

## CENTRE OF EXCELLENCE "MANHAZ" – MANAGEMENT OF HEALTH AND ENVIRONMENTAL HAZARDS

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 targets to be achieved by the Centre are the following:

- to create a common forum both for developers of the models for risk assessment, management of major accidents and decision support systems, and for members of emergency centres, inspectors of environmental protection and people responsible for safety management in chemical plants. The forum will enable to initiate a broader discussion and interaction, both to provide essential feedback to the developers and to familiarise the users with the nature and level of support they can expect in practice,
- to consolidate efforts of experts in environmental protection to include advanced models in the currently used software,
- to familiarise a broad spectrum of specialists working in the field of environmental protection with new trends in mathematical methods used in risk assessment.

The following work packages have been predicted in the EU project:

- WP1. Modelling of pollutant transport in atmosphere and water bodies for decision support systems in case of emergencies.
- WP2. Models and tools for assessment of risk related to transportation of dangerous goods by road and railway.
- WP3. Methods and models for assessment of risk related to transportation of dangerous goods by pipelines.
- WP4. Approaches to comparative risk assessment of fuel cycles of electricity generation.

- WP5. Organisation of national working team on safety assessment for medical applications of radiation.
- WP6. Organisation of summer school "Management of environmental hazards".
- WP7. Clearing house and information.

In 2003 two main sub-objectives could be recognised:

- a) carrying out three workshops foreseen by WP1, WP2, WP3 work packages;
- b) developing WWW MANHAZ portal;
- c) start organizing workshop, according to work plan of WP4 and WP5.

The main aim of these workshops was to present to the broad spectrum of specialists and persons engaged in decision making process, "the state of the art" of models and tools relevant for the topics covered by work packages WP1-WP3. A particular stress was put to the cumulative risk analysis, decision support systems and integrated information about the range of possible effects of contaminants and other stressors, and of different actions that can be taken to address them. Each workshop started with the presentation of the position paper especially prepared for the workshop by a leading scientist in the field. Apart from presentations and tutorials an very important part of the workshops were discussions between model developers and end-users. In particular, a number of specific problems that can be encountered in daily practise was discussed in details. Another direction of MANHAZ activity is the development of new numerical methods and algorithms for solving problems in pollutant transport in atmosphere and water bodies, and in the field of nuclear reactor physics.

## COMPUTER SYSTEM FOR MANAGING CRISIS SITUATIONS IN DANGEROUS FACILITIES

**Mieczysław Borysiewicz, Andrzej Furtek, Sławomir Potemski, Anna Wasiuk, Henryk Wojciechowicz**  
*Institute of Atomic Energy*

The work has been done as a second phase of the 3-year project "Computerised management system in crisis situation for chemical plants" being realised under the programme entitled „Fitting Polish labour conditions to European Union standards” coordinated by the Central Institute of Labour Protection, started in 2002. The aim of the project is to develop crisis management system for chemical plants, which should implement the following elements:

- (1) computerised version of emergency plans according to national regulations and EU Seveso II Directive,
- (2) numerical diagnosis of meteorological fields based on local measurements,
- (3) numerical maps with full topography, landuse and detailed plans of the plant,

- (4) advanced model of pollutant transport in atmosphere and water bodies,
- (5) support of emergency action based on items (1)-(4),
- (6) visualisation of results and preparation of reports.

In 2003 year two modules of the computerised system have been developed. The first one serves for preparation of action plans for rescue teams during emergency situation. This module must be in accordance with relevant law regulations and standards. The second module is devoted to diagnose local meteorological parameters taking into account elevation and local measurements. A special interpolation preserving equations of atmosphere has been used. This enables obtaining more precise meteorological parameters, which can further applied in modelling of transport pollutants in atmosphere.

## CMAQ - MULTISCALE SYSTEM FOR AIR QUALITY SIMULATIONS

**Mieczysław Borysiewicz, Andrzej Furtek, Sławomir Potemski, Anna Wasiuk, Henryk Wojciechowicz**  
*Institute of Atomic Energy*

The report [1] describes computer programme CMAQ that has been adopted to the Polish conditions. The Community Multi-scale Air Quality (CMAQ) modelling system has been designed to approach air quality as a whole by including state-of-the-science capabilities for modelling multiple air quality issues, including tropospheric ozone, fine particles, toxics, acid deposition and visibility degradation. In this way, the development of CMAQ involves the scientific expertise from each of these areas and combines the capabilities to enable a community modelling practice. CMAQ was also designed to have multi-scale capabilities so that separate models were not needed for urban and regional scale air quality modelling.

The target grid resolutions and domain sizes for CMAQ range spatially and temporally over several orders of magnitude. With the temporal flexibility of the model, simulations can be performed to evaluate longer term pollutant climatologies as well as short term transport from localized sources. With the model's ability to handle a large range of spatial scales, CMAQ can be used for urban and regional scale model simulations. By making CMAQ a modelling system that addresses multiple pollutants and different spatial scales, CMAQ has a "one atmosphere" perspective that combines the efforts of the scientific community. Improvements will be made to the CMAQ modelling system as the scientific community further develops the state-of-the-science.

To implement multi-scale capabilities in CMAQ, several issues, such as scalable atmospheric dynamics

and generalized coordinates, that depend on the desired model resolution are addressed. Meteorological models may assume hydrostatic conditions for large regional scales, where the atmosphere is assumed to have a balance of vertical pressure and gravitational forces with no net vertical acceleration on larger scales. However, on smaller scales such as urban scales, this assumption cannot be made. A set of governing equations for compressible non-hydrostatic atmospheres is available to better resolve atmospheric dynamics at smaller scales. These non-hydrostatic equations are more appropriate for finer regional scale and urban scale meteorology. Because CMAQ is designed to handle scale dependent meteorological formulations and a large amount of flexibility, CMAQ's governing equations are expressed in a generalized coordinate system. This approach ensures consistency between CMAQ and the meteorological modelling system. The generalized coordinate system determines the necessary grid and coordinate transformations, and it can accommodate various vertical coordinates and map projections.

The CMAQ modelling system simulates various chemical and physical processes that are thought to be important for understanding atmospheric trace gas transformations and distributions. The CMAQ modelling system contains three types of modelling components: a meteorological modelling system for the description of atmospheric states and motions, emission models for man-made and natural emissions that are injected into the atmosphere, and a chemistry-transport modelling system for simulation of the chemical

transformation and fate. CMAQ science code (updates) will be available via anonymous ftp.

The CMAQ consists of six interface processors:

- Meteorology-chemistry interface processor (MCIP).
- Photolysis rate processor (JPROC).
- Initial conditions processor (ICON).
- Boundary conditions processor (BCON).
- Chemical-transport model processor (CCTM).

The CMAQ modelling system was designed to have a flexible community modelling structure based on modular components. CMAQ CTM (CCTM) includes the following process modules:

- Horizontal advection.
- Vertical advection.
- Mass conservation adjustments for advection processes.

- Horizontal diffusion.
- Vertical diffusion.
- Gas-phase chemical reaction solver.
- Aqueous-phase reactions and cloud mixing.
- Aerosol dynamics and size distributions.
- Plume chemistry effects.
- Aerosol deposition velocity estimation.
- Photolytic rate computation.
- Process analysis.

#### References

- [1] M. Borysiewicz, A. Furtek, S. Potemski, A. Wasiuk, H. Wojciechowicz: *CMAQ – multiscale air quality simulation model*, (in Polish), Raport IAE-105/A, 2003.

### DECISION ANALYSIS OF CLEAN-UP ACTIONS IN INHABITED AREAS IN POLAND AFTER AN ACCIDENTAL RELEASE OF RADIONUCLIDES

**Slawomir Potemski**

*Institute of Atomic Energy*

The report [1] describes the results of workshop on “Decision analysis of clean-up actions in inhabited areas in Poland after an accidental release of radionuclides”. During the workshop the key elements of decision making process were identified and decision value tree was built using Value Tree methodology supported by WebHipse software. Basing on created decision tree the optimal strategy from clean-up actions was found for hypothetical radiological accident.

International organizations have for many years recommended that key players, e.g., authorities, expert organizations, industry, producers and the public should be involved in the national planning for protective actions in a case of a nuclear accident. Facilitated workshops provide a potential methodology for their involvement in the decision making on such national plans.

The workshop was a part of the research project EVATECH, “Information Requirements and Countermeasure Evaluation Techniques in Nuclear Emergency Management”, in the key action “Nuclear Fission” in the Fifth Euratom Framework Programme (FP5).

The main objectives of EVATECH in national workshops were:

- to develop methods for stakeholder involvement in exercises and emergency planning;
- to verify the factors driving decision making;
- to explore the information needs of all parties involved in decision making;
- to identify the forms of strategy that relevant organizations wish to consider.

The national workshop was held in the National Atomic Energy Agency. A group of experts from different institutions had to consider situation hypothetically one week after the release and decide which decontamination technique or combination of them should be applied. The results are given in the report [1].

#### References

- [1] S. Potemski: *Decision analysis of clean-up actions in inhabited areas in Poland after an accidental release of radionuclides*, FIKR-CT-2001-00193, EVATECH 2004-01-08, 2003.

### THE THIRD DSSNET EMERGENCY EXERCISE: DESCRIPTION AND EVALUATION

**Andrzej Furtek, Slawomir Potemski**

*Institute of Atomic Energy*

The structured evaluation of the experience gained with decision support systems (such as RODOS- Realtime

Online Decision Support System) and the information exchange between them is one of the key objectives of

the DSSNET (Decision Support Systems for Off-site Nuclear Emergency Management) work programme. To stimulate these activities and to facilitate the communication between the users and the R&D community, problem-oriented emergency exercises will be prepared, which cover the various time phases of an accident and extending from the near range to farther distances with frontier crossing transport of radionuclides. They will help to understand the strengths and weaknesses of both technical support tools, such as the RODOS systems, their interaction within data exchange networks and administrative arrangements on the local, regional national and international level. Main objective of the third emergency exercise was to use a radioactive release scenario causing long range atmospheric dispersion and emergency management problems for obtaining feedback on the performance of the corresponding model chains and the existing and improved data exchange procedures.

The report [1] describes the preparations for the exercise, the exercise scenario, the performance of the exercise, the response of the participating institutions, and the exercise evaluation by the exercise management team and by the participants.

The exercise was held on 27 May 2003 during the normal working hours from 6:00 UTC to 13:45 UTC. At the day of the exercise, the accident messages were provided in real-time on three different servers according to the separation into the groups North, South and West. The information was updated every minute, i.e. the participants had to watch continuously the site with the scenario information. According to the information given, the players had to operate the decision support systems and to produce the results relevant for decision making or asked in the evaluation forms, respectively. At certain points in time, UJD (Nuclear Regulatory Authority of Slovak Republic) and FZK (Forschungszentrum Karlsruhe) acting as coordinator of the three groups sent out by e-mail

messages about the availability of data files with meteorological data and source term information. These data files could be directly stored in the participants' RODOS systems as input for own interactive RODOS runs. In that way, interpretation or input errors could be avoided. In addition, UJD and FZK acting as country, where accident took place, informed the participants by e-mail when calculations for the various clusters were available and where they could be accessed.

According to the DSSNET working plans the emergency exercise dealt with the longer distance transport of radioactive material, going beyond the distance range of up to about 200 km as in the first two exercises. In that way the following objectives could be achieved:

1. Interaction between DSS (Decision Support Systems) and numerical weather predictions provided by national weather services.
2. Test of the performance of the long distance atmospheric dispersion models (and their interaction with the near range model in RODOS).
3. Information exchange between accident country and its neighbouring countries, in particular through the direct communication between DSS:
  - about the meteorological situation,
  - the status of the accident plant and prognosticated or assumed releases,
  - decisions about emergency actions and countermeasures,
  - results of DSS,
  - cross-border countermeasures and their mutual adaptation,
  - identification of technical, organisational or administrative weak-points.

## References

- [1] J. Erhardt (edit.): *The third DSSNET emergency exercise: description and evaluation*, DSSNET(WP1)-TN(03)01:01, 2003.

## ENSEMBLE ATMOSPHERIC DISPERSION CALCULATIONS FOR DECISION SUPPORT SYSTEMS

Mieczysław Borysiewicz<sup>1</sup>, Sławomir Potemski<sup>1</sup>, Roman Żelazny<sup>2</sup>, Andrzej Gałkowski<sup>2</sup>

<sup>1</sup>*Institute of Atomic Energy*

<sup>2</sup>*Institute of Plasma Physics and Laser Microfusion, Warsaw, Poland*

During the days of the Chernobyl nuclear accident, the European national long-range dispersion forecasts differed because of differences in national models and differences in weather prediction methods. Differences in national forecasts caused problems at the European level, as many National emergency management strategies did not cohere with those in neighboring countries. The ENSEMBLE project was set out to address this harmonization and coherence issues for emergency management and decision-making in relation to long range atmospheric dispersion modelling.

The idea behind ENSEMBLE originated from the 1994 ETEX project where about 50 long-range dispersion forecast models were run at several Institutes around the world to simulate two real long-range tracer releases involving a large part of the European territory. The participants of the ENSEMBLE project count 17 European meteorological institutes and national responsible emergency organisations in addition to Canadian, Japanese and US American agencies. The participating models are typically national nuclear emergency preparedness modules, but include also the

joint European atmospheric dispersion module developed within the European Real-time On-line Decision support System RODOS.

ENSEMBLE 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 system is developed with the purpose to reconcile among disparate national forecasts for long-range dispersion. ENSEMBLE addresses the problem of achieving a common coherent strategy across European national emergency management when national long-range dispersion forecasts differ from one another during an accidental atmospheric release of radioactive material.

A series of new decision-making "ENSEMBLE" procedures and Web-based software evaluation and exchange tools have been created for real-time reconciliation and harmonisation of real-time dispersion

forecasts from meteorological and emergency centres across Europe during an accident.

The report [1] describes two approaches to long-range atmospheric dispersion of pollutants based on the ensemble concept. In the first part of the report some experiences related to the exercises undertaken under the ENSEMBLE project of the European Union are presented. The second part is devoted to the implementation of mesoscale numerical prediction models on Beowulf cluster and its usage for long range atmospheric dispersion calculations based on available meteorological data from NCEP, NOAA (USA).

#### References

- [1] M. Borysiewicz S. Potemski, A. Galkowski, R. Żelazny: *Ensemble Atmospheric Dispersion Calculations for decision support systems*, Raport IAE-106/A, 2003.

### MIMS - MULTIMEDIA INTEGRATED MODELLING SYSTEM

Mieczysław Borysiewicz<sup>1</sup>, Andrzej Furtek<sup>1</sup>, Sławomir Potemski<sup>1</sup>, Anna Wasiuk<sup>1</sup>,  
Henryk Wojciechowicz<sup>1</sup>, Ewa Lisowska – Mieszkowska<sup>2</sup>

<sup>1</sup>Institute of Atomic Energy

<sup>2</sup>Institute of Environmental Protection, Warsaw, Poland

MIMS - Multimedia Integrated Modelling System is a framework application supporting designing, configuration and performing complex simulations using variety of models and tools related to them as iterators or analyses tools. MIMS performs modelling basing on user suggestions and dependently on type and amount of data user possesses.

Several trends in environmental modelling are driving a significant increase in the complexity of environmental modelling studies. These include the growing importance of combining models from multiple physical media (e.g. air, water, soil) or disciplines to make predictions that include an increasingly complete set of processes and outcomes:

- performing sensitivity and uncertainty studies to understand factors that affect results and to estimate the confidence that should be associated with predictions; and
- comparing multiple models and data sets that are intended to represent similar processes or contain similar information to understand models' and data sets' biases and errors.

The MIMS software suite will support the following activities:

- Data management and manipulation.
- Model coupling and swapping.
- Repetitive work, such as modelling of multiple locations and conducting sensitivity and uncertainty studies.
- Computation management, such as managing model executions on remote computers.

- Model evaluation.

The software suite will support these activities by automating common actions, simplifying manual operations, checking consistency based on information provided by modellers, and providing tools for various activities. To effectively meet the needs of users, we have identified a number of desirable characteristics for the software suite. The suite should:

- Be applicable to a wide variety of environmental issues.
- Be compatible with multiple families of models and multiple sources of data (e.g., field observations, satellites, models).
- Support feedback between models.
- Be easy for modellers to use.
- Run on multiple operating systems (e.g., Windows, UNIX, Linux).
- Support distributed computing in a flexible manner.
- Be open source.
- Allow modellers to incorporate their models into the system without losing "ownership".
- Allow users to choose their level of investment (e.g., achieve some benefit with limited effort or achieve greater benefit with greater effort).
- Make common operations easy to perform while also supporting less common and more complex operations.

The MIMS software suite will include several components. The framework provides a software infrastructure for composing, executing, and evaluating models. MIMS tools provide functionality required to

prepare models or their inputs or to operate on models' results. In the future, MIMS software libraries will provide a standard implementation of common functions required by models. Description of the MIMS software for usage in decision support system is given in ref. [1].

### MM5 - MESOSCALE MODEL OF THE EARTH ATMOSPHERE. IMPLEMENTATION OF THE SYSTEM ON THE BEOWULF CLUSTER AT THE INSTITUTE OF ATOMIC ENERGY

Mieczysław Borysiewicz<sup>1</sup>, Andrzej Furtek<sup>1</sup>, Sławomir Potemski<sup>1</sup>, Anna Wasiuk<sup>1</sup>,  
Henryk Wojciechowicz<sup>1</sup>, Andrzej Gałkowski<sup>2</sup>

<sup>1</sup>*Institute of Atomic Energy*

<sup>2</sup>*Institute of Plasma Physics and Laser Microfusion, Warsaw, Poland*

The fifth generation MM5 model is the last from the series, that began with mesoscale model developed by Anthes and Warner at the Pennsylvania State University on the early seventies. Since then the model has been changed many times as to make its applicable much wider. These extensions include (i) subgridding possibilities, (ii) nonhydrostatic dynamic of atmosphere, (iii) four dimensional data assimilation and more physical options (iv) possibilities to implement on different computer platforms.

The PSU/NCAR mesoscale model is a limited-area, nonhydrostatic or hydrostatic (Version 2 only), terrain-following sigma-coordinate model designed to simulate or predict mesoscale and regional-scale atmospheric circulation. It has been developed at Penn State and NCAR as a community mesoscale model and is continuously being improved by contributions from users at several universities and government laboratories.

The fifth-generation NCAR / Penn State Mesoscale Model (MM5) is the latest in a series that developed from a mesoscale model used by Anthes at Penn State in the early 70's that was later documented by Anthes and Warner (1978). Since that time, it has undergone many changes designed to broaden its usage. These include (i) a multiple-nest capability, (ii) nonhydrostatic dynamics, which allows the model to be used at a few-kilometer scale, (iii) multitasking capability on shared- and distributed-memory machines, (iv) a four-dimensional data-assimilation capability, and (v) more physics options.

The model (known as MM5) is supported by several auxiliary programs, which are referred to collectively as the MM5 modelling system.

Terrestrial and isobaric meteorological data are horizontally interpolated (programs TERRAIN and REGRID) from a latitude-longitude mesh to a variable high-resolution domain on either a Mercator, Lambert

### References

- [1] M. Borysiewicz, A. Furtek, E. Lisowska-Mieszkowska, S. Potemski, A. Wasiuk, H. Wojciechowicz: *MIMS – Multimedia Integrated Modelling System* (in Polish), Raport IAE-103/A, 2003.

conformal, or polar stereographic projection. Since the interpolation does not provide mesoscale detail, the interpolated data may be enhanced (program RAWINS) with observations from the standard network of surface and rawinsonde stations using either a successive-scan Cressman technique or multiquadric scheme. Program INTERPF performs the vertical interpolation from pressure levels to the sigma coordinate system of MM5. Sigma surfaces near the ground closely follow the terrain, and the higher-level sigma surfaces tend to approximate isobaric surfaces. Since the vertical and horizontal resolution and domain size are variable, the modelling package programs employ parameterized dimensions requiring a variable amount of core memory. Some peripheral storage devices are also used.

Since MM5 is a regional model, it requires an initial condition as well as lateral boundary condition to run. To produce lateral boundary condition for a model run, one needs gridded data to cover the entire time period that the model is integrated.

The MM5 model has been implemented on Beowulf cluster consisting of four 2-processors 2 GHz Xeon machines working under Red Hat Linux operating system. The details are given in the report [1]. The MM5 model is used to produce meteorological data for environmental decision support systems.

### References

- [1] M. Borysiewicz, A. Furtek, A. Gałkowski, S. Potemski, A. Wasiuk, H. Wojciechowicz: *MM5 - Mesoscale atmospheric model. Implementation on Beowulf cluster at IAE*, (in Polish), Raport IAE-102/A, 2003.

## SMOKE - EMISSION MODELLING SYSTEM

Mieczysław Borysiewicz, Andrzej Furtek, Sławomir Potemski, Anna Wasiuk, Henryk Wojciechowicz  
*Institute of Atomic Energy*

SMOKE - Emission modelling system [1] (Space Matrix Operator Kernel Emission modelling) - simulates emissions of gases and particles to the atmosphere taking into account surrounding meteorological conditions and performed socio-economical measures. Emissions are usually split into point sources, line sources (accidental release from source moving on the road) and area sources. Point source modules simulate emissions from single point (e.g. chimney). Line source modules simulate emissions that are long (e.g. from trucks). Area sources include moving sources not from the roads, biogenic emissions and other sources in relation to the area where population, animals and plants exist.

The SMOKE system allows emissions data processing methods to integrate high-performance-computing (HPC) sparse-matrix algorithms. The SMOKE system has greatly enhanced support for decision making about emissions controls for both urban and regional applications, has provided a mechanism for preparing specialized inputs for air quality modelling research, and has made air quality forecasting possible. SMOKE supports area, mobile, and point source emission processing and also includes biogenic emissions modelling. SMOKE now supports the Biogenic Emission Inventory System, version 2 and a version 3, prototype. SMOKE is partially integrated with EPA's Models-3 system, and work is ongoing to complete that integration process.

The current version of SMOKE is primarily an emission processing system and not an emission inventory preparation system. This means that, with the

exception of mobile sources, its purpose is to provide an efficient tool for converting emissions inventory data into the formatted emission files required by an AQM. For mobile sources, SMOKE additionally computes an emissions inventory from mobile-source activity data, using emission factors.

The sparse matrix approach utilized throughout SMOKE permits both rapid and flexible processing of emissions data. The processing is rapid because SMOKE utilizes a series of matrix calculations instead of less efficient algorithms used in previous systems. The processing is flexible because the processing steps of temporal projection, controls, chemical speciation, temporal allocation, and spatial allocation have been separated into independent operations wherever possible. The results from these steps are merged together at a final stage of processing using vector-matrix mathematics. One example of how this approach is beneficial is development of a control strategy. In SMOKE, changing a control strategy requires only the control and merge steps to be processed again, whereas in other systems, most or all of the steps need to be redone. The report [1] describes how to use SMOKE model.

### References

- [1] M. Borysiewicz, A. Furtek, S. Potemski, A. Wasiuk, H. Wojciechowicz: *SMOKE - Emission modelling system*, (in Polish), Raport IAE -104/A, 2003.

## MODELLING OF THE CONTAMINANT TRANSPORT IN THE WŁOCŁAWEK RESERVOIR

Mieczysław Borysiewicz<sup>1</sup>, Sławomir Potemski<sup>1</sup>, Andrzej Kadłubowski<sup>2</sup>,  
Igor Brovchenko<sup>3</sup>, Vladimir Maderich<sup>3</sup>

<sup>1</sup>*Institute of Atomic Energy*

<sup>2</sup>*Institute of Meteorology and Water Management, Warsaw, Poland*

<sup>3</sup>*Ukrainian Center of Environmental and Water Projects, Kiev, Ukraine*

In the report [1] customization of three dimensional model THREETOX for simulation of pollutant transport in water bodies for Włocławek Reservoir is described. Three main scenarios are taken into account – releases of sulphuric acid, crude oil and petrol. In particular the last two scenarios are of great interest as a special module TOXOIL has been developed for this purpose. Apart from results of simulation a general information about THREETOX model is also included in the report.

The report summarizes the description of the results of simulation of transport and fate of different types of contamination in the Włocławek Reservoir. The

transport of acid and oil slick has been considered as a study case for implementation of hydrological modules of the RODOS system (RODOS-HDM). The Włocławek Reservoir lies on the Vistula river. This place was chosen for study case because of the large refinery complex PKN "Orlen", located nearby in Płock, with a potential of major chemical accidents. There is also another big chemical plant in the nearest surroundings of the city Włocławek.

The plan of the report [1] is as follows. First the brief description of three-dimensional model of hydrodynamics, contaminant transport and oil transport

and fate model is given. Model in details is presented by Margvelashvili [2] and Brovchenko and Maderich [3]. Next results of model application to the Włocławek Reservoir are presented. The model was customized to this area, calibrated and verified against available data. The simulation results are summarized in last section. The report compares the results of implementation of THEETOX model for Włocławek Reservoir with the data given in the Safety Study of a pipeline operated by PKN "Orlen". The results of simulation showed the strong potential of THEETOX model for modeling and forecasting of contamination of coastal and inland waters.

## References

- [1] M. Borysiewicz, S. Potemski, A. Kadłubowski, V. Maderich: *Modelling of the contaminant transport in the Włocławek Reservoir*, Raport IAE-93/A, 2003.
- [2] V. Maderich, N. Margvelashvili, S. Yushenko, M. Zheleznyak: *3D modelling of the mud and radionuclide transport in Chernobyl cooling pond and Dnieper-Bug estuary*. Fine Sediments Dynamics in the Marine Environment, Proceedings of INTERCOH-2000., ed. J.C. Winterwerp and C. Kranenburg, Elsevier, p. 595-610, 2002.
- [3] I. Brovchenko, V. Maderich: *Numerical Lagrangian method for modelling of the surface oil slick spills*, Applied Hydromechanics, 4(76), No.4, 1-9, 2002.

## SHORT-RANGE TRANSPORT AND DISPERSION MODELLING FOR DECISION MAKING - 1<sup>ST</sup> MANHAZ WP1 WORKSHOP

**Mieczysław Borysiewicz, Andrzej Furtek, Sławomir Potemski, Anna Wasiuk, Henryk Wojciechowicz**  
*Institute of Atomic Energy*

The main objective of the first work package (WP1) is to create a common forum for developers of the advanced models for pollutant transport in atmosphere and water bodies, and users of decision support systems. The forum will enable to initiate a broader discussion and interaction, both to provide essential feedback to the developers and to familiarize the users (and decision makers) with the nature and level of support they can expect in practice.

The first workshop of WP1 on "Short-Range Transport and Dispersion Modelling for Decision Making", was held on November 17-18, 2003, at the premises of Centre of Excellence MANHAZ at the Institute of Atomic Energy, Świerk.

The Workshop consisted of presentations of position paper, technical papers and tutorials. The position paper was presented by Dr. Morten Nielsen from Risø National Laboratory, Denmark. The presentations of technical papers were given in the format of a typical conference, with 45 – 90 minutes available for each presentation and its discussion. The tutorials were organized to provide case studies of selected scenarios. Language of the workshop was English and Polish.

The technical topics included in the workshop programme covered a wide range issues under the general category of short range atmospheric transport and dispersion modelling for decision making. They were:

1. Modelling of dispersion and transport of contamination in air.
  - Types of models for calculations of dispersion and transport of contamination in air.
  - Main features of used computing models.
  - Meteorological parameters in atmospheric dispersion modelling: wind field models; meteorological pre-processors; new requirements concerning meteo data for calculation of contamination transport and air quality.
- Detailed modelling of releases of heavy gases and passive transport of contamination: modification of height of release source; deposition velocity.
2. General issues of short range pollutant modelling: atmospheric parameters; Gaussian dispersion equations; dispersion coefficients; plume rise; time-averaging of concentrations; wind velocity profiles; calculating stack gas plume dispersion; trapped plumes; fumigation; meteorological data.
3. Models of dispersion and transport used in air quality problems.
4. Meteorological modelling for input to transport and dispersion models.
5. Models of dispersion and transport for analysis of industrial accidents.
  - Source emission models: gas and liquid jet releases; two-phase jet releases; the flashing process; liquid pool evaporation (single component); liquid pool evaporation (multi component).
  - Transport and dispersion models: initial momentum jets and buoyant plumes; dense gas releases; transition to neutrally-buoyant plume transport and dispersion; modelling approaches other than box or slab models; nonhomogeneous terrain and wind fields; concentration fluctuations, averaging and sampling time.
  - Model evaluation and uncertainties.

- Examples of modelling of scenarios e.g. release of pressurized liquid chlorine; liquid (cryogenic) spill of refrigerated chlorine.
6. Decision support system related to pollution releases to atmosphere.
  7. Methods and criteria for emergency response and decision-making.

## **MODELS AND TOOLS FOR ASSESSMENT OF RISK RELATED TO TRANSPORTATION OF DANGEROUS GOODS BY ROAD AND RAILWAY - 1<sup>ST</sup> MANHAZ WP2 WORKSHOP**

**Mieczysław Borysiewicz, Andrzej Furtek, Sławomir Potempski, Anna Wasiuk, Henryk Wojciechowicz**  
*Institute of Atomic Energy*

The main objective of the second work package (WP2) is to provide analysis tools that can assist in improving management of hazards connected with the transportation of dangerous substances by land. In particular, it concerns prediction, when required by law, the influence of new transportation lines (roads and railways) on environment, and designing the ways of transporting dangerous materials. To make management more rational it is important to familiarise specialists with new approaches and recent development in the field of risk assessment methods for transportation of dangerous substances by roads and railway.

The first workshop of WP2 on „Models and tools for risk assessment of road/railroad transport of hazardous substances”, was held on November 19-20 2003, at the premises of the Centre of Excellence MANHAZ at the Institute of Atomic Energy, Swierk near Otwock.

Workshop consisted of presentations of position paper, technical papers and tutorials. The positions papers were presented by Mieczysław Borysiewicz from CE-MANHAZ and Bolesław Hancyk from the Institute of Organic Industry. The presentation of technical paper were given in the format of a typical conference, with 45 – 90 minutes available for each presentation and its discussion. The tutorials were organized to present simple models and selected case studies.

The technical topics of the workshop covered the following issues:

1. Transportation risk analysis (TRA); definitions; general framework of a TRA; typical reasons for conducting a TRA; transportation versus fixed facility risk evaluations; general similarities to fixed facility evaluations; differences from fixed facility evaluations.
2. Transportation risk management.
3. Conditions of risk management for transport.
  - Methodology of risk management for transport.
  - Selection of transportation routes.
  - Rules on limitation of frequency of accident events.
  - International cooperation concerning common recommendations and directives.
4. Accident consequence models.
  - Methodologies describing consequences.
  - Modelling consequences of accidental releases or emissions of substances, dangerous for human health and environment.
  - Models referring to consequences: biomechanics; vehicle engineering; road side obstacles.
  - Models for analysis and assessment of transportation organization and factors.
5. Examples of methodologies for assessment of risk related to transport accidents involving dangerous substances.
  - Simple algorithms for estimation of risk generated by transportation of dangerous substances by roads and railways.
  - Methods for hazard assessment: how to determine intensity of traffic; traffic profile, frequency of accidents; and probability of major transport accident.
  - Assumptions concerning selections of scenarios related to hazards for people: representative scenario: “fire”; representative scenario: “explosion”; representative scenario: “release of toxic substance”.
  - Assumptions concerning selection of representative scenarios that may impact ground waters: representative scenario: „release of hydrocarbons”; representative scenario: „liquid release influencing changes in water quality”.
  - Assumptions concerning selection of representative scenarios for surface waters: representative scenario: „release of hydrocarbons”; representative scenario: „liquid release influencing changes in water quality”.
  - Recommended methods for risk classification and prioritization.
6. New requirements of European Agreement concerning the International Carriage of Dangerous Goods by Road, ADR 2001.

## MODELS AND TOOLS FOR ASSESSMENT OF RISK RELATED TO TRANSPORTATION OF DANGEROUS GOODS BY PIPELINES - 1<sup>ST</sup> MANHAZ WP3 WORKSHOP

**Mieczysław Borysiewicz, Andrzej Furtek, Sławomir Potempski, Anna Wasiuk, Henryk Wojciechowicz**  
*Institute of Atomic Energy*

The main objective of the third work package (WP3) is to disseminate information on methods and computing tools which would assist in improving management of hazards connected with the transportation of dangerous substances by pipeline. To make management more rational it is important to familiarise specialists with new approaches and recent development in the field of risk assessment and safety management for pipelines. This problem is at present particularly important for Poland and other acceding states in connection with existing and planned pipelines.

The first workshop of WP3 on "Models and tools for estimating the risk of pipeline transport of hazardous substances" was held on November 20-21, 2003, at the premises of the Centre of Excellence MANHAZ at the Institute of Atomic Energy, Swierk.

The Workshop consisted of presentations of position paper, technical papers and tutorials. The position paper was presented by Adam S. Markowski from the Process and Environmental Safety Division of the Technical University of Lodz. The presentation of technical papers were given in the format of a typical conference, with 45 – 90 minutes available for each presentation and its discussion. During the tutorials some practical methods were shown for selected case studies.

The technical topics of the workshop covered the following issues:

1. Review of past accidents related to transportation of dangerous goods by pipelines.
  - Pipelines systems: natural gas; dangerous liquids (oil and chemicals), pipelines system elements.
  - Data on accidents: data sources, reports criteria.
  - Accidents characteristics based on statistical data: types of accidents, quantities of dangerous in accidents, failures frequency (general failures frequency; failures frequency depending on their causes); consequences and gravity scales of accidents; basic characteristics of selected pipelines accidents.
2. Technical and organizational solutions important for pipelines safety.
  - Design assumptions and rules concerning construction transmission pipeline: technical conditions of construction and commissioning; applied regulations and standards.
3. Safety management systems and integrity management programs for pipelines systems.
  - Technical and organizational measures for preventing accidents leading to dangerous substances emissions from pipeline systems.
  - Technical and organizational measures for mitigation of consequences.
4. Hazards related to transportation of dangerous liquids and gases by pipelines.
  - Data accumulation, identification and analysis of pipeline system hazards.
  - System operating reliability evaluation.
5. Relative risk assessment:
  - Third party damage index: depth of cover; activity level; patrol frequency and effectiveness; onecall; public education; aboveground exposures.
  - Corrosion index: atmospheric corrosion; internal corrosion; buried metal corrosion; corrosion index adjustment factors.
  - Design index: pipe strength; system safety factor; fatigue potential surge potential; integrity tests; earth movements; seismic activity; seismic faulting; landslide; scour potential.
  - Incorrect operations index scores: training; overpressure potential; safety systems; construction/design factors; mechanical error preventions; incorrect operations index adjustment factors.
6. Probabilistic risk assessment.
  - Identification of leak scenarios and their frequencies.
  - Consequences estimations: (fatalities and injuries, contaminations of drinking water, recreational water, prime agricultural land and wetlands contamination).
  - Pipeline risk acceptability criteria.
7. Regulatory instrument of EU states to manage pipeline safety.

