Emissions Dispersion Modelling Appraisal (Version 2 June 2016)

1. Introduction

This document focuses on modelling emissions from point sources and on emissions from incinerators in particular. However, some of the sources for which links are provided do give information on models geared to meet different requirements such as the modelling of national pollution patterns. It is not the purpose of this document to draw conclusions as to a preferred model but rather to lead Members to sources where others have drawn them. However, in section 8(2), a specific recommendation is made regarding 'on the ground' checks should an incinerator actually be commissioned.

Comments on this document will be welcomed. Please address them to the Coordinator of UKWIN.

Emissions dispersal modelling is a continually developing field and any comparisons are unlikely to remain fully valid for long.

Emissions Dispersion Modelling is undertaken to

a) replicate the flow patterns of the different pollutant types from combustion or other industrial processes as emitted at point (eg an incinerator flue) or other source types (eg a motorway).

b) estimate, for different pollutant types, the process contributions from these sources at preset point locations in the adjacent area.

The estimated process contributions, for each pollutant type, at the point locations are then added to the background levels and compared with the set down Environmental Quality Standards (EQSs) and Environmental Assessment Levels (EALs) for particular pollutants.

Tables showing how the results of modelling pollutant levels in the case of a planned waste incinerator, are presented in the planning application (the Environmental Statement) and the Environmental Permit (EP) application.

The modelling is undertaken using software tools designed for the purpose and approved, in the case of England and Wales, by the EA, and, in the case of Scotland, by the SEPA.

There are many dispersion modelling tools worldwide, some are 'proprietary' products, others are bespoke developments.

The proprietary tool most commonly used by UK companies seeking permits for waste incinerators has been ADMS (Atmospheric Dispersion Modelling System, developed by CERC in Cambridge) version 4.2 although this has lately upgraded to version 5.

AERMOD, a US Environment Protection Agency (EPA) product has also been used.

The tools are designed – in the case of an incinerator - to process the details of the flue gas emissions as they leave the incinerator in conjunction with the prevailing weather patterns – wind speeds and directions at differing altitudes, air temperatures and humidity and a digital representation of the land form in the adjacent area, and then to produce an indication as to how these emissions impact on the surrounding areas.

The tools are complex and, for the purposes of planning applications and EP applications, are required, from a mass of data relating to a specific period, to produce a single mean process contribution for each pollutant type at each of the selected point locations.

The actual levels of the pollutants in the flue gas of an incinerator will vary over the short and long term.

Moreover, it is important to understand that the results amount to mean values of pollutant levels that, at any one point in time, depend not only on the source but on the meteorological conditions at that time and, in temperature and wind direction terms, these can vary very considerably. The integrity of the actual results is therefore difficult to confirm, or disprove, other than by the capturing and testing of numbers of samples over a period. See section 9(b).

It is not the intention of this document to address the detailed functionality of any of the different models but links are provided to enable readers to access the ADMS and AERMOD websites and the respective user guides.

2. The Environment Agency

The EA sets out its modelling requirements in Air Dispersion Modelling Report Requirements in

https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit. This give advice on assessing the impact of releases to air from listed activities when applying for a permit under the Environmental Permitting Regulations.

The EA does not publish a list of approved models, neither does it, as a general rule, undertake 'off site' monitoring exercises to determine actual emissions levels as compared to modelled ones. The EA takes the view that the best approach is effective monitoring of emissions as they leave incinerator flues and, having set the standards for Continuous Emissions Monitoring (CEM), leaves it to operators to do this but also to submit periodic emissions levels reports.

The EA does, however, have a number of bespoke models for its own uses.

Local Authorities are responsible for monitoring pollution levels in their own areas but there is no statutory onus on them to undertake site specific monitoring of incinerator emissions.

However, recently issued Environmental Permits do include a requirement that the actual process contribution of certain pollutants do appear to require, a certain time after an incinerator has been commissioned, to be measured and compared with the modelled levels. There is further reference to this aspect in section 8 of this document (Conclusions).

UKWIN has been unaware, to date, of any 'on the ground' exercise specifically geared to the monitoring emissions from an incinerator. However, see section 9b.

3. Performance of different Dispersion Modelling Systems (DMS)

It is axiomatic that various parties (including those campaigning against waste incinerators) are keen to understand how accurately, or otherwise, different models can forecast emissions dispersal patterns.

Anti incineration campaigners are justifiably concerned at the information put forward by incinerator operators regarding emissions levels and the extent to which these add to pollution levels on the ground, particularly downwind of an incinerator.

4. ADMS

See http://www.environmental-expert.com/software/adms-5-air-pollution-modelling-software-18344 for general, and access to more specific information.

5. AERMOD

https://www3.epa.gov/ttn/scram/dispersion_prefrec.htm provides access to AERMOD documentation

Breeze Aermod (provides a graphical user interface to AERMOD)

http://www.breeze-software.com/aermod/

6. Model Comparison Issues

General

It is clear that no one model meets all requirements and that a number of models have been bespoke developed for 'in house' use and for a specific purpose. It seems that requirements relating to the geographical area of coverage have a particular bearing on the chosen solution, although not necessarily for the right reasons.

ADMS / AERMOD

An objective performance comparison is difficult since although these links access comparative reports, only one of them comes close to making a comparison on the basis of model results for a waste incinerator versus on the ground actual pollutant levels. It has not been possible to locate an ADMS / AERMOD comparison for emissions dispersal modelling for an incinerator.

It may well be that ADMS seems to be the preferred option for incinerator operators because it is considered easier to use than AERMOD.

Note also that both ADMS and AERMOD are being continually developed and that comparative assessments tend not to reflect the performance of the latest versions.

7. Peer Reviewed Sources

Note that source 1 is CERC, the ADMS developers.

ADMS and AERMOD

CERC, in a report dated December 2010, said that

1) COMPARING THE PERFORMANCE OF ADMS AND AERMOD USING A HYBRID MODEL AND CONDITIONAL ANALYSIS TECHNIQUES 2011

http://www.harmo.org/Conferences/Proceedings/_Kos/publishedSections/H14-305.pdf

Note (extract from the CERC's Hybrid Model section): Inter-comparison studies between different models can be time-consuming to organise and implement, particularly when models require different input parameters. Limited access to a range of dispersion models may also restrict some users comparing results between models.
Cambridge Environmental Research Consultants (CERC) have developed a 'hybrid' model that facilitates comparisons between 2 dispersion models: ADMS (CERC, 2008) and AERMOD (Cimorelli, 2004). It offers a more user-friendly, faster and more detailed comparison by enabling users to combine the meteorological pre-processor of one model with the dispersion algorithms of the other.

2) Performance Evaluation of AERMOD and ADMS-Urban for Total Suspended Particulate Matter Concentrations in Megacity Delhi

http://aaqr.org/VOL11_No7_December2011/10_AAQR-11-05-OA-0065_883-894.pdf

Note: This report relates to particulate modelling in an urban environment but the MATERIALS AND METHODS section presents a comprehensive comparison between the performance of the two models.

3) Reference: Comparison of the Complex Terrain Algorithms Incorporated into Two Commonly Used Local Scale Air Pollution Dispersion Models (ADMS and AERMOD) Using a Hybrid Model" October 2011

http://www.tandfonline.com/doi/abs/10.1080/10473289.2011.609750

(also available via other links)

ABSTRACT from this paper

ADMS and AERMOD are the two most widely used dispersion models for regulatory purposes. It is, therefore, important to understand the differences in the predictions of

the models and the causes of these differences. The treatment by the models of flat terrain has been discussed previously; in this paper the focus is on their treatment of complex terrain. The paper includes a discussion of the impacts of complex terrain on airflow and dispersion and how these are treated in ADMS and AERMOD, followed by calculations for two distinct cases: (i) sources above a deep valley within a relatively flat plateau area (Clifty Creek power station, USA); (ii) sources in a valley in hilly terrain where the terrain rises well above the stack tops (Ribblesdale cement works, England). In both cases the model predictions are markedly different. At Clifty Creek, ADMS suggests that the terrain markedly increases maximum surface concentrations, whereas the AERMOD complex terrain module has little impact. At Ribblesdale, AERMOD predicts very large increases (a factor of 18) in the maximum hourly average surface concentrations due to plume impaction onto the neighboring hill; although plume impaction is predicted by ADMS, the increases in concentration are much less marked as the airflow model in ADMS predicts some lateral deviation of the streamlines around the hill.

IMPLICATIONS arising from the paper

ADMS and AERMOD are the two most widely used regulatory atmospheric dispersion models worldwide and both models are accepted or recommended for use in many countries. Consequently they are frequently used for environmental impact assessments, permitting applications, etc. It is therefore important for regulators, policy makers, and environmental consultants to understand the differences in the predictions of the models and the causes of these differences. This paper uses a hybrid model system that allows specific components of the models to be compared, with the focus in this case on the differences between the models' treatment of the impacts on dispersion of complex terrain.

In a recent application for an Environmental Permit (EP) for an incinerator at Javelin Park, Gloucester, the applicant, used ADMS v4.2 to undertake the modelling in support of its EP application and argued that:

"An alternative model, AERMOD, is not considered appropriate due to the topography around the site. AERMOD has known issues with modelling terrain in the locality of the facility which is of a similar height or higher than the stack. In such circumstances AERMOD models a significant proportion of the plume impacting the hill, while ADMS models in detail the plume rise over and around the hills as well as plume impaction. The most recent assessment of AERMOD vs ADMS in regions of complex terrain, undertaken by Carruthers et al, came to similar conclusions".

See section 9(b) for more information regarding recent developments.

National Level Modelling

AIR QUALITY EXPERT GROUP **Fine Particulate Matter (PM2.5) in the United Kingdom**
See Appendix 2
http://www.defra.gov.uk/publications/files/pb13837-aqeg-fine-particle-matter-20121220.pdf

8. Conclusions

1) Emissions modelling is a highly complex process involving complex algorithms and requiring the input of large volumes of accurate data. Without the latter, and in the context of incinerator emissions, neither AERMOD nor ADMS can be expected to produce representative results. In any case, both models would appear to underestimate the effects of source contributions at some off site locations, often, but not always, by relatively small sources of magnitude.

2) One situation in which ADMS and AERMOD can produce significantly different results appears to be that in which ground levels, in the vicinity of an incinerator stack, can be higher than the top of the stack. It is recommended that, in such situations, Members apply pressure on the Planning Authority to agree to the to set up an Air Quality Monitoring Area covering the downwind side of the incinerator should an EP be granted and on the EA, as part of the EP consultation process, to ensure that EP applicants are not allowed simply to opt for the modelling that produces the most favourable results (for the applicant).

3) In the majority of UK cases, the modelled process contributions from incinerators at point locations are small relative to background pollution levels (although there are exceptions). This makes it difficult to prove or disprove modelling results other than in the medium term (eg over 12 months, at least, during which a full range of measured results must be taken). Even in relatively polluted areas, the modelled process contributions from incinerators, combined with background levels, are unlikely to reach EQS / EAL levels.

4) From UKWIN's position, the basis on which modelling results are presented in Planning Applications and EP applications, and in Decision documents, can be argued as leaving much to be desired. The practice is to address pollution levels in 'mean' terms such that there is no indication of peaks and troughs as may result, for example, from variations in emission levels from incinerators themselves and through meteorological variations. It tends to follow that however accurate the results a model may be capable of, the way in which these are presented is such that they may lose much of their potential significance.

9. Further Work

a) One aspect that still needs to be pursued relates to modelling the effects of the warm air plume from the air cooled condenser that is normally situated adjacent to an incinerator. Given that the air rising from such a condenser contains some six times the heat energy as compared to that leaving the flue, its effects need to be understood.

b) Local community groups in Gloucestershire are in the process of setting up a project that will monitor the 'on the ground' effects of the emissions from the Javelin Park incinerator.

The project will assess the results against the emissions dispersions as modelled by ADMS and against those modelled using Plumeplotter, a specially adapted version of AERMOD.

The Plumeplotter modelling suggests a very different result to that by ADMS, particularly in respect of the higher ground to the East of the incinerator.

Plumeplotter will also be using local wind direction data which the ADMS modelling did not.

Details of how campaigners can access this Emissions Modelling facility, and obtain details of how to set up an on the ground monitoring project, will be published separately.
