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Odour Regulations – Experiences from Australia

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Odorous emissions from waste treatment and management and intensive livestock operations often cause annoyance to local receptors, impacting quality of life, resulting in public complaints for regulatory agencies that require appropriate management responses. Within communities, there is often a large range of reactions to odorous emissions. On the one hand there are receptors that are very sensitive to specific odours (i.e. highly odour-sensitive) and will react very strongly to odours that are barely noticeable by the majority of the population. On the other hand there are other receptors within a population (often because of their association with the odour-generating activity) who are more tolerant to these odour annoyances. However, the bulk of the population lies between these two receptor groups, being unaffected by low levels of odour and being prepared to accept certain levels of odour annoyance. A major challenge for regulatory agencies is to provide community protection from offensive odours without unfairly disadvantaging odour-emitting industries that communities often rely on for their economic prosperity. To achieve this environmental outcome, regulators apply a range of odour management strategies, tailored to particular industry sources and emission impacts. Such strategies need to be able to minimise odour impacts from new activities, as well as resolve problems from existing operations.

1. Introduction

Odours are ranked as the main generators of public complaints by regulatory agencies in Europe, North America, and Australia (Lebrero et al., 2011). The growing number of complaints is due to the increased release of odorous gases and the growth of communities surround existing emission sources (Nicell, 2009; Pillai et al., 2010; Wang et al., 2012). Odours can indirectly affect the well being of communities, and within a community there can be a wide range of reaction to odours. There are people who are very sensitive to odours where as there are others within a community (often because of its association with the activity of odor generation) which are more tolerant of higher levels of odour. The majority of the population is between the two limits is not affected by low levels of odor and can tolerate certain levels of odor (DEC, 2006a).

Odours tend not to attract the same level of attention by authorities compared to environmental issues that a more visible, such as pollution of water and those generated in industrial areas. However, for those communities facing odour issues, the impacts are significant. Odour annoyance has been the biggest source of complaints registered by the Department of Environment of the State of New South Wales, South Australia (DEC, 2006a). Odours has also been a major source of complaints in Perth, Western Australia, which accounts for one third of the records. Most complaints of odour relating to industries that are centered around processing animal products (DEP, 2002).

The challenge is to protect communities from unpleasant odours without imposing unrealistic or unfair conditions on businesses and industries, which communities depend for their economic prosperity. To achieve this odour management strategies need to take into account the specificities of odorant sources and levels of tolerable impacts. Such strategies should be able to minimise the impact of odours of new activities, as well as troubleshoot existing businesses and services industries (DEC, 2006a).

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This paper will present an overview of environmental regulation and management strategies in Australia with the intent to establish improved odour impact regulation and management in Brazil and other South American countries.

1.1 Odour assessment criteria in Australia

The laws for regulating the emission of odours were developed in the 70s in European countries, Australia and United States. According to Nicell (2009), the most common approach to regulate odours was done by determining the maximum concentrations in ambient air (outside the boundaries of the property - primarily in OU or equivalent units). This approach does not regulate issuers by their respective emission rates, but by the perception of odours by neraby residents to the same region. The verification of compliance of these laws generally employs dispersion models to predict the concentrations of odours in the vicinity of the emitter. Table 1 shows the concentration limits of odours in ambient air (enforce) in Australia in 2013.

In all Australian state, technical handbooks to guide the management of odours have been established.

In State of New South Wales (NSW), for example, state regulated technical framework include "Assessment and management of odour from stationary sources in NSW" (DEC, 2006a) and "Technical notes" (DEC, 2006b), which are supported by professional association technical handbooks for sampling and modeling (CASANZ, 2013). All guideance documents support the use and demonstration of best practice technology and approaches that are available to minimize air pollution (such as odours) that include estimating impacts using models such as the dispersion of air pollutants (CASANZ, 2013). In practice (in NSW), 'offensive' odour can only be judged by public reaction to the odour, preferably under similar social and regional conditions. The nuisance level can be as low as 2 OU and as high as 7 OU. An odour assessment criterion of 7 OU is likely to represent the level below which 'offensive' odours should not occur. Therefore, the Technical Framework recommends that, as a design criterion, no individual should be exposed to ambient odour levels of greater than 7 OU (99th percentile, nose response time average) (DEC, 2006b).

Table 1: Odour concentration limits in ambient air in Australia (in 2013)

State	Odour concentration limits in ambient air	Averaging time and frequency of perception
Queensland	0.5 OU for tall stacks 2.5 OU for ground level sources and down washed plumes from short stacks. These criteria have been developed based on a 5 OU short term impact and have been translated to a one hour averaging time using a peak-to-mean ratio of 10:1 for tall stacks and 2:1 for other sources	1-hour average, 99.5% percentile
New South Wales	Individual odorous pollutants In the case of hydrogen sulfide Complex mixtures of odour, varying from 2 O.U.m³ (Rural residence) to 7 O.U.m³ (Urban area)	impact assessment criteria depending on population density Peak concentrations in 1 sec - with 99% percentile
South Australia	2 OU (2000 people or more); 4 OU (350-1999 people); 6 OU (60-349 people); 8 OU (12-59 people); 10 OU (less than twelve people)	3 mins averaging time using 99.9%
Victoria	Offensive odours must not be discharged beyond the boundaries of the premises	3 mins and worst operating condition using 99.9% percentile
Western Australia	2 OU 4 OU	3 mins using 99.5% percentile 3 mins using 99.9% percentile

2. Odour legislation in New South Wales

Depending on the individual characteristics of a new development and its proposed location, a varying degree of investigation into the potential for odour may be required. For this reason, in NSW, three levels of odour impact assessment for odour sources have been adopted, depending on whether an odour-emitting activity is new, modified or existing, regardless of whether these are classed as point or diffuse (DEC, 2006a). The framework also provides a process by which industry-specific odour assessment procedures may be developed (DEC, 2006a).

Level 1 is a screening - level technique based on generic parameters for the type of activity and site. It requires minimal data and uses simple equations to provide a broad estimate of the extent of any odour impact. It may be used to assess site suitability and odour mitigation measures for new or modified activities and is particularly suitable for smaller developments in sparsely populated areas such as a small broiler chicken farm located in a rural area with no existing or likely future sensitive receptors located nearby.

Level 2 is a screening - level dispersion modeling technique, using worst-case input data (rather than site-specific data). It is more rigorous and more realistic than a Level 1 assessment. It may be used to assess site suitability and odour mitigation measures for new, modified or existing activities. For example, Level 2 assessment can be used to determine whether a proposed upgrade and expansion of a sewage treatment plant would result in odour impacts on local residents;

Level 3 is a refined - level dispersion modeling technique using site-specific input data. This is the most comprehensive and most realistic level of assessment available. It may be used to assess site suitability and odour mitigation measures for new, modified or existing activities. For example, Level 3 assessment using concentrations of pollutants measured at site emission sources could be undertaken to assess whether proposed mitigation strategies would be adequate to reduce odour impacts from a waste oil processing facility, the subject of long-term numerous complaints from neighbours.

The level of assessment will depend on the specific characteristics of the proposal and the likelihood of operational odour impacts.
The three levels of assessment are designed so that the predicted odour impacts are more accurate as the level of assessment becomes higher (progressing from Level 1, which is generalised, to Level 3, which is site specific). This means that, for a given facility, the result of a Level 1 impact assessment would be more conservative (that is, would overestimate the impact) and less detailed about the nature and frequency of impact than the result of a Level 2 assessment, and so on. The three levels provide a cost-effective assessment approach based on the individual characteristics of a proposal, including scale and complexity; proximity of sensitive receptors; and topographic and meteorological conditions (DEC, 2006a).
The three levels of assessment are design tools, however, they can only predict the likely odour impacts. In some cases, once a facility is operational, odour impacts may be experienced at some locations. The operator will need to address these odour impacts and, if necessary, modify the facility based on actual, rather than predicted, operational outcomes (DEC, 2006a). The three levels of assessment methodology require consideration of odour impacts at existing sensitive receptors. In addition, where there are likely to be off-site impacts, the proponent should also consider the probability that surrounding land use will change. This means he or she should take into account how the activity will impact on future land use. The three-level assessment approach can be used to guide future land-use planning (DEC, 2006a).

3. Appropriate levels of assessment: NSW odour criteria

3.1 New or modified activities

It is not intended that a proponent would routinely progress through all levels of assessment. For some proposals a Level 1 assessment would be sufficient to identify whether a site is suitable for a proposed activity. On the other hand, if it is likely that odour will be a significant issue, there is no impediment to immediately conducting a level 2 or 3 assessment. If the proposal exceeds the Level 1 assessment significantly then the proponent might consider other sites rather than proceeding to level 2 or 3 assessments (DEC, 2006a).
Level 1 assessment is a screening technique that provides a broad estimate of probable odour impacts. If a proponent can demonstrate a clear ‘pass’ at Level 1 odour impact assessment, there is no need to undertake level 2 or 3 assessment, regardless of the size of the project, unless there are special risk factors such as: topographic or meteorological features that may funnel the odour plume or cause it to accumulate; a populated area located just outside the calculated separation distance (DEC, 2006a).
Criteria for individual odorous air pollutants in complex mixtures of odorous air pollutants:

A. Individual odorous air pollutants

The NSW EPA has adopted Ground-level concentration (GLC) criteria for individual odorous pollutants and toxic compounds, set on the basis of either odour or health impacts. Where several activities with similar odour character will result in a cumulative impact, the total of the odour emissions from all contributing activities needs to be considered (DEC, 2006a, CASANZ, 2013)

The framework adopts the GLC criteria in approved methods for the modeling and assessment of air pollutants in NSW, which are based on odour threshold or toxicity threshold (which ever is more stringent) (CASANZ 2013). These are used to assess the likely performance of a project and acceptability of impacts at any location beyond the boundary of a premise (DEC, 2006a).

In general, the GLC criteria are set in order to protect the public against adverse health effects, aesthetic effects, offensiveness and economic loss that might occur (for example, if vegetation is affected). Since the area of interest (the 'breathing zone') is close to the ground, the acceptable concentrations are referred to as ground-level concentrations (GLCs) (DEC, 2006a).

B. Complex mixtures of odorous air pollutants

Odorous air pollutants need to be managed carefully because they can be considered to cause harm and/or unreasonably interfere with the community's well being. Odour assessment criteria provide guideance for decisions about effective odour management but recognise it may be neither possible nor desirable to achieve 'no odour' (DEC, 2006a).

The detectability of an odour is a sensory property that refers to the theoretical minimum concentration that produces an olfactory response or sensation. This point is called the 'odour threshold' and defines one odour unit (1 OU). Therefore, an odour criterion of less than 1 OU would theoretically result in no odour impact being experienced (DEC, 2006a). In practice, the character of a particular odour can only be judged by the receiver's reaction to it, and preferably only compared to another odour under similar social and regional conditions.

Odour assessment criteria: These are applicable to complex mixtures of odours. The framework adopts the odour assessment criteria in Approved methods for the modeling and assessment of air pollutants in NSW (DEC, 2005). They are used to assess the likely performance of a project and acceptability of impacts at the nearest places where people are likely to work or reside (both existing and any likely future sites). These places are referred to in subsequent instances as 'sensitive receptors' or, more simply, 'receptor' (see glossary). If a receptor is, or is likely to be, located near the boundary of a premises that emits odour, then the criteria should be applied at and beyond the boundary of the premises. The appropriate criterion for a single affected residence is deemed to be a concentration of odour equal to seven times the theoretical minimum necessary to produce an olfactory sensation. This can be expressed as 7 odour units (7 OU). For receptors that have larger populations, in which there will be a greater range of sensitivities to odour (and a higher number of more sensitive individuals), acceptable odour is defined as 2 OU (DEC, 2006a).

Odour assessment criteria need to be designed to take into account the range in sensitivities to odours within the community, and provide additional protection for individuals with a heightened response to odours. This can be done using a statistical approach, which depends upon the size of the affected population. As the affected population size increases, the number of sensitive individuals is also likely to increase, which suggests that more stringent criteria are necessary in these situations. Therefore, the odour assessment criteria allow for population size, cumulative impacts, anticipated odour levels during adverse meteorological conditions and community expectations of amenity (DEC, 2006a).

A summary of odour assessment criteria for various population densities is shown in Table 2.

Table 2: Odour assessment criteria for complex mixtures of odorous air pollutants (CASANZ, 2013)

Population	Odour units (OU) 1=second average, 99th percentile
Rural residence <2	7
~10	6
~30	5
~125	4
~500	3
Urban area >2,000	2

For New facilities the impact assessment criteria for complex mixtures of odorous air pollutants must be applied as follows (DEC, 2005):

1. At the nearest existing or likely future off-site sensitive receptor;

2. The incremental impact (predicted impact due to the pollutant source alone) must be reported in units consistent with the impact assessment criteria (OU), as peak concentrations (i.e. approximately 1 second average) in accordance with the requirements of Section 6 and as the:
    a. 100th percentile of dispersion model predictions for Level 1 impact assessments, or
    b. 99th percentile of dispersion model predictions for Level 2 impact assessments.

3.2 Odour criteria for existing activities

If odour impacts are found to occur after a facility is operational, the extent of the problem and whether the impacts warrant further action or are acceptable can be determined using confirmed complaints. A comprehensive odour audit may assist to identify, quantify and prioritise sources of odour at a site so that odour-mitigation efforts may be efficiently targeted. Sampling and analysis of emissions of odour from high priority sources can be a useful component of an odour audit (DEC, 2006a).
In most cases the application of best management practices and negotiated changes to practice will be sufficient without the need to undertake odour modelling. In some situations, such as where significant management and control option changes are proposed, it may be appropriate to undertake a level 2 or 3 assessment to better quantify the extent to which these proposed measures may mitigate the odour. Level 1 assessment is not appropriate for use in this situation (DEC, 2006a).

Odour criteria for existing activities (DEC, 2006a):
Once a facility is operational the benchmark for the facility is no longer the odour assessment criteria but whether the emission of odour is:

- 'offensive' (for scheduled activities), or
- being prevented or minimised using best management practices (for scheduled and non-scheduled activities)

4. Conclusions

Odorous emissions from anthropic activities often cause annoyance to local receptors, impacting community quality of life, resulting in public complaints for regulatory agencies that require appropriate management responses. A major challenge for regulatory agencies is to provide community protection from offensive odours without unfairly disadvantaging odour-emitting industries that communities often rely on for their economic prosperity. To achieve this environmental outcome, regulators need to apply a range of odour management strategies, tailored to particular industry sources and emission impacts. How you apply these approaches will different for existing and new infrastructure as well as the complexity of the emission source.
Odour assessment and GLC criteria as used in the state of NSW, Australia demonstrate important planning tools that pontentially be establish in Brazil and other South American countries in order to establish and/or improve odour impact regulation and management designed to help with assessing the likely acceptability of a proposal or odour mitigation strategies:

- For a new or modified activity, the relevant odour assessment or GLC criteria should be used routinely by a proponent in project planning, to guide decisions on on choosing a location of odour-generating activities, construction and assess proposed odour management strategies;
- For existing activities, the relevant odour assessment and GLC criteria may be used on a case-by-case basis to guide the development and improvement of odour mitigation strategies to address odour impact problems arising during operation.

The odour assessment criteria are concerned with controlling odours to ensure offensive odour impacts will be effectively managed but are not intended to achieve 'no odour'.

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