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ERMIDT – THE EMERGENCY RESPONSE MODELS AND COMPUTATIONAL TOOLS INVENTORY DATABASE DEVELOPED IN THE FRAME OF IN COST ACTION ES1006

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Abstract: The renewed concern and increasing need in assessing risks and consequences from local-scale technological hazards and disaster events in complex built-up environments gave computational tools a unique value for emergency response management and large efforts have been taken in the development of different types of numerical tools able to address individual aspects and/or the overall response. Regardless the number and variety of emergency response computational tools and models (ERT) currently used by emergency management services and authorities, it is not always clear what the advantages and limitations of such tools and individual models approaches are. Aiming to collect detailed information of existing ERT for surveying modelling and simulation tools and computational approaches performance and limitations, the so-called ERMIDT (Emergency Response Models and Tools Inventory Database Tool) was developed in the framework of COST Action ES1006. This comprehensive and structured catalogue intends enabling an efficient access to specific information, such as type of application, type(s) of computational approaches and integrated models, aspects of hazards and incident scenarios addressed, input and output data, computational demands, verification/validation or related performance measures. It will also support establishing model-specific guidance regarding an efficient and reliable use of different ERT, or simply models that are or can be used according to the emergency response management specification and purposes considered. The ERMIDT comprises specific information on ERT and related models (Meteorological, Emissions/Source Term, Dispersion, Consequence and Risk) used individually or incorporated, applicable to individual or multiple interdependent aspects of local-scale airborne hazards and incident events emergency response.

Key words: *database, emergency response, models and computational tools, accidental releases, inventory*.

INTRODUCTION

The renewed concern and increasing need in assessing risks and consequences from local-scale technological hazards and disaster events in complex built-up environments gave computational tools a unique value for emergency response management and large efforts have been taken in the development of several types of numerical tools able to address individual aspects and/or the overall response.
Different Emergency Response Computational Tools and Models (ERT) are used by emergency management services and authorities for incidents and disaster events emergency preparedness, pre-event planning, training, response, guidance or post-incident recovery and restoration actions; however, it is not always clear what the advantages and limitation of such tools and individual models approaches are. Thus, it is of major importance to compile a detailed and updated ERT inventory for surveying modelling and simulation tools and computational approaches currently in use for assessing individual aspects or the overall of local-scale airborne hazards and incidents scenarios performance and limitations.

In order to collect detailed information on existing ERT, the so-called ERMIDT – Emergency Response Models and Tools Inventory Database Tool was developed in the framework of COST Action ES1006 [URL1]. A description of ERMIDT structure and content is presented.

EMERGENCY RESPONSE MODELLING TOOLS INVENTORY DATABASE TOOL (ERMIDT)

Aiming to collect detailed information on ERT currently used by emergency management services and authorities, researchers and model developers, the so-called ERMIDT tool was developed in the frame of COST Action ES1006 [URL1]. This comprehensive and structured catalogue intends enabling an efficient access to desired information, such as type of application, type(s) of computational approaches and models integrated, aspects of hazards and incident scenarios addressed, physical background, input data demands, model outputs, computational demands and information on model application/use, verification or related performance measures. The inventory will also support establishing model-specific guidance regarding an efficient and reliable use of different ERT, or simply models that are or can be used according to the emergency response management specification and purposes considered. The ERMIDT tool format and contents is further briefly presented.

In an attempted to make ERMIDT be appropriated for both ERT summarized and detailed analysis of suitable ERT, it comprises specific information concerning ERT, but also, the different types of models (Meteorological, Emissions/Source Term, Atmospheric Dispersion, Consequence and Risk) applicable to individual or multiple interdependent aspects of local-scale airborne hazards and incident events emergency response. Based on previous and ongoing research and technical work (see URL1, URL2; URL3, URL4) and user-friendly purposes, the ERMIDT was developed in the form of an Excel Workbook, comprising seven main 'data-sheets' (see Figure 1).

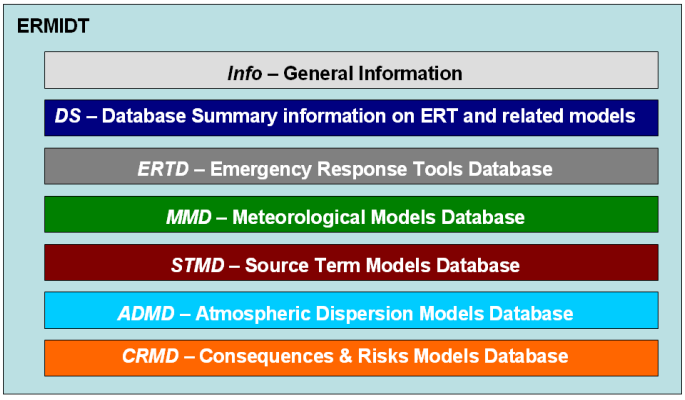


Figure 1. Schematic representation of ERMIDT workbook structure and data-sheets.

To distinguish the type of compiled information to fill in each data-sheet, an identification code and colour system has been defined for the ERMIDT tool (see Figure 1):

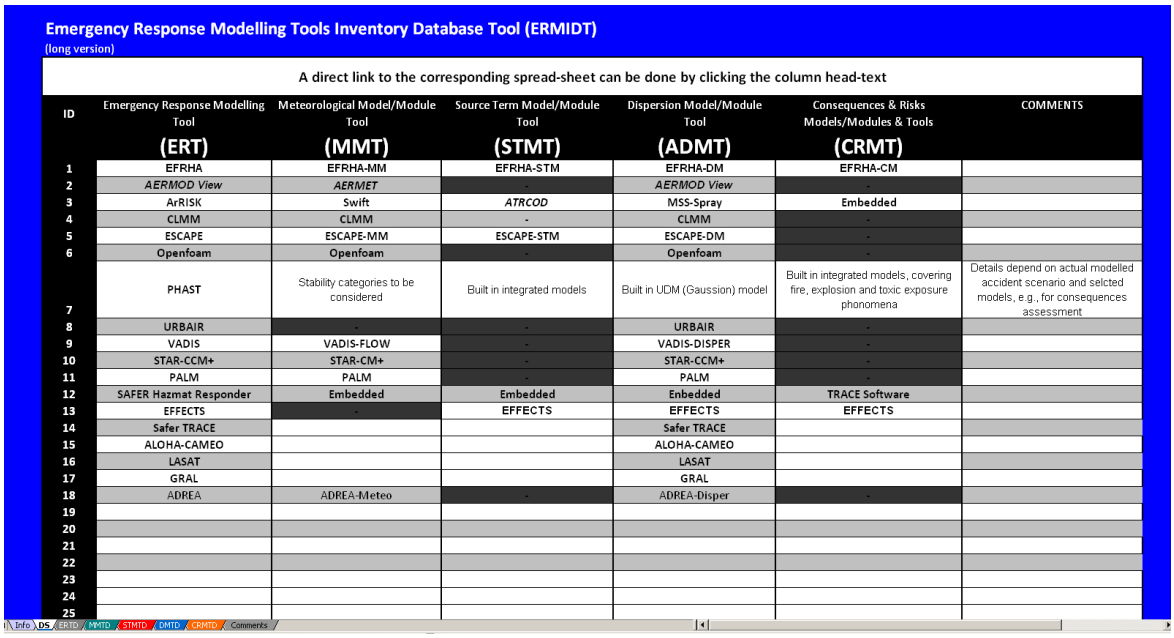
1 – *Info* – General ERMIDT Information (light grey)
2 – *DS* – Database Summary of Compiled ERT (dark blue)
4 – *ERTD* –Emergency Response Computational Tools Database (dark grey)
5 – *MMD* –Meteorological Models Database (dark green)
6 – *STMD* –Source Term Models Database (dark red)
7 – A*DMD* – Atmospheric Dispersion Models Database (light blue)
8 – *CRMD* –Consequences and Risk Models Database (orange)

The set of data-sheets can be divided in two main types of information. Whereas *Info* and *DS* data-sheets introduce, in a simplified way the main goal of the database and support/assistance information, as well as list the ERT and related models information already compiled; detailed technical information concerning ERT and related models/tools is separately compiled in 5 data-sheets (*SMTD*, *ERTD*, *MMD*, *STMD*, *ADMD* and *CRMD*). This structure enables analysing individual and integrated aspects and/or the overall response modelling process of local-scale airborne hazards and incidents scenarios.
Following a brief description of the different data-sheets compiled information is presented accordind to the type of information.

General information (*Info*, *DS*)
Intended to introduce the ERMIDT catalogue, a brief description of the main goals and support/assistance information is presented in *Info* data-sheet as a 'README content page'. This summarized content excludes the need to consult additional documentation or instructions.

Additionally, to allow checking which ERT information is already included, the *DS* data-sheet lists all ERT and related models already compiled in the ERMIDT. Bearing in mind the different types of models required/applicable to individual or multiple interdependent aspects of local-scale airborne hazards and incident events emergency response, the following model types are considered in the ERMIDT and *DS* list (as shown in Figure 2):

1 – Emergency Response Computational Tools,
2 – Meteorological Models, Modules and Tools,
3 – Source Term Models, Modules and Tools
4 –Dispersion Models, Modules and Tools
5 – Consequences and Risk Models, Modules and Tools.



Emergency Response Modelling Tools Inventory Database Tool (ERMIDT)
(long version)

A direct link to the corresponding spread-sheet can be done by clicking the column head-text

ID	Emergency Response Modelling Tool (ERT)	Meteorological Model/Module Tool (MMT)	Source Term Model/Module Tool (STMT)	Dispersion Model/Module Tool (ADMT)	Consequences & Risks Models/Modules & Tools (CRMT)	COMMENTS
1	EFRHA	EFRHA-MM	EFRHA-STM	EFRHA-DM	EFRHA-CM	
2	*AERMOD View*	*AERMET*	-	*AERMOD View*	-	
3	ArRISK	Swift	*ATRCOD*	MSS-Spray	Embedded	
4	CLMM	CLMM	-	CLMM	-	
5	ESCAPE	ESCAPE-MM	ESCAPE-STM	ESCAPE-DM	-	
6	Openfoam	Openfoam	-	Openfoam	-	
7	PHAST	Stability categories to be considered	Built in integrated models	Built in UDM (Gaussion) model	Built in integrated models, covering fire, explosion and toxic exposure phonomena	Details depend on actual modelled accident scenario and selcted models, e.g., for consequences assessment
8	URBAIR	-	-	URBAIR	-	
9	VADIS	VADIS-FLOW	-	VADIS-DISPER	-	
10	STAR-CCM+	STAR-CM+	-	STAR-CCM+	-	
11	PALM	PALM	-	PALM	-	
12	SAFER Hazmat Responder	Embedded	Embedded	Enbedded	TRACE Software	
13	EFFECTS	-	EFFECTS	EFFECTS	EFFECTS	
14	Safer TRACE			Safer TRACE		
15	ALOHA-CAMEO			ALOHA-CAMEO		
16	LASAT			LASAT		
17	GRAL			GRAL		
18	ADREA	ADREA-Meteo	-	ADREA-Disper	-	
19						
20						
21						
22						
23						
24						
25						

Info | DS | ERTD | MMTD | STMTD | DMTD | CRMTD | Comments

Figure 2. ERMIDT *DS* worksheet overall.

Direct hyper-links to each of the corresponding technical description data-sheets can be done by clicking the related column table top heading. Each record-cell listed in the *DS* data-sheet will correspond to a column of information in the associated sheets.

Technical description Databases (ERTD, MMD, STMD, ADMD and CRMD)

In an attempt to ERMIDT be appropriated for establishing a reference and comprehensive catalogue of the most relevant information of ERT currently in use and developed, the set of ERT and related models *Technical Description Databases Data-sheets* (*ERTD*, *MMD*, *STMD*, *ADMD* and *CRMD*) was included, bearing in mind specific modelling approaches and techniques characteristics, and application, in addition to data compiled in existing databases (see URL2, URL3 and URL4). Despite the main differences, a harmonized structure was developed consisting five main sets of information:

1 – General identification information
2 – Modelling properties
3 – Initialization & run options
4 – Solution techniques
5 – Model validation and application.

Whereas fields 1) and 2) are common to all technical Databases, 3) to 5) were individually prepared accounting the specific purposes, types of modelling approaches and techniques. To support and complete technical descriptions and parameters, model validation and application examples can be also included, particularly for establishing a scientific and methodical reference for local-scale airborne hazards modelling and model verification or related performance measures. Aiming to simplify the introduction

and reduce duplicate information, ERMIDT is also prepared to enable identifying models as components of ERMT, and therefore shortens the filling process.
Following, some highlights in the information and specificities considered in ERMIDT technical data-sheet are presented to demonstrate the type of desired information.

Emergency Response Computational Tools (ERT) can be considered the most complex and comprehensive tools currently used by emergency response services and authorities, and a challenge for model developers and researchers. Such tools often integrate different types of models, specifically developed and integrated to simulate individual and/or multiple interdependent aspects of the emergency scenario. Bearing in mind the wide variety of ERT currently in use, the ERTD covers, not only, the basic information and characteristics of such tools, but also, information regarding models/modules/tools integrated. General identification information can be directly linked to other technical data-sheets of the related models are integrated or linked to the ERT. Moreover this database enables analysing the main characteristics and application purposes of each of ERT compiled but also the level of knowledge or type of input demands and model outputs. This emergency response tools database (ERTD) is of particular interest to evaluate the type and nature of ERT currently used by emergency management services and authorities, researchers and model developers.

Although Meteorological Models (MM) are typically not considered as individual modules when integrated in ERT, it is important to describe the different modelling approaches considered in each tool, independently if meteorological parameters are determined by internal or linked models or methodologies. Contents of Meteorological Models Database (MMD) data-sheet were based on COST 728 Model Inventory Database [URL2] and the European Model Inventory System [URL3].

Bearing in mind the different types of airborne accidental or deliberated release conditions, Source Term Models (STM) can be considered one of the most important models, particularly in case of transient release scenarios. Given the wide variety of modelling approaches and release scenarios that can be integrated in ERT (for e.g. simple instantaneous or continuous releases of hazardous gases, or more complex two-phase transient of liquid followed by evaporation release scenarios), the Source Term Database (STMD) data-sheet comprises detailed and technical on the most common local-scale airborne hazard scenarios. Based on existing ERT, five main types of hazards are accounted, namely:

1 – Toxic gas release scenarios,
2 – Fire scenarios,
3 – Explosion scenarios,
4 – Nuclear material release scenarios,
5 – Biological material release scenarios.

Atmospheric Dispersion models (ADM) can be considered the main core of ERT, chiefly for local-scale airborne hazards in complex built-up areas. Even most ERT models integrate widely used ADM, a large number of these tools do not really account the influence of obstacles on air flow and airborne hazardous material dispersion. Therefore, it is of major importance to compile information of ADM currently integrated on ERT or used individually, able to predict the dispersion of airborne hazardous gases in built-up environments. Similarly to MMD, the Atmospheric Dispersion Models Database (ADMD) was prepared based on model inventory databases already available (see URL2 and URL3).

Despite commonly assumed as a post-processing data treatment step (and not an actual module) in ERT, Consequence and Risk Analysis models (CRAM) are available and must be also described, especially when safety and emergency response and countermeasures are determined. Additionally important for emergency pre-event planning and guidance measures, Risk Analysis is also relevant for emergency response services and authorities, particularly to establish safety and population rescue and evacuation zones in case of local-scale airborne hazards and incidents scenarios. For that reason, it is also relevant to compile information on CRAM main characteristics, performance and limitations of modelling approaches currently in use. The Consequences and Risks Models Database (CRMD) accounts the most relevant types of consequences on Human health and structures and risks, intimately related with the incident scenario analysed.

At present, the ERMIDT compiles information concerning 18 different ERT used in the framework of COST Action ES1006. From the listed models, 8 are categorized as ERT and 10 ADM models, frequently used in emergency response management and research studies. Even some ERT or ADM models may be linked to separated MM, it is common to refer to embedded or integrated MM models, or just input meteorological data. Six of the listed ERT include integrated STM, enabling considering different release conditions. Nonetheless, source term conditions are in general assumed as 'direct' and known input data. In what concerns to the ADM, it is possible to observe a wide variety of modelling approaches and types, from simple Gaussian to complex Computational Fluid Dynamics (CFD) atmospheric dispersion models. Five models include CRM, even so, limited output information is provided.

FINAL REMARK

The renewed concern and increasing need in assessing risks and consequences from local-scale technological hazards and disaster events in complex built-up environments gave computational tools a unique value for emergency response management (ERM) and large efforts have been taken in the development of several types of numerical tools able to address individual aspects and/or the overall response. Regardless the wide variety of ERT used by emergency management services and authorities for incidents and disaster events emergency preparedness, pre-event planning, training, response, guidance or post-incident recovery and restoration actions; it is not always clear what the advantages and limitation of such tools and individual models approaches are.

Aiming to collect detailed information on existing ERT, the so-called ERMIDT (Emergency Response Models and Tools Inventory Database) Tool was developed in the framework of COST Action ES1006. This comprehensive and structured catalogue intends enabling an efficient access to desired information, such as type of application, type(s) of computational approaches and models integrated, aspects of hazards and incident scenarios addressed, physical background, input data demands, model outputs, computational demands and information on model application/use, verification or related performance measures. It will also support establishing model-specific guidance regarding an efficient and reliable use of different ERT or simply models that are or can be used according to the emergency response management specification and purposes considered.

Taking into account the wide variety of existing numerical tools, the ERMIDT comprises specific information concerning ERT and related MM, STM, ADM and CRM models, used individually or incorporated in such tools, applicable to individual or multiple interdependent aspects of local-scale airborne hazards and incident events emergency response.

So far, ERMID compiles information of 18 different ERT and related models. A first analysis of the compiled information shows the wide variety of ERT currently available and used by emergency management services and authorities, but also researchers and model developers. All ERT include the ADM, but only a limited number include MM, STM and CRM.

Further improvements based on users and model developers are expected and dissemination of the tool among emergency management services, model developers and selling entities is ongoing.

ACKNOWLEDGEMENTS

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URL4 – http://fairmode.ew.eea.europa.eu/fol147338