegetation; and
- Applying wood mulch

Further discussion on these methods is provided in this section.

A significant effort in planning, implementation and monitoring is undertaken to ensure control particularly on embankments, stockpiles, roads, verges and drains. During winter of each year a dust control plan for the coming year is prepared. Progress is tracked at weekly review meetings, which include the personnel involved in implementing the dust control mechanisms. Weekly inspections and surveys are carried out to check the effectiveness of dust controls and identify areas needing attention. A meteorology consultant supplies a three-day local weather forecast on a daily basis, which includes a Dust Risk Rating that takes into account rain, wind speed and wind direction. This forecast allows Alcoa to maintain preparedness for conditions conducive for dust generation by, for example, operating sprinklers well ahead of forecast winds.

4.1 TURNING OVER MUD

Wide-track bulldozers or Amphirols are used to turn over the top 0.5 to 1 m of residue. This process reduces exposure of dry residue which is prone to dusting, while accelerating overall drying rates. When conditions conducive to dust generation are forecast, the frequency of mud turnover can be increased.
4.2 SPRINKLER SYSTEMS

Since the introduction of Dry Stacking in the late 1980s, Alcoa has been continuously improving its dust management systems through innovation and technology. In the transition from wet storage to dry stacking, two RDAs were converted during the 1990s, one of which is now a residue rehabilitation demonstration area. Sprinkler systems were installed as part of the construction of these facilities.

A detailed weather forecast is received every 24 hours from a consulting company that specialises in meteorological forecasting. This provides the residue operations with an indication of when high winds can be expected. The sprinkler systems are then set to pre-wet the drying bed areas to reduce the potential for dust generation in advance of the predicted winds.

Sprinkler system checks are performed daily to ensure the integrity of the reticulation system, associated pumps and pipe work. These checks are performed during the dust season from September to April.

The original sprinkler designs were based on 60 m x 90 m sprinkler spacing. The design was aimed at providing the best dust control for the major prevailing wind. All RDAs constructed prior to 2000 were constructed with sprinklers systems based on this design standard. It has since been found that this design standard has some limitations in high wind conditions as the area covered by each sprinkler changes shape from a circle to a pear shape leaving a proportion of the area unprotected.

As part of Alcoa’s commitment to continuous improvement, the company improved its design standard by reducing the spacing to 60 m x 60 m. All RDAs constructed since 2000 have the new design standard for dust suppression systems. Plate 4-1 shows the impact of the change in sprinkler design.

The standard has been applied at both Kwinana and Wagerup and results to date at these refineries have shown that the improved spacing is performing very well. The new RDA 9 at Pinjarra will incorporate this design.

The new design standard is now being reviewed to assess its ability to deliver improved performance. Field monitoring will quantitatively evaluate performance under various wind conditions. Alcoa has committed to upgrading the sprinkler system on the existing drying areas as soon as practicable. The
schedule and detail of the upgrade program will be determined as part of the preliminary engineering, however the oldest and more sensitive areas will be targeted first.

The comprehensive maintenance program in place for the sprinkler systems is currently under review and is aimed at achieving a consistent high standard program of sprinkler availability.

Plate 4-1 Old and New Sprinkler Designs
4.3 BITUMEN EMULSION

Approximately 700,000 L of bitumen emulsion is applied annually to a range of different surfaces including inner dyke walls and sand stockpiles (see Plate 4-2). The procedures for applying bitumen are detailed within the Alcoa’s Performance Support System under the document titled “Spray Bitumen for Dust Control (Ref), AQA document number 38101, Version 3”.

Plate 4-2 Bitumen Emulsion Being Sprayed to Reduce Dust Emissions From Embankment Walls

4.4 AGGREGATE AND WOOD MULCH

Crushed rock aggregate (blue metal) is now used as an effective dust suppressant on flat sand areas that are not scheduled for work in the short term. The Aggregate is screened to 14 mm for optimal performance. On average 3,000 tonnes of aggregate is used each year, representing approximately 30 hectares treated. This particular process is very effective and highly durable. A waste minimisation project for aggregate recovery and reuse was evaluated and is now in place.

Wood mulch is also spread on sand areas to provide a long-term, low-maintenance form of dust control and is used as an alternative to grass cover.
4.5 APPLICATION OF EMULSIFIED WASTE OIL

Waste oil collected from the refinery and associated mine sites, is analysed in an external laboratory for solvent and PCB content. Oil which meets the relevant standards, (approximately 100,000 L per year) is emulsified with water and sprayed onto roads within the residue area.

This method of dust suppression has been approved by the Department of Environment.

Most forms of dust stabilisation for roads provide a hard surface coating which when broken, allows dust emissions to occur. In contrast, emulsified waste oil coats the individual sand grains and does not result in the formation of a hard surface. When a vehicle travels along a road with this form of dust control tyre pressure causes the sand grains move around. The surface tension created by the oil coating immediately re-establishes a film making it an excellent form of dust suppressant.

The waste oil has a short life-span in this environment due to the chemical reaction with caustic and natural biodegradation. Investigations have shown the oil is undetectable below 2 m. These factors and the physical containment of the residue area ensure ground water is clearly protected.

A second form of dust suppression on less-used roads is simply to block them off. Reducing traffic has significantly reduced dust emissions (3).

Plate 4-3 Less Trafficked Roads are Blocked Off to Reduce Dust Emissions
4.6 PLANTING GRASSES AND NATIVE VEGETATION

In areas where there is no work planned for long periods of time, such as dyke walls or finalised batters, grass, and in some areas native plants, have been shown to be very successful in preventing dust emissions (Plate 4-4). In the order of 30 hectares of batter are seeded each year. Rehabilitation processes are discussed further in Section 9.

Plate 4-4 Grassed Areas on Internal Embankments.

4.7 OTHER OPERATIONAL CONTROLS

The deployment of water trucks is viewed as a short-term control option for dust. If an area requires a water truck, then the area is reviewed to determine whether a longer term treatment such as bitumen, grass, or rock aggregate would be a more effective means of control.

Ambient dust readings above 90 ug/m$^3$ (approximately one third of the license limit of 260 ug/m$^3$) are promptly investigated and appropriate control measures aimed at preventing future exceedances are applied. Internal and licence limits for dust emissions are detailed in section 5.1. The 90 ug/m$^3$ internal measure is a driver for continuous improvement in dust control.
AMBIENT AIR QUALITY MONITORING OVERVIEW

Alcoa maintains a program for ambient air quality monitoring at the Pinjarra refinery to ascertain the impacts of its atmospheric emissions on the receiving environment. Ambient monitoring is conducted at locations both on and off the refinery site. Ambient Air Quality Monitoring at Alcoa is defined as any activity carried out to assess the contribution Alcoa facilities make to regional air quality. Ambient Air monitoring systems covered by Alcoa include:

- Dust monitoring
- Gaseous monitoring
- Weather monitoring

The Ambient Air Dust monitoring program existing at the Pinjarra refinery comprises:

- Residue dust emissions monitoring
- Bauxite stockpile dust emissions monitoring

High volume air samplers (HVAS) are used to measure boundary line and internal strategic dust levels. Tapered Element Oscillating Microbalances (TEOMs) are used to continuously monitor dust emission levels at the RDA boundary.

Pinjarra also has a regional gas monitoring network. Parameters monitored are carbon monoxide and oxides of nitrogen. These substances were selected because they are the greatest gaseous emissions from point sources.

Weather monitoring occurs at a series of secondary stations throughout the refinery and residue area. One primary station is established at the Pilot Drainable Lake (PDL). Pinjarra Alumina Refinery has a DEC Environmental Monitoring Licence that specifies monitoring requirements.

Gas and weather monitoring do not provide samples for analysis. Dust monitoring intrinsically requires gravimetric analysis upon filter papers. All analyses are carried out by a laboratory that is NATA-accredited for gravimetric analysis of ambient air filter papers. Subsequent chemical analysis of samples may be carried out as a matter of routine or in response to known events, complaint investigations or as part of an associated project.
6 DUST MONITORING

6.1 AMBIENT DUST STANDARDS AND GUIDELINES

The National Environment Protection Council (NEPC) has produced the following national ambient air quality guidelines for the protection of human health:

- The National Environment Protection Measure (NEPM) (NEPC, 1998) sets national air quality standards for SO₂, NOₓ, Ozone, CO, particulate (as PM₁₀) and lead; and
- Variation to the National Environment Protection Measure (NEPC, 2002) which sets an Advisory Reporting Standard for particulate (as PM₂.₅).

The purpose of the Advisory variation is to gather sufficient data to facilitate a review of the Standard. A summary of the guidelines relevant to dust management is provided in Table 6-1.

Table 6-1 National Environmental Protection Measures – Ambient Air Guidelines

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Averaging Period</th>
<th>Ambient Guideline (ppm)</th>
<th>Ambient Guideline (µg/m³)</th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient Air NEPM Standard</td>
<td>1 day</td>
<td>-</td>
<td>50</td>
<td>5 days a year</td>
</tr>
<tr>
<td>Variation to the Ambient Air NEPM Advisory Reporting Standard</td>
<td></td>
<td>-</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 year</td>
<td>-</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

Note 1: Referenced to a temperature of 0 °C and absolute pressure of 101.3 kPa.
Note 2: Maximum allowable exceedances of the Standard, to be achieved by the year 2008.
Note 3: Goal is to gather sufficient data nationally to facilitate a review of the standard.

There is not an ambient air quality standard in a NEPM for Total Suspended Particulate (TSP), total dust load. Ambient dust level limits at the Pinjarra Racecourse are defined in the refinery’s Department of Environment licence. This specifies that the 24-hour average ambient dust level measured at the Racecourse monitoring station shall not exceed 260 micrograms per normal cubic metre (µg/m³).

In addition to the licence limits set by regulatory agencies, Alcoa has established its own Internal TSP internal measure. This Internal measure of 90 µg/m³ (at Pinjarra Racetrack) is approximately one third of the license limit. The purpose of the internal measure is to drive continuous improvement in
dust control and ensure that a higher level of performance than that determined by the environmental regulatory authorities is achieved.

The current Advisory Reporting Standard for PM$_{2.5}$ is $25\mu g/m^3$ in one day. Voluntary measurements undertaken by Alcoa to assist with the assessment of the Standard have shown that PM$_{2.5}$ values at the Pinjarra Racetrack are between 4 and 13 $\mu g/m^3$ per day and well within the proposed standard.

6.2 EXISTING DUST MONITORING SYSTEM

Dust monitoring around the Pinjarra refinery is undertaken through a network of monitors including high volume samplers and TEOMs. A brief summary of the monitors is presented in Table 6-2 with their locations presented in Plate 6-1.

Dust emissions from the residue drying area are monitored daily. This data is then used to gauge the effectiveness of dust control measures. As seen in Plate 6-1, Alcoa has nine ambient dust monitoring sites surrounding the refinery, including a compliance monitoring site located at the Pinjarra Racecourse. These sites are located to measure ambient dust concentrations due to emissions from the residue drying area and bauxite stockpiles.

### Table 6-2: Summary of the Alcoa Pinjarra Refinery Dust Monitoring Network

<table>
<thead>
<tr>
<th>Monitoring Site Name</th>
<th>Monitoring Site Code</th>
<th>Licence</th>
<th>Monitoring Site Code</th>
<th>Monitoring Type</th>
<th>Size Fraction Measured</th>
<th>Averaging Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pinjarra Race Track</td>
<td>RT001</td>
<td>Yes</td>
<td>HVAS</td>
<td>TSP</td>
<td></td>
<td>24-hour</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>HVAS</td>
<td>PM$_{10}$</td>
<td></td>
<td>24-hour</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>TEOM</td>
<td>TSP</td>
<td></td>
<td>6-minute</td>
</tr>
<tr>
<td>Fairbridge Airstrip</td>
<td>FB001</td>
<td>Yes</td>
<td>HVAS</td>
<td>TSP</td>
<td></td>
<td>24-hour</td>
</tr>
<tr>
<td>RDA 500 m (north)</td>
<td>NO001</td>
<td>No</td>
<td>HVAS</td>
<td>TSP</td>
<td></td>
<td>24-hour</td>
</tr>
<tr>
<td>RDA 500 m (central)</td>
<td>CE001</td>
<td>No</td>
<td>HVAS</td>
<td>TSP</td>
<td></td>
<td>24-hour</td>
</tr>
<tr>
<td>RDA 500 m (south)</td>
<td>SO001</td>
<td>No</td>
<td>HVAS</td>
<td>TSP</td>
<td></td>
<td>24-hour</td>
</tr>
<tr>
<td>Oakley South</td>
<td>QA001</td>
<td>Yes</td>
<td>HVAS</td>
<td>TSP</td>
<td></td>
<td>24-hour</td>
</tr>
<tr>
<td>Eastern Boundary</td>
<td>EB001</td>
<td>No</td>
<td>HVAS</td>
<td>TSP</td>
<td></td>
<td>24-hour</td>
</tr>
<tr>
<td>Oakley Dam</td>
<td>OA002</td>
<td>No</td>
<td>HVAS</td>
<td>TSP</td>
<td></td>
<td>24-hour</td>
</tr>
<tr>
<td>Bauxite Stockpile</td>
<td>BW001</td>
<td>No</td>
<td>HVAS</td>
<td>TSP</td>
<td></td>
<td>24-hour</td>
</tr>
<tr>
<td></td>
<td>PD001</td>
<td>No</td>
<td>TEOM</td>
<td>TSP</td>
<td></td>
<td>6-minute</td>
</tr>
</tbody>
</table>

The monitors are used by Alcoa for:

- control purposes including the use of the racetrack TEOM as a reactive control;
- compliance with licence conditions; and
• estimation of its NPI emissions.

As part of the Alcoa Pinjarra monitoring, chemical analysis is sometimes conducted for selected high-dust concentration days using in-house methodologies. At Pinjarra, a method using a very weak acid solvent and Inductively Coupled Plasma atomic emission spectroscopy (ICP) is used to determine the soluble silica, soluble aluminium and soluble sodium in the sample.

Plate 6-1 Ambient Dust Monitoring Locations

There are three types of dust sampling equipment located at the Pinjarra Racecourse, as depicted in Plate 6-2. These are:

• Tapered Element Oscillating Microbalance (TEOM) – measures dust concentration continuously (real-time) using a filter on a tapered element. Mass of dust is related to the frequency of oscillation of the element;
• High Volume Air Sampler (HVAS) – measures dust concentration over an averaging period (usually 24 hours) using a filter paper; and
• PM10 High Volume Sampler – measures dust concentration of particles less than 10 microns over an averaging period (usually 24 hours). Larger particles are removed before they reach the filter paper.

Plate 6-2 Dust Sampling Equipment at Pinjarra Racecourse

The TEOM monitor has a radio link which sends a signal every six seconds back to the refinery and causes an alarm to be triggered if dust levels at the Pinjarra Racetrack exceed the internal standard. Additional alarms are also triggered if wind speeds exceed a pre-determined level. This warning system ensures action is taken to control dust before it becomes a problem. When a dust sample exceeds the internal standard of 120 mg/m³ the sample is analysed for soluble aluminium, soluble silica and soluble soda.
7 RECEPTOR LOCATIONS

There are 14 residential locations close to, or within the Alcoa controlled buffer zone, but outside of the refinery industrial zone (Toxikos, 2003). Receptor locations are shown in Plate 7-1 which has been reproduced from the SKM (2003) report and their characteristics are summarised in Table 7-1. Toxikos (2003) performed a risk assessment for four of these locations based on the number of residences the location represents and, after inspection of the modelled ground level concentrations, the location of the highest concentrations of emission components. As a result of this analysis Toxikos chose locations 1, 3, 4, & 7 to conduct the health risk assessment.

- Location 1 is the site of the highest modelled 1-hour maximum and highest annual average VOC concentrations of all the fourteen modelled locations; hence is representative of the worst case exposure to emissions from the refinery. All other locations have lower exposures.
- Location 3 is representative of the nearest residence in Carcoola town site.
- Location 4 is at the edge of the Pinjarra Racecourse and therefore representative of a residence at Pinjarra town site that is potentially closest to the refinery; this location, while having lower exposures than Location 1, is representative of the highest exposure at the town of Pinjarra.
- Location 7 represents the south of the refinery (locations 6 – 11) and has been chosen because this is where the highest VOC exposure is predicted to occur for this immediate area.
Table 7-1: Receptor identification and description.

<table>
<thead>
<tr>
<th>Receptor identification number</th>
<th>Approx No of Residences for which Receptor Representative</th>
<th>Description of Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>Residence, Farmhouse</td>
</tr>
<tr>
<td>2</td>
<td>15</td>
<td>Fairbridge farm, permanent &amp; short stay accommodation</td>
</tr>
<tr>
<td>3</td>
<td>500</td>
<td>Nearest residence in Carcoola town site</td>
</tr>
<tr>
<td>4</td>
<td>2000</td>
<td>Nearest residence in Pinjarra town site</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>Residence, Farmhouse</td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td>Residence, Farmhouse</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
<td>Residence, Farmhouse</td>
</tr>
<tr>
<td>8</td>
<td>4</td>
<td>Residence, Farmhouse</td>
</tr>
<tr>
<td>9</td>
<td>4</td>
<td>Residence, Farmhouse</td>
</tr>
<tr>
<td>10</td>
<td>4</td>
<td>Residence, Farmhouse</td>
</tr>
<tr>
<td>11</td>
<td>4</td>
<td>Residence, Farmhouse</td>
</tr>
<tr>
<td>12</td>
<td>5</td>
<td>Residence, Farmhouse</td>
</tr>
<tr>
<td>13</td>
<td>1-3</td>
<td>Residence, Alcoa employee and family</td>
</tr>
<tr>
<td>14</td>
<td>4</td>
<td>Residence, Alcoa farmlands manager and family</td>
</tr>
</tbody>
</table>

Note 1: Receptor identification numbers correspond to locations in the SKM (2003) modelling report. Shaded locations are those for which the health risk assessment has been conducted (see text).
Plate 7-2: Location of nearest residences for which dispersion modelling was conducted (SKM 2003) to predict ground level concentrations of emission components.

Note 1: Locations 1, 3, 4 & 7 are the subject of the health risk assessment conducted by Toxikos in 2003.
The receptor locations corresponding monitoring points are summarised in table 7-2 below.

### Table 7-2: Sensitive receptor locations and corresponding monitoring points.

<table>
<thead>
<tr>
<th>Receptor identification number</th>
<th>Dust Monitoring Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>There are no dust monitors at this location. However, it is very rare for the wind to blow in a northeasterly direction towards this receptor. The wind generally comes off the scarp in a westerly direction.</td>
</tr>
<tr>
<td>2</td>
<td>The nearest dust monitor is located at the Fairbridge Airstrip.</td>
</tr>
<tr>
<td>3</td>
<td>Alcoa is currently in the process of building a dust monitor at this location.</td>
</tr>
<tr>
<td>4</td>
<td>The nearest dust monitor is located at the race track.</td>
</tr>
<tr>
<td>5</td>
<td>The nearest dust monitor is RDA 500m south.</td>
</tr>
<tr>
<td>6</td>
<td>The nearest dust monitor is Oakley South</td>
</tr>
<tr>
<td>7</td>
<td>The nearest dust monitor is Oakley South</td>
</tr>
<tr>
<td>8</td>
<td>The nearest dust monitors are Oakley South and Oakley Dam</td>
</tr>
<tr>
<td>9</td>
<td>The nearest dust monitors are Oakley South and Oakley Dam</td>
</tr>
<tr>
<td>10</td>
<td>The nearest dust monitors are Oakley South and Oakley Dam</td>
</tr>
<tr>
<td>11</td>
<td>The nearest dust monitors are Oakley South and Oakley Dam</td>
</tr>
<tr>
<td>12</td>
<td>There are no dust monitors at this location. However, it is very rare for the wind to blow in a northeasterly direction towards this receptor. The wind generally comes off the scarp in a westerly direction.</td>
</tr>
<tr>
<td>13</td>
<td>The nearest dust monitor is RDA 500m south.</td>
</tr>
<tr>
<td>14</td>
<td>The nearest dust monitor is RDA 500m south.</td>
</tr>
</tbody>
</table>
8  ONGOING RESEARCH

Alcoa is committed to conducting further research into dust monitoring and management. Table 8-1 provides a summary of both research programs that have been conducted recently and planned dust studies across Alcoa’s Western Australian operations.

Table 8-1 Summary of Current and Planned Dust Studies Across Alcoa’s Western Australian Operations

<table>
<thead>
<tr>
<th>Project Title</th>
<th>Objectives / Outcomes</th>
<th>Commence</th>
<th>Complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessment of Best Practice Sprinkler Design</td>
<td>▪ Review how sprinkler designs have been developed in the iron ore, coal and alumina industries in Australia; and&lt;br&gt;▪ Identify best practices and compare these with the process used by Alcoa.</td>
<td>Oct 2004</td>
<td>Nov 2004</td>
</tr>
<tr>
<td>Sprinkler and Operational Performance Assessment</td>
<td>▪ Test the latest design sprinkler layout under a range of wind conditions; and&lt;br&gt;▪ Compare the results with the previous design.</td>
<td>Oct 2004</td>
<td>Dec 2004</td>
</tr>
<tr>
<td>Rainfall and Dust Fall Monitoring at Wagerup</td>
<td>▪ Undertake a comprehensive study of aerosols including fine particle concentrations, dust deposition and rainfall, and the chemical composition of these components, using recognised techniques.</td>
<td>Jan 2005</td>
<td>TBA</td>
</tr>
<tr>
<td>WA Dust Study</td>
<td>▪ Assess the extent of PM_{10} and PM_{2.5} in dust emissions and at receptors;&lt;br&gt;▪ Compare these concentrations to NEPM standards;&lt;br&gt;▪ Assess the physical and chemical properties of this dust;&lt;br&gt;▪ Compile an intensive set of dust emission data for inclusion into the Pinjarra Upgrade Health Risk Assessment;&lt;br&gt;▪ Improve dust estimation accuracy for National Pollutant Inventory reporting; and&lt;br&gt;▪ Share outcomes with neighbouring communities.</td>
<td>Dec 2004</td>
<td>Apr 2006</td>
</tr>
</tbody>
</table>
9 REVIEW OF MANAGEMENT PLAN

This management plan may be altered from time to time to reflect changes to production requirements, or to stakeholder expectations.

Alcoa will undertake an appropriate level of stakeholder consultation in regard to dust management and this management plan. The level of consultation will be dependent upon the nature and significance of alterations.
10 DEVELOPMENT OF THIS PLAN

Alcoa will publish this dust management plan.

A summary of the Pinjarra Refinery Dust Management Plan for the Residue Disposal Area will be made available to the following parties:

1). Department of Environment;
2). Pinjarra Community Consultative Network and
3). The wider community and general public through key libraries.

1) Department of Environment

In accordance with Schedule 2 Commitments of Ministerial Statement 646 Alcoa will provide the Dust Management Plan for the Residue Disposal Area to the Department of Environment to be approved prior to commissioning of the Pinjarra Efficiency Upgrade.

2) Stakeholder Reference Group

In September 2003, Alcoa established a Stakeholder Reference Group (SRG) in order to undertake consultation on a range of issues related to the Pinjarra efficiency upgrade. This group comprises twelve members representing the following interests:

- Local community and Pinjarra residents;
- Farming community and Pinjarra refinery neighbours;
- Pinjarra refinery workforce;
- Local Government;
- Pinjarra businesses;
- Local education and training departments;
- Indigenous community;
- Local Landcare groups;
- Pinjarra refinery Community Consultative Network;
- Department of Environment;
- Department of Industry and Resources; and
- Pinjarra Efficiency Upgrade project team.
The SRG were invited to comment on the first version of the Dust Management Plan for the Residue Disposal Area. Alcoa will communicate the final document to the Alcoa Pinjarra Community Consultative Network. This may involve general summaries, presentations and/or special meetings to discuss significant outcomes as appropriate.

3) The Wider Community and General Public

Following submission to the Department of Environment the plan will be made publicly available to the wider community and general public.

Alcoa will then request the DEC to advertise the availability of the plan for public comment within their weekly DEC/EPA advertisement found within each Monday’s edition of ‘The West Australian’. In addition, hardcopies of the plan will be made available in government and local libraries as summarised in Table 9-1 below.

<table>
<thead>
<tr>
<th>Location</th>
<th>Address</th>
<th>Copies Available</th>
</tr>
</thead>
</table>
| DEC library         | Westralia Square
                    | Level 8, 141 St Georges Terrace
                    | Perth WA 6000
                    | Tel: +61-8-9222 7010                                                 | 2 hardcopies     |
| Battye Library      | Battye Library. Located inside the Alexander Library
                    | Building, Cultural Centre, Perth WA 6000                             | 2 hardcopies     |
| Public Library      | Mandurah Shire Library                                                  | 2 hardcopies     |
| Murray Shire Library| Located at the corner of Pinjarra Rd & Forrest St. Pinjarra             | 2 hardcopies     |

10.1 DEVELOPMENT OF MANAGEMENT PLAN

The following summary describes the milestones to date that influenced the development of this management plan:

DRAFT Version 1 presented to the SRG
Version 1 submitted to the Licensing Branch of DEC
Copy of Version 1 provided to Air Quality Management Branch of DEC
Copy of Version 1 presented to the Audit Branch of DEC who requested that they receive the final version prior to final commissioning
10.2 COMMUNITY CONSULTATION

A summary of community consultation that has been undertaken and comments provided is provided in Table 7-2 below.

<table>
<thead>
<tr>
<th>Consultation</th>
<th>Summary of Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preliminary draft of Dust Management Plan presented to SRG in January 2005</td>
<td>No comments received.</td>
</tr>
</tbody>
</table>
11 REFERENCES

Air Assessments, 2004 (Own Pitts), Memo to Alcoa, titled “Pinjarra Bauxite Residue Stakeholder Reference Group Queries”.


SKM, 2003 Pinjarra Refinery Efficiency Upgrade – Air Dispersion Modelling. 3 December 2003


Figures
Figure 1- Aerial Photograph of Pinjarra Refinery and surrounding area with residue disposal area to the west of the refinery
Appendix A

*Alcoa’s Sustainability Principles*
Sustainability Principles

Respect & Protect People
We listen to, and respect the views of our workforce and the communities wherever we operate, and we formulate partnerships that strengthen our interdependence and improve well-being.

Building Community Experience and Well-being
Our operations contribute to improved quality of life and build skills, knowledge and experience in the communities with which we interact, while respecting the significance and diversity of their culture and heritage.

Long-term Economic Benefit
Our operations deliver economic benefits to the regions and States in which they operate, to the nation, and to society in general. Our operations foster economic growth, generate wealth for the community, provide commercial returns to our shareholders and contribute to long-term economic health.

Efficient Resource Use & Cleaner Production
We use natural resources wisely and manage our environmental impacts to the benefit of the full range of our stakeholders by employing leading technology and best practice management, and by encouraging responsible design, use, recycling and disposal of our products.

Ecological Integrity & Biodiversity
Our operations maintain or enhance biological diversity and the fabric of ecological integrity in the environments in which we operate.

Meeting the Needs of Current and Future Generations
We take a long-term approach to our activities, and work in partnership with communities and governments to meet the needs and desires of today without compromising the ability of future generations to satisfy their own needs.

Stakeholder Involvement
We work with our communities, employees, customers, shareholders and suppliers to achieve outcomes and make decisions of mutual benefit. We report regularly to all our stakeholders on the sustainability performance of our operations.

Accountability & Governance
We practice ethical business governance, are accountable for our actions, continually improve our performance and integrate environmental, social and economic considerations in our decision-making.
Appendix B

Regulatory environmental approval conditions
Ministerial Statement 646, Pinjarra Refinery Efficiency Upgrade (Assessment No. 1498)

Schedule 2 Commitments

Condition 2 Air Emissions

Objective: To minimise fugitive dust emissions from the Residue Disposal Area.

Have in place and make publically available a Dust Management Plan for the Residue Disposal Area Which includes:

1. An upgrade of the existing sprinkler system; and

2. a review of operational controls