

Environmental Protection Agency. Enquiries should be addressed to PO Box 155 BRISBANE ALBERT STREET QLD 4002.

RE390 February 2001 ISBN 0-7242-8268-8

Visit us online at www.env.qld.gov.au

# Final Report of

# Mount Isa Mines Limited Panel Assessment Study

February 2001

#### The Minister for Environment

#### Dear Minister

In accordance with the provisions of the *Mount Isa Mines Limited Agreement Amendment Act 1997*, the panel has pleasure in presenting to you the final report of the Panel Assessment Study.

As you are aware the Panel Assessment Study was required to report to you on the environmental impacts of sulfur dioxide emissions at Mount Isa, under conditions projected to occur when the acid plant attached to the copper smelter is in operation. The panel has complied with its legislative requirements in providing to you interim reports every six months for its three year duration for tabling in Parliament.

The panel commends this final report to you, as required under clause 20(3) of the *Mount Isa Mines Limited Agreement* and notes in addition under clause 20 (4) that Mount Isa Mines Limited is required to consult with you on how the findings in the report should be included in its Integrated Environmental Management System.

As envisaged by the Act, the panel recommends that its report be made publicly available, and that appropriate access be provided to the array of supporting documents commissioned for the study. In addition, it is recommended that the panel meet with the community at Mount Isa following your receipt of the report.

It is noted that correspondence was received on 23 January 2001 from the representative of the Queensland Conservation Council (QCC), Ms Isabelle Vallin that the QCC would prepare and present a dissenting report to you.

The panel wishes to express its appreciation to the community at Mount Isa, particularly those who participated in the community survey.

The panel also expresses its thanks to the secretariat of the panel, namely Dr Peter Nimmo, Ms Nicole Conlon and Mr Scott McDowall, of the Environmental Protection Agency for their professional assistance and organisation of the study program and report preparation.

Yours sincerely

John Gilmour (Chair)

Director, Corporate Performance and Risk Environmental Protection Agency

Greg Ayers

Research Program Leader

CSIRO Division of Atmospheric Research

Bevan Borgelt

Consultant Metallurgical Engineer

Rov Harris

Mount Isa Mines Site Union Organiser

Australian Workers Union

al.

Robert MacLennan

Emeritus Professor of Medicine

Queensland Institute of Medical Research

heman

Brian Mayhew

Safety Health and Environment Manager,

MIM nominee

Ron McCullough

Mayor of Mount Isa City Council

Leigh Neilson Manager, Mount Isa

Manager, Mount WMCF nominee

John Thinee

President, Mount Isa Chamber of Commerce

David Williams

Atmospheric Science Researcher CSIRO Division of Energy Technology

# **Executive summary**

Mount Isa is a town of about 20,000 people in the remote north-west of Queensland.

The town is located alongside the copper and lead mining and smelting operations of Mount Isa Mines Limited (MIM). The smelting processes produce sulfur dioxide emissions that may impact on the residents of Mount Isa, and on the flora and fauna of surrounding areas. The issues surrounding this are the subject of this report.

In September 1999, an acid plant, designed to convert sulfur dioxide emissions from the copper smelter into liquid sulfuric acid was commissioned at Mount Isa by WMC Fertilizers Pty Ltd (WMCF). The acid is used in the manufacture of fertilizers at WMCF's facility at Phosphate Hill, 100 kilometres from Mount Isa.

At its existing capacity, the acid plant is capable of absorbing about 65 percent of the total sulfur dioxide emissions from MIM's operations. However, because of production problems at the Phosphate Hill plant, demand for acid has been limited and the acid plant has been operating at considerably below its capacity and therefore only absorbing a small portion of the total sulfur dioxide emissions available.

Under recent amendments to the *Mount Isa Mines Limited Agreement* between the Queensland Government and MIM, a Panel Assessment Study was commissioned to report on the environmental impacts of sulfur dioxide emissions from the smelters and on the likely reductions in that impact when the acid plant was operating on a normal full-time basis at or near its design production rate.

The then Minister for Environment set the terms of reference for the study, and appointed an independent panel to carry it out and report by 12 February 2001. This document is the final report of the panel to complete the study.

However, because of the reduced level of operations at the acid plant during the term of the study, the panel has not had the opportunity within the available time frame to directly measure the full potential of the plant to reduce the sulfur dioxide levels in community areas of Mount Isa.

The panel had access to reports commissioned by MIM into the fate of sulfur dioxide emissions from its smelters, and the impact this had on soil acidity and on floral and faunal diversity of the district. To augment this information, and to satisfy the terms of reference for the study, the panel commissioned reports into additional areas including:

- the history of smelting, sulfur dioxide emissions and air quality in Mount Isa;
- community perceptions regarding health and the environment in Mount Isa;
- the economic cost of health impacts of emissions from the smelters;
- the impact of smelter operations on regional, state and national economies; and
- available emission control options, and their feasibility and practicality at Mount Isa.

On the basis of all this material, the panel drew the following conclusions.

# Options for additional emission control measures at the smelters

- (1) There are technologies that could potentially further reduce sulfur dioxide emissions from the Mount Isa copper smelter. Those likely to be viable include:
  - ensuring that all process gases from the copper smelter are treated in the acid plant;
  - installing wet-scrubbing desulfurisation systems to treat the ventilation and fugitive gases; and
  - modifying the acid plant to be a double-contact unit, or installing a wet scrubber to treat the tail gas.

The commercial feasibility of these options is not established, and requires further investigation.

(2) There are also technologies that can potentially reduce sulfur dioxide emissions from the Mount Isa lead smelter. The most viable is likely to be installing an acid plant to treat off-gases from the sintering machine. As with options for the copper smelter, the

- commercial feasibility of this option needs to be confirmed.
- (3) The following options for additional reductions in sulfur dioxide emissions and ambient concentrations in Mount Isa could be further explored:
  - amending the operating protocols of the air quality control system;
  - treating all the process gases from the copper smelter through the acid plant;
  - improving the systems for collecting copper smelter vent gases and fugitive emissions that contain sulfur dioxide emissions;
  - using alkali scrubbing on the vent gases from the copper smelter;
  - treating the tail gas from the acid plant;
     and
  - installing an acid plant to treat the off-gases from the sinter plant at the lead smelter.

# Impact of sulfur dioxide emissions on community health

- (4) No evidence was found of a positive relationship between the rate of hospital presentations or admissions at Mount Isa for asthma/wheezing/shortness of breath and ambient levels of sulfur dioxide in community areas of the town.
- (5) Available evidence suggests that intermittent peaks in ambient sulfur dioxide levels occur in community areas of Mount Isa, but the exposure of people who are indoors at the time is significantly limited.
- (6) In Mount Isa, there are higher rates of hospital admissions for some respiratory complaints (including asthma in males), compared with other western Queensland towns. However, there is insufficient information available to determine the cause of this difference.
- (7) Based on survey results:
  - the rate of doctor-diagnosed asthma in Mount Isa is not substantially different from that in Australian communities

- that are not influenced by sulfur dioxide emissions from smelters; and
- a substantial number of people living in Mount Isa are of the view that smelter emissions cause health problems and/or irritation affecting the respiratory tract, skin and eyes.
- (8) There are considerable difficulties in determining if emissions from the smelters are causing any health impacts in the community in Mount Isa, and in assigning an economic cost to potential health impacts.
- (9) Indicative estimates of the economic cost of potential health impacts of emissions from the smelters are low compared to the economic value of the operation of the smelters.

# Impact of sulfur dioxide emissions on soil chemistry

- (10) Approximately half of the sulfur emissions from the Mount Isa smelters is deposited on continental Australia by processes of dry deposition of sulfur dioxide and aerosol sulfate, and wet deposition of sulfate. The other half is advected offshore.
- (11) The sulfur emissions from the Mount Isa smelters that are advected offshore do not contribute to environmental acidification because they are so highly diluted by atmospheric dispersion processes that have taken place since emission.
- (12) The significance of sulfur deposition arising from Mount Isa emissions will vary depending on the properties of the soil.
- (13) Sulfur deposition arising from emissions has caused acidification of soils, especially to the immediate north-west of Mount Isa. The acidification has reached a level likely to have biological implications in areas up to 20 kilometres downwind from the smelters for soil depths to two centimetres, in areas up to five kilometres downwind for soil depths to 10 centimetres, and not at all for greater soil depths.

(14) The operation of the acid plant is unlikely to bring about an improvement in affected soils, except in the long term, because the soils' capacity to neutralise acids has been exhausted by the historical acid deposition.

# Impact of sulfur dioxide emissions on ecosystems

- (15) Ecosystems within 15 kilometres downwind from the smelters have undergone measurable change, either as a direct or indirect result of sulfur dioxide emissions.
- (16) Beyond 15 kilometres downwind from the smelters, no impact on flora and fauna was observable.
- (17) Foliar injury symptoms consistent with toxicity from sulfur dioxide were not observed in areas more than five kilometres downwind from the smelters.
- (18) The richness of plant species is not influenced by emissions in areas more than 15 kilometres downwind from the smelters.
- (19) The richness of ant species has been halved in some areas within five kilometres downwind from the smelters.
- (20) The diversity of reptile species has been reduced on the ridges directly downwind from the smelters, particularly species that forage on insects.
- (21) The richness of bird species has been reduced close to the smelters, with insectivorous species being the most sensitive.
- (22) Reductions in emissions of sulfur dioxide brought about by the planned operation of the acid plant should result in proportionate reductions in the extent of direct plant foliar injury in areas downwind from the smelters.

# **Economic importance of the smelters**

- (23) MIM's operations in Mount Isa contribute greatly to the regional, state and national economy. Among the estimated benefits are:
  - 5,310 jobs in north-west Queensland, 8,200 jobs in Queensland, and 8,257 jobs in Australia;
  - \$186.2 million a year of gross product in north-west Queensland, \$456.3 million in Queensland and \$459.5 million in Australia;
  - \$344.4 million a year in wages in north-west Queensland, \$411.1 million in Queensland, and \$414.9 million in Australia;
  - \$72.9 million a year in taxes and other government income; and
  - 7 percent of Queensland's exports.

These benefits would be lost if smelting was discontinued at Mount Isa.

# Community attitudes regarding environmental management in Mount Isa

(24) Based on survey results:

- about three quarters of the people living in Mount Isa believe that smelter emissions is the most important environmental issue in Mount Isa, and more could be done to reduce them;
- people living in Mount Isa hold generally positive attitudes towards the environment, but recognise that their employment opportunities in the town depend upon the continued operation of the mine and the smelters;
- about 85 percent of the people living in Mount Isa are aware of the MIM air quality control system; and
- about half of Mount Isa's residents believe that the air quality control system is effective in managing air quality in community areas of the town.

Overall, no evidence was found of adverse effects of sulfur dioxide emissions on community health in the hospital admission statistics at Mount Isa. Nevertheless, the panel recognises that the Mount Isa community remains concerned about emissions from the smelters. Also, monitoring shows that national goals for short-term averages for ambient levels of sulfur dioxide are occasionally exceeded in community areas of the town during adverse weather conditions.

As noted earlier, the panel was unable to fully assess the combined effect of the operation of the acid plant and the air quality control system on the impact of sulfur dioxide emissions. This was because restricted operation of the Phosphate Hill fertilizer plant limited the demand for acid, and production levels at the acid plant were substantially restricted during the period of the study. Nevertheless, the panel is confident that the planned operation of the acid plant will make a significant improvement to the natural environment within the Mount Isa region.

The panel has made recommendations for further research including:



- quantifying the recovery of historical biodiversity impacts likely to result from the operation of the acid plant;
- quantifying the levels of sulfur dioxide that people living in community areas of Mount Isa are actually exposed to – levels likely to be substantially lower than ambient levels recorded by the monitoring network because concentrations indoors are substantially lower than concentrations outdoors;
- determining if community perceptions regarding emissions from the smelters change after the acid plant becomes fully operational;
- finding ways to improve the effectiveness of the air quality control system; and
- further developing feasible measures for reducing sulfur dioxide emissions from the smelters as they become practicable.

Implementation of the recommendations for further research will require on-going work. It would be appropriate for progress on implementation of the agreed recommendations to be routinely monitored and reported on to the Minister for Environment and Heritage and the Mount Isa community in an independent way. The panel has recommended that the Minister choose between two possible mechanisms for carrying out this task.

The panel is of the view that this report fully satisfies the terms of reference for the study, and provides an appropriate basis for MIM to consult with the Minister for Environment and Heritage on how to incorporate the findings of the study into the Integrated Environmental Management System (IEMS) for its operations at Mount Isa.

# **Contents**

Executive summary i								
Tal	ole of	f contents	٧					
1. Introduction								
	1.1	Context of the Panel Assessment Study	1					
		1.1.1 The companies and their operations	1					
		1.1.2 The Phosphate Hill proposal						
		1.1.3 Acid plant production estimates						
		1.1.4 Actual production outcomes						
		1.1.5 Ambient air quality standards	4					
	1.2	Panel membership and meetings	5					
		1.2.1 Membership	_					
		1.2.2 Meetings	5					
2.	Site	history	7					
	2.1	Mining and smelting	7					
		2.1.1 Introduction	7					
		2.1.2 Metal production	7					
		2.1.3 Lead smelting technology	7					
		2.1.4 Copper smelting technology	В					
	2.2	Sulfur dioxide sources	9					
		2.2.1 Stacks	-					
		2.2.2 Sulfur dioxide emission	0					
	2.3	Air quality control	1					
	2.4	Sulfur dioxide levels in Mount Isa community areas	2					
3.	Fate	of sulfur dioxide emissions1	5					
	3.1	Atmospheric dispersion and ultimate fate of emissions	5					
	3.2	Rates of acid deposition10	6					
-		Tolerances of soils to acid input						
		Impacts on flora and fauna						
	3.4	impacts on nora and radia	7					
4.	Comr	munity public health impacts	1					
	4.1.	Findings reported in scientific literature	1					
		4.1.1 Asthma						
		4.1.2 Other respiratory diseases						
		4.1.3 Other issues	2					
	4.2	Self-reported health impacts	2					
		4.2.1 Personal health	2					
		4.2.2 Family health						
		4.2.3 Children's respiratory symptoms	4					
	4.3	Hospital statistics	6					
		4.3.1 Asthma admissions and ambient sulfur dioxide levels						
		4.3.2 Mount Isa hospital admissions compared to other western Queensland towns 2	7					
	4.4	Economic cost of health impacts	9					

# **Contents** (continued)

5.	Economic impact of smelter operations						
6.	Community view						
	6.1	Effectiv	veness of the air quality control system	32			
	6.2	Emissi	ons and the environment at Mount Isa	32			
7.	Available emission controls for sulfur dioxide						
	7.1		wide practice	_			
			Copper smelter emission control practice				
		7.1.2	Lead smelter emission control practice	35			
	7.2	Option	s to reduce emissions of sulfur dioxide at Mount Isa	35			
	7.3	Feasibi	lity and practicality at Mount Isa	35			
8.	Recommendations for action						
	8.1	Implen	nentation management	39			
	8.2	Further	research	40			
9.	Con	clusion		42			
Аp	pend	lices					
Ар	pend	dix I:	Supporting documents	43			
Appendix II:		dix II:	References	44			
Appendix III:		dix III:	Abbreviations	46			
Appendix IV:		dix IV:	Terms of Reference for the Panel Assessment Study	47			
Appendix V:		dix V:	Extract from the Inter-Governmental Agreement on the Environment (February 1992)	48			
Appendix VI:		lix VI:	Extract from conditions of the Environmental Authority under the <i>Environmental Protection Act 1994</i> for the mining and smelting facilities operated by Mount Isa Mines Limited at Mount Isa	50			
Appendix VII:		dix VII:	State and national legislation regarding ambient air standards for sulfur dioxide	52			
Annendiy \/III.		lix VIII:	Biographical notes for panel members	53			

# 1. Introduction

# 1.1 Context of the Panel Assessment Study

# 1.1.1 The companies and their operations

Mount Isa is a town of about 20,000 people in the remote north-west of Queensland.

The town is located alongside the copper and lead mining and smelting operations of Mount Isa Mines Limited (MIM) and, for more than 60 years, the copper and lead smelters have been discharging sulfur dioxide emissions into the atmosphere.

The impact these emissions may have on the residents of Mount Isa, and on the flora and fauna of the surrounding district, is the subject of this study.

Over the years, MIM has considered recovering the sulfur dioxide contained in the gas stream that is emitted through tall chimneys above the smelters. However, these proposals had not proved viable because of the cost of the equipment required and its operation, and the lack of any market for the by-product generated.

# 1.1.2 The Phosphate Hill proposal

In the early 1990's, the options for recovering sulfur dioxide from the gas streams in Mount Isa were re-examined because of a proposal by WMC Fertilizers Pty Ltd (WMCF) to establish a fertiliser manufacturing plant at Phosphate Hill, some 100 kilometres from Mount Isa. Pivotal to the success of the WMCF project was the availability of natural gas from the central Australian gas fields. Natural gas is an essential feedstock for the manufacture of fertilizers from phosphate ores, and its availability made the Phosphate Hill project viable. The fertilizer manufacturing process also required large quantities of sulfuric acid which could be sourced, at least in part, from the sulfur dioxide gas stream from the Mount Isa smelters.

After due consideration, the fertilizer manufacturing plant was built at Phosphate Hill, and supplied by a single-contact sulfuric acid plant, built adjoining the Mount Isa copper smelter, using sulfur dioxide from the copper smelter as feedstock.

The total capital investment for the fertilizer-manufacturing project (including the acid plant and the gas capturing and cleaning equipment installed at Mount Isa) was more than \$800 million.

At the time MIM decided to supply sulfur dioxide to WMCF for conversion to sulfuric acid, it also announced project investments totalling around \$1 billion, which included:

- developing a new zinc-lead-silver mine (the George Fisher mine, 22 kilometres from Mount Isa);
- developing the Enterprise mine a new source of high-grade copper ore for the Mount Isa smelter);
- expanding and upgrading the copper smelter itself; and
- upgrading and expanding MIM's copper refinery at Townsville which is supplied from Mount Isa.

In committing to this level of capital investment, the corporations involved (WMCF and MIM) sought certainty that changes in government environmental requirements would not make the operation of the proposed facilities unviable in the future.

As a result, the *Mount Isa Mines Limited Agreement* (an agreement between the Queensland Government and MIM regarding the operation of MIM's facilities at Mount Isa) was amended to set requirements for emissions from the smelters, and to provide a mechanism for continuing improvement in the management of these emissions.

Under the revised terms of the Agreement, a Panel Assessment Study was to be carried out to assess the environmental impact of sulfur dioxide emissions from the smelters under conditions projected to occur when the acid plant was in operation. The study was also to identify suitable emission control technologies to enable MIM to meet ambient air standards for sulfur dioxide in compliance with environmental legislation. The then Queensland Minister for Environment set the terms of reference for the study, and in 1997, appointed an independent panel to carry it out, report directly to him, and submit progress

reports to Parliament every six months during the period of the study. (The terms of reference are listed in Appendix IV of this Report. Also listed — in Appendix V — is Section 3 of the Intergovernmental Agreement on the Environment, referred to in the Terms of Reference.)

The Queensland Environmental Protection Agency (EPA) provided technical and secretarial support to the panel.

All costs associated with the operation of the panel were borne by MIM. To date, these costs have totalled more than \$1.4 million including the fees for two major reports commissioned by MIM before the commencement of the Panel. These two reports — investigating where the sulfur dioxide emitted from the smelters goes, and its impacts on flora and fauna — were made available by MIM for use by the panel in its assessment.

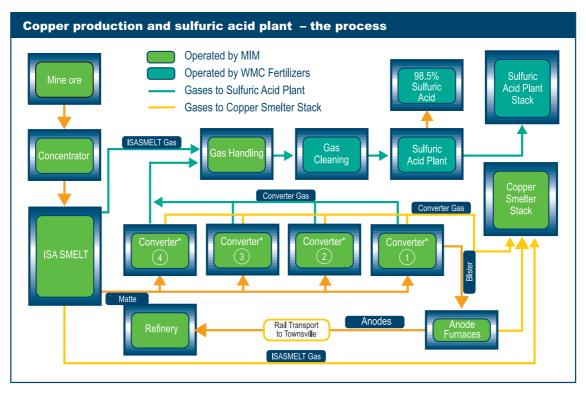
## 1.1.3 Acid plant production estimates

Originally, both WMCF and MIM expected that the acid plant might be able to treat around

95 percent of the sulfur dioxide emissions from the copper smelter. (This would equate to around 80 percent of total emissions from both the copper and the lead smelters.)

However, following detailed feasibility and design studies of the proposed acid plant by WMCF and the firming up of operational parameters as the project progressed, the company recognised that, initially, it would not be technically feasible to routinely treat all gases from the ISASMELT plus the three operating converters<sup>1</sup>. It considered that the plant should initially handle gases from the ISASMELT and two converters only. The possibility of including output from the third operating converter would be considered once the plant was in operation.

On the basis of this advice, the initial capture rate for the copper smelter was revised downwards from 95 percent to 80 percent of gas emitted, while the initial rate from both the lead smelter and the copper smelter was decreased from 80 percent to 65±5 percent.



The main sulfur dioxide producing components of the copper smelter are the ISASMELT unit, where concentrated copper ore is smelted to produce copper matte (about 60 percent copper), and four converters where the copper matte is converted into blister copper (about 99 percent copper). Only three of the four converters are operated at any one time because of routine maintenance requirements.

Even so, both MIM and WMCF were committed to maximising acid production from copper smelter gases. In addition, under the terms of the *Mount Isa Mines Limited Agreement*, MIM was required to make available to WMCF all the process gases collected from the converters.

As a result, MIM opted to invest sufficient funds to connect all four of its converters to the acid plant, even though it expected that initially only two converters would be needed to provide sufficient gas for the plant.

In time, it may be possible for the acid plant to accept the output of three operating converters (the fourth would always be down for maintenance). If this were to occur, MIM already has the infrastructure in place to deliver the smelter gases to the acid plant.

### 1.1.4 Actual production outcomes

The acid plant was designed to produce about 4,000 tonnes of sulfuric acid a day, and in the process, consume about 80 percent of the sulfur dioxide emissions from the copper smelter.

This would mean that, based on the copper smelter's production capacity of 265,000 tonnes of anode copper per year, the operation of the acid plant at its design production rate would absorb 493,000 tonnes of the 616,000 tonnes of sulfur dioxide emissions produced annually. The excess emissions are still vented to the atmosphere using an existing chimney. Emissions from the lead smelter which, at its production capacity of 160,000 tonnes would be about 156,000 tonnes of sulfur dioxide a year, are unaffected by the operation of the acid plant.

However, since its opening in September 1999, the acid plant has only operated at intermittent and low production rates. It has yet to operate at or near its design production rate on a normal full-time basis or for any extended period. This was the result of serious start-up problems at the WMCF fertilizer plant at Phosphate Hill, which limited the need for sulfuric acid.

Table 1-1 gives details of actual production rates at the acid plant since its commissioning.

TABLE 1-1
Acid Plant Performance to Date

Month	Sulfuric Acid Production (tonnes)
September 1999	17 978
October	25 956
November	0
December	0
January 2000	24 260
February	21 172
March	34 038
April	44 151
May	10 527
June	13 722
July	24 742
August	18 310
September	0
October	36 965
November	47 895

The company has been planning for a sulfuric acid production rate of 60 000 tonnes per month for early 2001, increasing gradually to 90 000 tonnes per month by late 2002

Because of the limited operation of the acid plant to date, the panel has not had the opportunity to directly assess by measurement its impact on sulfur dioxide levels in community areas of Mount Isa. Since the Agreement requires the panel to submit its final findings by 12 February 2001, it has been necessary to base this report on the data now available.

However, the panel notes that, despite early problems at the Phosphate Hill plant, there have been significant improvements in production rates and equipment reliability in recent months, and WMCF is confident that the facility will be operating at target production rates in the short to medium term.

At full production rate, the Phosphate Hill operations will consume an estimated 1.2 million tonnes of sulfuric acid a year. To help guarantee an uninterrupted supply of this quantity of sulfuric acid, WMCF is also

purchasing stocks of acid from Korea Zinc Ltd's zinc refinery at Townsville.

# 1.1.5 Ambient air quality standards

As noted above, the *Mount Isa Mines Limited Agreement* deals with the requirements to be met for air emissions at Mount Isa. The Agreement provides that the only ambient air quality standards for sulfur dioxide applying to the operation of the smelters are those specified in the Agreement, that is:

- maximum annual average concentration of 80 micrograms per cubic metre [0.028 ppm];
- maximum 24-hour average concentration of 365 micrograms per cubic metre [0.128 ppm]; and
- maximum three-hour average concentration of 1300 micrograms per cubic metre [0.455 ppm].

Note — See box below for a discussion of units of measurement for sulfur dioxide.

These levels must not be exceeded at any of the 10 air quality monitoring stations located in the Mount Isa area (and listed in the Agreement), unless the levels are exceeded due in whole or in part to abnormal operating conditions or unpredictable meteorological conditions.

The Environmental Authority issued under the *Environmental Protection Act 1994* for the MIM operations at Mount Isa takes due recognition of the Agreement. Conditions of the Environmental Authority relevant to this report are in Appendix VI.

State and Commonwealth environmental legislation has been enacted to set ambient air quality goals for sulfur dioxide. (See Appendix VII for details.) These goals are generally more stringent than the standards in the Agreement. However, they are intended to give direction to governments regarding overall management of ambient air quality in their decision making processes, and they do not create a statutory obligation on individuals or companies.

#### Units of Measurement for Sulfur Dioxide

The unit of measurement for sulfur dioxide concentration used in the *Mount Isa Mines Limited Agreement* is micrograms per cubic metre.

This unit is a mass of gas in a volume of air, and must therefore be expressed at a specified temperature and pressure. The usual practice in Australia in measuring air pollution concentration is to specify zero degrees Celsius (°C) at 101.325 kilopascals (kPa) air pressure. This differs from overseas practices, with the USA using 25 °C, and both 0 and 25 °C being used in various countries in Europe.

However most commercially available air quality monitoring instruments measure and record sulfur dioxide concentrations in parts per million by volume (ppm). As a result, this unit often appears in research papers, reports and statutory documents.

When the unit micrograms per cubic metre is used in this report, it is used in accordance with Australian practice, that is, at 0 °C at 101.325 kPa air pressure. The conversion factor at these reference conditions is:

1 ppm sulfur dioxide (by volume) = 2860 micrograms per cubic metre (at 0 °C and 101.325 kPa)



# 1.2 Panel membership and meetings

The primary objectives of the Panel Assessment Study were to:

- make assessments of the likely impacts of expected releases of sulfur dioxide from the MIM smelters at Mount Isa, once the acid plant was commissioned; and
- provide advice on emission control technology that would enable MIM to meet ambient air standards for sulfur dioxide.

This final report by the panel is aimed at informing future discussions between the Minister for Environment and Heritage and MIM about the on-going management of sulfur dioxide emissions from the smelters in Mount Isa.

The panel was constituted to provide an authoritative, accessible and transparent process for carrying out the study and preparing this final report.

# 1.2.1 Membership

The members of the panel were

# John Gilmour (Chair)

Director, Corporate Performance and Risk, Environmental Protection Agency

### Greg Ayers

Research Program Leader, CSIRO Division of Atmospheric Research

#### Bevan Borgelt

consultant metallurgical engineer

### Roy Harris

Mount Isa Mines Site Union Organiser, Australian Workers Union

### Leigh Neilson

Manager, Mount Isa, WMCF nominee (from 12 October 2000)

### Steven Campbell

Manager, Mount Isa, WMCF nominee (from 12 August 1998 to 12 October 2000)

# Brian Mayhew

Safety Health and Environment Manager, MIM nominee (from 13 January 2000)

### Ross Willis

Commercial Manager, MIM nominee (from 15 March 1999 to 13 January 2000)

#### Tim Hodge

Safety, Health and Environment Manager, MIM nominee (from 1 February 1998 to 15 March 1999)

#### Jim Fewings

Safety, Health and Environment Manager, MIM nominee (to 1 February 1998)

### Ron McCullough

Mayor of Mount Isa City Council

#### Robert MacLennan

Emeritus Professor of Medicine, Queensland Institute of Medical Research

### John Thinee

President, Mount Isa Chamber of Commerce

#### Isabelle Vallin

Queensland Conservation Council nominee (from 10 August 2000)

#### • James Whelan

Queensland Conservation Council nominee (from 22 September 1998 to 10 August 2000)

#### Brian Clark

Queensland Conservation Council nominee (to 22 September 1998)

#### David Williams

atmospheric science researcher, CSIRO Division of Energy Technology.

Notes: The panel was expanded on 12 August 1998 to include a representative from WMCF.

See Appendix VIII for biographical notes for panel members.

#### 1.2.2 Meetings

As required under Part II, Clause 20 of the *Mount Isa Mines Limited Agreement,* the panel met at least six times a year for the three years commencing 13 February 1998. Details of panel meetings are as follows:

**1997** 29 July — Brisbane

15 September — Mount Isa\*

16 December — Brisbane

1998 12 May — Brisbane

21 July — Teleconference

8 September — Mount Isa\*

22 October — Correspondence

1 December — Brisbane

**1999** 28 January — Teleconference

25 May — Brisbane

26 July — Teleconference

2 September — Mount Isa\*

9 November — Teleconference

7 December - Brisbane

**2000** 21 January — Teleconference

2 May — Brisbane

28 June — Mount Isa\*

22 August — Brisbane

12 October — Brisbane

5 December — Brisbane

**2001** 9 January — Teleconference

23 January — Teleconference

In addressing its terms of reference, the panel met mostly in plenary session, with the support of a single sub-committee providing advice to the panel on the economic impact of sulfur dioxide emissions on human health in the town.

To evaluate the operational characteristics of a modern sulfuric acid plant, a sub-committee travelled to Kalgoorlie in 1998 to inspect a plant at the WMC nickel smelter, which was similar to that proposed for Mount Isa.

With support from MIM, the panel established a work program that allowed for the orderly consideration of the available material, the identification of knowledge gaps, and the commissioning of work needed to bridge those gaps.

In general, where a need for substantial additional research was identified, the panel has noted the matter as a recommendation for future action in this report.

All reports produced for or considered by the panel are listed in Appendix 1. Copies of these documents together with this final report are available on CD ROM and can be obtained from the EPA's Naturally Queensland Information Centre, Ground Floor, 160 Ann Street, Brisbane.

Telephone: (07) 3227 8185

Fax: (07) 3227 8749

Email: nqic@env.qld.gov.au

These documents are also available on the EPA's web site at www.env.qld.gov.au

<sup>\*</sup> Note: The panel conducted public meetings in Mount Isa whenever it had panel meetings there so that the community could become acquainted with the scope, conduct and progress of the panel's work, and to allow plenty of opportunities for public input to the process.

# 2. Site history

This chapter addresses Terms of Reference item 3(a):

3. Specify that the Panel's repart shall include:(a) the site history of smelting, sulfur dioxide sources and air quality control;

The site history of the Mount Isa smelters is discussed by B. V. Borgelt in the report entitled "Management of Sulfur Dioxide at Mount Isa", 1998. The following sections are based on this report, and also on updated information supplied by MIM.

# 2.1 Mining and smelting

#### 2.1.1 Introduction

Lead smelting has been carried out at Mount Isa since June 1931. Copper smelting began as a wartime measure in the lead smelter in April 1943 but this was terminated in May 1946, and lead smelting was resumed. The copper smelter on the present site was commissioned in 1953.

The smelters primarily treat concentrate from the lead-zinc-silver and copper ore bodies, mined by Mount Isa Mines Limited at Mount Isa. Both smelters, particularly the copper smelter, also treat concentrates from other mines in north-west Queensland. The lead smelter currently has approval to produce 210,000 tonnes of crude lead bullion a year, and the copper smelter has approval for 300,000 tonnes of anode copper.

The bullion from the lead smelter is transported by rail and ship to a lead refinery operated by the MIM Holdings group in England, while the anodes from the copper smelter are railed to the MIM Copper Refinery at Townsville.

# 2.1.2 Metal production

Crude lead production averaged about 40,000 tonnes a year from 1932 to the late 1950's when production was increased to 60,000 tonnes a year due to higher lead concentrate grades, improved operating procedures and better blast furnace design.

When a large, updraft sintering machine was installed in 1967, lead production increased to more than 120,000 tonnes per year. It increased even further, when the lead ISASMELT plant came on stream in 1991, to

peak at 206,460 tonnes in 1993. However, the lead ISASMELT plant was shut down in 1996, and production capacity is currently about 160,000 tonnes a year of crude lead from the conventional sintering machine/blast furnace section of the plant. However, due to shutdowns for maintenance, (planned and unplanned), and the need to manage ambient air quality in community areas of Mount Isa (see Section 2.3), actual lead production rates are expected to be somewhat lower.

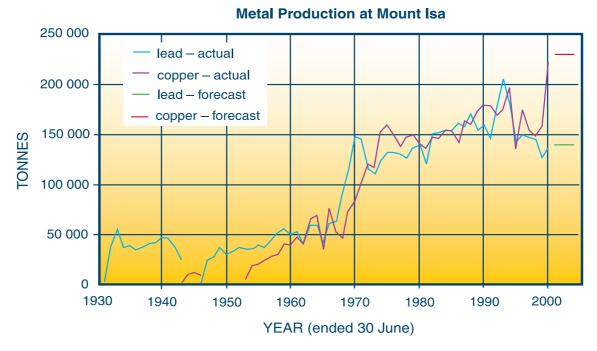
Blister copper production began at a rate of some 20,000 tonnes a year in 1953, and steadily increased as the plant was expanded and technology improved to peak at 160,250 tonnes of blister copper a year in 1975. Anode production was introduced in 1979, and production was maintained in the range of 140,000 to 200,000 tonnes of anodes a year until 1998. A large copper ISASMELT plant was installed in 1992, to run in parallel with the old roaster/reverberatory furnace system. This oldsystem section was shut down permanently in August 1997. In the following year, the ISASMELT converter and anode production facilities were expanded to give a production capacity of 265,000 tonnes of anode copper a year. As in the case of the lead smelter, actual production rates of copper are expected to be somewhat lower due to shutdowns for maintenance and the need to manage ambient air quality in Mount Isa (see Section 2.3).

Figure 2-1 provides a history of the annual metal production from the smelters at Mount Isa, and planned production rates for the next four years. (These rates were current at the time this final report was prepared, but are subject to on-going review.)

## 2.1.3 Lead smelting technology

Most of the world's primary lead smelters still use conventional sintering machine/blast furnace technology to produce crude lead. While this method appears inefficient compared to the newer high-intensity smelting

FIGURE 2-1



technologies, it is nevertheless reliable and economic; hence its continued use at many smelters.

Mount Isa initially used standard-type, small 42-inch (107-cm) wide, downdraft sintering machines and eight of these machines were eventually installed. While most sinter plants used a complicated two-pass system, MIM pioneered the use of a single-pass system, with a large recirculating load of crushed return sinter to dilute the sulfur content of the feed. This proved to be very effective.

By the 1950's, a number of MIM's competitors were changing to large, updraft sintering machines. As a result, one of the small machines was converted to trial updraft operation in 1962. Subsequently, in 1967, a single 1000 square foot (92.9m²) updraft sintering machine was built and commissioned to completely replace the eight small sintering machines.

Collaboration with the Commonwealth Scientific and Industrial Research Organisation (CSIRO) on submerged-lance smelting technology over many years resulted in the installation of a lead ISASMELT demonstration reactor in 1982 to smelt lead concentrates and produce lead oxide slag. The unit was also used for trial dross smelting. As a result, in

1991, a lead ISASMELT plant, with a capacity of 60,000 tonnes a year, was built with both oxidation and reduction reactors. This plant was shut down in 1996 because of a fall in demand for lead, and the adverse economics of operating the plant at low production rates.

For many years, the main source for lead ore for the smelter has been the Mount Isa mine. However, the Mount Isa ore body is now nearly exhausted, and is set to be replaced by the company's George Fisher mine, near Mount Isa. It will become the major zinc-lead-silver ore source for the Mount Isa smelting operations.

The George Fisher mine is expected to produce about 100,000 tonnes of lead concentrate a year for the smelter, which will also source concentrate from the Cannington Mine.

Even with these alternative sources, the lead smelter will continue operating using its sintering machine/blast furnace section. The lead ISASMELT plant is not expected to be activated in the foreseeable future.

### 2.1.4 Copper smelting technology

Copper was briefly smelted at Mount Isa during the war years (1943 – 1946), using the existing sintering and blast furnace equipment at the lead smelter to produce copper matte.

Equipment salvaged from small, defunct copper smelters in north Queensland was installed at Mount Isa to convert the copper matte to blister copper — at a nominal capacity of 12,000 tonnes a year.

In 1953, copper smelting commenced on the present site, using conventional smelting technology of multiple-hearth roasters, producing hot calcine feed to a small, coal-fired reverberatory furnace. The copper matte was converted to blister copper in small Pierce Smith converters, and the blister copper caste from a holding furnace into a small casting wheel producing small blister slabs. It was not long before this system was changed to begin casting large blister ingots, using cranes in the converter aisle.

Increasing the number of multi-hearth roasters from two to six units, widening the reverberatory furnace and installing a second large reverberatory furnace gradually expanded the capacity of the smelter. The converter section capacity was similarly increased, with bigger cranes and a wider aisle, standard 13-foot x 30-foot (4.0m x 9.1m) converters and new cranes. The converter shells were later extended from 30 foot (9.1m) to 35 foot (10.7m). Converter slag was treated by slow cooling, grinding and flotation, rather than by the previous return of molten converter slag to the reverberatory furnaces.

In 1970, when the forecast target for copper production was 150,000 tonnes a year, MIM began to investigate the introduction of a more suitable smelting technology. Flash-furnace smelting technology was seriously considered but, at that time, high oxygen enrichment was not common practice, and an annual target of 150,000 tonnes was considered just beyond the capacity of a single, flash-smelting unit. Consequently, the existing six multi-hearth roasters were replaced by a large, fluid-bed roaster. At the same time, improvements were made in plant hygiene, including the installation of secondary fume hoods on the converters.

A copper anode furnace and casting facility was installed in 1979.

Further development of ISASMELT technology resulted in the installation of a small copper ISASMELT unit, located to discharge molten matte and slag into the No. 2 reverberatory furnace. This unit demonstrated the potential of high-intensity, submerged lance smelting technology, particularly with high oxygen enrichment of the blast air. As a result, a larger copper ISASMELT unit was installed in 1992, with a nominal capacity of 180,000 tonnes of copper a year, to run in parallel with the old roaster/reverberatory furnace smelting plant.

Operating these two different smelting systems in the one plant proved more difficult than expected. As a result, the performance of both smelting sections of the plant and the converter section suffered. The roaster/reverberatory furnace smelting system was shut down permanently in 1997.

In 1998, the copper smelter was expanded to a nominal capacity of 265,000 tonnes of copper anodes a year, using a simplified flow sheet and a single copper ISASMELT primary smelting unit. This expansion meant that, as well as processing concentrate from Mount Isa, the smelter could also treat concentrate from the Ernest Henry Mine — a joint venture between MIM and Pasminco near Cloncurry, some 150 kilometres east of Mount Isa. The Ernest Henry mine now supplies about 100,000 tonnes of contained copper a year to the Mount Isa smelter.

# 2.2 Sulfur dioxide sources

# 2.2.1 Stacks

When lead smelting began at Mount Isa in 1931, the gases from both sintering machine and the blast furnace were treated in an electrostatic precipitator for dust collection, and then discharged into the atmosphere via a stack about 40 metres high, located on the hill near the old Urquhart shaft and head frame.

In 1940, a baghouse and 96-metre steel stack were installed at the smelter to handle the blast furnace gases. During the 1950's, the old electrostatic precipitator and 40-metre stack were shut down and all gases from the smelter were treated through the baghouse and the 96-metre stack.

The current 270-metre stack at the lead smelter was built in 1979. This stack has a reinforced-concrete shell, supporting internal gas ducts that can be accessed from inside the shell.

The initial stack at the copper smelter was 98 metres high, with a reinforced concrete shell lined with acid resistant brick. It was used to handle all smelter gases from the start up of the plant in 1953. A larger stack of the same type, but 153 metres high, was built in 1960, and soon replaced the older stack by handling all smelter gases. This 98-metre stack is still in place although it has not been used for almost 50 years. The construction of the WMCF acid plant in 1999 included the installation of a new stack, 110 metres high, to handle the tail gases from the plant.

Currently, the 153-metre stack at the copper smelter is used to exhaust the low-concentration sulfur dioxide gases from the anode furnaces, converter secondary hoods, some fume ventilation hoods, and any process gas not able to be taken by the acid plant. Vent gases from the rotary holding furnace and the

ISASMELT lance port and tapping floor presently discharge through another ventilation stack, 70 metres high, also located near the smelter.

### 2.2.2 Sulfur dioxide emission

Mass emissions of sulfur dioxide from smelter operations at Mount Isa have steadily increased in line with the increase in metal production. Over the last 10 years, emissions have averaged 160,000 tonnes a year from the lead smelter, and 420,000 tonnes a year from the copper smelter. These are based on gas emission concentrations averaging 4 to 6.5 percent sulfur dioxide from the lead-sintering machine, and 10 to 30 percent from the copper ISASMELT process.

Figure 2-2 shows a history of annual sulfur dioxide emissions from the smelters at Mount Isa over the years. The box, over page, provides details on projected emissions over the next four years.

FIGURE 2-2

#### Sulfur Dioxide emissions at Mount Isa



### Estimated sulfur dioxide emissions from the smelters over the next four years

	Lead smelter	Copper smelter	Removal by	Net total
	emissions	emissions	acid plant	smelter emissions
Year	('ooo tonnes)	('ooo tonnes)	('ooo tonnes)	('ooo tonnes)
2000 – 2001	137	535	176	496
2001 – 2004	137	535 – 580	428 – 464	244 – 253

#### Notes:

- (1) Estimates are based on information available at the time of preparation of this report, and are subject to on-going review.
- (2) Estimated removal by the acid plant for 2000-2001 is based on WMCF estimates of acid production for the year, then assuming continuous minimum sulfur-burning of six tonnes an hour, and the balance of acid production from copper smelter process gases.

# 2.3 Air quality control

Before the acid plant was commissioned, sulfur dioxide from both smelters at Mount Isa was released directly to the atmosphere through tall stacks, without any desulfurisation. However, the tall stacks did limit the concentrations of sulfur dioxide in community areas of Mount Isa and within the environment generally.

In a 1998 report entitled "Behaviour of the Mount Isa smelter plumes", D. Williams noted that, for most of the year, the wind blows the plumes of gases away from Mount Isa community areas. However, during the passage of synoptic weather fronts, the plume swings counter-clockwise across the town, and shutdown action is taken at the smelters to severely curtail emissions so as to avoid excessive ambient levels of sulfur dioxide in the town.

Since 1974, the smelting operations at Mount Isa have been subject to an air quality control (AQC) system that initiates shutdowns of smelter operations when excessive levels of sulfur dioxide are predicted or detected in community areas of Mount Isa.

The goal of the air quality control system is compliance with the ambient air quality standards defined in the *Mount Isa Mines Limited Agreement*. (See Section 1.1.5 for details.)

For predictive controls, AQC personnel use data collected locally from meteorological stations operated by MIM and by the Bureau of Meteorology. Data collection systems include weather balloons, telemetered surface wind and temperature monitors, a radar wind profiler (the first installed in Australia), weather charts and satellite images. The data is used to forecast adverse weather conditions that will necessitate shutdowns of the smelters during the course of any 24-hour period.

For reactive controls, 10 continuous sulfur dioxide monitors, located in Mount Isa community areas, are linked to computers at the AQC system control room to provide realtime data on sulfur dioxide levels. Computers analyse the data for both current sulfur dioxide levels and trends. The smelters are immediately shut down if it seems likely that the ambient air quality standards in the *Mount Isa Mines Limited Agreement* will be exceeded.

The AQC system shuts down the copper smelter more often than the lead smelter because the lead smelter has a higher stack and lower total sulfur dioxide emissions. Emissions from the lead smelter are also less intense than from the copper smelter. Average downtime due to AQC procedures has been about 10 percent at the copper smelter, and 3 percent at the lead smelter.

# 2.4Sulfur dioxide levels in Mount Isa community areas

As noted earlier, the goal of the air quality control system is to maintain the ambient air quality standards for sulfur dioxide in community areas of Mount Isa, as set down in the *Mount Isa Mines Limited Agreement*, and ratified in the *Mount Isa Mines Limited Agreement Act 1985*. These standards are:

- maximum annual average concentration of 80 micrograms per cubic metre [0.028 ppm];
- maximum 24-hour average concentration of 365 micrograms per cubic metre [0.128 ppm]; and
- maximum three-hour average concentration of 1300 micrograms per cubic metre [0.455 ppm].

Since the introduction of the air quality control system in 1974, there has been a marked improvement in the air quality at Mount Isa. Over the past 30 years, the annual average sulfur dioxide concentration in community areas has decreased from about 100 micrograms per cubic metre to 12 micrograms per cubic metre [0.035 to 0.0042 ppm] – significantly ahead of the required standard.

Figures 2-3 to 2-6 show the history of sulfur dioxide levels in community areas of Mount Isa over the last 10 years based on data collected at the 10 monitoring sites operated by MIM under the air quality control system. The figures show measured air quality compared against the standards contained in the *Mount Isa Mines Limited Agreement*, and the national ambient air quality standards contained in the *National Environment Protection (Ambient Air Quality) Measure 1998.* The sulfur dioxide monitoring data can be summarised as follows:

 Annual average — measured levels have been consistently below the national standard of 0.02 ppm, and have clearly improved over the last ten years.

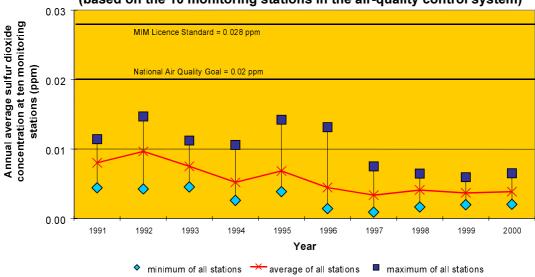
- 24-hour average at some stations there are a few days in each year during which the measured 24-hour average concentrations exceed the national standard of 0.08 ppm. The number of times this occurs in a year varies considerably from station to station, reflecting the typically localised nature of higher concentration events at Mount Isa. During the last 10 years, individual stations have exceeded the national standard for between zero and six days per year.
- Three-hour average at some stations there are a few three-hour periods in each year during which the measured three-hour average concentrations exceed the standard of 1300 micrograms per cubic metre [0.455 ppm] in the *Mount Isa Mines Limited Agreement*. The number of times this occurs in a year varies considerably from station to station, reflecting the typically localised nature of higher concentration events at Mount Isa. During the last 10 years, individual stations have exceeded the MIM standard for between zero and four three-hour periods per year.
- One-hour average at each station there are a number of hours in each year during which the measured one-hour average concentrations exceed the national standard of 0.2 ppm. The number of times this occurs in a year varies considerably from station to station, reflecting the typically localised nature of higher concentration events at Mount Isa. During the last 10 years, individual stations have exceeded the national standard for between five and 108 hours per year.

The Environmental Protection Agency also monitors sulfur dioxide levels in Mount Isa, and reports the results in monthly bulletins and annual summary and trend reports, available on the EPA's web-site at: www.env.qld.gov.au/environment/science/air/

FIGURE 2-3

# Annual average sulfur dioxide concentration in Mount Isa 10 year history

(based on the 10 monitoring stations in the air-quality control system)



### FIGURE 2-4

# 24-hour average sulfur dioxide concentration in Mount Isa 10 year history

(based on the 10 monitoring stations in the air-quality control system)

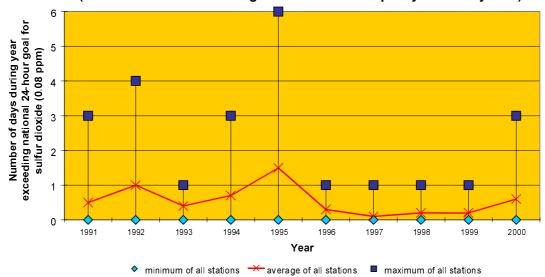
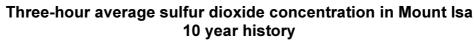
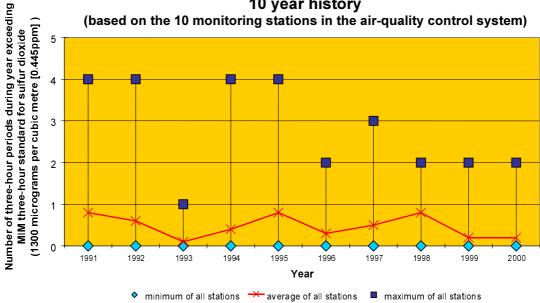


FIGURE 2-5



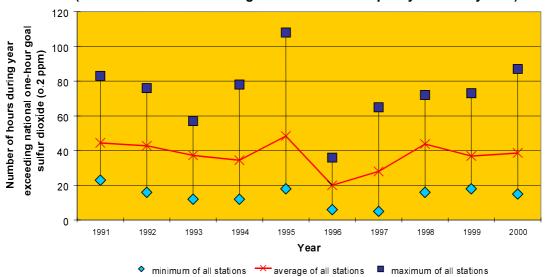
(based on the 10 monitoring stations in the air-quality control system)



#### FIGURE 2-6

# One-hour average sulfur dioxide concentration in Mount Isa 10 year history

(based on the 10 monitoring stations in the air-quality control system)



# 3. Fate of sulfur dioxide emissions

This chapter addresses Terms of Reference items 1(a), 1(b) (partly) and 3(d):

- Refer the following matters for assessment and report to the Panel of persons established by me (the Minister) to make assessments of the likely impacts of expected releases of sulfur dioxide to the atmosphere by Mount Isa Mines Limited at Mount Isa following the installation of the announced acid plant:
  - (a) the likely atmospheric dispersion and ultimate fate of the sulfur dioxide emissions; and
  - (b) the likely economic, environmental and social impacts of the sulfur dioxide emissions.
- 3. Specify that the Panel's report shall include:
  - (d) the fate of sulfur dioxide emissions from the smelters, rates of acid deposition, identification of acid input tolerances of soils impacted by acid deposition and impacts on terrestrial flora and fauna;

At the time this report was prepared, the acid plant had not operated at design capacity for significant periods since its commissioning. This was because demand for sulfuric acid had been curtailed by unexpected interruptions to the operation of the Phosphate Hill fertilizer works.

Consequently, the panel has not been able to directly measure changes in environmental impacts resulting from the installation of the acid plant. The details presented below generally relate to the impact of sulfur dioxide emissions from the smelters when the plant was not operating fully. However, where practical, modelling has been used to predict the likely environmental benefit from the operation of the acid plant. Obviously, sulfur dioxide emissions will be reduced when the acid plant is operating at design capacity.

# 3.1 Atmospheric dispersion and ultimate fate of emissions

In 1997, MIM commissioned a multi-faceted research project to:

- determine the fate of MIM sulfur emissions in terms of dispersion, deposition (wet and dry) and advection both locally at Mount Isa and across the Australian continent: and
- evaluate the likely impact of MIM emissions on the acidity of soils around Mount Isa, based on measured soil and surface water properties.

The research team involved participants from several CSIRO divisions — Atmospheric Research, Land and Water, and Energy Technology- and from the Northern Territory University. Local technical support was provided by MIM. The team was involved in a field program near Mount Isa from September 1997 to September 1998.

The results of the project were reported by Ayers et al in "MIM — Emissions and the environment — Final report to Mount Isa Mines Limited", 1999.

The report drew the following conclusions regarding the fate of sulfur emissions from MIM's smelters:

"Measurements of sulfur emissions from Mount Isa over the 12-month period, coupled with continental-scale numerical modelling, suggest that slightly more than half the sulfur emissions are deposited in Australia, with slightly less than half advected offshore. However, the very large dilution of emissions by dispersion during transport to the continental boundary ensures that the contribution made to atmospheric levels of sulfur species at the continental rim is modelled to be significantly less than the contribution made by the 'natural' background sources of these species. Thus, no implications exist for environmental acidification

"Over the Australian continent, modelled deposition of sulfur emissions to the

surface was dominated by dry deposition of sulfur dioxide, followed in importance by dry deposition of aerosol sulfate, with wet deposition of sulfate the smallest component of deposition. The low 'acid rain' component of total sulfur deposition is a consequence, in part, of the relatively infrequent occurrence of rainfall in the Mount Isa region. This implies, overall, a relatively inefficient removal pathway by rainfall, contributing to long atmospheric residence times for sulfur species, in turn facilitating advection over long distances.

"Inefficient\* dry deposition of sulfur dioxide to the continental surface also contributes to an increased atmospheric residence time, and thus increased time for advection. Dry deposition rates were found to be only about half those determined at temperate latitudes elsewhere in Australia. The low value applicable to the Mount Isa environs is a consequence of the aridity of the soil surface, and water stress suffered by local vegetation for the majority of the year.

"The composition of the MIM plume was modelled to change from predominantly gaseous sulfur dioxide with a minor aerosol sulfate component at the source, to a majority of aerosol sulfate and minority of gaseous sulfur dioxide by the time of advection to the continental margin. This change of plume composition with time was first documented qualitatively two decades ago, and reflects the atmospheric oxidation processes that convert SO<sub>2</sub> to aerosol SO<sub>4</sub><sup>2-</sup>. An annual average oxidation rate of 0.75 ± 0.25 percent per hour was deduced in this study."

Based on these findings, the panel concludes that:

- Approximately half of the sulfur emissions from the Mount Isa smelters is deposited on continental Australia by processes of dry deposition of sulfur dioxide and aerosol sulfate, and wet deposition of sulfate. The other half is advected offshore.
- The sulfur emissions from the Mount Isa smelters that are advected offshore do not contribute to environmental acidification because they are so highly diluted by atmospheric dispersion processes that have taken place since emission.

# 3.2 Rates of acid deposition

After being emitted from the smelters, sulfur dioxide is oxidised to form sulfate, which then reacts with moisture to form sulfuric acid. These processes take place both in the atmosphere, and on soil and plant surfaces. The overall process is referred to as acid deposition. Rates of acid deposition from the emissions from the Mount Isa smelters were reported by Ayers et al, in "MIM — Emissions and the environment — Final report to Mount Isa Mines Limited", 1999.

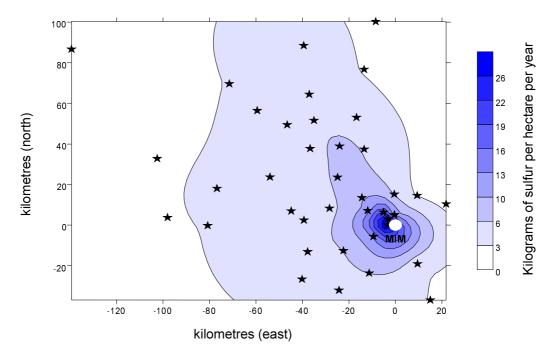
The estimated distribution of total acid deposition around Mount Isa for 1997-98, based on atmospheric measurements, is shown on the map in Figure 3-1.

Modelling techniques were used to estimate how the deposition would occur if the acid plant was in full operation. These results are presented in Figure 3-2.

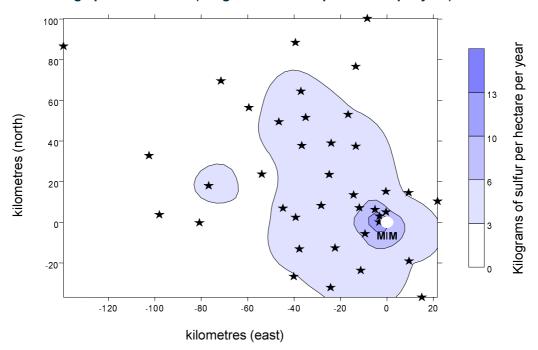
<sup>\*</sup> Note: The term "inefficient" when used in this context is not intended to imply that there is anything wrong that could somehow be corrected. It means that the process involved (in this case, dry deposition of sulfur dioxide to the continental surface) naturally occurs at a relatively slow rate when compared to the rate in other parts of the world.

FIGURE 3-1

# Map of estimated total acid deposition around Mount Isa resulting from the emissions from the smelters in 1997 – 98 (in kilograms of sulfur per hectare per year)



Projected total acid deposition around Mount Isa resulting from the emissions from the smelters when the acid plant is operating at design production rate (kilograms of sulfur per hectare per year).



(Note: monitoring sites are indicated by ★)

# 3.3 Tolerances of soils to acid input

The tolerances of local soils to acid input and the impact of sulfur dioxide emissions on soil structure was reported by Ayers et al, in "MIM-Emissions and the environment — Final report to Mount Isa Mines Limited", 1999.

The report drew the following conclusions:

"Soil and surface water measurements made at multiple sites around Mount Isa indicated that the deposited sulfur species acted primarily as an input of mineral acidity to the surface soils, titrating out acid neutralising capacity and acidifying the surface layers in regions of high deposition and low acid-neutralising capacity, as evident in the spatial pattern of pH in such soils. Elevation of sulfate levels was documented in the soils most exposed to sulfur deposition. However, the sulfate anion was also found to be mobile and subject to redistribution across the region via leaching and runoff, appearing in surface waters as a counter-ion for readily leached base cations, such as magnesium.

"Synthesis of the surface-soil geochemical data with biodiversity response data generated independently near Mount Isa by the study by Griffiths (1998) enabled empirical development of a surface soil "indicator" pH value adopted to represent the point at which effects on biodiversity become undetectable.

"Application of this 'indicator' variable to the measured soil pH data suggested that, as in the case of the biological effects noted by Griffiths (1998), soil geochemical changes of potential biological significance were probably restricted to downwind distances of about 15 – 20 kilometres for the 0-2 centimetre surface soil layer; to the lesser distance of only about 5 kilometres for the 0-10 centimetre surface soil layer; and were not detectable at all in the 10 – 20 centimetre soil layer.

"Development and validation of atmospheric transport models in this work enabled changes in atmospheric sulfur dioxide levels and total acid deposition fluxes to be predicted around Mount Isa for the emissions scenario anticipated to apply after commissioning of the acid plant.

"In the case of soil geochemical response to acid deposition within the 15 kilometre distance identified by Griffiths (1998) as the limit of detectable effects upon biodiversity, it was concluded that the predicted reduction in levels of acid deposition will have little effect on surface soil pH in soil types having limited acid-neutralising capacity. The reason for this is that cumulative effect of past acid deposition over decades has used up the available acid-neutralising capacity in sensitive soils. A reduction in acidic deposition does not restore that capacity which, even at zero ongoing deposition, would only recover over the long timescales associated with the weathering rates of the parent soil materials. We conclude therefore that the predicted reduction in emissions will have little immediate effect on surface soil pH within 15 kilometres of the smelters."

# Based on these findings, the panel concludes that:

- The significance of sulfur deposition arising from Mount Isa emissions will vary depending on the properties of the soil.
- Sulfur deposition arising from Mount Isa emissions has caused acidification of soils, especially to the immediate northwest of Mount Isa. The acidification has reached a level likely to have biological implications in areas up to 20 kilometres downwind from the smelters for soil depths to two centimetres, in areas up to five kilometres downwind for soil depths to 10 centimetres, and not at all for greater soil depths.
- The operation of the acid plant is unlikely to bring about an improvement in affected soils, except in the long term, because the soils' capacity to neutralise acids has been exhausted by the historical acid deposition.

# 3.4 Impacts on flora and fauna

Mount Isa is situated in the semi-arid region of Australia. Mean annual rainfall is 400 millimetres, most of which falls between December and March, and the mean maximum temperature is 31.5 °C. Geologically, the area around Mount Isa is characterised by erosional Tertiary surfaces with rock outcrops, skeletal soils and an intense drainage system. Sandstone, shale and quartzite dominate.

MIM commissioned a research project in 1997 to:

- assess the impacts of long-term sulfur dioxide emissions from the Mount Isa copper and lead smelters on the floral and faunal diversity of the district; and
- establish benchmark sites to allow changes in biodiversity to be assessed, following a reduction in sulfur dioxide emissions.

The project was carried out by the Cooperative Research Centre for Sustainable Development of Tropical Savannas and the CSIRO Division of Wildlife and Ecology. The results were reported by A.D. Griffiths in "Impact of sulfur dioxide emissions on savanna biodiversity at Mt Isa, Queensland — Final report to Mt Isa Mines Ltd", 1998.

The report drew the following conclusions:

"The absence of any pre-emission biological data required a comparative assessment of similar environments in the vicinity of the metal smelters (at Mount Isa). Fifty-eight sites were selected 5 – 35 kilometres downwind (west and north) from the point source (the MIM smelters), along with 14 reference sites not in the path of the plume (east). A stratified survey design was implemented using two primary levels. The first level was related to four sulfur deposition zones based on soil sulfate levels: high (3-6 kilometres north and west of point source), medium (7 - 15 kilometres)north and west), low (30 - 35 kilometres north) and background (20 - 25 kilometres east). The second level related to two distinct habitats supporting largely different plants and animals: sandstone ridges and

alluvial plains. Every site (one hectare) was sampled for plants and vertebrates, while a subset of sites was sampled for ants. Standardised survey methods were used throughout.

"A rich flora and fauna is present in the Mount Isa district. Five hundred and seventy species were recorded from this survey, including two species previously unrecorded in Queensland. Plants were the most diverse group recorded in the survey (260 species), followed by ants (174 species), birds (94 species) and reptiles (42 species). Mammals (17 species) and frogs (3 species) occurred at very low levels of richness and abundance, making assessments of sulfur dioxide impacts difficult to obtain due to time constraints. They were subsequently excluded from the analysis.

"Plant species richness increased to a distance of 15 kilometres downwind of the smelters. The total number of species present in the high sulfur deposition zone was half that of the low and background zones. The composition of the vegetation close to the smelters was dominated by widespread, exotic and parasitic species. Foliar injury symptoms consistent with toxicity from sulfur dioxide emissions were recorded in up to 35 percent of species present in the high sulfur deposition zone, with no particular family or group exhibiting greater sensitivity. Foliar injury consistent with toxicity from sulfur dioxide emissions was not recorded past 5 kilometres from the emission point source.

"Ants remained abundant and reasonably diverse in all four sulfur deposition zones. However, total species richness was 50 percent lower in the high sulfur zone compared to the low and background zones, resulting in a distinctly different composition in the high sulfur zone. The functional group composition of the ant community remained reasonably similar throughout all zones, although several individual ant species showed clear patterns in relation to sulfur dioxide.

Species that favour conditions that are more arid were common closer to the emission point source.

"Reptile species diversity was reduced in the ridge habitat directly downwind of the smelters. Species that forage on insects during the day declined the most. Reptile species inhabiting the alluvial plain recorded no obvious response to sulfur dioxide emissions. Bird species richness increased with increasing distance downwind of the smelters, but the abundance of birds was not related to smelter emissions. This was due to a small number of bird species (e.g. yellow-throated miner and cockatiel) being very abundant in the high sulfur zone. Insectivorous bird species tended to be the most sensitive to sulfur dioxide deposition.

"Two major findings can be drawn from this study. First, the natural environment within 15 kilometres downwind of the metal smelters at Mount Isa has undergone considerable change, either as a direct or indirect result of sulfur dioxide emissions. Second, the extent of this change varies among the different groups of flora and fauna, and is possibly related to an organism's ability to disperse away from the area of high sulfur dioxide deposition."

The likely effect of the operation of the acid plant was estimated by Ayers et al, and reported in "MIM — Emissions and the environment — Final report to Mount Isa Mines Limited", 1999. The report drew the following conclusions:

"Development and validation of atmospheric transport models in this work enabled changes in atmospheric sulfur dioxide levels and total acid deposition fluxes to be predicted around Mount Isa for the emissions scenario anticipated to apply after commissioning of the acid plant. A near-proportional response to reduction in sulfur emissions was predicted for atmospheric sulfur dioxide levels close to Mount Isa. The implication is that within the 15-kilometre distance identified by Griffiths

(1998) as the limit of detectable effects upon biodiversity, any of the effects caused by direct exposure to atmospheric sulfur dioxide (e.g. foliar injury in plants) will reduce in extent in proportion to the reduction in emissions. Clearly this is a positive environmental gain."

Based on these findings, the panel concludes that:

- ecosystems within 15 kilometres downwind from the smelters have undergone measurable change, either as a direct or indirect result of sulfur dioxide emissions;
- beyond 15 kilometres downwind from the smelters, no impact on flora and fauna was observable;
- foliar injury symptoms consistent with toxicity from sulfur dioxide were not observed in areas more than five kilometres downwind from the smelters;
- the richness of plant species is not influenced in areas more than 15 kilometres downwind from the smelters;
- the richness of ant species has been halved in some areas within five kilometres downwind from the smelters;
- the diversity of reptile species has been reduced on the ridges directly downwind from the smelters, particularly species that forage on insects;
- the richness of bird species has been reduced close to the smelters, with insectivorous species being the most sensitive; and
- reductions in emissions of sulfur dioxide brought about by the planned operation of the acid plant should result in proportionate reductions in the extent of direct plant foliar injury in areas downwind from the smelters.

# 4. Community public health impacts

This chapter addresses Terms of Reference items 1(b) (partly) and 3(c):

- 1. Refer the following matters for assessment and report to the Panel of persons established by me (the Minister) to make assessments of the likely impacts of expected releases of sulfur dioxide to the atmosphere by Mount Isa Mines Limited at Mount Isa following the installation of the announced acid plant:
  - (b) the likely economic, environmental and social impacts of the sulfur dioxide emissions.
- 3. Specify that the Panel's report shall include:
  - (c) the results of available studies, research and monitoring relevant to community public health impacts;

At the time this report was prepared, the acid plant had not operated at design capacity for significant periods since its commissioning because demand for sulfuric acid had been curtailed by unexpected interruptions to the operation of the Phosphate Hill fertilizer works.

Consequently, the panel has not been able to directly measure changes in community sulfur dioxide exposure resulting from the operation of the acid plant. The details presented below relate to the community public health impacts of the sulfur dioxide emissions from the smelters in the absence of operation of the acid plant.

# 4.1. Findings reported in scientific literature

The scientific literature reports that sulfur dioxide emissions can cause asthma and other respiratory disease in humans.

#### 4.1.1 Asthma

Short-term exposure to elevated levels of sulfur dioxide has been shown experimentally to induce asthma symptoms in asthmatics. Such symptoms include wheezing, shortness of breath and bronchoconstriction.

Ferrari and Salisbury, in "Sulfur dioxide" 1998, summarised the health effects of sulfur dioxide as follows:

"The scientific data indicate that for asthma sufferers in Australia, short-term reductions in lung function may occur when sulfur dioxide goals are exceeded (i.e. a 10-minute average of greater than 0.25 ppm or a one-hour average of greater than 0.2 ppm). The reductions may be transient and small on

average but an unknown number of people with greater sensitivity to sulfur dioxide may experience clinically significant reductions in lung function, and some who already have impaired lung function may be severely affected. It is possible that reducing sulfur dioxide exposures in Australia could reduce the number and severity of asthma attacks.

"Acute lung function effects become evident in experimental exposure studies with exercising asthmatics after about 10 minutes of exposure. This is why the 10-minute goal is necessary, especially around point sources, to indicate exposure of the sensitive population.

"The long-term effects of sulfur dioxide are not well understood, particularly the question of whether sulfur dioxide actually causes lung disease rather than simply provoking attacks of asthma. Recent epidemiological evidence appears to indicate that moderately elevated ambient sulfur dioxide levels (annual means of above 0.008 ppm) are linked to an increased incidence of respiratory illness and symptoms, and decreases in pulmonary function. However, annual average figures can conceal many high short-term peaks, which may be more closely correlated with the health effects than the long-term average."

Ambient sulfur dioxide levels in community areas of Mount Isa have been extensively monitored for many years. (See Section 2.4 for details.) It is not uncommon for short-term ambient levels in the town to fall in the range within which asthmatics have been affected in experimental studies.

# 4.1.2 Other respiratory diseases

Sulfur dioxide in the emission plumes can form sulfate particles, which are a component of particulate matter with an aerodynamic diameter of less than 10 micrometres (PM10). Elevated PM10 levels have been linked with increased incidence of respiratory disease and premature death in epidemiological studies of exposed populations in various industrialised parts of the world.

A useful summary of these epidemiological studies can be found in a U.S. Environmental Protection Agency report entitled "Human health benefits from sulfate reductions under Title IV of the 1990 Clean Air Act Amendments", 1995.

There is limited monitoring data available regarding ambient levels of sulfate particles in Mount Isa community areas. A report prepared by G. Ayers entitled "PM10 aerosol sulfate at Mt *Isa*", 1999 indicates that the smelter emissions result in an estimated increase above the background in annual average sulfate particles in community areas of Mount Isa of two to three micrograms per cubic metre. The same measure of particle concentrations for cities in the USA (taken from 1982 to 1989) ranged from 3.6 to 23.5 micrograms per cubic metre, with a mean of 11 micrograms per cubic metre. (See Pope et al, "Particulate air pollution as a predictor of mortality in a prospective study of U.S. adults", 1995.) For Australian cities, the range is estimated to be 0.4 to 1.5 micrograms per cubic metre. (See Chan et al, "Characterisation of chemical species in PM2.5 and PM10 aerosols in Brisbane, Australia", 1997, and Ayers et al, "Chemical and physical properties of Australian fine particles: a pilot study: final report to Environment Australia", 1999.)

Based on this information, the panel's studies of hospital statistics and community health surveys were concentrated on looking for evidence of increased incidence of asthma and other respiratory diseases in Mount Isa.

### 4.1.3 Other issues

The panel notes that, in a survey of community perceptions conducted in 1999, a substantial number of Mount Isa residents reported believing that smelter emissions caused health problems and/or irritations affecting the skin and eyes. (See Section 4.2 for details.) However, based on the literature, (e.g. S. McDowall, "Literature survey of the effects of sulfur dioxide on human skin", 2000), it appears unlikely that sulfur dioxide at the levels measured in the community areas of Mount Isa would cause eye or skin damage or irritation. Why Mount Isa residents were reporting these problems was not fully understood by the panel at the time of preparing this report.

# 4.2 Self-reported health impacts

R. MacLennan, M. Hensley, and D. Lloyd carried out a survey of self-reported health impacts and community attitudes in Mount Isa in 1999. Their results were documented in the report entitled "Community opinion and public health impacts in Mt Isa from sulfur dioxide emissions by Mount Isa Mines Ltd", 2000. The findings from the parts of the survey that dealt with self-reported health impacts are summarised and discussed below.

#### 4.2.1 Personal health

When the survey respondents were asked whether a doctor had diagnosed them as having asthma while living in Mount Isa, 16.9 percent of adult respondents answered "yes" (12.9 percent of males and 21.0 percent of females).

This is comparable with an outcome of a New South Wales Health survey in 1997. When the same question was asked in that survey , 16.2 percent of adult respondents answered "yes" (14.6 percent of males and 17.8 percent of females). (See NSW Health Department, "NSW health survey 1997 — Asthma ever diagnosed by doctor — 18+ years", 2000.)

The MacLennan, Hensley and Lloyd report made the following observations:

"These data support the conclusion that the prevalence of asthma in Mount Isa is not different to that found nationally. However, the relatively low proportion of males in our sample with a history of doctor-diagnosed asthma could be related to a high proportion of respondents working in mining, and that highly susceptible males have chosen to work elsewhere. Females with a much higher proportion of asthma might have less flexibility although, in the NSW survey, overall proportions were higher in females (17.8 percent versus 14.6 percent).

"Although it is commonly believed in Mount Isa that asthma is a common health problem, the prevalence of doctor-diagnosed asthma in respondents is no higher than in New South Wales. Only 11 adult respondents had ever had to seek emergency medical treatment for asthma (among 464 respondents who had lived an average of 20 years in Mount Isa)."

When 464 adult respondents to the Mount Isa survey were asked: "To what extent do you think that the fumes from the smelter have affected your health?"

- 32 (6.9 percent) said "greatly";
- 182 (39.2 percent) said "moderately";
- 239 (51.5 percent) said "not at all";
- 3 (o.6 percent) refused to answer; and
- 8 (1.7 percent) did not know.

Of the 214 (182+32) who said their health was affected:

- 125 (58.4 percent) reported nose and sinus problems (27 percent of all respondents);
- 79 (36.9 percent) reported non-asthma respiratory problems (17 percent overall);
- 74 (34.6 percent) reported asthma (16 percent overall);
- 56 (26.2 percent) reported eye problems (12 percent overall); and
- 45 (21.0 percent) reported skin problems (10 percent overall).

When asked: "To what extent do fumes from the smelter irritate your nose or throat?":

- 201 (43.3) percent said "greatly";
- 215 (46.3) percent said "moderately; and
- 48 (10.3) percent said "not at all".

When asked: "To what extent do fumes from the smelter irritate your skin?"

- 17 (3.7 percent) said "greatly";
- 48 (10.3 percent) said "moderately"; and
- 399 (86 percent) said "not at all".

Overall, 65 (48+17) persons reported skin irritation whereas earlier in the survey only 45 reported a skin health effect, presumably because not all irritations are considered an effect on health.

The MacLennan, Hensley and Lloyd report made the following observation:

"Interpretation of reported skin problems (Question 18.1, item 3; and Question 21) is difficult since, on first impression, skin problems should not be related to air pollution. However, it is possible that for some people the material in the fall-out from a smelter may irritate the skin given that 1 percent of the emissions come out as sulfur trioxide, which immediately turns to sulfuric acid. The acid plant is expected to remove 80 percent of this, and could therefore reduce this symptom. It is also possible that this result represents a tendency for people in surveys to overplay the role of an external factor such as air pollution, especially when prompted by questions, and that any conclusions as to adverse effects may have to be correspondingly discounted."

When asked how often during the year (1999) they had been troubled by smelter fumes, respondents reported a median of six times. One-third indicated they had had been troubled by the fumes at work, and about one-third said it had been while they were at home. When asked what they did about it, about half said they went inside, and a quarter said they did nothing.

In summary, the MacLennan, Hensley and Lloyd report made the following observations:

"With respect to their own health, half the participants thought that fumes from the smelter affected their health "greatly" or — more commonly — "moderately". The most common symptom reported was irritation of the nose and sinuses — in 27 per cent of participants."

# 4.2.2 Family health

When asked: "To what extent do you think that the fumes from the smelter have affected your family's health?"

- 56 (12.1 percent) said "greatly";
- 165 (35.6 percent) said "moderately";
- 183 (39.5 percent) said "not at all";
- 52 (11.2 percent) had no family;
- 4 (0.9 percent) refused to answer; and
- 3 (o.6 percent) did not know.

Among the 221 (165+56) families affected, the following health problems were identified:

- asthma problems in 66.5 percent (35.8 percent of the total number of respondents with families);
- nose and sinus problems in 43.4 percent
   (23.4 percent overall);
- non-asthma respiratory problem in 33.5 percent (18.0 percent overall);
- eye problems in 18.1 percent
   (9.7 percent overall); and
- skin problems in 17.2 percent
   (9.2 percent overall).

# 4.2.3 Children's respiratory symptoms

Regarding the health of children, the survey focused on the symptoms already investigated in a previous survey of children's health in industrial areas of central New South Wales — the Hunter and Illawarra study of airways and air pollutants (HISAAP), reported by Lewis et al in "Outdoor air pollution and children's respiratory symptoms in the steel cities of New South Wales", 1998.

The Mount Isa survey followed the HISAPP study by analysing three specific symptoms in children. However, the Mount Isa survey

covered children aged from one to 13 years, while the HISAPP study focussed only on children from 8 to 10 years:

The symptoms were:

- Dry cough at night for at least two weeks in the absence of a cold or a chest infection. This is a common problem in children with asthma. The HISAAP study found a significant relationship between coughing at night and particulate pollution.
- Chest colds: To parents, the concept of the "cold" that "goes to the chest" is reasonably accepted. In the HISAAP study, there were almost twice as many chest colds in children from the area with the most particulate pollution to that with the least. The presence of adults smoking indoors also increased the proportion of children with chest colds.
- Wheezing: In general, wheezing is considered to an accurate marker of asthma. In the HISAAP study, wheezing was not associated with air pollution except when children were living in homes with unflued gas heating.

Regarding **dry cough at night lasting more than two weeks,** the Mount Isa survey found that the reported occurrence was:

- 20.2 percent of the 0 4 year olds;
- 20.5 percent of the 5 7 year olds;
- 11.8 percent of the 8 10 year olds; and
- 10 percent of the 11 13 year olds.

In comparison, for the 8 - 10 year olds in the HISAAP study, the following was found:

- industrial Newcastle: 18.3 percent
- non-industrial Newcastle: 24 percent
- industrial Wollongong: 19.3 percent
- non-industrial Wollongong: 16.5 percent

The incidence of this dry coughing among the Mount Isa children in the 8-10 years age group (11.8 percent) was obviously less than that reported for all HISAAP children. The MacLennan, Hensley and Lloyd report noted that this symptom is definitely less common in Mount Isa children.

Regarding **chest colds**, the Mount Isa survey found that the reported occurrence of four or more episodes of chest cold in the previous year was:

- 21 percent of the 0 4 year olds;
- 12.3 percent of the 5 7 year olds;
- 10.5 percent of the 8 10 year olds; and
- 15 percent of the 11 13 year olds.

In comparison, for the 8-10 year olds in the HISAAP study, the results were:

- industrial Newcastle: 7.4 percent
- non-industrial Newcastle: 7.2 percent
- industrial Wollongong: 7.3 percent
- non-industrial Wollongong: 5.2 percent

The proportion for the Mount Isa children in the 8 – 10 years age group (10.5 percent) was greater than that reported for the HISAAP children. The MacLennan, Hensley and Lloyd report noted that it was impossible to say whether or not this difference was significant, given the potential differences between communities and the variation in symptoms over time.

Regarding **wheezing**, the Mount Isa survey found that the reported occurrence of four or more episodes of wheezing in the previous year had been:

- 7.2 percent in o 4 year olds;
- 11 percent of the 5 7 year olds;
- 11.8 percent of the 8 10 year olds; and
- 10 percent of the 11 13 year olds.

In comparison, for the 8-10 year olds in the HISAAP study, the results were:

- industrial Newcastle: 11 percent
- non-industrial Newcastle: 7.6 percent
- industrial Wollongong: 8.2 percent
- non-industrial Wollongong: 10.7 percent

Regarding this symptom, the MacLennan, Hensley and Lloyd report noted that the incidence among Mount Isa children in the 8 –10 years age group (11.8 percent) was similar to that reported in the HISAAP study.

In summary, the MacLennan, Hensley and Lloyd report made the following observations:

"With respect to respiratory symptoms in children, the Mount Isa data are very similar

to those from two industrial areas of New South Wales — Newcastle and Wollongong. It should be noted that the HISAAP study found no significant effect of sulfur dioxide levels on respiratory symptoms. In general, the sulfur dioxide levels in the one suburb in Newcastle industrial areas are substantially lower than those experienced in Mount Isa.

"With respect to specific symptoms, wheezing of children in Mount Isa was similar to those in industrial Newcastle. More parents reported chest colds in their children in Mount Isa than in Newcastle industrial areas, but reported less dry cough at night."

The MacLennan, Hensley and Lloyd report also analysed the data regarding children's respiratory symptoms to look for any association between the children's place of residence and local ambient sulfur dioxide levels. For this purpose, Mount Isa was divided into four quadrants: North-West, North-East, South-West and South-East. The following observations were made:

"A history of *any* dry cough at night was highest at younger ages and decreased with age, as did dry cough at night lasting *more than two weeks*. *Any* dry cough was highest in the North-West (includes Soldiers Hill) but this was not statistically significant, unadjusted or when adjusted for age. It can be seen that, given the small numbers of respondents, all four quarters do not appear to differ in the proportions of children with dry cough *lasting more than 2 weeks*.

"A history of *four or more chest colds* varied by age, but not with any statistical significance; but children in the North-West were significantly less likely to have four or more. This is unexplained. There was no relation to reported smoking in the home, or to use of gas for cooking or heating.

"The likelihood of *four or more attacks of wheezing* increased with age although this was not statistically significant. There were no statistically significant relationships between wheezing and the presence of carpets in bedrooms, smoking in the home

or use of gas cooking/heating. Four or more attacks of wheezing were less likely in the South-East compared with the North-West, but the number of cases was small and the difference was not statistically significantly. As far as is known, no analyses of sulfur dioxide have been done, comparing different quarters of the town."

The panel notes that an increased incidence and severity of asthma symptoms in asthmatics has been reported in the literature as a potential effect of elevated exposure to sulfur dioxide. (See U.S. Environmental Protection Agency, "Human health benefits from sulfate reductions under Title IV of the 1990 Clean Air Act Amendments", 1995). However, because people have limited ability to accurately recall the frequency of their symptoms, and to objectively judge how severe those symptoms were, no attempt was made to gather this type of information in the community survey. This is consistent with the practices used in other community health surveys. (See Lewis et al, "Outdoor air pollution and children's respiratory symptoms in the steel cities of New South Wales", 1998; and NSW Health Department, "NSW health survey 1997 — Asthma ever diagnosed by doctor — 18+ *years*", 2000.)

The panel considered the possibility of seeking further quantitative information regarding the effects of sulfur dioxide on asthmatics in Mount Isa. One possible methodology is to carry out comparative studies involving panels of asthmatics living in Mount Isa and in similar western Queensland towns that have no significant source of sulfur dioxide.

However, such studies would need to directly monitor personal exposure to sulfur dioxide for each individual in the study so that reported symptoms and medication usage could be compared with sulfur dioxide levels. This is because sulfur dioxide levels in Mount Isa vary significantly over time, and often from one part of the town to another.

Such a study would be technically difficult and expensive. Due to the high costs involved, it could only be justified if there were indications in previous work of elevated incidence of

asthma symptoms in Mount Isa associated with sulfur dioxide. This does not appear to be the case at present.

The panel makes the following conclusions based on survey results:

- The rate of doctor-diagnosed asthma in Mount Isa is not substantially different from that in Australian communities that are not influenced by sulfur dioxide emissions from smelters.
- A substantial number of people living in Mount Isa are of the view that smelter emissions cause health problems and/or irritation affecting the respiratory tract, skin and eyes.

# 4.3 Hospital statistics

# 4.3.1 Asthma admissions and ambient sulfur dioxide levels

A study into the possibility of a statistically significant relationship between short-term, ambient levels of sulfur dioxide in Mount Isa and hospital presentations and admissions for asthma symptoms was carried out by A. Donoghue and M. Thomas, reported in "Point source sulfur dioxide peaks and hospital presentations for asthma", 1999.

The report concluded that at Mount Isa:

- there was a clear relationship between incidence of asthma cases and the month of the year i.e. there were more emergencyroom presentations and more admissions to hospital in the winter months;
- there was no evidence of any positive relationship between peak ambient sulfur dioxide levels and either emergency room presentations or hospital admissions;
- a slight negative relationship between emergency room presentations and peak ambient sulfur dioxide levels is an artifact of shared seasonality that could not be completely explained by the statistical methodology used to adjust for seasonality; and

 brief exposures to high concentrations of sulfur dioxide emanating from point sources at Mount Isa do not cause symptoms in asthmatics sufficiently serious to require hospital presentation.

In this study, a significant uncertainty was the degree to which ambient monitoring data for sulfur dioxide could be considered a reasonable measure of the population's exposure to the emissions. People typically spend the majority of their time indoors. Also, in Mount Isa, more than 90 percent of houses have evaporative air conditioners, and these are effective in removing sulfur dioxide from air entering the house, reducing the concentration of gas indoors, compared to the ambient level in the outside air. The degree of difference is uncertain, but clearly, a substantial dampening effect would be expected.

This was examined in a study of five houses in Mount Isa by G. Ayers and R. Gillett, reported in "Final report: indoor/outdoor SO<sub>2</sub> levels in Mt Isa", 1999, and Ayers et al, "Indoor vs. outdoor SO<sub>2</sub> levels near an isolated industrial source in tropical Australia", 2000. The study measured the average weekly sulfur dioxide levels indoors and outdoors for a 15-week period, commencing in early January 1999. While the scale of this study was limited, the data obtained suggest strongly that:

- indoor exposure to sulfur dioxide in the homes studied was much less than outdoor exposures at the same time; and
- any short-term elevation of ambient sulfur dioxide levels outdoors, caused for example by changes in weather conditions, does not penetrate indoors enough to be discernible.

The panel concludes that:

- No evidence was found of a positive relationship between the rate of hospital presentations or admissions at Mount Isa for asthma/wheezing/shortness of breath and ambient levels of sulfur dioxide in community areas of the town.
- Available evidence suggests that intermittent peaks in ambient sulfur dioxide levels occur in community areas of Mount Isa, but the exposure of people who are indoors at the time is significantly limited.

# 4.3.2 Mount Isa hospital admissions compared to other western Queensland towns

In a study by R. MacLennan, hospital admission rates for Mount Isa were compared with several similar towns in western Queensland without a major sulfur dioxide source, including Cloncurry, Longreach, Charleville, Barcaldine and Winton. The study was based on data supplied by Queensland Health for the four years 1995 – 96 to 1998 – 99, and reported in "Community opinion and public health impacts in Mt Isa from sulfur dioxide emissions by Mount Isa Mines Ltd", 2000.

The study compared age-standardised hospital admission rates for a range of respiratory and cardiovascular diseases (including asthma) in the various towns, looking for indications of relative differences in community health in Mount Isa likely to be caused by smelter emissions.



The following results were obtained regarding the age-standardised rate per thousand (ASR) for the principal diagnosis on admission to hospital:

Principal diagnosis on	ASR for females		ASR for males	
admission to hospital	Mount Isa	Other towns	Mount Isa	Other towns
Total respiratory				
diseases	69.0	60.8	76.9	65.1
Asthma	19.4	19.2	15.9	12.8
Total chronic obstructive				
pulmonary diseases	8.3	3.7	8.0	13.5
Lung cancer	0.7	0.3	1.6	1.7
Pneumonia, acute bronchitis and influenza	30.1	23.8	35.1	23.2
Total cardiovascular diseases including heart disease, high blood				
pressure and stroke	45.5	28.8	40.9	38.3

The MacLennan study made the following comments regarding these findings:

"These analyses of hospital admissions are generally consistent with those from the interview survey where comparisons can be made. However, as with most epidemiological surveys, any interpretations must be made cautiously.

"Several factors other than the incidence of disease could influence admission to hospital. Males living in cities such as Mount Isa could be more likely to seek admission than those living in smaller towns and in surrounding more remote areas. Related to this may be the distance from a rural property to the nearest hospital, and more frequent home care.

"The incidence of respiratory disease, as reflected in hospital admission data, has many causes. These include infectious microbiological agents, hyper-reactivity of the airways, and various forms of air pollution of which tobacco smoking is likely to be relevant in the populations compared. Emergency admission rates for asthma are

similar in females in Mount Isa compared with comparison areas, and moderately higher in males in Mount Isa."

For the above study, data was not available to allow the confounding effects of occupational exposure, smoking, diet and other life-style factors to be assessed.

The panel notes that the higher rates of hospital admissions for respiratory infections in Mount Isa, discussed in this section, and the higher rates of chest colds reported in the survey of self-reported health impacts by parents of children in Mount Isa discussed in the section of Family Health, are unlikely to be related to sulfur dioxide exposure, but warrant further investigation.

Based on these findings, the panel concludes that in Mount Isa, there are higher rates of hospital admissions for some respiratory complaints (including asthma in males), compared with other western Queensland towns. However, there is insufficient information available to determine the cause of this difference.

## 4.4 Economic cost of health impacts

Making a meaningful assessment of the economic cost of the potential impact of sulfur dioxide emissions on Mount Isa's community public health proved a difficult task.

This is particularly so since the community survey and the comparison of hospital admission statistics failed to find evidence of any health effects in Mount Isa that could be attributed to emissions from the smelters.

As a result, the panel commissioned a theoretical study of the issues involved in estimating the economic cost of potential health impacts of sulfur dioxide emissions in Mount Isa, reported in: S. McDowall, "Assessing the economic value of health impacts of sulfur dioxide emissions in Mount *Isa*", 2000. This was reviewed by G. Mooney, Professor of Health Economics, Curtin University and University of Sydney, reported in: "Mt Isa Mines: Some comments from an economist's perspective on the assessment of the health effects", 2000; and the Health Economics Team, Queensland Health Department, reported in: "Economic assessment of the health impact of sulfur dioxide (SO<sub>2</sub>) emissions in Mt Isa", 2001.

The studies examined the three steps necessary to attribute an economic cost to the impact of pollution on community health:

- modelling the exposure of the population to the pollutants involved;
- establishing a dose-response relationship between exposure to the pollutant and the various expected health end-points, then, by combining this relationship with the exposure model, calculating the expected number of occurrences; and
- assigning a value to each of the health endpoints and multiplying by the expected number of occurrences.

The report by G. Mooney raised a number of issues regarding the potential variability of such economic assessments, including:

 limitations in the willingness to pay methodology for assigning costs to health and amenity impacts;

- objective versus subjective evaluations of costs; and
- misperceptions regarding health effects.

In the Queensland Health study, the health impacts were predicted using statistical relationships developed in overseas epidemiological studies. Costs were allocated on the basis of Queensland Health ratings of the cost of specific medical treatments. This study also drew on overseas studies of other direct and indirect costs of illness and premature death. This resulted in an indicative estimate of \$252,000 to \$723,000 for the annual cost of health impacts of sulfur dioxide and sulfate pollution in Mount Isa.

The Queensland Health study acknowledged that this methodology has a high degree of uncertainty because:

- many of the costing studies are based on U.S. data, or larger scale epidemiological studies, and possibly reflect the combined effects of several pollutants which are present at higher levels than have been or will be experienced in Mount Isa;
- the levels of pollutants in Mount Isa would likely be affecting population areas on a more intermittent and less chronic scale than at the equivalent U.S. locations;
- the population in Mount Isa has a younger age profile, with less older persons who are relatively at higher risk of early mortality, or increased morbidity; and
- the effects of intermittent high levels of emissions can be mitigated by going indoors.

#### The panel concludes that:

- there are considerable difficulties in determining if emissions from the smelters are causing any health impacts in the community in Mount Isa, and in assigning an economic cost to potential health impacts; and
- indicative estimates of the economic cost of potential health impacts of emissions from the smelters are low compared to the economic value of the operation of the smelters.

## 5. Economic impact of smelter operations

This chapter addresses Terms of Reference item 3(e):

- 3. Specify that the panel's report shall include:
  - (e) the economic impact of the smelter operations expressed in terms of estimates of welfare losses, welfare regional redistribution and current account effects should smelting operations be discontinued;

The panel commissioned a study of the economic value of smelting operations by Kinhill Pty Ltd, which was published in "Economic analysis of the operations of the smelters at Mount Isa", 1999.

Kinhill's evaluation was based on advice from MIM that closing the copper and lead smelters would make MIM's entire Mount Isa Business Unit unviable. The Business Unit consists of MIM's mining, concentrating and smelting operations at Mount Isa; its coke works at Bowen; and its copper refinery and marketing operation at Townsville.

The Kinhill report concluded that, in September 1999, the primary economic impacts of closing the copper and lead smelters, and the flow-on effects on the Mount Isa Business Unit, could be summarised as:

"Employment impacts: Losses of employment resulting from retrenchment of personnel directly employed by the Mount Isa Business Unit and the flow-on impacts total approximately 5,310 in the North West Region, 8,200 in Queensland and 8,257 in Australia. Retrenchments in the North West region would result in out-migration of approximately 11,000 residents from the region or about 50 percent of the local population (based mainly in Mount Isa). The main industries to be impacted in Queensland would be Mining and Mineral Processing (44.9 percent), Retail and Wholesale Trade (14.2 percent), and Finance, Property and Business (10.1 percent).

"Production impacts: Due to the present low mineral commodity prices (prevailing at the time the report was prepared), the impact of closure of the Mount Isa Business Unit would be less than under normal market conditions. Low prices have depressed gross operating surpluses of

mining and mineral processing entities within the Business Unit. Closure of the Business Unit is estimated to lead to a decline in the North West region Gross Regional Product of \$186.2 million per annum (p.a.). Queensland's Gross State Product would decline by about \$456.3 million p.a., and Australia's Gross Domestic Product by \$459.5 million p.a. Taking into account longer term data provided by the company, the impacts could be approximately 12 percent higher than these estimates. The main impacts in Queensland would be in Mining and Mineral Processing (80.3 percent), Chemicals, petroleum and coal products (6.5 percent), and Other Transport (4.3 percent).

"Income impacts: Losses of wages, salaries and supplements would be approximately \$344.3 million p.a. in the North West region, \$411.1 million p.a. in Queensland, and \$414.0 million in Australia. Over 80 percent of the impacts would be experienced in the North West region.

"Contribution to Local, State and Commonwealth governments through payments of taxes and charges: Losses of annual contributions from the Mount Isa Business Unit would be approximately \$59.3 million, comprising \$11.3 million in payroll taxes, \$13.6 million in royalties and \$34.4 million in mainly Commonwealth taxes. Taking into account longer-term data, losses could rise to approximately \$72.9 million p.a.

"Trade impacts: The total trade position (merchandise exports less merchandise imports) is expected to deteriorate initially by about \$1,106.4 million after adjustment of export and import trading positions. This would be caused in large part by a net loss of export revenues from reductions of mineral concentrate and processed metal

sales to overseas markets. The impact on exports would only be partially offset by reductions in imports. Net export losses represent approximately 7 percent of total exports from Queensland. These estimates do not incorporate the effects of subsequent changes to economic demand or exchange rate adjustments, which are expected to partially offset the direct impacts on the trade account.

"Impact on transactions of contract services and supplies in Mount Isa:
Information provided by Mount Isa Mines
Limited indicates that at least 50 percent of all transactions conducted by the Mount Isa
Business Unit are transacted with vendors or suppliers in Mount Isa. On an annualised

basis, the current gross value of transactions is at least \$358 million p.a.

"Other impacts in Mount Isa: Closure of the Mount Isa Business Unit would have further impacts on local communities, particularly Mount Isa. Underground mine tours in Mount Isa are a major tourism attraction. The company supports a wide range of charities, events, medical services and recreational facilities. Additionally, it owns and manages a substantial component of Mount Isa's water infrastructure. If the

Business Unit were to cease operating, alternative funding would be required to sustain many of these services. Some services may not be sustainable without external support, if the community were to experience a large loss of its resident population."

The panel notes that since Kinhill completed its evaluation, mineral commodity prices have improved. This may have increased the economic benefits generated by the Mount Isa Business Unit as detailed by Kinhill in 1999.

The panel concludes that MIM's operations in Mount Isa contribute greatly to the regional, state and national economy.

Among the estimated benefits are:

- 5,310 jobs in north-west Queensland, 8,200 jobs in Queensland, and 8,257 jobs in Australia;
- \$186.2 million a year of gross product in north-west Queensland, \$456.3 million in Queensland and \$459.5 million in Australia;
- \$344.4 million a year in wages in northwest Queensland, \$411.1 million in Queensland, and \$414.9 million in Australia;
- \$72.9 million a year in taxes and other government income; and
- 7 percent of Queensland's exports.

These benefits would be lost if smelting was discontinued at Mount Isa.



## 6. Community view

This chapter addresses Terms of Reference item 3(f):

3. Specify that the panel's report shall include:

(f) community views on the emissions and on the effectiveness of the air quality control system;

As indicated in previous sections, in 1999, a survey of self-reported heath impacts and community attitudes in Mount Isa was carried out by R. MacLennan, M. Hensley and D. Lloyd. The results were documented in the report entitled "Community opinion and public health impacts in Mt Isa from sulfur dioxide emissions by Mount Isa Mines Ltd", 2000.

The findings from the parts of the survey that dealt with community attitudes are summarised below.

## 6.1 Effectiveness of the air quality control system

When asked: "Are you aware of the air quality control system operated by the mine?"

- 389 (83.8 percent) said "yes";
- 74 (15.9 percent) said "no"; and
- 1 (0.2 percent) did not answer.

When asked: "If YES, how effective do you think it is?"

- 73 (15.7 percent) said "very";
- 171 (36.0 percent) said "moderately";
- 91 (19.6 percent) said "slightly";
- 42 (9.1 percent) said "not at all";
- 8 (1.7 percent) did not know; and
- 79 (17 percent) said "not relevant" or no answer.

Overall, a large majority (93.6 percent of males and 74.3 percent of females) stated that they were aware of the air quality control system operated by MIM, and more than half (59.4 percent of males and 45.6 percent of females) stated that they thought it was effective.

However, in a different part of the survey, only 39.2 percent of respondents agreed with the statement "The air quality control system at Mount Isa smelter is effective." (Of the respondents, 48.2 percent disagreed and 12.5 percent were not sure.)

## 6.2 Emissions and the environment at Mount Isa

In conducting the survey, a telephone interviewer began by telling respondents: "I am phoning to find out your views on the fumes from the smelter and the effectiveness of the air quality control system, and about possible health effects for you and your children."

When then asked to nominate the single most important environmental issue in Mount Isa, 71 percent of respondents gave answers that could be grouped under the heading "copper smelter fumes/air pollution/sulfur and lead contamination".

When asked to nominate the single most important thing government could do to protect or improve the environment of Mount Isa over the next few years, 41 percent of respondents gave answers that could be generally grouped under the heading "enforce air quality controls/reduce emissions/extend air quality system".

The survey asked a series of standard questions aimed at determining the ecological stance of the Mount Isa community, based on a scale called the New Environmental Paradigm Scale – a research tool designed in the United States to measure environmental values and beliefs. The results of this section of the survey were that 8 percent of respondents were proecological, 72 percent were in the neutral or mid category, and 20 percent were antiecological. The MacLennan et al report noted that this result was very similar to results obtained in such surveys of New South Wales' residents in 1994 and 1997.

The survey also asked respondents to state their agreement or otherwise with a series of statements regarding environmental issues, some of which are specific to Mount Isa. The results included:

- 33.4 percent of respondents agreed with the statement: "Over the past 12 months, the quality of the air in Mount Isa has improved."; while 56.9 percent disagreed and 9.7 percent were not sure.
- 79.2 percent of respondents agreed with the statement: "There is more that can be done to reduce the fumes from the smelter at Mount Isa."; while 9 percent disagreed and 11.6 percent were not sure.
- 37.8 percent of respondents agreed with the statement: "Everything feasible is being done to limit exposure of the people of Mount Isa to the fumes from the smelter."; while 51.1 percent disagreed and 11.2 percent were not sure.
- 53.7 percent of respondents agreed with the statement: "Environmental issues are generally well managed in Mount Isa."; while 37.8 percent disagreed and 8.4 percent were not sure.
- 48.7 percent of respondents agreed with the statement: "Pollution is the price we pay for employment."; while 48.8 percent disagreed and 3.4 percent not sure.
- 92.2 percent of respondents agreed with the statement: "A prosperous economy depends on maintaining a healthy environment."; while 5.6 percent disagreed and 2.2 percent were not sure.
- 50.4 percent agreed with the statement: "I'm not prepared to give up my job to reduce pollution and improve the environment."; while 32.2 percent disagreed, 15.9 percent were not sure, 0.2 percent refused to answer, and 1.1 percent said it was irrelevant.

The MacLennan et al report concluded that, according to the participants in the community survey:

- The single most important and second most important environmental issues in Mount Isa related to air and water pollution and quality.
- More could be done to improve the quality of the air, limit the exposure of residents to smelter fumes and to reduce smelter fumes in Mount Isa.

- There was support among residents for government action to protect or improve the environment of Mount Isa, particularly in relation to air and water pollution and quality.
- The strictness of government regulations to protect or improve the environment was about right for households but needed to be stricter for manufacturing and mining industries.
- While acknowledging the tension between employment and the environment, Mount Isa residents held generally positive attitudes towards the environment.

The panel concludes that, based on survey results:

- about 85 percent of the people living in Mount Isa are aware of the MIM air quality control system;
- people living in Mount Isa hold generally positive attitudes towards the environment, but recognise that their employment opportunities in the town depend upon the continued operation of the mine and the smelters;
- about half of Mount Isa's residents believe that the air quality control system is effective in managing air quality in community areas of the town; and
- about three quarters of the people living in Mount Isa believe that smelter emissions is the most important environmental issue in Mount Isa, and more could be done to reduce them.

## 7. Available emission controls for sulfur dioxide

This chapter addresses Terms of Reference items 3(b) and 4:

- Specify that the panel's report shall include:
   (b) available emission controls, and the feasibility and practicality of their application to the smelters at Mount Isa;
- 4. The Panel Assessment Study shall investigate and report within three years on emission control technologies that would enable Mount Isa Mines Limited to meet ambient air standards for sulfur dioxide in compliance with environmental legislation.

### 7.1 World-wide practice

World-wide practice for control of sulfur dioxide emissions is discussed by B V Borgelt in reports entitled "Management of sulfur dioxide at Mount Isa", 1998, and "Options for control of sulfur dioxide emissions at Mount Isa", 2000. The following sections are based on these reports.

## 7.1.1 Copper smelter emission control practice

The treatment of sulfur dioxide at copper smelter varies around the world.

In places such as South America, Canada, Australia and Pakistan, copper smelters are generally located in remote areas, and therefore have limited or, in some cases, no sulfur dioxide recovery from smelter gases.

But, in the USA and Europe, copper smelters typically achieve 95 percent or slightly greater recovery of sulfur dioxide from emission gases. Normally, double-contact acid plants are used to treat the gas from the smelting processes. Tail gases from the acid plants, as well as fugitive and secondary vent gases, are generally discharged into the atmosphere through tall chimneystacks without further treatment. In a few cases, these low-concentration sulfur dioxide gas streams may be treated in a wet-scrubbing system to further reduce levels in order to meet some particular local environmental requirement. However, this is not the general practice, certainly in the USA.

Japan is conspicuous among copper smelting countries. Its smelters achieve sulfur dioxide recovery levels of 99 percent. Japanese acid plants are generally double-contact units, with

a tail gas of less than 200 parts per million (ppm) sulfur dioxide. In addition, wet scrubbers (of limestone, lime, caustic, magnesia or aluminium hydroxide types) are used to treat tail gas from the acid plant as well as vent and fugitive gases from the smelter, to reduce the average sulfur dioxide emission levels to less than 50 ppm.

The panel notes that it is common in some countries for government to directly subsidise the cost of providing infrastructure to this high standard.

Copper smelters with sulfur dioxide recoveries of greater than 90 percent account for 60 percent of the world's primary copper production. Most of the smelters that achieve these results are equipped with the newer, high-intensity smelting technologies, with associated high oxygen air enrichments.

Single-contact acid plants achieve sulfur dioxide conversion efficiencies of about 97 percent, compared to more than 99.5 percent for double-contact plants. Thus, for smelters with a single contact acid plant either a conversion to a double contact plant has to be made or acid plant tail gas scrubbing is required to achieve overall sulfur dioxide recoveries of 99 percent.

Of the various scrubbing systems available, the wet-limestone system is the most popular. The cost of a wet limestone system to remove sulfur dioxide from the gas stream of a single-contact acid-plant tail is about 10 percent of the capital cost of the acid plant. A scrubbing system for ventilation gas streams with low-level sulfur dioxide concentrations would cost about the same.

The panel concludes that there are technologies that could potentially further reduce sulfur dioxide emissions from the Mount Isa copper smelter. Those likely to be viable include:

- ensuring that all process gases from the copper smelter are treated in the acid plant;
- installing wet-scrubbing desulfurisation systems to treat the ventilation and fugitive gases; and
- modifying the acid plant to be a doublecontact unit, or installing a wet scrubber to treat the tail gas.

The commercial feasibility of these options is not established, and requires further investigation.

## 7.1.2 Lead smelter emission control practice

Most overseas smelters produce acid from lead and lead-zinc sinter plant off-gases. However, the sulfur dioxide content of these gases ranges from 4.5 percent to 7.0 percent, and the unit capital and operating cost of the acid production is relatively high.

Apart from the off-gases from the sintering machine, all other gas streams in the lead smelter (such as the blast furnace process gas and other ventilation gas streams) contain no significant levels of sulfur dioxide. Therefore, they do not require any further treatment other than the present bag filtering systems to control dust and particulate emission control.

The panel concludes that there are technologies that can potentially reduce sulfur dioxide emissions from the Mount Isa lead smelter. The most viable is likely to be installing an acid plant to treat off-gases from the sintering machine. As with the options for the copper smelter, the commercial feasibility of this option needs to be confirmed.

## 7.2 Options to reduce emissions of sulfur dioxide at Mount Isa

If the acid plant in full operation does not achieve the desired ambient air quality standards for sulfur dioxide, further options to reduce sulfur dioxide emissions from the smelters and/or the acid plant could be explored. The following potentially practical options were identified in the Borgelt 2000 report:

- Amend the operating protocols of the AQC system, and increase the shut-down time in the smelters as necessary to meet desired ambient air standards.
- Direct all process gases from the copper smelter ISASMELT during start-ups and shutdowns to the acid plant.
- Install equipment and/or alter procedures so that it is unnecessary for three copper smelter converters to blow simultaneously. This will avoid the present need to vent process gases from the third blowing converter to the atmosphere because of throughput limitations in the acid plant.
- Reduce blowing rates in the converters for the short periods when the three converters blow simultaneously so that process gases from all three can be accepted by the acid plant.
- Add double-contact capability and/or tailgas scrubbing to the existing acid plant.
- Improve the capture of fugitive gases, and redirect copper smelter vent and fugitive gases from the 70-meter stack to the 153metre stack.
- Add a scrubber to remove sulfur dioxide from vent and fugitive gases.
- Add a new acid plant to treat lead smelter sinter plant off-gases.

## 7.3 Feasibility and practicality at Mount Isa

At the time of preparing this report, there was insufficient information to determine with any confidence whether the above options are feasible and practical at Mount Isa.

Nevertheless, the Borgelt 2000 report

presented options for further investigation in approximate order of priority for further evaluation. These are discussed below.

## (1) Amended the operating protocols of the air quality control system

In principle, this option offers an alternative to installing various emission control technologies. In simple terms, it involves a considerably more conservative air quality control strategy with a resultant increase in smelter downtime, reducing the likelihood of emissions impacting on ambient air quality in community areas of Mount Isa. However, further investigations involving atmospheric-dispersion modelling studies, and perhaps trial runs, would be needed to determine if such a strategy could further improve ambient air quality after the acid plant is in full operation. Then it would be necessary to estimate the amount of shutdown time needed to meet relevant ambient air quality standards for sulfur dioxide. The cost in terms of lost production would then provide a basis for comparison with the various options for additional emission control technologies discussed below.

## (2) Treat all copper smelter process gases through the acid plant

Once the acid plant commences operating at full production, it would be possible to determine the feasibility and practicality of sending all copper smelter process gases to the acid plant. This would involve:

- Determining the safe, practical, minimum blast rates for the copper converters, and then testing the potential of the acid plant to handle all process gases from the ISASMELT and three converters on reduced blowing rates for brief periods each day;
- Alternatively, attempting to optimise converter scheduling in order to achieve copper production targets by blowing only two of the three operational converters at any one time.
- Determining the maximum initial
   ISASMELT smelting rate, and the fastest

ramp-up time to the normal smelting rate, consistent with tolerable acid plant operating conditions, and then sending all ISASMELT process gases to the acid plant during start-ups and shutdowns.

Operating patterns for the converters are driven, at least in part, by the operation of the upstream ISASMELT furnace.

Consequently, converter operations cannot be considered without evaluating the interface with the ISASMELT. While it may be possible to treat all copper smelter process gases in the acid plant through operational scheduling alone, it is more likely that a new holding furnace would be needed to partially decouple the converters from the ISASMELT. This would require significant capital outlay and be difficult to achieve given space limitations at the smelter.

Alternatively, a matte-granulation system could be installed to process copper matte in excess of the restricted converter capacity. Matte could be sold as a product, but at significant loss in value compare to anode copper. Installation of a matte granulator would involve a large capital cost. Also, this type of plant is commonly considered to involve significant operational safety issues.

The converter scheduling option would lead to a large increase in acid production at Mount Isa. This would mean that another way of using, or disposing of, this extra acid would need to be identified. At present, there is no apparent market or use for additional acid in the region.

Alternatively, the converter scheduling option could involve reducing the amount of anode copper produced to match the demand for acid. This would cut revenue at the smelter significantly, and reduce the efficiency of the copper smelter. It would also mean that MIM's operations were being constrained by the operation of a plant owned by a different company.

## (3) Improve copper smelter vent and fugitive sulfur dioxide emissions system

The main objectives of this option would be to improve working conditions for plant operators, and to reduce low-level fugitive emissions, both of which can adversely affect the ambient air quality in Mount Isa. A detailed study would be needed to determine costs, feasibility, and practicality of this option. This would involve:

- Measuring the flow rates and sulfur dioxide levels for each emission point more accurately, and carrying out an atmospheric-dispersion modelling study to determine the potential this option has to reduce ambient levels of sulfur dioxide in community areas of Mount Isa.
- Studying and designing systems to more effectively capture these gases at the various sources (including rotary holding furnace, matte pouring area, and blister copper pig pouring area), and preparing detailed cost estimates.
- Studying and assessing the practicality of redirecting the three component vent streams that are emitted via the 70-metre matte vent stack to the 153-metre copper smelter stack, and preparing detailed cost estimates.

The main effect of these options is to redirect emissions from current low-altitude sources to a higher altitude emission point. While not changing the total volume of sulfur dioxide emitted, changing the emission point may help to reduce the impact of these emissions on ambient air quality.

### (4) Alkali-scrub copper smelter vent gases

The study into possible improvements to the existing vent and fugitive emission systems and the possible redirection of all vent and fugitive gases into a single gas stream would have to be completed before a meaningful study could be undertaken regarding an alkali scrubbing system for these gases. It is technically possible to

reduce sulfur dioxide emissions to less than 50 parts per million (ppm) by using alkali scrubbing of copper smelter vent gases. However, this would involve capital costs of at least \$20 million at Mount Isa and high operating costs. A detailed study would be needed to determine how feasible and practical this would be at Mount Isa.

### (5) Treat acid plant tail gas

Known and proven technology is available to reduce acid-plant tail gas emissions to low levels. The main technical options are modifying the plant to be double-contact, and alkali scrubbing. Both options would have a capital cost of approximately \$20 million. A double-contact acid plant would be simpler to operate than an alkali scrubber, and would not generate a significant waste-disposal problem. While the operating costs of these alternatives have not been estimated, the cost of reagents is expected to make an alkali scrubber more expensive to operate. The only apparent advantage of an alkali scrubber is that it is capable of reducing sulfur dioxide concentrations in tail gas to less than 50 ppm, whereas the limit for a double-contact acid plant is about 200 ppm. A double-contact acid plant would produce an estimated 20,000 tonnes of additional acid a year. This extra acid would have a significant value, if a market could be found for it. A detailed study would be needed to determine the feasibility and practicality at Mount Isa for these options.

It is noted that increasing the capture rate at the acid plant will result in additional acid manufacture, and the issue of finding a market/disposal route for the additional acid remains to be resolved.

## (6) Acid plant for lead smelter sinter plant process gases

Known and proven technology is available for an acid plant that can treat off-gases from the lead smelter sinter plant. The likely outlays for this option would be a capital cost of about \$80 million, and

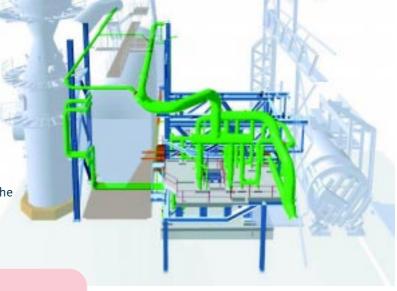
operating costs of about \$30 per tonne of acid. A study of this option should consider:

- medium to long term prospects for acid markets;
- the projected life of the Mount Isa leadzinc stream and the medium to longterm economics of the stream; and

 if an acid plant were not installed, the estimated additional shutdown time at

the lead smelter
needed to meet the
relevant standards
for ambient air
quality, and the effect
this would have on
lead production and
unit costs.

For those of the above six options found to be feasible and practical, further studies would be needed to determine the improvement in ambient air quality likely to be achieved by their implementation.



The panel concludes that the following options for additional reductions in sulfur dioxide emissions and ambient concentrations in Mount Isa could be further explored:

- amending the operating protocols of the air quality control system;
- treating all process gases from the copper smelter through the acid plant;
- improving the systems for collecting copper smelter vent gases and fugitive emissions that contain sulfur dioxide;
- using alkali scrubbing on the vent gases from the copper smelter;
- treating the tail gas from the acid plant;
   and
- installing an acid plant to treat the off-gases from the sinter plant at the lead smelter.

### 8. Recommendations for action

This chapter addresses Terms of Reference item 3(g):

- 3. Specify that the panel's report shall include:
  - (g) recommendations for further research, and in connection with term of reference 3, anything necessary to be done to achieve consistency between Section 3 of the Intergovernmental Agreement on the Environment and the conduct of the smelter operations;

[See Appendix V for an extract from the Intergovernmental Agreement on the Environment.]

In addressing its terms of reference, the panel has identified matters that could not be finalised in the timeframe allowed for this project. In some cases, future actions have been suggested. In others, more research will be needed before proposals can be formulated. The panel's recommendations covering both these perspectives are presented here.

### 8.1 Implementation management

As discussed earlier, the *Mount Isa Mines Limited Agreement* requires the panel to report on emission control technologies that would enable MIM to meet ambient air standards for sulfur dioxide in compliance with environmental legislation. The Agreement also provides that, upon publication of the panel's report, MIM shall consult with the Minister for Environment and Heritage to determine how those findings should be included in the Integrated Environmental Management System (IEMS) for MIM's operations at Mount Isa.

While there is no requirement in the Agreement for the panel to continue its involvement in this process, the panel is of the view that there is considerable value in putting in place a mechanism to ensure that those of its recommendations accepted by the Minister and incorporated into the IEMS are overseen by some party.

Options for such a mechanism — one that will allow for monitoring and reporting to the Minister on these matters — include:

### (i) Continuation of present panel

The panel was established by the then-Minister for Environment in 1997. It was made up of members who would both represent relevant stakeholder parties, and bring a high level of independence and professional expertise to work within the specific (and somewhat technical) terms of reference of the Panel Assessment Study

Now that the current panel has completed the specific tasks set for the study, its members are of the view that it is inappropriate for them to be reconvened. They propose that any future panel that may be established should have a membership appropriate to the functions and tasks assigned to it.

#### (ii) Environmental Protection Agency

Through its responsibilities under the *Environmental Protection Act 1994*, the Environmental Protection Agency already has a specific role in managing environmental aspects of the Mount Isa operations, including responsibility for issuing relevant environmental authorities for MIM operations at Mount Isa.

While the EPA could oversee the matters raised in this study, the panel believes that it would be preferable for the Minister to receive advice from a person or group separate from the Agency.

### (iii) Establishment of new panel

The current panel consists of 11 members who were appointed to provide authoritative and representative input into the Panel Assessment Study under specific terms of reference.

Any on-going activity emanating from the study will have a different focus, with a prime objective of monitoring and reporting on the implementation of the agreed actions through the IEMS. However, the EPA could still provide any necessary technical input, drawing on external advice as required. While there are, no doubt, grounds for having another representative group to oversight implementation, the

panel's assessment is that the establishment of a new expert panel is unnecessary as long as the implementation process is reported publicly, and the Minister has independent advice, as proposed below.

### (iv)Independent advisor to the Minister for Environment and Heritage

The panel has already concluded that it is appropriate that the Minister receive separate advice from that provided by the EPA in matters relating to the implementation of the panel's findings through the IEMS.

The panel considers that one appropriate option is that the Minister appoints an independent advisor at a senior level, with substantive environmental management experience and a capacity to be aware of representative community and industry views.

The role of the advisor would be to monitor whether or not the actions agreed by MIM and the Minister regarding the recommendations in this report have been implemented, and to report to the Minister and the community on progress being made.

### (v) Community Air Quality Committee

The panel considers that another appropriate option is that the Minister appoints a Community Air Quality Committee to monitor whether or not the actions agreed by MIM and the Minister regarding the recommendations in this report have been implemented, and to report to the Minister and the community on progress being made.

In putting forward this option, the panel recognises that any recommendations that are accepted will essentially be implemented in Mount Isa itself, and there would be advantages in involving the local community in this function.

While the panel sees merits in both Option (iv) (the independent advisor to the Minister) and Option (v) (the Community Air Quality Committee), it was not able to reach consensus within the group on a recommended approach.

The differences primarily related to a suitable balance between involving the community at a local level through a committee approach and having an advisor able to readily assess and interpret scientific and technical information. There was, however, agreement on the need to ensure independent advice was given to the Minister and to the community on implementing the agreed recommendations.

The panel recommends that the Minister considers either Option (iv) (appointing an independent advisor) or Option (v) (appointing a Community Air Quality Committee) as the most appropriate mechanism for monitoring whether or not the actions agreed by MIM and the Minister regarding the recommendations in this report have been implemented, and reporting to the Minister and the community on progress being made.

### 8.2 Further research

The panel has several recommendations relating to the need for further research.

All these recommendations have been made with due consideration of the overarching principles expressed in Section 3 of the Intergovernmental Agreement on the Environment.

### Impacts on flora and fauna

It is recommended that:

- MIM continues its current study involving measurements of sulfur dioxide using passive gas samplers to cover at least one full year when the acid plant is operating regularly at or near its design rate. The objective of this research would be to confirm that downwind environmental exposure to sulfur dioxide shows the expected reduction.
- At the conclusion of this study, MIM report its findings to the EPA.

- Within six months of receiving the report, the EPA and MIM jointly design a monitoring program to look for signs of recovery in affected flora and fauna that may reflect the reduction in sulfur dioxide emissions because of the operation of the acid plant.
- MIM implements the agreed monitoring program and reports its findings through the mechanism for monitoring and reporting established by the Minister.

### Impacts on the community

It is recommended that:

- MIM commissions a study into whether or not there are any reliable and costeffective methods for determining personal exposure to sulfur dioxide, with particular emphasis on accurately identifying exposure during short-term peaks; and
- if a suitable method is identified, MIM commissions a study of the levels of personal exposure to sulfur dioxide in community areas of Mount Isa.

### Effectiveness of air quality control system

It is recommended that MIM investigates practicable measures to further improve the effectiveness of its air quality control system.

### Community health and perceptions survey

It is recommended that, after the acid plant has been operating on a normal full-time basis at or near its design production rate for one year, MIM commissions a study to repeat the community health and perceptions survey.

#### Feasible emissions controls

It is recommended that if the relevant ambient air quality standards for sulfur dioxide are not met in community areas of Mount Isa when the acid plant is operating on a normal full-time basis at or near its design production rate, MIM further investigates the feasibility and practicality of the emission control options discussed in this report.

### 9. Conclusion

The panel found that there is evidence of historical impact of sulfur dioxide emissions on soil chemistry and biodiversity in areas downwind from the smelters at Mount Isa, but not beyond a range of 20 kilometres. In addition, the panel recognised that, when the acid plant is operating at full production, there should be a gradual recovery of this biodiversity in the short to medium term. However, the recovery of acidified soils downwind from the plant is likely to be long-term.

No evidence was found in the hospital admission statistics of adverse effects of sulfur dioxide emissions on community health in Mount Isa. Nevertheless, the panel recognises that the Mount Isa community remains concerned about emissions from the smelters. Also, monitoring shows that national goals for short-term averages for ambient levels of sulfur dioxide are occasionally exceeded in community areas of the town during adverse weather conditions.

The panel notes that it was unable to fully assess the combined effect of the operation of the acid plant and the air quality control system on the impact of sulfur dioxide emissions. This was because restricted operation of the Phosphate Hill fertilizer plant limited the demand for acid, and production levels at the acid plant were substantially restricted during the period of the study. Nevertheless, the panel is confident that the planned operation of the acid plant will make a significant improvement to the natural environment within the Mount Isa region.

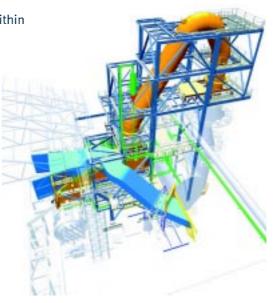
The panel has made recommendations for further research including:

- quantifying the recovery of historical biodiversity impacts likely to result from the operation of the acid plant;
- quantifying the levels of sulfur dioxide that people living in community areas of Mount Isa are actually exposed to – levels likely to be substantially lower than ambient

- levels recorded by the monitoring network because concentrations indoors are substantially lower than concentrations outdoors;
- determining if community perceptions regarding emissions from the smelters change after the acid plant becomes fully operational;
- finding ways to improve the effectiveness of the air quality control system; and
- further developing feasible measures for reducing sulfur dioxide emissions from the smelters as they become practicable.

Implementation of the recommendations for further research will require on-going work. It would be appropriate for progress on implementation of the agreed recommendations to be routinely monitored and reported on to the Minister for Environment and Heritage and the Mount Isa community in an independent way. The panel has recommended that the Minister choose between two possible mechanisms for carrying out this task.

The panel is of the view that this report fully satisfies the terms of reference for the study, and provides an appropriate basis for MIM to consult with the Minister for Environment and Heritage on how to incorporate the findings of the study into the IEMS for its operations at Mount Isa.



## **Appendix I**

### Supporting documents

- "Assessing the economic value of health impacts of sulfur dioxide emissions in Mount Isa", McDowall, S., 2000.
- "Behaviour of the Mount Isa smelter plumes", Williams, D., 1998.
- "Community opinion and public health impacts in Mt Isa from sulfur dioxide emissions by Mount Isa Mines Ltd", MacLennan, R., Hensley, M., and Lloyd, D., 2000.
- "Economic analysis of the operations of the smelters at Mount Isa", Kinhill Pty Ltd, 1999.
- "Economic assessment of the health impact of sulfur dioxide  $(SO_2)$  emissions in Mt Isa", Queensland Health, 2001.
- "Final report: Indoor/outdoor SO<sub>2</sub> levels in Mt Isa", Ayers, G. P., and Gillett, R. W., 1999.
- "Impact of sulfur dioxide emissions on savanna biodiversity at Mt Isa, Queensland Final report to Mt Isa Mines Ltd", Griffiths, A. D., 1998.
- "Literature survey of the effects of sulfur dioxide on human skin", McDowall, S., 2000.
- "Management of sulfur dioxide at Mount Isa", Borgelt, B. V., 1998.
- "MIM- Emissions and the environment Final report to Mount Isa Mines Limited", Ayers, G. P., Carras, J.N., Gillett, R.W., Granek, H., Hibberd, M. F., Lilley, W. E., Manins, P.C., Merry, R., Mullins, P. J., Munksgaard, N., Smith, C., Szemes, F., Parry, D., and Williams, D., 1999.
- "Mt Isa Mines: Some comments from an economist's perspective on the assessment of the health effects", Mooney, G., 2000.
- "Options for control of sulfur dioxide emissions at Mount Isa", Borgelt, B. V., 2000.
- "PM10 aerosol sulfate at Mt Isa", Ayers, G. P., 1999.

Copies of these documents together with this final report are available on CD ROM and can be obtained from the EPA's Naturally Queensland Information Centre, Ground Floor, 160 Ann Street, Brisbane (telephone: (07) 3227 8185, fax: (07) 3227 8749, email: nqic@env.qld.gov.au). These documents are also available on the EPA's web site at www.env.qld.gov.au

## **Appendix II**

#### References

Ayers, G.P., "PM10 aerosol sulfate at Mt Isa", Report to the MIM Panel Assessment Study, 1999.

Ayers, G.P., and Gillett, R.W., "Final report: Indoor/outdoor SO<sub>2</sub> levels in Mt Isa", Report to the MIM Panel Assessment Study, 1999.

Ayers, G.P., Keywood, M.D., Gras, J.L., Cohen, D., Garton, D., and Bailey, G.M., "*Chemical and physical properties of Australian fine particles: a pilot study: final report to Environment Australia*", Environment Australia, 1999.

Ayers, G., Gillett, R.W., Granek, H., and Johnson, D., "Indoor vs outdoor SO<sub>2</sub> levels near an isolated industrial source in tropical Australia", Clean Air and Environmental Quality, Volume 34, No. 4, November 2000, pp 33-37.

Ayers, G.P., Carras, J.N., Gillett, R.W., Granek, H., Hibberd, M.F, Lilley, W.E., Manins, P.C., Merry, R., Mullins, P.J., Munksgaard, N., Smith, C., Szemes, F., Parry, D., and Williams, D., "*MIM-Emissions and the environment — Final report to Mount Isa Mines Limited*", 1999.

Borgelt, B.V., "Management of sulfur dioxide at Mount Isa", Report to the MIM Panel Assessment Study, 1998.

Borgelt, B.V., "Options for control of sulfur dioxide emissions at Mount Isa", Report to the MIM Panel Assessment Study, 2000.

Chan, Y.C., Simpson, R.W., Mactainsh, G.H., Vowles, P.D., Cohen, D.D., and Bailey, G.M., "*Characterisation of chemical species in PM2.5 and PM10 aerosols in Brisbane, Australia*", Atmos. Environ., 31, 1997, pp 3773-3785.

Donoghue, A.M. and Thomas, M., "Point source sulfur dioxide peaks and hospital presentations for asthma", Occupational and Environmental Medicine, Vol 56, No. 4, 4 January 1999, p 232.

Ferrari, L., and Salisbury, J., "Sulfur dioxide", National Environmental Health Forum Monographs, Air Series No. 4, 1998.

Griffiths, A.D., "Impact of sulfur dioxide emissions on savanna biodiversity at Mt Isa, Queensland — Final report to Mt Isa Mines Ltd", 1998.

Kinhill Pty Ltd, "*Economic analysis of the operations of the smelters at Mount Isa*", Report to the MIM Panel Assessment Study, 1999.

Lewis, P.R., Hensley, M.J., Wlodarczyk, J., Toneguzzi, R.C., Westley-Wise, V.J., Dunn, T., and Calvert, D., "Outdoor air pollution and children's respiratory symptoms in the steel cities of New South Wales", MJA, Vol 169, 2 November 1998, pp 459-463.

MacLennan, R., Hensley, M., and Lloyd, D., "Community opinion and public health impacts in Mt Isa from sulfur dioxide emissions by Mount Isa Mines Ltd", Report to the MIM Panel Assessment Study, 2000.

McDowall, S., "Literature survey of the effects of sulfur dioxide on human skin", Report to the MIM Panel Assessment Study, 2000.

McDowall, S., "Assessing the economic value of health impacts of sulfur dioxide emissions in Mount Isa", Report to the MIM Panel Assessment Study, 2000.

Mooney, G., "Mt Isa Mines: Some comments from an economist's perspective on the assessment of the health effects", Report to the MIM Panel Assessment Study, 2000.

National Environment Protection Council, *"Final impact statement for the ambient air quality national environment protection measure"*, 26 June 1998.

NSW Health Department, "NSW health survey 1997 — Asthma ever diagnosed by doctor — 18+ years", <a href="www.health.nsw.gov.au/public-health/hs97/ast\_a1\_18.htm">www.health.nsw.gov.au/public-health/hs97/ast\_a1\_18.htm</a>, 21 August 2000.

Pope, C.A., Thun, M.J., Namboodiri, M.M., Dockerty, D.W., Evans, J.S., Speizer, F.E. and Heath, C.W., "Particulate air pollution as a predictor of mortality in a prospective study of U.S. adults", Am J Respir Crit Care Med, Vol 151, pp669 – 674, 1995.

Queensland Health, "Economic assessment of the health impact of sulfur dioxide (SO.) emissions in Mt Isa", Report to the MIM Panel Assessment Study, 2001.

U.S. EPA, "Human health benefits from sulfate reductions under Title IV of the 1990 Clean Air Act Amendments", 1995.

Williams, D., "Behaviour of the Mount Isa smelter plumes", Report to the MIM Panel Assessment Study, 1998.

## **Appendix III**

### **Abbreviations**

AQC air quality control

**ASR** age standardised rate (per thousand)

CSIRO Commonwealth Scientific and Industrial Research Organisation

**EPA** Environmental Protection Agency (of Queensland)

HISAAP Hunter and Illawarra study of airways and air pollutants

IEMS Integrated Environmental Management System

km kilometreskPa kilopascals

MIM Mount Isa Mines Limited

PM10 particulate matter with an aerodynamic diameter of less than 10 micrometres

ppm parts per million (by volume)

**US EPA** United States Environmental Protection Agency

WMCF WMC Fertilizers Pty Ltd

°C degrees Celsius

## **Appendix IV**

### Terms of Reference for the Panel Assessment Study

I, Brian George Littleproud Minister for the Environment in the State of Queensland, hereby:

- 1. Refer the following matters for assessment and report to the Panel of persons established by me to make assessments of the likely impacts of expected releases of sulfur dioxide to the atmosphere by Mount Isa Mines Limited at Mount Isa following the installation of the announced acid plant:
  - a) the likely atmospheric dispersion and ultimate fate of the sulfur dioxide emissions; and
  - b) the likely economic, environmental and social impacts of the sulfur dioxide emissions;
- 2. Specify that subject to my approval, the Panel may commission technical investigations necessary to fill any substantial knowledge gaps which prevent the Panel from fulfilling these terms of reference;
- 3. Specify that the Panel's report shall include;
  - a) the site history of smelting, sulfur dioxide sources and air quality control;
  - b) available emission controls, and the feasibility and practicality of their application to the smelters at Mount Isa;
  - c) the results of available studies, research and monitoring relevant to community public health impacts;
  - d) the fate of sulfur dioxide emissions from the smelters, rates of acid deposition, identification of acid input tolerances of soils impacted by acid deposition and impacts on terrestrial flora and fauna;
  - e) the economic impact of the smelter operations expressed in terms of estimates of welfare losses, welfare regional redistribution and current account effects should smelting operations be discontinued;
  - f) community views on the emissions and on the effectiveness of the air quality control system;
  - g) recommendations for further research, and in connection with term of reference 3, anything necessary to be done to achieve consistency between Section 3 of the Intergovernmental Agreement on the Environment and the conduct of the smelter operations;
- **4.** The Panel Assessment Study shall investigate and report within 3 yrs on emission control technologies which would enable Mount Isa Mines Limited to meet ambient air standards for sulfur dioxide in compliance with environmental legislation.
- 5. Specify that the Panel shall conduct its work in accordance with procedures detailed in the letter of invitation to Panel members dated 23 June 1997.

**Brian Littleproud** 

**Minister for Environment** 

Sman Ath proud

## **Appendix V**

## Extract from the Inter-Governmental Agreement on the Environment (February 1992)

### SECTION 3 — PRINCIPLES OF ENVIRONMENTAL POLICY

- **3.1** The parties agree that the development and implementation of environmental policy and programs by all levels of Government should be guided by the following considerations and principles.
- 3.2 The parties consider that the adoption of sound environmental practices and procedures, as a basis for ecological sustainable development, will benefit both the Australian people and environment, and the international community and environment. This requires the effective integration of economic and environmental considerations in decision-making processes, in order to improve community well-being and to benefit future generations.
- 3.3 The parties consider that strong, growing and diversified economies (committed to the principles of ecologically sustainable development) can enhance the capacity for environmental protection. In order to achieve sustainable economic development, there is a need for a country's international competitiveness to be maintained and enhanced in an environmentally sound manner.
- **3.4** Accordingly, the parties agree that environmental considerations will be integrated into Government decision-making processes at all levels by, among other things:
  - (i) ensuring that environmental issues associated with a proposed project, program or policy will be taken into consideration in the decision making process;
  - (ii) ensuring that there is a proper examination of matters which significantly affect the environment; and
  - (iii) ensuring that measures adopted should be cost-effective and not be disproportionate to the significance of the environmental problems being addressed.
- 3.5 The parties further agree that, in order to promote the above approach, the principles set out below should inform policy making and program implementation.
  - 3.5.1 precautionary principle
    - Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.
    - In the application of the precautionary principle, public and private decisions should be guided by:
    - (i) careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and
    - (ii) an assessment of the risk-weighted consequences of various options.
  - 3.5.2 intergenerational equity
    - the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.
  - 3.5.3 conservation of biological diversity and ecological integrity conservation of biological diversity and ecological integrity should be a fundamental consideration.

- 3.5.4 improved valuation, pricing and incentive mechanisms
  - environmental factors should be included in the valuation of assets and services
  - polluter pays i.e. those who generate pollution and waste should bear the cost of containment, avoidance or abatement
  - the users of goods and services should pay prices based on the full life cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any wastes
  - environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solutions and responses to environmental problems.

## **Appendix VI**

# Extract from conditions of the Environmental Authority under the Environmental Protection Act 1994 for the mining and smelting facilities operated by Mount Isa Mines Limited at Mount Isa

- (A6) The holder of this environmental authority must participate in a panel assessment study, which is to commence by 1 December 1996, to report on the environmental impacts of sulfur dioxide emissions from the copper and lead smelters.
- (B1) Ambient air quality impacts of the activities to which this authority relates shall be managed by the "Air Quality Closed Loop Control System" (AQC System) as defined in Appendix 1.
- (B2) The limits at each of the air quality stations shown in Appendix 2 will be:
  - (a) the annual arithmetic mean sulfur dioxide concentration is not to exceed 80 micrograms per cubic metre;
  - (b) the maximum 24 hour running average sulfur dioxide concentration is to be 365 micrograms per cubic metre; and
  - (c) the maximum 3 hour running average sulfur dioxide concentration is to be 1,300 micrograms per cubic metre.
- (B<sub>3</sub>) Condition B<sub>1</sub> does not apply under abnormal operating conditions nor does condition B<sub>2</sub> apply under abnormal meteorological conditions.
- (H1) "Abnormal operating conditions" include equipment startup, equipment shut down, unforeseen plant malfunctions, accidents and emergencies
- (H2) "Abnormal meteorological conditions" means atmospheric conditions which cause sulfur dioxide released on the premises to be transported to the locality of the air quality stations shown in Appendix 2 such that exceedance of the limits set in condition B2 is unavoidable through the normal operation of the AQC system.

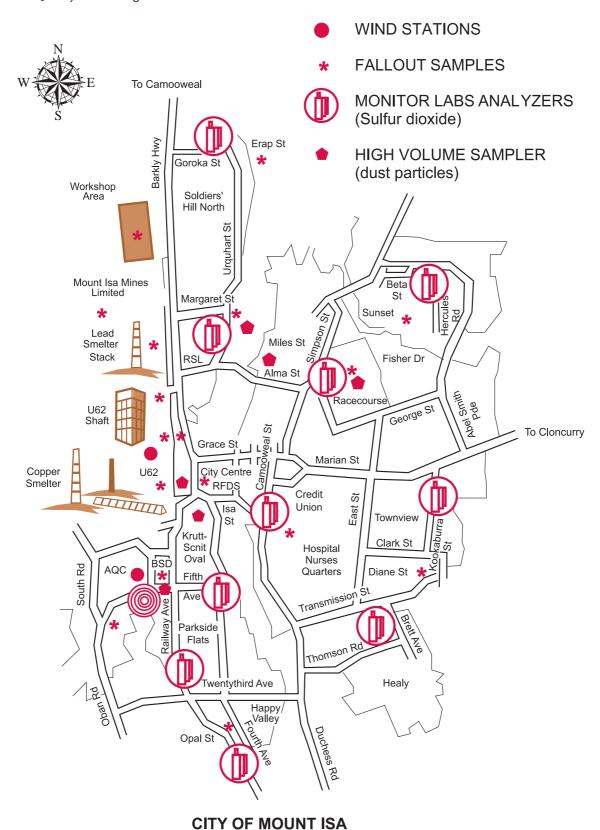
### Appendix 1

### Air Quality Closed Loop Control System

- 1. The licence holder shall have a policy which provides for:
  - (a) the appointment of air quality control personnel (AQC personnel) with responsibility to decide whether or not meteorological conditions are suitable for all or part of the smelting operations having regard to the goals of condition B(2);
  - (b) authorisation and responsibility of AQC personnel to appropriately advise the licence holder's smelter operating management concerning the operation of all or part of the smelting operations.
  - (c) except under conditions of emergency, or when plant and individual safety are of concern, for the smelter operating management to act on the advice of the AQC personnel.
  - (d) a linkage of default of any of the responsibilities under (a) to (c) above with the licence holder's disciplinary procedures.
- 2. To provide information to the AQC personnel the licence holder shall maintain:
  - (a) ten (10) real time sulfur dioxide analysers at the locations approximately shown in Appendix2;
  - (b) a radar Doppler anemometer and wind speed and direction indicators;
  - (c) access to relevant information available from the Bureau of Meteorology.

### Appendix 2

Air Quality Monitoring Stations



## **Appendix VII**

## State and national legislation regarding ambient air standards for sulfur dioxide State

The *Environmental Protection (Air) Policy 1997*, a policy under the *Environmental Protection Act 1994* (Qld), includes the following air quality goals for sulfur dioxide:

Goals relevant to protection of human health:

10-minute average: 0.25 ppmone-hour average: 0.2 ppmannual average: 0.02 ppm

Goals relevant to protection of biological integrity:

24-hour average: 0.04 ppm annual average: 0.02 ppm

The policy states that these goals are intended to be achieved as part of progressively achieving the object of the policy over the long term.

#### **National**

The National Environment Protection (Ambient Air Quality) Measure 1998, a measure under the National Environment Protection Council Act 1994 (C'wealth), includes the following national environment protection standards for sulfur dioxide in ambient air:

one-hour average: 0.2 ppm 24-hour average: 0.08 ppm annual average: 0.02 ppm

The goal of the measure is for the standards to be achieved at performance monitoring stations by 28 June 2008, subject to allowable exceedences stated in the measure. These allowable exceedences (for sulfur dioxide) are:

one-hour average: one day per year 24-hour average: one day per year

annual average: none

The measure includes a protocol regarding the location of performance monitoring stations. The protocol aims to ensure that they obtain a representative measure of the ambient air quality likely to be experienced by the general population in a region or sub-region. The measure specifically excludes the management of point sources.

## **Appendix VIII**

### Biographical notes for panel members

John Gilmour Director — Corporate Performance and Risk Environmental Protection Agency

Mr Gilmour, who has senior-level responsibilities within the Queensland Environmental Protection Agency, works closely with the EPA Director-General and participates in the Agency's Board of Corporate Governance and Executive Management Group. Raised in north Queensland, Mr Gilmour received a civil engineering degree from James Cook University. He also has environmental and business administration tertiary qualifications. He previously worked with the Coordinator General's Department, the Northern Territory Conservation Commission and a Brisbane-based civil engineering consultancy. He commenced work with the Irrigation Commission.

Mr Gilmour was appointed as Executive Director (Environment) in 1991 within the then Department of Environment & Heritage and was responsible for leadership of the Environment Program for seven years. The Environment Program had responsibility for pollution control; waste management; project assessment and facilitation; air, noise and water quality monitoring; and contaminated land. It was delivered operationally throughout the Department's regions. The Environment Program was responsible for the introduction of the Queensland *Environmental Protection Act 1994*, widely recognised as among the most modern and comprehensive environmental legislation in the world.

Mr Gilmour also represents Queensland on the Standing Committees of the Australian and New Zealand Environment and Conservation Council and the National Environment Protection Council.

### Dr Gregory Ayers Research Program Leader CSIRO Division of Atmospheric Research

Dr Ayers has spent more than twenty years studying aspects of multi-phase reactive chemistry in the atmosphere. He has worked on problems as diverse as photochemistry in the Antarctic air-ice chemical exchange, aerosol-cloud interactions relevant to climate, and acid-deposition assessment and studies on urban haze in South-East Asia, employing both measurements and theoretical modelling techniques. For more than a decade, Dr Ayers led the Sulfur Program at the Australian Baseline Station (Cape Grim), studying all aspects of the atmospheric cycles of gaseous, rainwater and aerosol sulfur species.

In 1995, Dr Ayers was awarded the Priestley Medal of the Australian Meteorological and Oceanographic Society for excellence in the science and application of his research into acid deposition. Recently, he has given attention to the issue of air quality and personal exposure, leading a team developing low-cost measurement methods for application to the study of the nexus between indoor and outdoor air quality. Currently, Dr Ayers is a Research Program Leader at CSIRO's Division of Atmospheric Research, leading the Aerosol Program.

### Bevan Borgelt Consultant Metallurgical Engineer

Mr Borgelt worked for 35 years with MIM in its various operations in the non-ferrous extractive metallurgical industry at Mount Isa and throughout the world. He spent 22 years at Mount Isa, mainly in the lead and copper smelters, including 10 years as Copper Smelter Superintendent/ Manager, responsible for operations and maintenance. He was involved in the expansion of activities at the copper smelter, including process selection, basic engineering equipment, specification and selection, and commissioning.

Mr Borgelt has studied various aspects of gas cleaning and handling at Mount Isa, including sulfuric acid and phosphoric acid production. He has reviewed acid-plant operations at copper smelters in Texas, Arizona, New Mexico and Washington, and visited most of the significant copper smelters in

the world, including those in Japan, USA, Canada, Finland, Sweden, Germany and Bulgaria. Over the past 15 years, Mr Borgelt has worked as an independent consultant, mainly on zinc and copper smelter studies, often with an accent on environmental issues.

### Roy Harris Mount Isa Mines Site Union Organiser Australian Workers' Union

Mr Harris was born and raised in Melbourne. He worked in a variety of occupations (including jobbing moulder, core maker, concrete fabrication worker, hand held miner, raise miner, three-boom jumbo miner and tyre fitter) before taking on his current position of Mount Isa Mines Site Union Organiser for the Australian Workers' Union. He is a committee member/director of a number of community organisations, and has held a variety of posts in the Mount Isa Branch of the Australian Labour Party.

### Leigh Neilson Manager — Mount Isa WMC Fertilizers Limited

Mr Neilson completed a cadetship in Applied Chemistry at Associated Pulp and Paper Mills at Burnie in Tasmania in 1966. He joined Sulphide Corporation (later to become Pasminco) zinc smelting and refining operations at Cockle Creek, NSW. In 1996, he was appointed Copper Smelter Manager at WMC's Olympic Dam Corporation's complex. Mr Neilson was responsible for the detailed start-up preparation and smooth integration of the expanded Olympic Dam Process Plant from late in 1997 through to early 1999. He transferred to WMC Fertilizers' Mount Isa operation for the commissioning, start-up and establishment of the new acid plant, the largest of its kind in the world.

### Steven Campbell Manager — Mount Isa WMC Fertilizers Limited

From 1996, Mr Campbell was responsible for the planning, designing, construction and commissioning of the WMC Fertilizers' acid plant, adjacent to the MIM copper smelter in Mount Isa. His role encompassed negotiating commercial, land tenure and licensing agreements with MIM, overseeing the environmental licensing process for the plant, and leading the community consultation process. He was accountable for delivery of the entire site works at Mount Isa, including cost (\$180 million) and schedule.

Prior to that, Mr Campbell worked as an engineering contractor for Future Fuels/Davy John Brown for a year, and in various sales/marketing/business development and engineering /commissioning roles for Orica (formerly ICI Australia Pty Ltd) for nine years. From 1989 to 1991, he oversaw the design and construction of a chemical complex at Yarwun, Gladstone, which encompasses one plant producing 20,000 tonnes of sodium cyanide a year, and another producing 6,000 tonnes of chlorine/caustic soda a year.

### Brian Mayhew Safety, Health and Environment Manager Mount Isa Mines, Mount Isa Business Unit

Mr Mayhew is a civil engineer with a background in infrastructure maintenance in the mining, transport and electricity industries, as well as catchment and environmental management in water and hydro-electricity operations. He has worked for MIM since May 1999, and his current role includes managing safety, health, hygiene, environment and emergency services at the Mount Isa Mines complex.

Ross Willis Commercial Manager Mount Isa Mines, Mount Isa Business Unit

Mr Willis was Commercial Manager at Mount Isa Mines from October 1998 until January 2000 when he transferred to MIM's Carpentaria Gold Mine at Ravenswood to take up the position of General Manager. He is a mechanical engineer, and also holds a Diploma in Management and a Master of Business Administration degree. Mr Willis has a strong background in engineering, and has also worked in MIM's open-cut mine at Newlands as Engineering Manager and Operations Manager, as well as being Planning Manager of Newlands, Collinsville and the Abbot Point Project.

### Tim Hodge Safety, Health and Environment Manager Mount Isa Mines, Mount Isa Business Unit

Mr Hodge held the position of Safety, Health and Environment Manager at Mount Isa Mines from January 1998 to March 1999. Prior to this appointment, he was the Environmental Services Manager from December 1997. Mr Hodge held various positions before commencing with MIM including research and advisory roles with the Western Australian and South Australian Departments of Agriculture; Technical Services Manager with AMF-Agra Fertilizers, and Agronomist with Hi-Fert.

### Jim Fewings General Manager, Health Safety and Environment Mount Isa Mines, Mount Isa Business Unit

Jim Fewings worked for 32 years with MIM, based in Mount Isa. During that period, he held a number of positions in operations and research, including most recently being Research and Development Manager for eight years and General Manager, Health Safety and Environment, for two years. The Panel Assessment Study was initiated during his later appointment.

### Cr Ron McCullough Mayor of Mount Isa

Councillor McCullough was born in Northern Ireland. He came to Australia in 1960, and spent six months in Sydney before finding his way to Mount Isa. He worked for MIM for 20 years, in a number of roles including miner, timberman, shift boss and safety officer. Cr McCullough was elected to local government in 1985, and became Mayor of Mount Isa in April 1990. He still retains that position. He has accepted a number of roles while in local government but has become most involved in addressing the health needs of the community in north-west Queensland, including being a board member of the Northern Regional Health Authority for four years. He currently chairs the Management and Advisory Committees of the Mount Isa Centre for Rural and Remote Health, and participates in a multitude of other local and State committees.

### Prof Robert MacLennan Emeritus Professor Queensland Institute of Medical Research

Professor MacLennan was born in Brisbane and graduated in medicine from the University of Queensland. He was Senior Principal Research Fellow and head of Epidemiology and Population Health at the Queensland Institute of Medical Research from 1982 until his retirement in 1996, and Professor in the Joint Tropical Health Program with the University of Queensland. Previously he held appointments at a number of universities, both in Australia and overseas, and at the International Agency for Research on Cancer at the World Health Organisation.

Professor MacLennan has served on many committees, including being the chair of the steering committee of the La Trobe Valley Health Study (1980-1983), and the expert committee to review "Veterans and Agent Orange Report of the Institute of Medicine, US National Academy of Sciences (1993 – 1994)". His major interests are in the environmental causes of chronic diseases, in particular cancer epidemiology, field epidemiology and tropical health. He has done epidemiological field work in Australia, Papua New Guinea, France, USA, Colombia, Ecuador, Kenya, Uganda, Denmark, Finland, Hong Kong, Singapore and Thailand.

#### John Thinee President

#### **Mount Isa Chamber of Commerce**

Mr Thinee is a licensed real estate agent and auctioneer, and has lived in Mount Isa for 34 years. He is currently the principal of Jays Real Estate, which he and his wife established about 20 years ago. He has four children, two employed in the family business. Mr Thinee is on a number of community organisation committees, including the Salvation Advisory Board, the Mount Isa Schools and Industry Links, the North West Development Initiative Group (Mining Branch), the Mount Isa-Townsville Economic Development Zone, the Carpentaria Minerals Expo and the Mount Isa Recreational Fish Stocking Group. He has been a member of the Mount Isa Chamber of Commerce for the last 10 years and president for the past six years.

#### Isabelle Vallin

#### **Queensland Conservation Council**

Ms Vallin is a qualified teacher and has worked in Canberra as a university lecturer and as a speechwriter and adviser to the former Minister for Foreign Affairs, the Hon. Gareth Evans QC. Ms Vallin became Executive Director of the Conservation Council of Canberra and the South East Region (NSW) before moving to Queensland where she worked in the Department of Environment and Heritage on the National Pollutant Inventory (NPI) Trial as project officer and then project manager. Ms Vallin is currently completing the first Australian report on industry's response to the NPI implementation (South Australia). She is also the Secretary/Treasurer of the Brisbane Consumers' Association.

### James Whelan

#### **Queensland Conservation Council**

Mr Whelan co-ordinated the Queensland Conservation Council's "Smogbusters" project from 1995 to 2000. He is a qualified secondary school teacher, and an adult and community educator with a long-standing interest in air quality. He was a vocal critic of the Queensland legislation to exempt MIM from state and national air quality standards, having contributed to the development of the National Environment Protection Measure for Ambient Air.

#### **Brian Clark**

#### **Queensland Conservation Council**

Mr Clark holds qualifications in both mechanical and electrical engineering and is registered as a chartered engineer. His career has included both project design and project management in major energy and process chemical plant installations. He has also managed chemical plants. Mr Clark is now retired from professional practice and has developed a comprehensive interest in ambient air quality resulting from major pollution sources.

## David Williams CSIRO Division of Energy Technology

Mr Williams has been with the CSIRO since 1963. Since 1976, he has been involved in a wide range of experimental studies concerning atmospheric science and air pollution. The overall objectives of these studies have been to assess a (potential) pollution situation in order to provide data to help optimise control strategies and assist decision makers, to improve the science of air pollution and to contribute to the assessment and mitigation of greenhouse gas emissions. The studies have included extensive field investigations into a variety of air pollution problems at many locations around Australia. The field studies have involved extensive use of aircraft and specially instrumented vehicles and have resulted in better understanding and models of pollution processes.

Mr Williams has authored or co-authored more than 50 papers in international journals and conferences and 40 reports to industry and government departments. He is an Associate Editor, Atmospheric Environment, and a member of the Clean Air Society (Australia).