Research report: Dispersion modelling and calculations in support of *EI Model code of safe practice Part 15: Area classification code for installations handling flammable fluids*

2nd edition

RESEARCH REPORT: DISPERSION MODELLING AND CALCULATIONS IN SUPPORT OF EI MODEL CODE OF SAFE PRACTICE PART 15: AREA CLASSIFICATION CODE FOR INSTALLATIONS HANDLING FLAMMABLE FLUIDS

Second edition

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Project management and technical editing were carried out by Dr Mark Scanlon (Energy Institute).

Affiliations refer to the time of participation.

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FOREWORD

The third edition of EI *Area classification code for installations handling flammable fluids* ('EI15') was published in July 2005 and incorporated both technical clarifications and editorial amendments. EI15 is widely used in both the upstream and downstream sectors of the petroleum industry, as well as in other industry sectors that handle flammable fluids. In addition, it is regarded as a key methodology for addressing the area classification requirements of the Dangerous Substances and Explosive Atmospheres Regulations (DSEAR).

In developing the second edition of EI15, some research studies were commissioned to strengthen its evidence base; this included the research published as the first edition of EI *Calculations in support of IP15: The area classification code for petroleum installations*.

Following publication of the third edition of EI15, this research was commissioned to further extend the dispersion analysis and calculation basis of EI15: the findings are described here in the second edition of EI *Research report: Dispersion analysis and calculations in support of EI15: The area classification code for installations handling flammable fluids*.

The research described here focused on the following technical issues:

— Sensitivity analysis of ambient temperature, relative humidity, weather and surface roughness on dispersion characteristics from point sources for various fluid categories.

— Sensitivity analysis of the nature and ambient temperature of the underlying surface (e.g. concrete, dry soil), weather, and surface roughness on dispersion characteristics from pools of various diameters and depths, for various fluid categories.

— Determination of whether any existing IP15 fluid categories apply to liquefied natural gas (LNG), or if it requires specific modelling and sensitivity analysis of parameters (hole diameter, release pressure, temperature, relative humidity, weather, surface roughness, surface type) to determine dispersion characteristics.

Publication of the new research augments the following technical issues in the first edition:

— Work item 2: Shape factors and hazard radii for pressurised releases – see Section 3 of EI *Calculations in support of IP 15: The area classification code for petroleum installations* (see Addendum 1).

— Work item 4: Liquid pools due to spillage – see Section 5 of EI *Calculations in support of IP 15: The area classification code for petroleum installations* (see Addendum 1).

In practice, information on these issues in the earlier report is not invalidated, but rather is augmented in the second edition. Consequently, and because no further technical work has been carried out on other work items in the earlier report, the first edition is entirely replicated as Addendum 1.

The research reported here should be considered independent of the Energy Institute's Area Classification Working Group, although commissioned and reviewed by them; going forward, they intend to consider how the findings of the new research affects the continuing technical integrity of pertinent aspects of the third edition of EI15.

The information in this publication should assist process safety engineers, safety advisors, designers, or others with responsibility for hazardous area classification to better determine the extent of hazardous areas in a consistent manner for specific fluid and process, weather and environment dependent values. The information is internationally applicable provided it is read, interpreted and applied in conjunction with relevant national and local requirements.

For further information on the suite of EI publications on hazardous area classification see http://www.energyinst.org.uk/ei15.

This publication may be further reviewed from time to time. It would be of considerable assistance in any future revision if users would send comments or suggestions for improvement to:

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1 INTRODUCTION

The third edition of EI *Area classification code for installations handling flammable fluids* ('EI15') was published in July 2005 and incorporated both technical clarifications and editorial amendments. EI15 is widely used in both the upstream and downstream sectors of the petroleum industry, as well as in other industry sectors that handle flammable fluids. In addition, it is regarded as a key methodology for addressing the area classification requirements of The Dangerous Substances and Explosive Atmospheres Regulations (DSEAR).

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2 OBJECTIVE AND SCOPE OF WORK

The project has aimed to strengthen the evidence base of EI15 by researching the following technical issues, as requested by the EI Area Classification Working Group:

1. **Sensitivity effects of parameters on dispersion characteristics**. EI15 Annex C sets out atmospheric dispersion results for a range of fluid compositions, modelled for a single set of atmospheric conditions and other release parameters. The dispersion modelling included in EI15 Annex C will be repeated as a calibration of the models to be used. The new research will extend the parameter ranges of atmospheric temperature, relative humidity, wind speed, reference height, stability, reservoir temperature and surface roughness. In addition, modelling would be carried out for both the existing EI15 hazard radius lower flammable limit (LFL) boundary and a 0.5 LFL boundary.

2. **Area classification arising from pools formed as a result of instantaneous releases**. EI15 currently only addresses continuous releases (leaks) for particular mass flow rates/hole sizes, continuing over a period of time. Additional research is required to investigate the factors that affect vapour dispersion from gasoline spills resulting from an instantaneous release that would be subject to area classification. These factors potentially include pool size, pool depth, confinement by kerbs or bunds, the nature and temperature of the underlying surface (e.g. concrete, water), wind speed, and topography.

3. **Application of the EI15 methodology to liquefied natural gas (LNG).** EI15 does not specifically address LNG, a rapidly growing market and a material that recent work has shown presents particular challenges in modelling dispersion. The research for EI15 will determine whether it aligns with any of the existing and well established fluid categories or warrants separate treatment. In the latter case hazard radii would be modelled equivalent to those for materials already addressed. The intent of each of these technical issues was further discussed with the EI Area Classification Working Group, which led to the agreed approach described in Section 3. This research report delivering the project findings aims, so far as is practicable, to align with EI15, to enable the findings to be integrated into any future edition.