National Environment Protection (Ambient Air Quality) Measure

Technical Paper No. 9

Lead Monitoring

Prepared by the
Peer Review Committee

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PREAMBLE

The National Environment Protection Measure (NEPM) for Ambient Air Quality was made in June 1998 with the desired environmental outcome of "ambient air quality that allows for the adequate protection of human health and well-being" across Australia. The NEPM sets national standards against which ambient air quality can be assessed. The NEPM includes a monitoring protocol to determine whether these standards are being met. Each jurisdiction is required to submit to the National Environment Protection Council (NEPC) a monitoring plan consistent with the protocol.

The Peer Review Committee (PRC) was established to assist NEPC in its task of assessing and reporting on the implementation and effectiveness of the NEPM by participating jurisdictions. The PRC includes government experts from all participating jurisdictions, in addition to representatives from industry and community groups. A significant activity of the PRC is the provision of advice to NEPC on the adequacy of jurisdictional monitoring arrangements, to ensure as far as possible that a nationally consistent data set is obtained.

To assure the consistency and transparency of its advisory function, the PRC has developed a set of guidance papers that clarify a number of technical issues in interpretation of the NEPM protocol. These Technical Papers provide the basis for PRC assessment of jurisdictional plans, aimed at assuring the quality and national consistency of NEPM monitoring.

The PRC Technical Papers are advisory for jurisdictions, and they will evolve with time as the science of air quality monitoring and assessment develops and as practical experience with monitoring increases.

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1. PURPOSE

The purpose of this paper is to provide guidelines for monitoring lead in ambient air in major cities under the Ambient Air Quality - National Environment Protection Measure - (AAQ NEPM).

2. INTRODUCTION

The AAQ NEPM sets an ambient air quality standard for lead as 0.50 μg/m^3, arithmetic mean averaged over a calendar year.

The AAQ NEPM specifies that

- lead sampling must be carried out for a period of 24 hours at least every sixth day;
- measurement of lead must be carried out on total suspended particles (TSP) or its equivalent; and
- particulate lead must be determined using High Volume Sampler Gravimetric Collection – Flame Atomic Absorption Spectrometric Method (AS2800-1985 and AS2724.3-1984).

Lead was included in the list of criteria pollutants in the AAQ NEPM on the basis of its historical widespread occurrence in urban air and its effects on human health.

There has been a longstanding concern over the effect of long-term exposure to low levels of lead on the nervous system and the intellectual development of young children. Many jurisdictions have been monitoring lead in air at sites such as childcare or healthcare centres, schools and at locations where maximum concentrations are expected such as near busy roads.

Current lead levels in urban air are generally low and decreasing and Clause 14(3) of the AAQ NEPM is applicable to monitoring programs in jurisdictions. Clause 14(3) states that "Fewer performance monitoring stations may be needed where it can be demonstrated that pollutant levels are reasonably expected to be consistently lower than the standards mentioned in this Measure."

3. DISCUSSION

Outside the major local point sources, such as lead smelting facilities, roads are the main locations of lead emissions. The principal source of public exposure to airborne lead in major Australian cities is the emissions from motor vehicles using leaded petrol. Lead compounds were added to petrol as octane extenders. Australian Environment Council Report No 22 *Air emission inventories (1985) for the Australian capital cities*, AGPS, Canberra, summarised vehicle lead emissions for each of the capital cities as generally more than 90% of total emissions except when a major industrial source was present. Emission inventories of the major cities have since been refined, but still confirm vehicles as the dominant source. More than 90 percent of this airborne lead is associated with fine particles (particles with diameters up to 2.5 μm).

Australia has undertaken a very effective long-term national strategy to control lead in air. Programs undertaken in all jurisdictions over a quarter of a century have led to progressively lower levels of lead in leaded petrol and an increased use of unleaded petrol. Unleaded petrol (ULP) was introduced in 1985 for use in catalyst–equipped cars. The normal replacement of vehicles with ones designed to use ULP has automatically reduced the use of leaded petrol, total lead emissions and therefore the lead concentration in ambient air. For example, sales of leaded petrol in Australia halved from 1980 to 1995. This reduction was augmented by the progressive decrease in the lead content of leaded petrol itself. 1995 estimates of vehicle lead emissions in Victoria, South Australia and Tasmania, where estimates are readily available, were one-fifth, one-fifth and one-third of the 1980 levels. As part of the national strategy, leaded petrol is being

phased out completely by the year 2002. A rapid decrease in airborne lead is therefore anticipated to coincide with the phaseout of lead in petrol.

Annual ambient lead concentrations from six Australian capital cities for the period 1981 to 2000 are shown in Figure 1. Monitoring data from the peak site, described as a roadside monitoring station, from each of the six cities are used in this graph. Data from each city demonstrate the same pronounced downward trend. By the year 1995 the annual peak concentrations at every city fell below the AAQ NEPM Standard. The siting and exposure at these peak sites, are not exactly the same; for example, the distance to roads varies from 2 to 15 metres, and the traffic density varies from moderate to very heavy. In addition, the lead content in petrol and the rate of decrease in lead in petrol over the period of record varied from city to city. These variations are likely to account for different concentration levels between cities, particularly before 1994.

The pronounced downward trends in the national ambient monitoring results demonstrate the effectiveness of the national lead strategy. All of the current monitoring sites in the major urban regions, including the sites close to heavily trafficked roads, show compliance with the AAQ NEPM Standard of 0.50 $\mu g/m^3$. With the approach of the complete phaseout of lead in petrol, further reductions are expected in lead levels in ambient air.

Lead is no longer a general urban public health concern, unless there are significant emissions from large point sources in the area. In the major cities where vehicles have been the dominant source, intensive monitoring of lead is no longer warranted.

Monitoring requirements of regions where significant lead emissions from large point sources (such as smelters) exist or are planned are not covered in this technical paper.

4. MONITORING STRATEGY

In view of the current status of compliance and the demonstrated downward trends in ambient lead levels and in lead emissions to air, the Peer Review Committee (PRC) considers that limited monitoring at one or more peak sites (where the worst case, maximum concentrations, are expected) in a major city region is sufficient to monitor compliance with the AAQ NEPM Standard. Compliance at peak sites will reassure the public, as the exposure in residential areas would be significantly less than the levels at peak sites. Limited or reduced monitoring of lead in major cities would also enable jurisdictions to focus their resources on monitoring lead in regions where emissions from stationary point sources and their impacts on neighbouring populations may be of concern or on monitoring other pollutants of concern.

The highest concentrations of lead are expected to be found near major roads with heavy traffic. The requirement is that each major city nominates at least one roadside peak station for monitoring lead. Variations in topography, population and meteorology should be considered in establishing the number and sites of the monitoring stations. Monitoring sites must be located near roads and heavy traffic corridors where maximum concentrations are expected. In locating the monitors, emissions inventories, traffic patterns, physical and meteorological characteristics of the region should be considered.

Studies showing the vertical and horizontal lead distribution in ambient air indicate that lead levels decrease exponentially with distance from roads. Because of the steep concentration gradients, peak sites need to be located close to busy roads. Studies in the US show that concentrations are greatest at the breathing level height of about 1.1 metre. Optimal placement of the sampler inlet for lead monitoring is considered to be at breathing height level. However, in recognition of the practical difficulties in monitoring at the breathing height, the USEPA allows monitors to be placed at a vertical height between 2 and 7 metres. The USEPA criteria

for spacing from roads specify that monitors should be placed between 2 and 15 metres on the downwind side of the roadways. The upper limits are seen as compromises in difficult cases. It is understood that these peak sites are high exposure sites generally not representative of residential areas.

5. KEY ELEMENTS OF THE TECHNICAL PAPER

With the phaseout of lead in petrol, the main source of airborne lead in the major cities is expected to be eliminated by the year 2002. Already the population not resident alongside high-traffic arterial roads is exposed to concentrations of lead that are many times less than the AAQ NEPM Standard.

When applying the screening criteria developed for implementation of the AAQ NEPM (NEPC (Ambient Air Quality) Measure Technical Paper No. 4), the extensive data available satisfy the Category A and B screening requirements. Monitoring results at GRUB (Generally Representative Upper Bound) sites for periods of over 5 years, with concentrations showing a downward trend to less than 50% of the AAQ NEPM Standard, appear to meet the criteria.

In view of the above, it is appropriate to use indicator sites near high traffic flows to measure airborne lead in major urban areas. Monitoring results and petrol supply decisions indicate that this approach is more than sufficient to monitor the phaseout of the use of lead in petrol. Data from peak sites can be used to confirm continued compliance with the AAQ NEPM and to assess national trends and general conditions of exposure for other population centres.

It is anticipated that within 2 years, motor vehicle lead will be so low that the continued routine measurement of lead in urban air would be hard to justify, unless the region is exposed to a major non-vehicle source.

When airborne lead concentrations at peak sites are consistently well below the AAQ NEPM Standard it can be concluded that compliance with the AAQ NEPM Standard and Goal has been achieved.

In regions where there are no current or anticipated significant non-vehicle sources (mines, industry) monitoring of 24-hour lead levels will no longer be required once measurements at peak sites are consistently at or below the level of precision threshold (about 10% of the AAQ NEPM Standard).

Figure 1. Annual Lead Concentrations at Australian Capital Cities, 1981-2000