Atmospheric Dispersion Modelling

Liaison Committee Report: ADMLC-R11

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INCLUDING

A review of the applicability of Gaussian modelling techniques to near-field dispersion

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PREFACE

In 1977 a meeting of representatives of government departments, utilities and research organisations was held to discuss methods of calculation of atmospheric dispersion for radioactive releases. Those present agreed on the need for a review of recent developments in atmospheric dispersion modelling, and a Working Group was formed. Those present at the meeting formed an informal Steering Committee that subsequently became the UK Atmospheric Dispersion Modelling Liaison Committee. That Committee operated for a number of years. Members of the Working Group worked voluntarily and produced a series of reports. A workshop on dispersion at low wind speeds was also held, but its proceedings were never published.

The Committee has been reorganised and has adopted terms of reference. The organisations represented on the Committee, and the terms of reference adopted, are given in this report. The organisations represented on the Committee pay an annual subscription. The money thus raised is used to fund reviews on topics agreed by the Committee, and to support in part its secretariat, provided by Public Health England (PHE). The new arrangements came into place for the start of the 1995/96 financial year. This report describes the most recent activities of the Committee. These include a review of the applicability of Gaussian modelling techniques to near-field dispersion. The technical specification for the contract is given in this report, and a link to the contract report can be found on the ADMLC website. Previous studies funded by the Committee are described in its earlier reports.

The Committee intends to place further contracts in future years and would like to hear from those interested in tendering for such contracts. They should contact the secretariat:

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1 ORGANISATIONS REPRESENTED ON THE COMMITTEE

The organisations on the committee at the time of publication of this report are:

Atomic Weapons Establishment, Aldermaston (AWE)

Defence Science and Technology Laboratory (Dstl)

Department for Environment Food and Rural Affairs (DEFRA)

Environment Agency for England (EA)

Environmental Protection Agency for Ireland (EPA)

Food Standards Agency (FSA)

Health and Safety Executive (HSE)

UK Meteorological Office (MetOffice)

National Resources Wales (NRW)

Office for Nuclear Regulation (ONR)

Public Health England (PHE)

Scottish Environment Protection Agency (SEPA)

The present Chairman is Dr Simon Gant of the Health and Safety Executive and the Secretariat is provided by PHE.

2 TERMS OF REFERENCE

The terms of reference of the committee are:

Areas of technical interest

1. ADMLC's main aim is to review current understanding of atmospheric dispersion and related phenomena for application primarily in authorisation or licensing of discharges to atmosphere resulting from industrial, commercial or institutional sites. ADMLC is primarily concerned with dispersion from a particular regulated site or from discrete sources, and will not normally consider work in the following areas: traffic pollution, acid rain and ozone.
2. ADMLC is concerned both with releases under controlled conditions occurring at a constant rate over long periods, and with releases over shorter periods such as accidents or controlled situations where the release rate varies.
3. ADMLC is concerned with modelling dispersion at all scales, including on-site and within buildings.

Organisations and outputs

4. The Committee shall consist of representatives of Government Departments, Government Agencies and organisations with an interest in modelling dispersion of material for the situations identified above. Each organisation represented on the Committee shall pay an annual membership fee.
5. ADMLC believes that it can be most effective by limiting its membership to about 25 organisations. New organisations will only be admitted to membership of ADMLC if the majority of existing members agree to their membership.
6. ADMLC aims to review, collate, interpret and encourage research into applied dispersion modelling problems. It does not endorse particular brands or suppliers of commercial models. However, it is concerned to ensure that users for industrial applications are aware of what is available, how it can be applied to particular problems and of the uncertainties in the results.
7. The Committee will commission work on selected topics. These should be selected following discussion and provisional agreement at meetings of the Committee, followed by confirmation after the meeting. It will produce reports describing current knowledge on the topics. These may be reports from contractors chosen by the committee or may be based on the outcome of conferences or workshops organised on behalf of the committee. The money raised from membership fees will be used to fund contractors, organise workshops and report on their outcome, and any other matters which the Committee may decide.

3 WORK FUNDED DURING THE YEAR

3.1 A review of the applicability of Gaussian modelling techniques to near-field dispersion

The review will assess the value of Gaussian model outputs to emergency responders when applied to predict near-field dispersion (typically 50-100m).

Gaussian plume and puff models are used extensively in atmospheric dispersion modelling systems, especially for conducting air quality predictions for the dispersion of material from relatively large sources (e.g. large stacks) over long periods. Comparisons of predictions from Gaussian plume models against measured data for far field receptors have shown that they provide efficient solutions. However, there is also a need to predict air quality or health impacts resulting from the dispersion of material from relatively small sources over relatively short periods. Predictions from Gaussian models are rarely compared against dispersion data from short term releases at distances over a few tens of metres as this is outside their intended domain of use. Nevertheless, such models are widely applied in such cases; in particular to provide rapid predictions to support emergency response [1]. ADMLC is interested in determining criteria to define the practical limits of applicability of Gaussian modelling techniques as distance from the source and exposure time are reduced.

Gaussian plume models such as the R91 model [2] provide simple ensemble average predictions based on a 10 m wind observation that are consistent with meteorological timescales of an hour. More complex Gaussian puff models such as SCIPUFF [3] use gridded time varying meteorology and a second order closure to provide predictions for short term releases with estimates for concentration variance. However, the Gaussian approach cannot resolve the increasingly chaotic fluctuations in concentration due to small scale turbulence and other local wind field effects introduced by the close proximity of obstacles, such as buildings, to the source. It is hypothesised that as the source is approached and timescale of interest reduced, or as the proximity to an obstacle is reduced, a point is reached at which the spatial and temporal variations in concentration are such that a Gaussian ensemble average prediction is of little value to the emergency responder, i.e. a limit of belief is reached.

To test the hypothesis it is suggested that a study is conducted to derive criteria that can be used to define the limit of belief of Gaussian modelling approaches given a threshold for health effects. To achieve this it is suggested that the study should compare near-field predictions from a Gaussian approach to those from a range of other numerical methods such as a Rockle code and Large Eddy Simulation, and experimental data if possible.

The scope of the comparison is limited to short duration releases of a neutrally buoyant gas over a range of stability conditions. The aim is to compare the variation in the predicted dosage as a function of downwind distance, crosswind distance and exposure time, for the different methods. The exercise should be conducted for a simple open terrain and then with a simple obstacle (e.g. a cube) of 3 different sizes that is placed at a range of distances downwind of the source in the direction of the wind.

The outputs should be processed and presented in non-dimensional form and a toxicity index (similar to a pollution index) approach used to determine how the hazard area/distance from source for a given level of harm varies depending on the material released, release duration, stability, obstacle size, location and modelling approach (all of which are to be agreed with ADMLC). Recommendations for the criteria to be used to determine the limit of applicability of Gaussian models should then be derived.

1. COST ES1006 Best Practice Guidelines for the use of Atmospheric Dispersion Models in Emergency Response Tools at local-scale in case of hazmat releases into the air, April 2015

2. Clarke, R.H. A Model for Short and Medium Range Dispersion of Radionuclides Released to the Atmosphere, National Radiological Protection Board NRPB-R91, Sep 1979.

3. Sykes, R.I., Parker S.F., Henn D.S., Chowdhury B.,' SCIPUFF Version 3.0 Technical Documentation, DRAFT, Sage Management, June 2015.