Atmospheric Dispersion Modelling

Liaison Committee Report: ADMLC-R13

July 2021

INCLUDING

Review of dense-gas dispersion for industrial regulation and emergency preparedness and response

Public Health England
Chilton
Didcot
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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 dense-gas dispersion for industrial regulation and emergency preparedness and response. 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)

EDF Energy

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)

RISKAWARE

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 dense-gas dispersion for industrial regulation and emergency preparedness and response

The release of dense gases is a consideration for industrial regulation and emergency preparedness and response. The dispersion of releases of dense gases is dissimilar to neutral or buoyant releases, and specific information and approaches are required to model exposure in order to inform risk assessment, management, and communication.

ADMLC is interested in a review of factors affecting the dispersion of dense gases, dense gas release scenarios, and approaches to predicting and mitigating exposure. The aim is to define typical and plausible dense gas release scenarios (to be discussed and agreed with the Committee) and evaluate approaches to modelling exposures, and to explore options for the assessment and mitigation of exposure as part of 1) industrial regulation 2) emergency preparedness and response. The report must distinguish between these two phases, particularly the differing timescales of release.

The work must be informed by an initial evaluation of the global incidence and impact on health of past dense gas release scenarios (ie, past industrial and transport-related accidents) and the potential for, and potential impact on health of, future releases in the UK based on the prevalence and failure rate of sources and any other relevant factors (ie, future incidents in the UK). The past and current framework for risk assessment and emergency response should be considered as part of this evaluation and explained in brief. The key characteristics/risk factors associated with dense gas releases versus neutral and buoyant releases should be considered, and a summary of the differences and/or differences in assessment approaches detailed. The initial evaluation should be used to contextualise discussion of the following topics of interest, focussing on chemical properties and release scenarios in particular.

Physicochemical properties. Physical form (including pressure and temperature liquefied gases, and evaporating liquids), hazardous properties (eg, flammability or toxicity) and impact criteria (including whether a given gas is dense or passive at the relevant concentration(s)).

Suggested release scenarios. Anticipated to include indoor and outdoor releases, spills/overfills, and leaks from fixed storage and pipework and mobile (transport) sources. The implications of different combinations of source types (to be discussed and agreed with the Committee) and release scenarios should be explored, and potential release durations and masses should be outlined.

Factors affecting dispersion. To include source conditions, meteorology, heat transfer and phase change, humidity, surface roughness, obstacles, and topography.

Existing experimental data. To include field-scale tests, wind-tunnel tests, model validation databases, and evaluation of data quality/completeness.

Dense gas dispersion models. Approaches including integral, shallow-layer, Lagrangian, computational fluid dynamics, and a summary of strengths and weaknesses (including an assessment of the availability of input data and the suitability of candidate models for different end-users (ie, industrial regulators, emergency planners, and emergency responders). This must include (but not necessarily be limited to the) consideration of models typically available to UK emergency responders (eg, ALOHA, ADMS, NAME) and those used by more advanced users (eg, Met Office, AWE, DSTL, HSL) to predict the dispersion of dense gases, including indirect approaches such as the estimation and use of an 'effective' source-term by specifying a cloud extent after the initial dense gas phase (once density effects become insignificant relative to general dispersion).

Prediction of ingress. To include explanation of the physics of the infiltration of an external dense gas indoors (focussing on particular issues or differences related to dense gases), experimental data, and available models.

Mitigation measures. Review of on-site and off-site recommendations/guidance for preventing or minimising exposures to hazardous dense gases (eg, water sprays, vapour fences, use of foam, sheltering indoors (to include ventilation behaviour and choice of shelter room), and evacuation), factors which affect their initial and ongoing effectiveness (and any contraindications), and their implications for incident management.

The output of the review should consist of a comprehensive report with findings communicated in a suitable format and summarised in an executive summary or abstract. The key considerations associated with dense gas releases versus neutral and buoyant releases should be described. The review must indicate when it is essential to use a dense gas model to model exposure, and the scale of features that must be represented to do so (eg, only buildings, or buildings and fences, kerbstones, ditches etc). The summary section of the report must include reasoned recommendations for future research and current operational practice, namely dispersion modelling, industrial regulation and wider emergency preparedness and response.