

CENTRE OF EXCELLENCE MANHAZ – MANAGEMENT OF HEALTH AND ENVIRONMENTAL HAZARDS

The EU Centre of Excellence MANHAZ (Management of Health and Environmental Hazards) was established in 2003 in the Institute of Atomic Energy in Świerk.

The mission of the Centre of Excellence MANHAZ is to provide leadership, expertise and integration of efforts related to risk assessment of activities involving hazardous substances in Poland. The main areas of activities CoE MANHAZ cover variety of problems related to development and practical implementation of recommended methodologies, procedures guides, computer programs and data bases for the following four groups of problems:

1. Management of major accident hazards – advanced tools and information systems for supporting authorities in the management of risks and emergency situations due to technological hazards.
2. Management of chemical hazards *relating to* emission of chemicals, their transport and transformation in the environment, environmental and health risk assessment: models, data bases, stand alone computer programs and systems for health and environmental risks assessment and decision making.
3. Risk assessment of fuel cycles of electrical power generation, including externalities.
4. Tools for radiological risk assessment and decision making for close and distant accidents.

The Centre is getting involved in a number of projects on infrastructure security management in Poland. In particular it concerns:

- development of computer aided decision support system for crises management in the agglomeration of Warsaw;
- customization of existing methodologies for security vulnerability assessment of chemical installations in Poland;
- GIS based decision support systems for crisis managing chemical, radiological or terrorist emergencies – cooperation with the National Defence University.

In 2007 one of the most important tasks of the Centre was related to the participation in the national project on: *Hazard models for urban agglomeration and crisis management system exemplified by the city*

Warsaw. The consortium of institutions began realisation of the project in the mid of 2006. The Institute of Atomic Energy is responsible for two parts of the system dealing with modelling of radiological and chemical. The radiological part is being implemented jointly with the Material Research Laboratory of the Institute of Atomic Energy.

The main objective of the project is the development of a prototype of the new advanced, integrated system of modules and data that:

- determines emergency zones based on simulations of the dispersion of hazardous nuclear, biological, and chemical materials released to the atmosphere and water bodies in urban areas,
- provides essential information on required resources, such as search and rescue teams, equipment, medical assistance, food, evacuation and shelter, needed in case of emergency situation,
- has access to all the necessary databases and GIS-based information, which can be distributed geographically among different urban services,
- enables co-ordination of emergency action in real-time based on reliable system for information exchange and interoperability capabilities among different systems.

The MANHAZ Centre acts also a Technical Support Organization for the Centre for Radiological Events of the National Atomic Energy Agency and is involved in the integrated project EURANOS “European approach to nuclear and radiological emergency management and rehabilitation strategies”.

The staff of the Centre has been also engaged in the development of environmental systems for management of air quality.

References

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SYSTEM SECURITY RISK ANALYSIS

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The industry and operators of various element of critical infrastructure face the important need to assess whether current security measures effectively address the new and unforeseen threats, and make enhancements as required to provide for the safety of the public, workers, and the environment. Security risk management involves the systematic identification, analysis, treatment (e.g., mitigation, acceptance, transfer), monitoring, and communication of risk. Key components of a security risk management process are risk analysis, in which a system, its components, and their relationships are analyzed with respect to threats and vulnerabilities; risk assessment, in which the level of risk is determined based on analysis and a well-defined approach to identifying and assigning values to risk factors, including possible consequences or impacts of threats; and risk communication, in which the results of a risk assessment are translated into terms that are meaningful to decision-makers.

Security incidents are intentional, rather than accidental, which is a key basis to understanding the hazards, likelihood, and possible consequences. The risk that is being analyzed to solve security issues is an expression of the likelihood that a defined threat will reach a specific vulnerability of a particular attractive target or combination of targets to cause a given set of consequences.

The estimate of consequences may be different in magnitude or scope than is normally anticipated for accidental releases. In the case of security events, adversaries are determined (sometimes at all costs) to find vulnerabilities and to maximize damage. In addition, theft or diversion of chemicals is normally not considered in accidental release studies, but should be included in security studies.

A second unique term of interest is vulnerability, which is any weakness that can be exploited by an adversary to gain unauthorized access to an asset. Vulnerabilities can result from, but are not limited to, management practices, physical security weaknesses, or operational factors.

A variety of approaches to system security risk analysis and risk assessment have been taken:

Policy-based approaches focus on security requirements, as stated in organizational Policy documents, or in applicable regulations or standards. Failure to meet a requirement – typically, to implement a specific safeguard – constitutes a potential source of risk. In a policy-based approach, the consequences of such a failure are analyzed and assessed.

Threat-based approaches focus on how an adversary could exploit technical aspects of a system (e.g., inherent vulnerabilities, poor configuration of key components), as well as non-technical aspects of the system's operational environment, to produce adverse effects. Analysis, rather than assessment, predominates in a threat-based approach.

Asset-based approaches focus on the assets that must be protected from threats. An asset-based approach includes identification of system components, as well as analysis of their interconnections and dependencies.

Mission- or objective-based approaches focus on the missions or business objectives that must be achieved, despite the presence of threats. A mission-based approach includes identification of business functions and how those functions relate to (e.g., depend upon, impose requirements on) systems and their behavior.

The analytical portion of these approaches is called a Security Vulnerability Analysis (SVA). The leading institutions and organizations (e.g. Center for Chemical Process Safety - CCPS) dealing with chemical process safety) created the SVA methodology to help companies to evaluate the vulnerability of their chemical sites to terrorist attack or other malicious acts. Methods available to SVAs can have varying scopes, varying levels of detail, and utilize different methods.

The SVA approach can also be applied to information/cyber security, where the objective is to protect critical information systems including hardware, software, infrastructure, and data from loss, theft, or damage. In a chemical facility, protecting information and computer networks means more than safeguarding a company's proprietary information and keeping the business running, as important as those goals are. It also means protecting chemical processes from hazardous disruptions and preventing unwanted chemical releases. To an adversary, information and network access can provide the power to harm the company, its employees, and the community at large.

A analysis of SVA methodologies and approaches to SVA based security management in chemical process industry, the related information/cyber security and Industrial Control System were studied by the author, in the framework of the project on integrated methods for major accidents . risk and security implement in the period 2005- 2007 by the Central Institute of Labour Protection in Warsaw

POLLUTANT AIR CONCENTRATION PREDICTION SYSTEM FOR URBAN AGGLOMERATIONS

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The aim of the project 3 T09D 017 28 supported by the Ministry of Science and Higher Education and implemented in the period 2005 -2007 by the Institute of Environmental Protection in cooperation with the Centre of Excellence MANHAZ in the Institute of Atomic Energy was to develop an integrated pollutant air concentration prediction system for urban agglomeration (SPSZP-Ag) for predicting air quality, analyzing emission events and accidental releases and calculating contaminant transport, including secondary contamination and analysis of selected areas, taking into account ozone, dust, NO_x, SO_x, heavy metals and hazardous substances. According to adopted assumptions, the SPSZP-Ag system was designed largely on the base of calculation systems developed for the U.S. Environmental Protection Agency, namely CMAQ (transport calculations and pollutant transformation in the atmosphere) and SMOKE (source inventarisation and emission calculations), as well as on the base of meteorological models MM5 and WRF.

State-of-the-art solutions for emission and transport modelling and pollutant transformation calculation systems, as well as solutions for space information techniques and integration of calculation models were implemented during the development of the SPSZP-Ag system. The prototype software for the SPSZP-Ag system was implemented on the Beowulf cluster running under the Linux operating system in the Centre of Excellence MANHAZ and using the MPI package for parallel computing.

The following five subsystems were developed in the frames of the SPSZP-Ag system. Two versions of emission modelling subsystems: an advanced one (EMS/SMOKE) (1) basing on the concepts and structure of SMOKE and a simplified one (2), better suited for the present Polish emission inventarisation prac-

tices. The subsystems were developed for processing raw emission inventarisation data into input for given computation grids for further processing in the atmospheric pollutant transport and transformation modelling subsystem; A meteorological modelling subsystem (3), implementing MM5 and WRF models for mesoscale and local meteorological parameter forecasting, taking into account the characteristics of urban areas; A transport and transformation modelling subsystem PMTTZ/CMAQ (4) simultaneously taking into account many pollutants in air in many space scales, including the urban agglomeration scale, enabling the simulation of all important chemical and physical processes influencing the transport, transformation and deposition of pollutants in air using emission in meteorological models and adapting tools for microscale calculations (ENVI-met model) and for the pollutant transport for street canyons (OSPAM program); An urban community health hazard estimation subsystem PON/APEX, linked with PMTTZ/CMAQ (5). The subsystem is based on the Pollutant Air Pollutants Exposure model (APEX) developed for the US EPA. The SPSZP-Ag includes IO/API tools for input and output processing and for calculation results visualization (PAVE).

The SPSZP-Ag system enables to simultaneously analyze emissions and transport for many pollutants in many space scales (from local to urban agglomeration to regional), taking into account the coupling of transport models and chemical transformations to the dynamics of the atmosphere. SPSZP-Ag was used to simulate the pollutant distribution in air for selected emission scenarios in the Warsaw agglomeration using emission data delivered by the Mazovian Voivodeship Environmental Protection Inspectorate. More information on SPSZP-Ag is available at the Web site: <http://www2.cyf.gov.pl/spszp-ag>.

THE SIMULATIONS OF EMERGENCY SITUATIONS CAUSED BY ACTS OF TERROR WITH THE USAGE OF TOXIC OR RADIOACTIVE SUBSTANCES IN URBAN AREAS

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The Centre of Excellence MANHAZ is engaged in a project aiming at the development of system for management of crisis situation arisen due to chemical or radiological releases in urban areas [1].

A general concept for developing modules for chemical and radiological emergencies is based on the following assumptions:

- the main aim of the simulation modules of chemical and radiological emergency situation is determining emergency zones, taking into account possible consequences for various types of hazards,
- the simulators to determine emergency zones should be as fast as possible.

Therefore the main idea is to include as many elements of the system as possible into databases from which they can be fast and easily extracted. To meet these requirements, the system should contain as many pre-defined scenarios as possible. In case of real emergency these scenarios have to be adapted taking into account the current conditions. Such an approach enables fast estimation of emergency zones, however with possible lost of precision. Nevertheless in emergency response context the most important is to determine the areas where some countermeasures like evacuation or sheltering have to be applied as fast as possible. Secondly the databases will contain also information related to decision making process like pre-defined tasks for rescue teams linked to appropriate templates of crisis situation. This will allow building step by step knowledge database, causing that the system can evolutionally change its character from typical "command and control" type to the expert system.

Then for each type of hazard it is necessary:

- to develop simulation module to make prognosis of the situation,
- to include into databases data requested to perform simulations,
- to define decision templates and tasks for any rescue teams and urban services.

Such a general approach allows for generalization and unification of the logical model and utilization of some formal programming techniques.

The implementation of the subsystem for chemical emergencies will be based on the following elements:

- databases of physical-chemical substances,
- intervention levels linked to substances database,
- basic scenarios for selected substances or groups of substances depending on the type of release, storing and transportation conditions,
- adaptive part of scenario depending on meteorological conditions and localization of source of release,
- emergency simulator,
- simulation results presented on digital maps in the form of emergency zones.

The basic scenarios will be calculated using either the Unified Model for Pollutant Dispersion in Atmosphere (UPDMA) or well known Hazard Prediction and Assessment Capability (HPAC) code. In principle the basic approach is similar to that one used in the Off-site Consequence Analysis Guidance for the Risk Management Program, however it is significantly extended to much greater number of different scenarios. All the results of pre-calculated scenarios with different meteorological conditions taking into account a number of special parameterizations for urban agglomeration will be stored in databases. It is also planned to carry out CFD (Computational Fluid Dynamics) calculations for a set of particularly vulnerable locations of Warsaw in order to verify the simplified approach.

The proposed approach depends on two factors:

- the proper choice of basic scenarios (in particular how many pre-calculated cases should be included into database),
- the proper identification of crisis situation which corresponds to good parameterization of pre-defined scenarios.

The solution is to build gradually huge enough databases, which will be useful in the future. Analogously approach will be applied for the radiological part of the system.

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SPATIAL PLANNING OF PREVENTING AND ABATEMENT MEASURES IN THE CONTEXT OF MAJOR ACCIDENTS

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The report on “*Spatial Planning of Preventing and Abatement Measures*” [1] with recommendations on Spatial Planning Measures and Land Use Plans focusing on issues of major industrial accidents was prepared by M. Borysiewicz as a part of his involvement in the Rivershield Project [2] coordinated by the Institute of Environment Protection in Warsaw. The RIVER SHIELD Project is implemented under the EU Community Initiative INTERREG III B CADSES Neighbourhood Programme by the Institute of Environmental Protection (IEP) from Warsaw. The subject of the Polish part of this Project is the Oder River (the Odra River) in the Lubuskie Region. It is expected that the project will strengthen the capacity of emergency and environmental services engaged in the process directed at the reduction of the effects of potential industrial accidents.

The report [1] consists of the *Guidelines for Land Use Planning in the context of the Seveso II Directive* and 4 attachments:

- A. Relevant Steps in Major Accidents Quantitative Risk Assessment Process.
- B. Environmental Risk Assessment.
- C. HSE's Current Approach to Land Use Planning (LUP) Policy and Practice.
- D. Planning Assessment Method Using Sensitivity Levels and 2 D Decision Matrix for Land Use Planning.

The Guidelines cover the following important topics: role of land use planning in major accidents risk management, principles and consideration of additional technical measures, hazard and risk assessment methodologies and criteria, database of land use planning scenarios and risk assessment data, modeling and end-points as well as environmental risk assessment methods.

The experts from the Lubuskie Region prepared an expertise on “*Risk Analysis of the Major Industrial Accidents in the Lubuskie Region as the Element of the Documentation concerning the Spatial Planning*”, which together with the report on “*Spatial Planning of Preventing and Abatement Measures*” will provide rationales for proposals of modification of current land use plans in the Lubuskie Region in Poland.

References

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DIRECT COSTS OF NUCLEAR TREATIES, AGREEMENTS AND AGENCIES

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The technical report [1] and the dedicated website: <http://manhaz.cyf.gov.pl/manhaz/ind.php?ff=projects> are the main tangible results of the project TW6-TRE-DICNT implemented in Centre of Excellence MANHAZ.

The contents of the technical report covers the following groups of problems:

- Inventory of International Nonproliferation Organizations & Regimes: International treaties; Treaties, conventions & agreements related to the IAEA's work; Treaties, conventions & agreements under IAEA auspices; Safety & Security; Science & Technology; Safeguards & Verification; Organization & Cooperative Agreements.
- The safeguards system of the International Atomic Energy Agency including: Legal Basis of Agency Safeguards; Evolution of the Safeguards System 1991 – 2005; Measures to Strengthen the Safeguards System, 1991-2005.
- Problems of safeguards system implementation.
- Safeguards current status.
- Financing IAEA verifications of the NPT.
- Cost of implementation of nonproliferation regime in states including: U.S. Financial Support to Meet Safeguards Obligations of IAEA; US FY 2006 Budget request for Defense Nuclear Nonproliferation; Case of Poland.
- Expanding the nonproliferation regime on a different financial basis. IAEA Safeguards expenditures and resources.
- EURATOM, including: Operation of the EURATOM safeguards office; EURATOM safeguards resources (budget, staff resources and safeguards equipment).
- FUSION energy, including externalities and proliferation implications of thermonuclear-fusion energy systems: Risk assessment of fusion research; Technical points related to thermonuclear weapons and their proliferation; Nuclear Weapons Proliferation Issues of Thermonuclear-Fusion Energy Systems; Common proliferation implications of all fusion energy systems; Neutron abundance: Fusion-fission hybrids and plutonium breeders; Tritium abundance: Boosted-fission and pure-fusion nuclear weapons; Dedicated nuclear weapons materials production facilities; Latent thermonuclear proliferation; Induced nuclear proliferation; Specific proliferation implications of inertial confinement fusion (ICF): Nuclear weapon-effects research, Driving force of spin-off technologies, Declassification and latent proliferation.

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THE CALCULATION MODELS FOR ASSESSMENT OF TERRORIST THREATS IN AQUEOUS ENVIRONMENT AND URBAN POTABLE WATER DISTRIBUTION NETWORK

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The modeling two most essential cases of water contamination threat, the surface waters and the drinking water distribution system was considered [1]. The general approach to modeling of contaminations spreading in aqueous environment with one - and three-dimensional models was also outlined. The latter is based on the idea of THREETOX code [2] and its further extensions [3]. The code is used to simulate 3-D hydrodynamics fields, suspended sediment and toxicant transport. The code includes a set of sub-models. The hydrodynamics are simulated on the base of a three-dimensional, time-dependent, free surface, primitive equation model. The model equations are written in Cartesian co-ordinates. The water body is assumed to be hydrostatic and incompressible. The concept of eddy viscosity/diffusivity and Prandtl's hypothesis with the variable turbulence length scale are used to define the turbulence stresses. At the free surface all fluxes (momentum, heat, etc.) are prescribed. At the bottom and the land boundaries the conditions of no diffusive fluxes of any property are used. The open lateral boundary conditions are modified radiation conditions.

Three-dimensional advection-diffusion equations are used to simulate the toxicant transport in the water column and an ordinary differential equation is applied to simulate concentration of a toxicant averaged over the thickness of an upper exchangeable layer of bottom deposition. The boundary conditions are: no flux of the toxicants concentration in solute and in the suspended sediments through the water surface, and its flux is

equal to the sum of fluxes of the particulate and diluted toxicants at the bottom boundary.

The models were applied to dispersion and transport calculations of oil and sulphuric acid spills to the Wloclawek reservoir.

The report [1] discusses also computer programs developed in the Centre of Excellence MANHAZ for determination of concentration of pollutants in surface waters basing on simplified numerical models recommended by International Atomic Energy Agency [3]. The last part of the report presents modeling systems for simulation of contamination dispersion in drinking water distribution net EPANET and EPANET-MSX, the latter is an extension to the original EPANET that allows it to model any system of multiple, interacting chemical species [5]. These models can be utilized by crisis centers for quick assessment of threats caused by release of toxic substances to potable water networks.

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THE APPLICATION OF MM5 NUMERICAL WEATHER PREDICTION SYSTEM FOR HIGH RESOLUTION SIMULATIONS

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For the purpose of atmospheric dispersion models to be applied in urban areas either in case of accidental release of hazardous material into atmosphere or for examining air quality it is absolutely necessary to have accurate meteorological fields in highest possible resolution. This can be obtained by applying a limited area numerical weather prediction model. One the most popular and mature models is mesoscale model MM5 [1] developed by the Penn State University and NCAR consortium. In order to use this model for high resolution simulations it is necessary to have detailed data on elevation, land use etc. and include special parameterization. The data of the resolution of 1 km are available from the US Geological Survey. In order to evaluate different types of parameterizations which can be used in MM5 system CCU-CAML lidar measurements (in particular aerosol vertical profiles) performed at Ispra station (Italy) [2] were utilized. In such a way estimation of boundary layer could be done by means on measurement and compared with the predictions obtained from MM5 simulations.

A series of numerical simulations were performed to understand to which extent the lidar-detected evolution of the particles distribution along the vertical could be explained by the boundary layer and/or horizontal transport processes. A particular stress was put on investigation of boundary layer parameters. The conclusions of the simulations can be summarized as follows:

Using MM5 and available data sets it is possible to investigate local phenomena in the atmospheric boundary layer (like mountain breeze or ground inversion), but there are some obvious limitations related to the following aspects:

The best resolution of terrain, land use and vegetation data sets is 30 sec, which correspond to about 0.9 km (at middle latitudes). Then 1 km grid size is a reasonable choice for high resolution calculations. This in turn means that it can be difficult to simulate some very local effects – like impact of the areas, which shape doesn't suit very much to the grid (for example long and narrow lake).

There is a need for appropriate computer power as one can roughly estimate the time needed for making simulations on n nested grid as proportional to the number of grid points times 3 to the (n-1) power. It should be also stressed that putting more advanced physics option makes it necessary to decrease time step to fulfil the Courant-Friedrich-Levy stability condition.

The MM5 modelling system has a possibility to include observation data using nudging procedure. In particular it could be of some advantage to add information on vertical profiles. The problem is however such, that requested data are often not available for the area of interest. In general coupling of observational data with high resolution numerical weather simulation is useful if the measured data have good frequency and come from at least a few stations in the domain. In this respect the drawback of used lidar station is that there are no nocturnal data.

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APPLICATION OF THE ENSEMBLE SYSTEM TO ANALYSIS OF ETEX EXPERIMENT

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The long-range tracer experiments ETEX [1], conducted in the autumn 1994, were organized jointly by the European Commission, the World Meteorological Organization and the International Atomic Energy Agency. Two different releases of passive tracers (PMCH and PMCP respectively), known as ETEX-1 and ETEX-2, took place in Rennes, France and a network of detection stations covering the area from Switzerland to Norway and from the United Kingdom to Poland was established to find concentration fields. Then a reliable set of measurement data was obtained, which can be used in the validation and evaluation of long-range atmospheric dispersion models. In 1999 the ENSEMBLE project [2] was set out to address harmonization and coherence issues for emergency management and decision-making in relation to long range atmospheric dispersion modeling.

The participants of the ENSEMBLE project count most European Meteorological Institutes and national responsible emergency organizations in addition to Canadian, Japanese, Korean and US American agencies. The ENSEMBLE system can be seen as a web-based decision support system for real-time exchange and evaluation of national long-range dispersion forecasts of nuclear releases with cross-boundary consequences. The created datasets within the ENSEMBLE system can be statistically evaluated to generate various uncertainty measures of predicted concentrations. Apart from real-time exercises the ENSEMBLE group was also activated to perform simulations both for ETEX-1 and ETEX-2 experiments [3]. For the purpose of the analysis the results of the models' simulation as well as measurement data were put on a regular geographical grid of 0.5° · 0.5° resolution and with 3h time step. Made in 2004, first analysis of the ETEX-1 experiment based on 16 models' dataset by the means of the ENSEMBLE system, showed that the median of the distribution of models' results ("median model") gave better results than any other single model or average of the

ENSEMBLE models or any other percentile, in terms of statistical parameters (like factors of 2 or 5). Similar analysis, with 15 models' datasets, was also made for ETEX-2 experiment. In comparison with ETEX-1, where a good agreement with measurement data was found, the analysis of the ETEX-2 case showed some essential discrepancies between the results of the models and observational data.

Additional analyses were also performed for a few weighted models obtained from both ETEX-1 and ETEX-2 datasets in addition to the median model. In particular the Bayesian Model Averaging (BMA) algorithm was applied to find the weights for the models, corresponding to the probabilities that the model is the closest one to the observation data. In these analyses 25 and 15 models' results were used for ETEX-1 and ETEX-2 respectively.

Relatively good agreement has been found for the models based on the BMA schemes applied to two distinct ETEX experiments. Additional comparison have been made between the combined models created by the weights calculated in different manner: the BMA-based and the least square fitting with the average and two medians: the median obtained from the models' results of the simulations and the median calculated using probability density function resulted from the BMA scheme. In general it can be stated that for emergency response purposes the median model can be considered as a reasonable compromise.

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IMPROVING OFF-SITE EMERGENCY MANAGEMENT: DEMONSTRATION PROJECTS UNDER EURANOS FRAMEWORK

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The EU integrated project “European approach to nuclear and radiological emergency management and rehabilitation strategies” (EURANOS) was established to harmonize European efforts in improvement of off-site emergency in case of nuclear accident anywhere in Europe. The MANHAZ centre of the Institute of Atomic Energy acting as the Technical Support Organisation for the Centre for Radiation Events of the National Atomic Energy Agency is also involved in the project. In 2007 a main demonstration subproject was entitled “ENSEMBLE evaluation of long-range atmospheric dispersion forecasts from national weather and prediction services”.

The purpose of all demonstration projects is also to engage National Emergency Centres using RODOS in specific exercises, where they could test both the functionality and the usability of RODOS for specific non NPP issues. The objective of the demonstration therefore was twofold, to gain the experience in operating and using RODOS for non NPP events and to provide feedback on both the usefulness and the improvements needed within RODOS.

The aim of the mentioned above subproject on operability of RODOS and ENSEMBLE systems was to demonstrate the adequacy of the ENSEMBLE approach and system to support the decision making in the early phase of an accident.

All the opinions and suggestions presented in the institutional reports have been grouped into the following categories:

1. Relevance of the dissemination of multiple model forecasts for emergency response.
2. Adequacy of the ENSEMBLE system for emergency management centres.
3. User interface, design, functionality.
4. Adequacy of the ENSEMBLE-RODOS interface.
5. Other aspects.

A special session of the ENSEMBLE system was organized for the demonstration project CAT2DEM02. All participating institutes received proper user ID and password to access this session. The session was a fully functional version of the ENSEMBLE system where the specific dataset for the demonstration were available. By accessing the system each users had the possibility to operate the ENSEMBLE system with the tools using actual datasets as usually produced by the

ENSEMBLE modelling community and relating to a specific release case.

The ENSEMBLE system has been perceived by the participants of the CAT2DEM02 demonstration project as a very useful tool in supporting decision makers in case of nuclear emergency [1]. The multi-model approach is seen as relevant for emergency response because it can assist in producing more scientifically justified judgment on the radiological situation during such an event. In particular, verification of national dispersion calculation results can be easily performed by the means of the ENSEMBLE system. Possibility of detailed and objective comparison of different models is a great value of the system. The information provided by the ENSEMBLE system can be very useful for early phase of the nuclear accident, essentially in case of the transboundary issues.

The system is seen as user friendly and easy to operate. Nevertheless the participants suggested some further improvements. Some of the proposed improvements are already in the new version of the system, which appeared in the meantime. For example, it concerns GIS-like approach for the presentation of the results in the system.

Some participants suggested also the need of more training before practical use of the system, as the system was originally designed for meteorological centres, where understanding of the ensemble methodology is higher than in emergency centres.

The most critical part of the system is related to the ENSEMBLE-RODOS interface. All the participants would like to have a possibility of calculating doses basing on the concentration fields available in the ENSEMBLE system. However, currently this interface can be treated rather as a premature prototype. Besides there are other unsolved elements, related to lack of consistency between both systems: ensemble approach for dealing with uncertainties is not incorporated into the RODOS system by any means.

Additionally some operational aspects should be solved in case of inclusion of the ENSEMBLE system into national emergency plans.

References

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SECURITY OF INDUSTRIAL CONTROL SYSTEMS

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Recently, several factors have raised concern about the security of industrial control systems (ICS) which are key components of much of national critical infrastructures including the electric power, water and water treatment, oil and gas production and distribution as well as industrial and military manufacturing. First, there has been a general trend to replace specialized control devices, particularly controllers and communications elements, with general purpose computer equipment and associated data communications technology. Second, many companies have chosen to interconnect certain parts of their process control networks with their corporate intranet once they have introduced general-purpose equipment into the process control system.

To help industry address these issues, the National Institute of Standards and Technology (NIST) has initiated an industry wide group called the Process Controls Security Requirements Forum (PCSRF) [1]. The PCSRF is developing its security specifications using the Common Criteria (CC). The CC, ISO/IEC 15408 [2], is a meta-standard of criteria and constructs used to develop security specifications in support of the evaluation of products and systems. The specifications define and characterize the security problem including assumptions about the operational environment, threats that may be encountered and policies that must be enforced. Also characterized is the intended approach to eliminate, minimize or monitor defined threats, and enforce stated policy.

The PCSRF has developed the Security Capabilities Profile (SCP) [3] as a first step towards development of protection profiles for industrial control systems. (SPP-ICS) [4]. It is an extension of the ISO/IEC 15408 Common Criteria to support integrated systems.

The SPP-ICS specifies the integrated set of security requirements for industrial control systems. The integrated set of requirements includes requirements for operating policies and procedures, requirements for information technology based system components, requirements for interfaces and interoperability between

system components, and requirements for the physical environment and protection of the system. The goal of this aspect of analysis and design is to define security requirements for subsystems or system components at the lowest possible level while at the same time retaining the required level of assurance and security functionality for the integrated system as a whole. The security subsystem includes both the information technology based components and the non-information technology based elements implemented via policies and operating procedures. Particular attention is given to the interaction and dependencies between the security subsystem and the overall industrial control system.

The System Target of Evaluation (STOE) deals with protecting data confidentiality, data integrity and system availability without interfering with safety system functions. Data integrity focuses on protecting data flows to and from the controller and the other ICS components or subsystems. The STOE is also intended to protect system availability to assure continuity of operations. The STOE consists of the security services and procedures, both automated and manual, which are designed to meet the security objectives defined to counter threats to the ICS. The recent work [5, 6] presents the development of structured methods ICS security analysis including STOE framework.

References

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USE OF HPAC PACKAGE FOR RISK SIMULATION IN RELEASE OF DANGEROUS SUBSTANCES IN THE ATMOSPHERE

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One of the current objectives for Centre of Excellence MANHAZ is acquiring the ability to calculate scenarios for crisis situation management for chemical and radiological emergencies, especially in urban areas. The main tool used for this purpose is the U.S. Defence Threat Reduction Agency's Hazard Prediction and Assessment Capability (HPAC) code enabling the user to simulate risks arising from releases of dangerous substances to the atmosphere.

HPAC enables the calculation of a range of different chemical/biological/nuclear (CBN) agent release scenarios, which include scenarios taking place:

- in a chemical/nuclear/industrial facility,
- in an urban environment,
- during transport,
- as a result of using a chemical/radiological weapon,
- as a result of intercepting a missile with a CBN load.

The scenario conditions can be set in great detail, taking into consideration many factors which may influence the consequences of the release, including the description of the CBN agent used (species, quantity, container type, localisation) and its carrier, the localisation of the event, current and forecast meteorological conditions, local topology, urban geometry and single building interior geometry. For the selected scenario HPAC provides calculated contaminant concentrations and risks as well as predictions of their dispersion in the environment. The MANHAZ implemented the HPAC code and carried out pilot calculations for several locations in Warsaw to test the applications of the code. The report [1] describes the HPAC code possibilities and the work methodology and can be treated as a documentation for the Polish user of the code.

References

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PRESENTATION OF FLUENT PACKAGE CAPABILITIES

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The CFD (Computational Fluid Dynamics) programs allow detailed calculational analysis of fluid flows in complex environment, eliminating the necessity of time-consuming and expensive experimental investigations during the design and modernization cycle of devices. The CFD programs allow to get the essential information about flow of liquid (the layout of velocity field, pressure field), the heat and mass transfer including chemical reactions.

The CFD models are used in industries including aerospace, automotive, chemical processing, power generation, heating, ventilation, air conditioning, biomedical, oil and gas, marine and many others. From ventilation comfort in large buildings to the tiniest scale in micro-pumps and nanotechnology, a wide range of problems can be addressed due to the scalable nature of fluid dynamics. Specialized models for combustion, reacting flows and radiation, rotating machinery, electronics cooling and many other applications, help provide the insight into equipment and processes required to increase production, improve longevity and decrease waste.

The application of Computational Fluid Dynamics (CFD) to the understanding of urban wind flow and dispersion processes has gained increasing attention

over recent years. While many of the simpler dispersion models are based on a set of prescribed meteorology to calculate dispersion, the CFD approach has the ability of coupling the wind field to dispersion processes. This has distinct advantages when very detailed results are required, such as for the case where the releases occur around buildings and within urban areas. CFD also has great flexibility as a testbed for turbulence models, which has important implications for atmospheric dispersion problems.

The accurate prediction of the spread of dangerous substances is important for scenarios that help in preparing for possible attacks, as well as in the analysis and damage assessment that follows an event.

The IAE report [1] includes description of CFD package FLUENT adapted to cluster of computers in the Centre of Excellence "MANHAZ" enabling parallel processing and calculation examples.

References

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THE EXPERIMENTAL STUDY OF VOCs REMOVAL FROM EXHAUST GASES USING THE ELECTRON BEAM FROM AN ACCELERATOR

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Volatile organic compounds (VOCs) are released into atmosphere from various industrial processes. Their main origins are: mobile sources, organic solvent application, petroleum industry, combustion of fossil fuels (industrial and non-industrial), waste treatment and disposal. Emission of VOC to the atmosphere can cause stratospheric ozone layer depletion, ground level photochemical ozone formation and toxic or carcinogenic human health effects. VOCs contribute to the global greenhouse effect. The reduction of VOCs emission is of a growing concern of international conventions as well as EU Directives. The purpose of this project was to study the concentration of VOCs emitted from combustion of the light fuel oil Ekoterm-Plus (PKN Orlen, Plock) and their removal efficiency using the electron beam from an accelerator. The light fuel oil Ekoterm-Plus (Table 1) is commonly used for residential heating in the municipal and living sectors in Poland.

Table 1. Properties of light fuel oil Ekoterm-Plus.

Property	Unit	Value
Density at 15°C	kg/m ³	830.8
Kinematic viscosity at 20°C	cSt	3.88
High heating value	MJ/kg	42.6
Sulfur content	% wt.	0.04
Water content	% wt.	0.015
Ash content	% wt.	0.002
Pour point	°C	-30
Flash point	C	66

The study was performed in the laboratory plant [1] at Institute of Nuclear Chemistry and Technology at Warsaw. The oil was burned by a Jet 4.5 EV burner. The obtained flue gas was irradiated in a process vessel (PV) by the electron beam from the ILU-6M accelerator. At the inlet PV, the sample gas was extracted for analysis of flue gas composition by two independent systems. The SO₂ and NO/NO_x concentrations were continuously determined by a set of two extractive gas analyzers The Model 10A/R (chemiluminescence NO/NO_x analyzer) and the Model 40 (pulsed fluorescent SO₂ analyzer), manufactured by the Thermo Environmental Instrument Corporation (USA).

Organic pollutants occur in flue gas in two phases: particulate phase and gas phase consisting of semivolatile and volatile compounds with boiling points higher than 100°C. The project was dedicated to gas phase volatile compounds. Their concentrations were determined by an off-line method. The sample probe was made from stainless steel and was fitted with heated gas filters. Two ceramic coaxial filters were used for the

removal of particulate substance from a sample gas. After filtration, the sample gas was transported through a heated stainless steel tube to a dry-ice-cooled condensate trap (to separate a condensate) and to a gas adsorption tubes (two tubes of XAD-2 resin and one tube of activated carbon). Gas filters and gas transported line were kept at the same temperature of 180°C to avoid condensation. In each run, the sampling flow rate was of 1l/min and the gas volume sample was about 300 liters. After completion of the sampling the condensate trap and sorbent tubes were hermetically closed, wrapped in aluminium foil and shipped to the laboratory in a portable refrigerator. Samples were analyzed in the following 48h (to prevent degradation) using a GC/MS system, manufactured by Shimadzu (Japan).

Very low concentrations of SO₂ (in the range 20-35 ppmv) and NO_x (in the range 15-25 ppmv) occurred in the flue gas. Table 2 presents the VOCs identified in the light oil combustion gases.

Table 2. VOCs identified in the light oil combustion gases.

Compounds group	Subgroup	Concentration [µg/Nm ³]
Aliphatic hydrocarbons	Alkanes	10 ¹
	Alkenes	10 ¹
Aromatic hydrocarbons	BTX	10 ¹ -10 ²
PAH	2- and 3-ringed	10 ¹ -10 ²
Oxidized aromatic	Aromatic acids	10 ¹ -10 ²
	Aromatic aldehydes	10 ¹ -10 ²
Hydrocarbons	Aromatic alcohols	10 ¹ -10 ²
Hydrocarbons containing sulphur	Thiophenes	10 ⁰
	Thiazoles	10 ⁰

The identified volatile organic compound occurred in low concentrations of µg/Nm³. Among them in the higher concentrations of 10-100 µg/Nm³ were detected: aromatic hydrocarbons, oxidized aromatic hydrocarbons and 2- and 3-ring PAHs. The main adverse environmental impacts of VOCs are connected with the photochemical ozone formation in the atmosphere. In the case of this flue gases these effects were insignificant due to the low identified concentration of NO_x which is necessary for these photochemical reactions. The 2- and 3- ring PAHs do not reveal the carcinogenic effect on humans. Thus the total environmental reactivity of this flue gas is very low.

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