Review of an Assessment of Ethanedinitrile for Log Fumigation

Report to the Environmental Protection Authority

Prepared by Dr Bruce Graham

April 2018

GRAHAM
ENVIRONMENTAL
CONSULTING LTD

Executive Summary

This report provides a review and assessment of several documents relating to the use of ethanedinitrile (EDN) for fumigation of logs under tarpaulins. The documents were submitted to the EPA in support of an application under the Hazardous Substances and New Organisms Act 1996 for the import and use of ethanedinitrile as a fumigant on timber and logs under commercial conditions

METHODOLOGY

The potential air concentrations of EDN released from the fumigation of log piles were assessed by the applicant using a technique known as atmospheric dispersion modelling. Some of the key factors to consider in dispersion modelling are the specific model to be used, the meteorology for the site under consideration, and the source characteristics.

Dispersion Model

The model used for this assessment was AEROMOD. This is routinely used in New Zealand and elsewhere for assessing the effects of industrial discharges to air. However, it is debateable whether this, or any other dispersion model, is really suitable for simulating the complex release patterns that are likely to occur during the ventilation phase of a log pile fumigation.

Meteorology

The meteorological inputs for the model were based on a data set for the Port of Tauranga. As one of the larger log handling facilities in New Zealand this is an appropriate choice, and the modelling results may also be generally applicable to other large ports in New Zealand. However, they may not be directly relevant to more constrained locations, such as Picton, where the plume behaviour would be significantly affected by the surrounding local topography.

Source Release Rates

The release estimates for EDN were based on a fumigation phase of 23 hours followed by ventilation in the final hour of a 24-hour cycle. The EDN releases during fumigation are due to gradual permeation of the gas through the tarpaulin, and this was determined using laboratory tests on samples of the tarpaulin normally used by New Zealand operators. Typically, about 10% of the applied EDN was lost by permeation through the material over a 24 hour period.

The EDN releases during the ventilation stage were estimated using the data from a laboratory-based study of EDN absorption into samples of *pinus radiata* logs. The results for treatment at 150 g/m^3 showed a residual average EDN concentration of 11.1 g/m^3, or 5216 ppm. In other words, more than 90% of the EDN had been taken up by the logs and less than 10% was available for release during ventilation.

The report on the laboratory study contains extensive discussion and analysis of the effects of loading rates on the level of EDN uptake. The term loading refers to the proportion of 'air space' in the chamber (or under the tarpaulin) that is taken up by the logs. The absorption studies involved an average loading of 37% and it was argued that the data should be modified to reflect a loading of 50%. The proposed change is not insignificant; for the 150 g/m^3 treatment rate the residual EDN concentrations are reduced to 1.4 g/m^3. This represents a 99% uptake of the applied EDN, rather than the ~90% figure noted above.

The modelling for the ventilation phase was based on the reduced EDN concentrations. However, there is no real-world data available to support the use of these very low gas concentrations. As a result, the current review has been based on both the as-reported results and those that would be produced for the much higher concentrations reported for a 37% load factor.

Other Source Characteristics

The modelling was based on individual log piles with a total volume of 750 m^3. However, it is known from previous studies that some log piles can be up to twice this size. This would require the use of double the amount of EDN and corresponding releases of twice the amount of residual gas. For the purposes of this review, the modelling results were adjusted upwards by a factor of 2 to account for this possible difference in log pile volume.

MODELLING RESULTS

The modelling assessment considered fumigation of a single log pile, and fumigation of up to 30 log piles at a time. The results for the latter are of most interest here because they represent a probable worst-case scenario for fumigations at New Zealand ports.

The fumigation days for both scenarios were selected using a Monte Carlo technique, which involved repeated random sampling through a 5-year meteorological data set. The results given in the modelling report are for the 95th and 90th percentile results but only the 95th percentiles have been considered here, in order to give a more conservative assessment. Similarly, only the results for an EDN treatment rate of 150 g/m^3, have been considered because that is the maximum rate proposed by the applicant. The key results are those shown in the table below.

	EDN Concentrations (in ppm) versus Distance away from the Logs					
	20m	**40m**	**60m**	**80m**	**100m**	**120m**
24-hour average as reported	0.029	0.019	0.014	0.012	0.010	0.009
24-hour average after adjustment*	0.429	0.281	0.207	0.178	0.148	0.133

(* The adjusted figures shown in the bottom row of the table account for the possibility that residual EDN concentrations under the tarpaulins could be much higher than assumed in the modelling, and that the log piles could be double the assumed size of 750 m^3)

DISCUSSION

The modelling assessment was nominally based on fumigations being done at the Port of Tauranga. The results may be generally applicable to other large ports, but they may not be directly relevant to more constrained locations, such as Picton. In addition, the modelling report is solely concerned with releases from log piles under tarpaulins, and the results cannot be used to predict the potential effects from other fumigation operations.

Potential Risks

The potential risks from log pile fumigations were considered for both occupational and non-occupational situations by assessing the results against the relevant exposure criteria.

For occupational exposures it was noted that all of the modelling results were well below the proposed workplace exposure standard. However, the modelling results are not really suitable for making decisions about workers operating closer than 10 metres to the log piles, because of the uncertainties in characterising the likely air movements around the log piles. In very simple terms, anyone standing close to the log piles when the tarpaulins are removed has the potential to be exposed to instantaneous EDN concentrations of between, say, 700 to 5,200 ppm. Clearly, under that situation the use of appropriate PPE would be essential.

The situation for non-occupational bystanders was assessed by comparing the results against two exposure criteria; an acute exposure guideline level (AEGL) of 2 ppm (1-hour average), and a proposed Tolerable Exposure Limit (TEL) of 0.034 ppm as a 24-hour average.

All of the 1-hour average results were well below the AEGL, so compliance with this limit should not be a concern. However, this was not the case for the 24-hour results. Here the as-reported results were all below the 0.034 level, but the adjusted results were all well above it. None of the latter would be acceptable unless appropriate control measures are put in place.

Control Options

For the purposes of this assessment the modelling results were adjusted upwards to account for the possibility that residual EDN concentrations under the tarpaulins could be much higher than assumed in the modelling, and that the log piles could be double the assumed size of 750 m^3. Therefore, one option for addressing these uncertainties would be to require that ventilation of the log piles should not be undertaken until the EDN concentrations drop below, say, 700 ppm and that the log piles sizes should be limited to no more than 750 m^3.

The use of buffer distances is a key control measure for the current uses of methyl bromide as a fumigant and there would be some logic in continuing to apply that approach for EDN. The applicant has proposed that a buffer distance of 20 metres be applied. However, for the reasons given in section 4 of this report, buffer distances of around 50 or 120 metres may be more appropriate.

Monitoring

The report concludes with a brief discussion of air monitoring options. The applicant has proposed using an electrochemical gas analyser for monitoring EDN exposures. The instrument specified has an operating range of 1 to 50 ppm and a repeatability 2 ppm. As a result, this instrument would only be marginal for monitoring against a workplace exposure standard of 2 ppm and it would definitely not be suitable for monitoring against any exposure limits lower than that. No other suitable instruments have been identified for the continuous monitoring of sub-ppm levels of EDN in air, and it is likely that the only viable options would involve the collection of gas samples, either in gas containers or on absorption tubes, followed by analysis in a laboratory.

Contents

Review of an Assessment of Ethanedinitrile for Log Fumigation

1. Introduction

This report provides a review and assessment of several documents relating to the use of ethanedinitrile (EDN) for fumigation of logs under tarpaulins. It has been prepared under contract to the New Zealand Environmental Protection Authority (EPA).

1.1 Documentation

The documents reviewed in this work were submitted to the EPA in support of an application under the Hazardous Substances and New Organisms Act 1996 for the import and use of ethanedinitrile as a fumigant on timber and logs under commercial conditions (EPA ref: APP202804). The documents reviewed were as follows:

- Ethanedinitrile (EDN): A new fumigant for phytosanitary treatment of New Zealand export logs. Brierley, *et al*, Plant & Food Research, Auckland. July 2017.
- Tarp permeability testing for EDN. Laboratory study AAL 2017-GEN-01, Ajwa Analytical Laboratories LLC, Gilroy, California. December 2017.
- Air Concentration Dispersion Modelling Assessment of Ethanedinitrile (EDN) Concentrations in Tauranga Port, New Zealand. Sullivan Environmental Consulting Inc., Alexandria, Virginia. January, 2018.

These documents cover experimental and theoretical studies of the use of EDN as a log fumigant. All of the studies are based on recognised methodologies and been carried out to an acceptable degree of scientific rigor.

Several other documents were also consulted in preparing this report and these have been noted at the relevant places in the text.

1.2 EDN Properties and Exposure Criteria

Ethanedinitrile is a colourless gas with a pungent and penetrating almond-like odour. It has a boiling point of -21°C and is normally supplied as a pressurised liquid. It is heavier than air with a specific gravity of 1.806 (relative to air = 1).

The gas concentrations in air can be expressed in units of either parts per million (ppm) or mg/m^3, using the following conversion factor: 1 ppm EDN = 2.128 mg/m^3. Worksafe New Zealand is currently consulting on setting a Workplace Exposure Standard for EDN of 2 ppm, as an 8-hour average. The Science Memo prepared by the EPA for this application has proposed a Tolerable Exposure Limit (TEL) for EDN of 0.034 ppm as a 24-hour average. An acute exposure guideline level (AEGL) of 2 ppm (1-hour average), as recommended in other jurisdictions, is also relevant[1].

1.3 Report Layout and Content

The key document to be considered here is the dispersion modelling report. The methodology used for the modelling will be discussed in section 2 of this report, including key aspects such as model selection, meteorology, and the source characteristics. The modelling results will then be summarised and discussed in section 3, followed by a more targeted discussion in section 4 of the potential risks from EDN use and the possible options for minimising or managing those risks.

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[1] See Appendices A and H of the Science Memo prepared by the EPA.

2 Dispersion Modelling Methodology

The potential air concentrations of EDN released from the fumigation of log piles were assessed using a technique known as atmospheric dispersion modelling. This attempts to simulate the movement of the gas away from the log piles and its dispersion downwind under the influence of atmospheric conditions. Some of the key factors to consider in dispersion modelling are the specific model to be used, the meteorology for the site under consideration, and the source characteristics, each of which will be discussed in the sections below.

Dispersion modelling is commonly used for assessing the potential effects of industrial discharges to air, especially through one or more stacks or vents. It has also been used for determining the effects of area sources, such as oxidation ponds, and motor vehicles traveling on roads. However, its application to the releases of fumigants from log piles is not well-established. Some specific models have been developed for assessing the effects of releases from soil fumigation but these releases have quite different characteristics from those for log piles.

The main difficulty with assessing the releases from log piles is in adequately characterising the gas discharge rates and the geometry of their releases. For fumigations under tarpaulins the bulk of the releases will occur more or less instantaneously along the top and sides of the log piles as the tarpaulins are removed. The movement of the gases will be significantly affected by any induced draft caused by the tarpaulin removal, and by any micro-meteorological effects in and around the log piles (eg. wind whirls and eddies). None of these factors can be adequately simulated using the normal modelling approach, which is usually limited to a consideration of reasonably uniform release distributions coupled with the wind conditions occurring generally across a site.

Given these limitations, it is important to recognise that the modelling results should be regarded as having a high degree of uncertainty. As a general principle[2], dispersion modelling results are usually taken as being reliable to within a factor of ±2. However, for the current application the uncertainty is likely to be somewhat higher. The additional uncertainty arises from the difficulties noted above, and cannot be quantified.

It should also be noted here that the modelling report is solely concerned with releases from log piles under tarpaulins. The application documents also cover other fumigation operations, such as logs inside shipping containers and logs placed in ships' holds. However, the modelling results for logs under tarpaulins cannot be used to predict the potential effects from either of these uses.

2.1 Dispersion Model Used for the Assessment

The model used for this assessment was AEROMOD. This was developed by a committee established by the US Environmental Protection Agency (US EPA) and the American Meteorological Society. It was formally adopted by the US EPA in 2005 for use in regulatory applications[3], and has since been accepted for regulatory purposes in several Australian States[4]. It is also being routinely used in New Zealand, although there is no national system for formal recognition of such models. It has effectively replaced the model known as AUSPLUME.

AEROMOD is an appropriate model for use in this assessment, although the reservations noted above regarding the modelling of log pile fumigations will still apply.

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[2] MfE, 2004. Good Practice Guide for Atmospheric Dispersion Modelling. Ministry for the Environment, Wellington.

[3] See: https://www.epa.gov/scram/air-quality-dispersion-modeling-preferred-and-recommended-models.

[4] Eg. see http://www.epa.vic.gov.au/our-work/monitoring-the-environment/monitoring-victorias-air/regulatory-model-for-air-pollution-modelling.

2.2 Meteorology

The assessment was nominally based on fumigations being done at the Port of Tauranga. As one of the larger log handling facilities in New Zealand this is an appropriate choice. The modelling results produced for Tauranga may be generally applicable to other large ports, such as Northport. However, they may not be directly relevant to more constrained locations, such as Picton, where the plume behaviour would be significantly affected by the surrounding local topography.

Meteorology is a key input to the dispersion model, and includes parameters such as wind speed and direction, atmospheric stability (turbulence) and mixing height. A meteorological database is normally assembled covering one or more years of recent data and, in this case, the applicant's consultants considered a 5-year period of 2012 to 2016.

To access this data the applicant's consultants initially tried using a UK web-based service but, perhaps not surprisingly, the available information was found to be inadequate. It appears to have been based on the hourly manual weather observations that are made during daylight hours only at most New Zealand airports. Ideally, they should have accessed the 24-hour continuous data generated by the automatic weather station operated by the NZ Met. Service at Tauranga airport.

As an alternative approach, the applicant's consultants purchased a data set from a US-based company, Lakes Environmental Software Met Data Services. It is not clear what local data, if any, was used to produce this data set. However, the wind rose shown in Figure 1 of the modelling report is generally similar to those reported previously by others[5,6], which suggests that the data can be taken as reasonably representative of the local weather conditions.

2.3 EDN Emission Rates

The fumigation of logs under tarpaulins typically involves fumigation over a period of about 16 to 24 hours, with the tarpaulins in place, followed by a ventilation phase, when the tarpaulins are removed. For the purposes of the modelling, it was assumed that the fumigation phase took 23 hours while the ventilation phase occurred over the final hour of a 24-hour cycle.

2.3.1 Releases during Fumigation

The EDN releases during fumigation are due to gradual permeation of the gas through the tarpaulin. The rate of permeation will be determined by the thickness and composition of the tarpaulin material and the concentration differential across the tarpaulin (ie. inside vs outside).

The method used for determining the permeation rate is described in the report by Ajwa Analytical Laboratories, and involved tests on actual samples of the tarpaulin normally used by New Zealand operators. The tests were carried out using a standard ASTM method and involved three replicates at each of three treatment concentrations of around 50, 100 and 150 g/m^3. Typically, about 10% of the applied EDN was lost by permeation through the material over a 24 hour period.

2.3.2 Releases during Ventilation

The EDN releases during the ventilation stage were estimated using the data reported by Brierley *et al* (as listed in s1.1 above), from a laboratory-based study of EDN absorption into samples of *pinus radiata* logs. This involved treatments at EDN concentrations of 50 to 225 g/m^3 in a fumigation chamber for periods of up to 24 hours. For convenience, the discussion here will be focussed on the results for 150 g/m^3, which is the proposed maximum treatment rate.

The results for treatment at 150 g/m^3 showed residual average EDN concentration of 11.1 ± 8.9 g/m^3, or 5216 ± 4182 ppm. In other words, more than 90% of the EDN had been taken up by the

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[5] Chappell, P R, 2013. The Weather and Climate of Bay of Plenty. NIWA Science and Technology Series, No 62. NIWA, Wellington.

[6] AECOM, 2015. Te Puke WWTP - Air Quality Assessment. AECOM Consulting Services Ltd, Auckland.

logs and less than 10% was available for release during ventilation. This is a significantly higher level of removal compared to methyl bromide, where it is believed that about 35% of the initial fumigant is available for release.

The report by Brierley *et al* contains extensive discussion and analysis of the effects of loading rates on the level of EDN uptake. The term loading refers to the proportion of 'air space' in the chamber (or under the tarpaulin) that is taken up by the logs. The absorption studies involved an average loading of 37% and it is argued by the authors that the data should be modified to reflect a loading of 50%, which they claim is the rate typically achieved in port operations. However, no data or factual information has been provided to support the 50% figure and, given the bulk log handling procedures used at the ports it is hard to see how such a standardised rate could ever be achieved. This level of control would require careful selection and placement of individual logs on each pile, which just isn't done.

The modification proposed by Brierley *et al* is not insignificant; for the 150 g/m^3 treatment rate the residual EDN concentrations drop from 11.1 ± 8.9 g/m^3 to 1.4 ± 1.0 g/m^3. This represents a 99% uptake of the applied EDN, rather than the ~90% figure noted above.

The applicant was asked to provide a technical explanation of the loading effect to support the use of the reduced figures, but none was forthcoming.

The emission rate used in the modelling for the ventilation stage was based, more or less, on the reduced figures reported by Brierley *et al*[7]. However, for the current assessment it would be more appropriate to work with the original, much higher, figures. This is easily accounted for by multiplying the modelling results by a factor of 7.4 (11.1 divided by 1.5).

2.4 Other Source Characteristics

The modelling report provides assessments for the fumigation of a single log pile, and fumigation of up to 30 piles at a time. The results for the latter are of most interest here because they represent a probable worst-case scenario for fumigations at New Zealand ports.

The individual log piles were assumed to be 60 metres long, 5 metres wide and 2.5 metres high, giving a total volume of 750 cubic metres (m^3). According to the applicant these dimensions represent typical port practices, based on the advice received from one operator. However, they do not represent the possible worst case.

A review of methyl bromide fumigation operations prepared by the author in 2009[8], reported log piles ranging in volume from about 160 to 1500 m^3. In addition, from personal observations at Tauranga and other ports it is quite common for the logs to be stacked much higher than 2.5 metres.

The height of the log piles should not have a significant effect on the downwind EDN concentrations beyond a distance of about 10 to 20 metres away from the piles. However, the volume of the log piles will. Quite simply, a log pile of 1500 m^3 would require twice the amount of EDN as one of 750 m^3, and would release double the amount of residual gas. For the purposes of producing a worst-case assessment, the modelling results should be adjusted upwards by a factor of 2 to account for this possible difference in pile volume.

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[7] The figure actually used was 1.5 g/m^3 but no reason for this minor change from 1.4 g/m^3 was given.

[8] Graham, B, 2009. Review of Methyl Bromide Monitoring Reports. Report prepared for the EPA in support of the reassessment of methyl bromide, Graham Environmental Consulting Ltd, Auckland.

3. Dispersion Modelling Results

This section provides a summary of the key dispersion modelling results, while the significance of these will be discussed in section 4.

3.1 Overview

The modelling was done for two scenarios, fumigation of a single log pile and fumigation of multiple log piles on the same day. The multiple pile scenario was based on three groups of 10 piles with a spacing of about 100 metres between each group. On 60% of the days modelled it was assumed that only one set of 10 piles would be fumigated, while on 30% of the days two groups were fumigated and all three groups were fumigated on the remaining 10% of days. Within each group two log piles were fumigated per hour, and the start times for each group were randomly selected within the period of 7 am to 7 pm. Data collected by the Bay of Plenty Regional Council[9] shows that the number of log piles treated on any day is highly variable, but 30 log piles per day is a reasonable estimate of the probable maximum.

The fumigation days for both scenarios were selected using a Monte Carlo technique. This involved repeated random sampling, in this case using 40 cycles through the 5-year meteorological data set. This generates a set of 40 results for each scenario. The results given in the modelling report are for the 95th and 90th percentiles, which represent the 3rd and 5th highest values for the dataset of 40 results. The use of these percentiles is quite common in dispersion modelling because it is argued that the absolute maximum values represent weather conditions that may only occur on relatively rare occasions.

The modelling results are presented in the report as contour plots which show the concentration distributions around the log piles. It should be noted that these contour plots represent the combined effects of multiple fumigations throughout the year. On any one occasion the concentration plume would only travel in a single downwind direction away from the log piles. The contours are produced by combining the results for all days.

The modelling was carried out for EDN treatment rates of 50, 100 and 150 g/m^3, but only the latter values will be considered here because that is the maximum rate applied for by the applicant. Similarly, only the 95th percentile results will be considered, in order to give a more conservative assessment.

3.2 Results for a Single Log Pile

The results for single log pile fumigations are summarised in Table 3.1 below. All of the concentration values are given in units of parts per million, ppm.

The figures given in the first and third data rows of the table are the 'as reported' values given in the modelling report, while the figures given in the second and fourth data rows have been adjusted for the two factors discussed in sections 2.3 and 2.4 (ie. load factor and log pile size).

The values given in the table were taken from Figures A3.1 and A6.1 of the modelling report. As can be seen from those figures the highest concentrations occur to the side of the log piles (ie. nominally to the north or north-east of the pile, as it is laid out in the figures). It should be noted that the concentration values for each distance away from the log pile were determined by visual estimation from the figures, so may not be very precise.

The fall-off in concentration with increasing distance away from the log pile is relevant to the consideration of control measures, such as buffer distances, which will be discussed in the next section.

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[9] Iremonger, S., Bay of Plenty Regional Council, pers comm, 2016.

Table 3.1: EDN Concentration Results (in ppm) for a Single Log Pile.

	EDN Concentrations at Varying Distance away from the Log Pile					
	10m	**20m**	**30m**	**40m**	**50m**	**60m**
1-hour average, as reported	0.004	0.0035	0.0025	0.002	0.0015	0.001
1-hour average after adjustment	0.059	0.052	0.037	0.030	0.022	0.015
24-hour average as reported	0.010	0.007	0.005	0.003	0.002	0.001
24-hour average after adjustment	0.148	0.104	0.074	0.044	0.030	0.015

One surprising feature of the modelling data is that the 24-hour results are higher than the one-hour values. If the modelling had been solely concerned with the ventilation phase of the process it would have shown a single EDN peak spread over say, one to two hours, followed by very low (effectively zero) concentrations for the remainder of the 24-hour period. From simple mathematical considerations, the maximum 1-hour value for that situation would be at least an order of magnitude higher than the corresponding 24-hour average result. The fact that this is not seen here suggests that the 24-hour results have been strongly influenced by the preceding fumigation phase, where the releases are solely due to permeation through the tarpaulin. This is surprising, since the total releases during this phase are only about 20% of the ventilation releases in the final hour (see Figure 4 of the modelling report).

3.3 Results for Multiple Log Piles

The results for multiple log pile fumigations are summarised in Table 3.2 below, with the data having been taken from Figures A-9.1 and A-12.1 of the modelling report. The information presented in the table is much the same as described above for Table 3.1, apart from the use of an expanded distance scale. In addition, the concentration estimates were made in an easterly direction away from the log piles to avoid the apparent plume merging shown in between the groups of log piles. This merging is an anomaly of the contour smoothing rather than an actual effect, because the plumes from adjacent piles will not flow towards each other under normal wind conditions (eg. under a south-westerly wind they will both flow to the north-east).

Table 3.2: EDN Concentration Results (in ppm) for Multiple Log Piles.

	EDN Concentrations at Varying Distance away from the Log Pile					
	20m	**40m**	**60m**	**80m**	**100m**	**120m**
1-hour average, as reported	0.020	0.015	0.012	0.010	0.007	0.007
1-hour average after adjustment	0.296	0.222	0.178	0.148	0.104	0.104
24-hour average as reported	0.029	0.019	0.014	0.012	0.010	0.009
24-hour average after adjustment	0.429	0.281	0.207	0.178	0.148	0.133

4. Discussion

This section provides a discussion of the modelling results in terms of the potential risks associated with EDN fumigations and possible control options, including monitoring.

4.1 Limitations in the Scope of the Assessment

As noted previously, the modelling assessment was nominally based on fumigations being done at the Port of Tauranga. The modelling results may be generally applicable to other large ports, such as Northport. However, they may not be directly relevant to more constrained locations, such as Picton.

Also, as noted previously, the modelling report is solely concerned with releases from log piles under tarpaulins. The application documents also cover other fumigation operations, such as logs inside shipping containers and logs placed in ships' holds. However, the results for logs under tarpaulins cannot be used to predict the potential effects from either of these uses.

4.2 Potential Risks from Log/Tarp Fumigations

The potential risks from log pile fumigations can be assessed by comparing the modelling results with the various exposure criteria noted in section 1.2. This will be considered below for occupational and non-occupational situations.

4.2.1 Workplace Exposures

All of the 1-hour and 24-hour results shown in Tables 3.1 and 3.2 are well below the proposed workplace exposure standard (WES) of 2 ppm, even after adjustment for log pile size and loading factors. (For the purposes of this comparison it can be assumed that the 8-hour average results would be intermediate between the 1-hour and 24-hour values). This suggests that workers could safely operate at distances of 10 metres or more away from the log piles without needing respirators and other personal protection equipment (PPE).

The modelling results are not really suitable for making decisions about workers operating closer than 10 metres to the log piles, because of the uncertainties in characterising the likely air movements, as discussed at the start of section 2 of this report. However, in very simple terms, anyone standing close to the log piles when the tarpaulins are removed has the potential to be exposed to instantaneous EDN concentrations of between, say, 700 to 5,200 ppm. Clearly, under that situation the use of appropriate PPE would be essential.

4.2.2 Non-Occupational Exposures

The situation for non-occupational bystanders can be assessed by comparing the results against the various exposure criteria given in the Science Memo prepared by the EPA for this application. Two limits will be considered here; the acute exposure guideline level (AEGL) of 2 ppm (1-hour average), and the proposed Tolerable Exposure Limit (TEL) of 0.034 ppm as a 24-hour average.

All of the 1-hour average results given in Tables 3.1 and 3.2 are well below the AEGL, so compliance with this limit should not be a concern. However, this is not the case for the 24-hour results. Here the as-reported results are all below the 0.034 level, but the adjusted results are all well above it. None of the latter would be acceptable unless appropriate control measures are put in place, as will be discussed below.

4.3 Options for Minimising or Managing the Risks

As noted above, all of the as-reported 24-hour average modelling results are below the TEL of 0.034 ppm. However, these results were adjusted upwards to account for the possibility that residual EDN concentrations under the tarpaulins could be much higher than assumed in the modelling, and that the log piles could be double the assumed size of 750 m^3. Therefore, one option for addressing these uncertainties would be to require that the EDN gas concentrations be measured prior to ventilation, and ventilation should not be undertaken until the concentrations drop below, say 700 ppm. In addition, log piles sizes could be limited to no more than 750 m^3.

Variations on these limits could be considered in conjunction with the use of buffer distances, as discussed below.

The use of buffer distances is a key control measure for the current uses of methyl bromide as a fumigant and there would be some logic in continuing to apply that approach for EDN. The applicant has proposed that a buffer distance of 20 metres be applied. However, the as-reported 24-hour average results given in Table 3.2 suggest that this may not be far enough away. The overall uncertainty in the modelling method should be kept in mind when comparing the results against any criteria. As discussed at the start of section 2, the modelling results should be regarded as having an uncertainty of ±2 or greater. On this basis, for an exposure limit of 0.034 ppm, the modelling results should only be regarded as acceptable if they fall below a value of 0.017 ppm. Based on the as-reported 24-hour results in Table 3.2, a buffer distance of around 50 metres would appear to be appropriate. Alternatively, if log piles of up to 1500 m^3 were allowed (ie. double the size assumed in the modelling), a buffer distance of about 120 metres would be necessary.

4.4 Monitoring

The applicant has proposed using an electrochemical gas analyser for monitoring EDN exposures. The instrument specified has an operating range of 1 to 50 ppm and a repeatability 2 ppm. As a result, this instrument would only be marginal for monitoring against a workplace exposure standard of 2 ppm and it would definitely not be suitable for monitoring against any exposure limits lower than that.

Some possible options for monitoring low levels of EDN in air were reviewed by the author in 2013. These included a range of sophisticated (and relatively expensive) instruments but none of these had the necessary sensitivity. It was also noted that the photoionisation devices that are currently used for methyl bromide would not be suitable because the ionisation potential of EDN is too high for the gas to be detected.

Most likely the only viable options for monitoring EDN would involve the collection of gas samples, either in gas containers or on absorption tubes, followed by analysis in a laboratory.