Expert Position Statement on health-based standards for Australian regulated thresholds of nitrogen dioxide, sulfur dioxide and ozone in ambient air.

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Background

Given the overwhelming importance of clean air to health, the statement addresses the pending revision of national standards for the air pollutants: nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and ozone (O_3).

Our Recommendations:
1. Lower the thresholds of nitrogen dioxide, sulfur dioxide, and ozone, and alter the reporting metrics. The value and forms proposed are outlined in a table on pages 3-4.
2. The network of NEPM compliance monitors should be expanded to reflect particular risks from widespread source emissions and hotspots, such as traffic on major roadways.
3. Air quality monitoring data should be made publicly available through a coordinated national website, allowing access to real-time and historical data.
4. Air quality standards should include compliance obligations and enforcement mechanisms.
5. Strong health-based standards should be set now to protect health, with an exposure reduction framework in place for continual improvement of the standards.

Ambient air quality standards for Australia are set by agreement between the various state and territory environment ministers, in a process known as the National Environment Protection Measure, or NEPM. The purpose of the NEPM is to “minimise the risk of adverse health impacts from exposure to air pollution for all people, wherever they may live”. The NEPM standards are advisory and not enforceable under law. Individual states and territories use the Ambient Air Quality (AAQ) NEPM standards as a guide to form their own enforceable standards.

Australia’s first AAQ NEPM standards were adopted in 1998 for six criteria air pollutants; particulate matter, lead, carbon monoxide, nitrogen dioxide, sulfur dioxide and ozone. After 21 years, the standards for nitrogen dioxide, sulfur dioxide and ozone are under review. The standards for these pollutants are currently set well-above international best practice levels.

Nitrogen Dioxide (NO_2)

Nitrogen dioxide is formed from high temperature combustion, such as emissions from vehicles, coal-fired power stations and industrial processes. Nitrogen dioxide can irritate eyes, nose, throat and lungs, causes coughing, shortness of breath. Higher exposure causes illness and disease, impacting a wide range of organs including the lungs, heart and circulatory system. There is strong evidence for adverse effects in vulnerable groups including people with chronic disease, the elderly and children.[1]

Sulfur Dioxide (SO_2)

Fossil fuels contain traces of sulfur compounds, producing sulfur dioxide when they are burnt. The majority of the sulfur dioxide emissions come from coal-fired power generation. Exposure to sulfur dioxide can damage the lungs. People with impaired heart or lung function including asthma are at increased risk. Sulfur dioxide is involved in the creation of acid rain and secondary fine particle air pollution which causes cardiovascular and respiratory diseases, including cancer.[2]

Ozone (O_3)

Ozone is a gas that is formed on hot sunny days when oxides of nitrogen react with organic substances in the air. Motor vehicle exhaust fumes produce as much as 70% of the oxides of nitrogen and 50% of the organic chemicals that form ozone. Ozone can impact the airways and lungs. People who are exposed to ozone can experience difficulty in breathing and coughing. Ozone can increase susceptibility to lung infections and aggravate lung diseases such as asthma, chronic obstructive pulmonary disease, and chronic bronchitis. People with asthma might have more attacks and athletes might find it harder to perform as well as usual.[3]

Health impacts: a summary of recent Australian evidence. (See table on pp.5-6)

Ambient air pollution contributes to over 3000 premature deaths each year in Australia.[4] Even at low concentrations, nitrogen dioxide, sulfur dioxide and ozone are impacting the health of Australians. Coal-fired power stations and motor vehicles are the main sources of sulfur dioxide and nitrogen dioxide respectively, in Australia.[5,6] Diesel powered vehicles emit a much higher amount of nitrogen dioxide compared to petrol vehicles.[7]

The following studies have been conducted in Australia and published in the last decade, demonstrating statistically significant health impacts at pollutant concentrations below NEPM thresholds (summarised in table on pp.5-6).

Traffic related nitrogen dioxide is strongly associated with childhood asthma with effect sizes much greater than previous studies.[8,9,10] Increased susceptibilities have been noted in sub-groups such as younger children (between 0 - 4 years)[10,11] and carriers of specific genetic variants.[12] Nitrogen dioxide is also associated with increased risk of atopy[12] and, consistent with international evidence,[13] reduced lung function,[8,12] which can lead to lifelong adverse health effects and premature death.[13]

Adverse neonatal outcomes, including preterm birth, low weight at birth and fetal growth restriction are associated with maternal exposures to nitrogen dioxide, sulfur dioxide, and ozone.[14,15,16] Laboratory confirmed paediatric influenza has also been associated with ozone.[17]

Adverse health effects from nitrogen dioxide, sulfur dioxide and ozone are not limited to paediatric and neonatal outcomes. A longitudinal cohort of middle-aged Australians demonstrated positive associations between traffic-related nitrogen dioxide exposure and both current asthma, the incidence of new asthma, and atopy.[9,12]

Long term exposure to sulfur dioxide has been associated with cardiorespiratory mortality. The association persisted at low concentrations and was found to vary across the geographic area of Brisbane.[18]

Reducing air pollution in Australia

Air pollution 'hotspots' - both in urban and regional areas close to freight routes, busy roads, intersections, certain industry, mining activities and coal-fired power stations - result in some communities bearing a higher burden of air pollution health impacts and environmental injustice.[19,20,21,22]

In urban areas, vehicle emissions contribute up to 80% of nitrogen dioxide emissions.[5] Australia holds the lowest rank out of the 35 OECD countries for fuel quality.[23] While diesel vehicles are being phased out in many OECD countries due to the health impacts associated with diesel emissions, in Australia the proportion of diesel vehicles on the roads has increased.[24,25]

In response to the US Clean Air Act 1990, many US power plants installed wet flue-gas desulfurisation units (scrubbers) which can remove 99% of sulfur dioxide emissions.[26] Nitrogen dioxide emissions can also be dramatically reduced with the instillation of selective catalytic reduction.[26] None of Australia's ten largest coal-fired power stations have been fitted with these technologies. Yet internationally, many similar power stations have been successfully retrofitted with such pollution-reduction technology.[27,28]

Lowering the NEPM standards for nitrogen dioxide and sulfur dioxide, and making them enforceable, will require Australian vehicle and coal-fired power station emissions to be reduced in line with international best practice. This is an important step towards addressing the current air pollution related health inequities.

Air pollution related mortality costs the Australian public an estimated $16 billion per year.[29] In the United States, the cost benefit analysis of the US Clean Air Act for 1970 – 1990 has been estimated at a value of $US 22.2 trillion (health related economic benefits) compared to the implementation costs of $US 0.52 trillion.[30] In the UK, a study over four decades from 1970-2010, demonstrated that effective pollution control policies can bring substantial public health benefits.[31]

Our Recommendations:

1. Lower the thresholds of nitrogen dioxide, sulfur dioxide, and ozone, and alter the reporting metrics. The value and forms proposed are outlined in the table on p.4:

Table Key:	
Ppb	Parts per billion
RIS	Regulatory Impact Statement
99th centile	The value in a data set that is exceeded by 1% of data points
WHO	World Health Organization
Yearly worst hour	The highest value of the 8,760 1-hour values in a year. The 99th centile of hourly values potentially allows for 87 bad air days per year.
Daily worst hour	The 365 values for daily 1-hour maximum. The 99thcentile of daily worst hour permits 4 bad air days per year.

Standard (All units in ppb)	**International standards**	**Current Australian standard**	**NEPM RIS proposal**	**Our proposal**
SO_2 1-hour	**US:** 75, as 99th centile of daily worst hour **Canada:** 70, as 99th centile of daily worst hour **EU:** 124	200, as yearly worst hour, not to be exceeded.	100, as yearly worst hour, not to be exceeded.	60, as 99th centile of daily worst hour.

SO_2 24-hour	**WHO:** 7.6 **EU:** 44 **UK:** 44	80	20, no exceedances.	8, no exceedances.
SO_2 annual	**Canada:** 5 No standard in other jurisdictions.	20	No standard	No standard
NO_2 1-hour	**WHO:** 97 **US:** 100, as 99th centile of daily worst hour **EU:** 97	120, as yearly worst hour, not to be exceeded.	90, as yearly worst hour.	72, as 99th centile of daily worst hour.
NO_2 annual	**WHO:** 19 **US:** 53 **EU:** 19	30	19, no exceedances.	9, no exceedances.
O_3 1-hour	**NZ:** 70 **Japan:** 60	100	No standard	70
O_3 4-hour	No standard in other jurisdictions.	80	No standard	No standard
O_3 8-hour	**WHO:** 47 **US:** 70, as 99th centile of daily worst hour **Canada:** 63 **EU:** 56	No standard	65	47

2. The network of NEPM compliance monitors should be expanded to reflect particular risks from widespread source emissions and hotspots, such as traffic on major roadways. Air quality standards should protect people wherever they live, including those close to coal-fired power stations and major roadways. To accurately reflect population exposure, the network of NEPM compliance monitors should be expanded to more effectively evaluate the exposure of vulnerable groups and populations living near major sources of air pollution. This includes urban roadside locations where people live, work and learn, including schools and childcare centres.

3. Air quality monitoring data should be made publicly available through a coordinated national website, allowing access to real-time and historical data. This should include records from daily monitoring of key pollutants, health alerts for the general public and at-risk population sub-groups, and regular modelling of dispersal from all major point sources, such as coal-fired power stations and major roadways. This is critical to provide individuals and communities with information about what they are breathing.

4. Air quality standards should include compliance obligations and enforcement mechanisms. A strong and proactive approach to air pollution prevention requires robust and well-resourced institutional arrangements capable of decisive policy intervention. This includes incentives and penalties that create a sufficient deterrent to prevent non-compliance. This is critical to provide affected members of the community a recourse for action when adversely affected by air pollution.

5. Strong health-based standards should be set now to protect health, with an exposure reduction framework in place for continual improvement of the standard, in order to "minimise the risk of adverse health impacts from exposure to air pollution for all people, wherever they may live". There is no rational basis for proposing a weak standard now and a tighter standard in future. An exposure reduction framework is required for continually improving the standards as new human and environmental health data becomes available.

Table of Australian Studies demonstrating statistically significant health impacts of nitrogen dioxide, sulfur dioxide, and ozone at concentrations well-below current and NEPM RIS proposed thresholds (published in the last decade):

Study and location	**Findings**
Knibbs et al. (2018)[8] Across 12 Australian cities	Small increases in nitrogen dioxide exposure are significantly associated with increased risk of asthma and reduced lung function in children (7 – 11 years). Mean NO_2 exposure 8.8ppb.
Chen (2018)[14] Brisbane	SO_2, NO_2 and O_3 associated with adverse birth effects (preterm birth and low birth weight) with the strongest effect observed for sulfur dioxide and ozone and trimester 3 exposure. Mean SO_2 1.84ppb. Mean NO_2 6.74ppb. Mean O_3 16.76ppb.
Bowatte (2018)[9] Cohort of Australians, originally recruited from Tasmania, now residing across Australia	NO_2 associated with Increased risk of both the development and persistence of asthma in middle-aged Australians. Mean NO_2 5.4ppb.
Bowatte (2017)[12] Cohort of Australians, originally recruited from Tasmania, now residing across Australia	Long term exposure to NO_2 associated with allergies, wheeze, and reduced lung function in middle aged. Carriers of GSTT1 null genotype are at increased risk. Mean NO_2 5.4ppb.
Perret et al. (2017)[32] Cohort of Australians, originally recruited from Tasmania, now residing across Australia	Positive association between NO_2 and raised Interleukin6 levels (marker of systemic inflammation). Mean NO_2 4.2 ppb.
Li et al. (2016)[15] Brisbane	Preterm birth associated with exposure to NO_2 and SO_2 directly prior to onset of labour. Mean NO_2 6.52 ppb. Mean SO_2 1.95 ppb.
Xu et al. (2013)[17] Brisbane	O_3 significantly associated with lab confirmed influenza in children 0 – 14 years. Mean O_3 15.3 ppb.

Perreira (2012)[16] Perth	Exposure to NO_2 in mid-late pregnancy is associated with increased risk of fetal growth restriction. Mean NO_2 23.04ppb.
Periera et al. (2010)[10] Perth	NO_2 exposure associated with increased hospital ED admissions for asthma in children. Children 0 – 4 years most vulnerable to the effects. Mean NO_2 6.79 ppb.
Wang et al. (2009)[18] Brisbane	Long-term exposure to SO_2 associated with cardio-respiratory mortality. Mean SO_2 5.4ppb.
Hu et al. (2008)[33] Sydney	SO_2 and high temperatures contribute to excess mortality in summers in Sydney. Mean SO_2 1 ppb.
Jalaludin et al (2008)[11] Sydney	NO_2, SO_2 and O_3 associated with ED visits for asthma in children. Results most consistent for 1 – 4 years age group. Mean NO_2 23.2 ppb.

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