# Best Practice in Applying Emergency Response Tools to Local-scale Hazmat Incidents

## 17th International Conference on Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes (HARMO17), 9-12 May 2016.

S. Herring[1], P. Armand[2], C. Gariazzo[3]

[1]Dstl, [2]CEA,[3]INAIL.

Contact: sjherring@dstl.gov.uk

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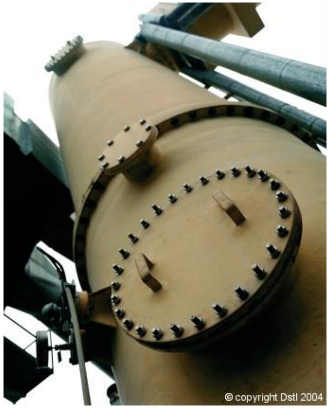
# Introduction

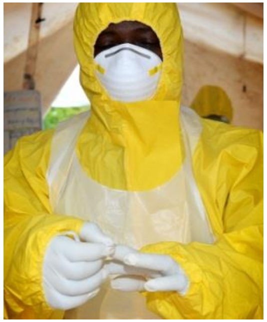
- Many potentially dangerous Chemical, Biological and Radiological (CBR) materials are produced, transported and used in urban areas:




# Introduction

- Accidental or malicious releases are a significant threat to people, the environment and infrastructure.
- First responders and decision makers require tools to provide situational awareness to:
  - Protect people;
  - Minimise environmental effects;
  - Protect infrastructure.



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# COST Action ES1006

- A four year Action on: *'Evaluation, improvement and guidance for the use of local-scale emergency prediction and response tools for airborne hazards in built environments'*
- Three elements:
  - Methodology for model evaluation;
  - Model performance comparisons;
  - Development of best practice guidance.

# Emergency Response Tools

- A wide range of ERTs exist:

**Simple dispersion model** → **Incident management system**

- Value is dependent on accuracy of dispersion modelling:

**Simple analytic model** → **Complex, resource intensive methods**

# Challenges

- Providing dispersion models that can handle:
  - Environmental complexity;
  - Uncertainty in source term parameters and meteorological conditions;
  - The timescale requirements.

Better, more informative hazard predictions → Better situational awareness → Better decisions and outcomes

# Types of Dispersion Model

| Model type | Description | Execution time |
|---|---|---|
| 1 | Do not resolve dispersion around buildings. Typically semi empirical Gaussian plume/puff methods of varying complexity and sophistication. | Seconds to minutes |
| 2 | Resolve the dispersion around buildings. Typically couple rapid flow field calculation methods with Lagrangian particle dispersion models. | Minutes to hours |
| 3 | Resolve the dispersion around and within buildings by solving fluid flow equations. computational fluid dynamics methods such as RANS and LES modelling. | Hours to days |

# Concerns

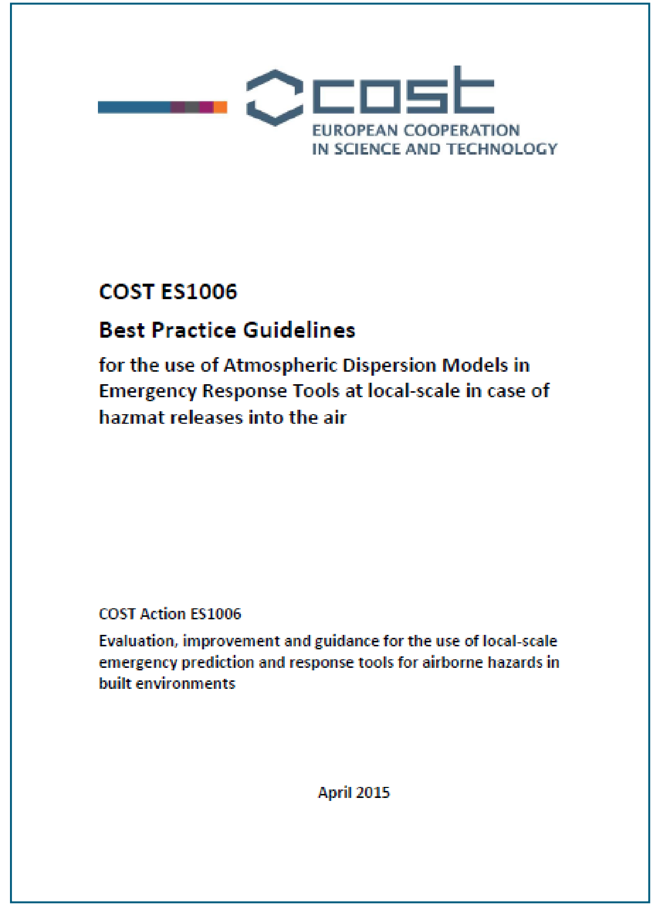
- Accurate and timely local-scale dispersion modelling is essential to provide the situational awareness required to respond effectively to releases of hazardous materials in urban areas;
- First responders often use only the simplest Type 1 models which may be subject to large errors;
- Emergency responders are not taking advantage of more sophisticated approaches that could be used.

# Model Comparisons

- ES1006 compared model predictions from ~20 models against dispersion data from:
  - Wind tunnel experiments;
  - An urban field experiment;
  - An actual  incident.
- Results showed that:
  - Increasing model sophistication led to increasing model predictive accuracy when data was from a wind tunnel;
  - Model performance differences reduced when the data was from the field.

# BPG requirements

- For the BPG to be useful to the target audience it had to be:
  - Applicable to the wide range of situations that might be encountered;
  - Applicable to actors at a range of decision making levels;
  - Written for the responder and not the ERT developer: clear, succinct and avoiding technical details.


EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

**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

COST Action ES1006

Evaluation, improvement and guidance for the use of local-scale emergency prediction and response tools for airborne hazards in built environments

April 2015

# Best Practice Guidance

- Action conducted a survey, including the ARIA BARPI[1] database of 40,000 accidents, to identify range of threat scenarios:

| Scenarios | |
|---|---|
| Ruptured transfer pipe on a chlorine tanker | Small leak of chlorine from a moving train |
| Ammonium hydroxide liquid pool | Hydrochloric acid reaction vessel accident |
| Sulphur oxide leak within a building | Spill of vinyl chloride onto the sea at a port |
| Fire in a petrochemical storage facility | Underwater leak of styrene after ship hits reef |
| Total rupture of an ammonia rail tanker | Long release of legionella from cooling tower |
| Fire at a pesticide storage warehouse | Anthrax release from research facility exhaust stack |
| Rupture of butane pipe, followed by ignition | Leak of fission products from a nuclear power station |
| Malevolent release of chemical agent | Terrorist use of Radiological Dispersal Device (RDD) |

[1]Analysis, Research and Information on Accidents, Bureau for Analysis of Industrial Risks and Pollutions

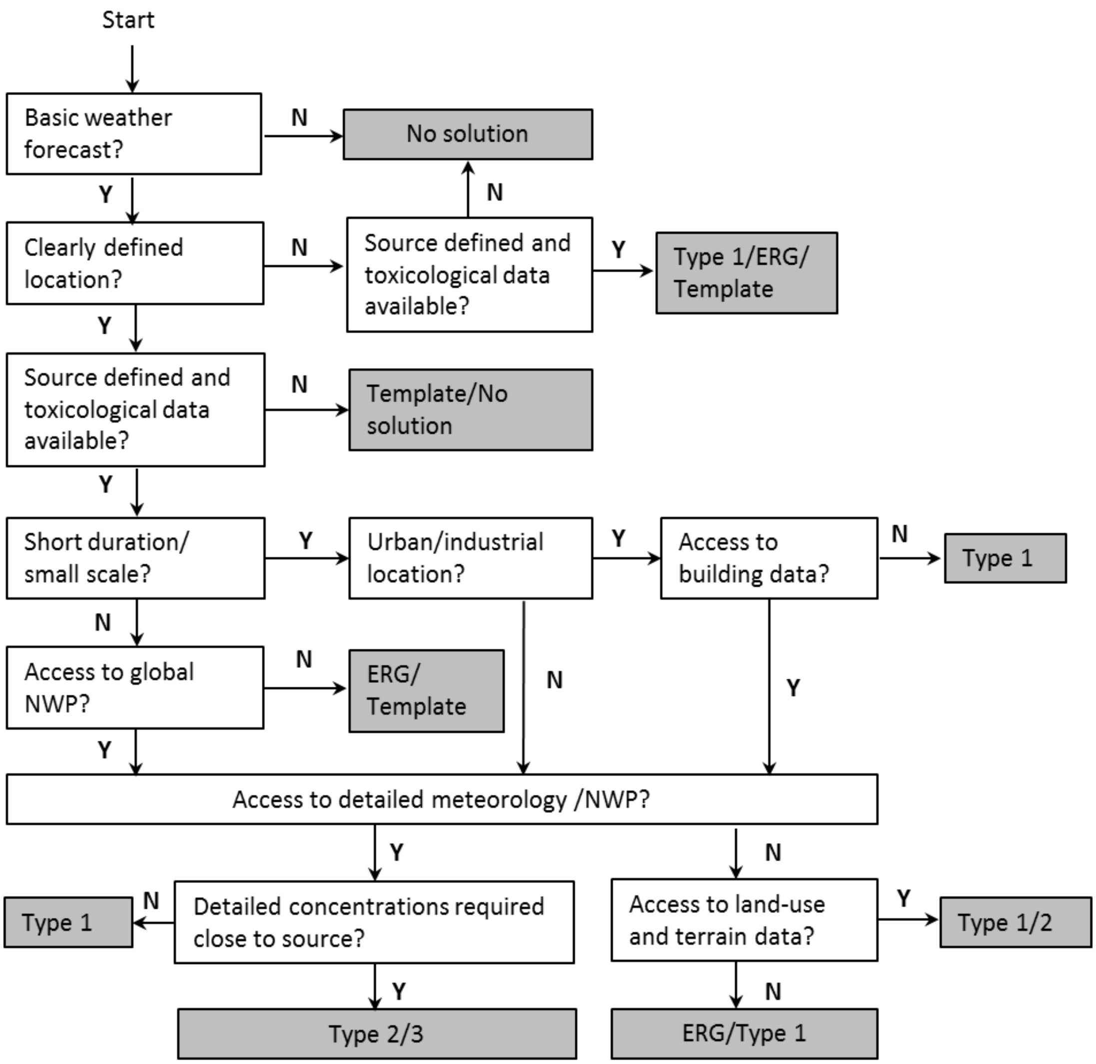
# Best Practice Guidance

- Impractical to provide detailed guidance for handling every type of scenario;
- Guidance related to 4 scenarios:

| Release type | Description |
|---|---|
| Neutrally buoyant | A small amount of chlorine released within an urban area. |
| Positive buoyancy release | A toxic plume produced by a warehouse fire. |
| Dense gas release | A leakage of many tonnes of chlorine or LPG, involving the flashing and pooling of material. |
| A dirty bomb | An explosive release of radionuclides. |

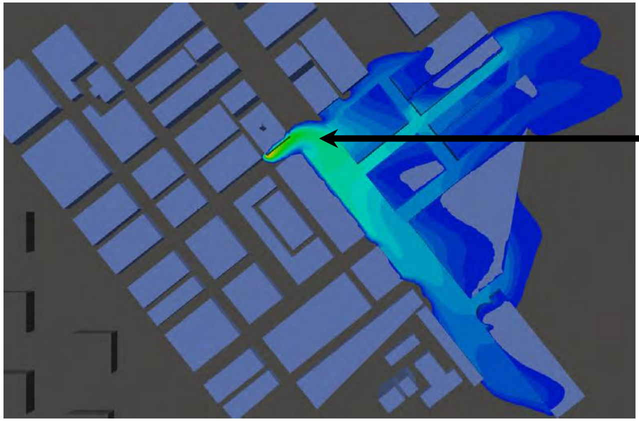
# Flowchart

- Hazard predictions should employ the most sophisticated modelling approach possible, given:
  - The input information;
  - The time available.



# Further Considerations

- Type 2 or 3 models can provide a substantially enhanced level of situational awareness identifying:
  - Localised areas of high concentration;
  - Risk from short-term fluctuations.



Dispersion turning through 90 degrees

# Improving Emergency Response Modelling

- Recognition of the limitations of current methods, and benefits of more sophisticated ones;
- Development of approaches to enable more sophisticated methods to be used in rapid response;
- Utilisation of developments in connectivity to:
  - Improve the quality of input data;
  - Enable greater computing resources to be accessed;
  - Bring responder and modeller closer together.

# Summary

- COST Action ES1006 has produced a BPG document for Emergency Responders;
- Emergency response modelling should use:
  - Models with a validated level of accuracy;
  - The most sophisticated modelling approach possible, given the input information and time available.
- Scientists and practitioners should work closely together to leverage the state-of-the-art to create better emergency response systems.

# Acknowledgements

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# Questions?