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Improvement, Extension and Integration of Operational Decision Support Systems for Nuclear Emergency Management (DSSNET)

J. Ehrhardt (Ed.)

Institut für Kern- und Energietechnik
Programm Nukleare Sicherheitsforschung

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Zusammenfassung

Verbesserung, Erweiterung und Integration operationeller Entscheidungshilfesysteme für das nukleare Notfallschutzmanagement (DSSNET)

Das im Oktober 2000 gebildete Netzwerk DSSNET hatte zum Ziel, ein effektives und anerkanntes Forum zur besseren Kommunikation und zum besseren Verständnis zwischen den Institutionen zu errichten, die einerseits für das operationelle Notfallschutzmanagement zuständig sind, und die andererseits Methoden und Werkzeuge für den Notfallschutz - insbesondere Entscheidungshilfesysteme – entwickeln. Hierdurch sollten begründete und konsistente Beurteilungen über praktische Verbesserungen des Notfallschutzes in Europa möglich werden. 37 Institutionen aus 21 Ländern in Ost- und Westeuropa, davon etwa die Hälfte verantwortlich für das operationelle Notfallschutzmanagement, bildeten das Netzwerk. Von der Vielzahl der Einzelzielsetzungen sind die wichtigsten, dass

- sich zukünftige F&E Arbeiten an den Bedürfnissen der Benutzer orientieren,
- die Benutzer frühzeitig über neue Entwicklungen und deren Potenzial, den Notfallschutz zu verbessern, informiert werden,
- Entscheidungshilfesysteme durch Rückmeldung von operationellen Erfahrungen ertüchtigt werden,
- der Informations- und Datenaustausch zwischen Nachbarstaaten verbessert wird,
- eine größere Kohärenz zwischen existierenden Entscheidungshilfesystemen erreicht wird und die gemeinsame Entwicklung von neuen oder verbesserten Funktionen der Entscheidungshilfesysteme vorangetrieben wird, und
- die praktische Einsatzfähigkeit von Entscheidungshilfesystemen verbessert wird.

Um die Kommunikation und die Interaktion zwischen den operationellen und F&E Institutionen zu stimulieren wurden fünf problemorientierte Notfallschutzübungen durchgeführt, die die verschiedenen Zeitphasen nach einem kerntechnischen Unfall abdeckten und deren Szenarien sich vom Nahbereich bis zu großen Entfernungen mit grenzüberschreitendem Transport von Radionukliden erstreckten.

Der Bericht beschreibt die Zielsetzungen des DSSNET Netzwerks, die fünf Notfallschutzübungen und ihre Auswertung. Sie lieferten wertvolle Einblicke und Erfahrungen für Benutzer und Entwickler von Entscheidungshilfesystemen. Insbesondere wurde die Notwendigkeit festgestellt, sehr viel häufiger mit den Systemen zu üben und deren Interaktion mit dem Notfallschutzmanagement zu trainieren. Die Rückmeldungen über die operationellen Aspekte der Entscheidungshilfesysteme fanden zum größten Teil Eingang in Systemverbesserungen.

Abstract

The DSSNET network was established in October 2000 with the overall objective to create an effective and accepted framework for better communication and understanding between the community of institutions involved in operational off-site emergency management and the many and diverse RTD institutes further developing methods and tools in this area, in particular decision support systems (DSS), for making well informed and consistent judgements with respect to practical improvements of emergency response in Europe. 37 institutions from 21 countries of East and West Europe have been members of the network with about half of them responsible for operational emergency management. The objectives of the network have been numerous and the more important ones include:

- to ensure that future RTD is more responsive to user needs,
- to inform the user community of new developments and their potential for improving emergency response
- to improve operational decision support systems from feedback of operational experience
- to identify how information and data exchange between countries can be improved,
- to promote greater coherence among operational decision support systems and to encourage shared development of new and improved decision support systems features, and
- to improve the practicability of operational decision support systems.

To stimulate the communication and feedback between the operational and the RTD community, problem-oriented emergency exercises were performed, which covered the various time phases of an accident and which extended from the near range to farther distances with frontier crossing transport of radionuclides.

The report describes the objectives of the DSSNET, the five emergency exercises performed and the results of their evaluation. They provided valuable insight and lessons for operators and users of decision support systems, in particular the need for much more intensive training and exercising with decision support systems and their interaction with emergency management. The feedback received on operational aspects of decision support systems was largely translated into operational improvements.

INHALTSVERZEICHNIS

1 Executive summary

The DSSNET network was established in October 2000 with the overall objective to create an effective and accepted framework for better communication and understanding between the community of institutions involved in operational off-site emergency management and the many and diverse RTD institutes further developing methods and tools in this area, in particular decision support systems (DSS), for making well informed and consistent judgements with respect to practical improvements of emergency response in Europe. 37 institutions from 21 countries of East and West Europe have been members of the network with about half of them responsible for operational emergency management. The objectives of the network have been numerous and the more important ones include:

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- to improve the practicability of operational decision support systems.

To stimulate the communication and feedback between the operational and the RTD community, problem-oriented emergency exercises were performed, which covered the various time phases of an accident and which extended from the near range to farther distances with frontier crossing transport of radionuclides. In order to evaluate the experience gained with decision support systems and the information exchange between them, a structured approach was used through the establishment of Working Groups. Each Working Group addressed one of five work packages, which covered areas identified by the members of the network as relevant with respect to improving the practical applicability of decision support systems: user interfaces, results and interaction with decision-makers (WP2); exchange of data and information relevant for decision-making (WP3); system functions, networks and processing of on-line data (WP4); European database (WP5); hydrological problems (WP7). In this way, the most important interfaces between the operational community and the methods and tools for decision support systems developed by the RTD institutes were covered.

Five emergency exercises were prepared, performed, and evaluated in the frame of WP1 within the four contractual years of the DSSNET. They provided valuable insight and

lessons for operators and users of decision support systems, in particular the need for much more intensive training and exercising with decision support systems and their interaction with emergency management. The feedback received on operational aspects of decision support systems was largely translated into operational improvements. Questionnaires were developed, distributed and evaluated by the Task Leaders of the Work Packages. The results were important input to RTD projects running in parallel, such as RODOS Migration, DAONEM, EVATECH and MODEM.

2 Objectives and strategic aspects

The DSSNET network was established in October 2000 with the overall objective to create an effective and accepted framework for better communication and understanding between the community of institutions involved in operational off-site emergency management and the many and diverse RTD institutes further developing methods and tools in this area, in particular decision support systems (DSS), for making well informed and consistent judgements with respect to practical improvements of emergency response in Europe. 37 institutions from 21 countries of East and West Europe were members of the network with about half of them responsible for operational emergency management (see Annex 3). The objectives of the network were numerous and the more important ones included:

- to ensure that future RTD is more responsive to user needs,
- to inform the user community of new developments and their potential for improving emergency response
- to improve operational decision support systems from feedback of operational experience
- to identify how information and data exchange between countries can be improved,
- to promote greater coherence among operational decision support systems and to encourage shared development of new and improved decision support systems features, and
- to improve the practicability of operational decision support systems.

To stimulate the communication and feedback between the operational and the RTD community, problem-oriented emergency exercises were performed, which covered the various time phases of an accident and which extended from the near range to farther distances with frontier crossing transport of radionuclides. Work Package WP1 dealt with the preparation, performance and evaluation of the emergency exercises.

In order to evaluate the experience gained with decision support systems and the information exchange between them, a structured approach was used through the establishment of further Working Groups. Each Working Group addressed one of five work packages, which covered areas identified by the members of the network as relevant with respect to improving the practical applicability of decision support systems: user interfaces, results and interaction with decision-makers (WP2); exchange of data and information relevant for decision-making (WP3); system functions, networks and processing of on-line data (WP4); European database (WP5); hydrological problems (WP7). In this way, the most important interfaces between the operational community and the methods and tools for decision support systems developed by the RTD institutes were covered.

A secretariat was established at Forschungszentrum Karlsruhe GmbH to co-ordinate and manage the network (Work Package WP6) and an Advisory Committee was created to monitor progress, to advise on the scope and content of emergency exercises, work packages and annual meetings, and to act as a discussion forum for strategic aspects of off-site emergency management in Europe (see also Sec. 3.6.1).

3 Scientific and technical description of the results

According to the structure of the work programme, this Chapter is subdivided into seven main Sections which contain the individual contributions from the Task Leaders of the following work packages:

WP1: Preparation and conduct of exercises
J. Ehrhardt, H. Miska

WP2: User interfaces, results and interaction with decision makers
K. Sinkko, J. C. Lentijo

WP3: Exchange of data and information relevant for decision making
C. Rojas-Palma, T. Duranova

WP4: System functions, networks and processing of on-line data
W. Raskob, Ch. Salfeld

WP5: European database
W. Raskob, S. Potempski

WP6: Management and co-ordination
J. Ehrhardt, A. Weis

WP7: Hydrology
R. Heling

At the start of the network, WP3 was led by M. De Cort, JRC Ispra, and WP4 consisted of two work packages led by W. Raskob and C. Rojas-Palma. After the 2nd members meeting in Ljubljana, June 2001, the structure of the Work Packages was re-established as listed above, however, with JRC acting as Task Leader for WP5 and NRG as Task Leader of the new WP7. After the termination of the JRC membership in August 2002, Wolfgang Raskob became Task Leader of WP5.

3.1 WP1: Preparation and conduct of exercises

3.1.1 Problem description and objectives

Main objective of WP1 is the performance and structured evaluation of emergency exercises with decision support systems in (pre-) operational use in Europe, such as ARGOS, RODOS and RECASS. Altogether, five emergency exercises were performed within the reporting period, one more than initially planned per contractual year.

3.1.2 Work performed and progress achieved

Main purpose of the first emergency exercise was to test the on-line operation of these decision support systems during a simulated real-time emergency exercise covering the near range and the early phase of a nuclear accident. The accident scenario was designed in such a way, that all functions of the decision support systems, in particular the RODOS system, relevant in the pre-release and release phases and short after the passage of the plume have to be activated. The main task of the participants was to operate their decision support system in its various modes (automatic and/or interactive) according to the accident information given at the day of the exercise and to produce all information relevant for the national emergency management (radiological advisers). The intention was ***not*** to exercise data exchange between countries nor to extensively intercompare results obtained in the different countries.

The exercise was held on 24 April 2001 between 6:30 UTC and 14:30 UTC using the DSSNET Homepage as tool to disseminate scenario information. The sequence of events describing the accident situation, in particular prognosticated and/or assumed release data, was provided password protected in EMERCON forms on the DSSNET Homepage, which builds part of the RODOS Homepage http://www.rodos.fzk.de.

As a consequence of the evaluation and as most of the participants expressed their interest to repeat this kind of exercise, FZK agreed to perform the type of the first emergency exercise once again at the beginning of 2002. The repetition was held on 27 February 2002 between 7:20 UTC and 13:30 UTC using again the DSSNET Homepage as information tool. As a consequence of the members' request to repeat the first DSSNET emergency exercise, more effort that initially planned was invested in WP1.

After the start of the MODEM project ("Monitoring data and information exchange among decision support systems", FIS5-2001-00144), input to its work programme is needed on the data and information to be exchanged between neighbouring countries in case of a cross-border transport of radioactive material. Main objective of the second emergency exercise performed on 28 May 2002 between 7.00 UTC and 13.45 UTC was therefore to use a radioactive release scenario causing cross-border problems for obtaining feedback on existing and improved data exchange procedures between neighbouring countries.

Information about the exercise was provided through different channels and on different levels:

- Any information about the accident, the release and the local weather situation was provided by FZK via the DSSNET Homepage as in the first two DSSNET exercises using the EMERCON forms ("official channel");.

- In parallel, information about the local accident situation was accessible through a "direct channel": The weather information was provided by FZK in the form of files with time series of atmospheric parameters for performing interactive dispersion calculations. The weather was identical for all participants. In addition, during the

accident progression, the source term was made available by FZK at certain points in time for downloading by each participant via ftp.

- The RODOS software has been extended by tools for storing the files. In that way, each NEIGHBOURLAND player could perform own calculations based on the source term and meteorological data coming directly from ACCILAND (FZK). The availability of the files was announced by E-mail.

- In addition to the direct exchange of input files, FZK acting as ACCILAND made available the results of RODOS runs at certain points in time in the form of the Web-sites for users of Category C.

- Any requests from the participants could be sent to FZK by E-mail; for that purpose, FZK generated a special E-mail address: dssnet@rodos.fzk.de. Two German radiological experts (Horst Miska and Erich Wirth) familiar with the needs of decision-makers supported the FZK Team in answering incoming questions about decisions taken in ACCILAND.

The evaluation of the exercise and the separate questionnaire distributed by the MODEM co-ordinator (C. Rojas-Palma, SCK·CEN Mol) in parallel for completion by the exercise participants helped gain more insight in the needs of improved data exchange procedures.

The 3rd DSSNET emergency exercise was held on 27 May 2003. According to the DSSNET working plans and as announced during the 3rd members' meeting in Copenhagen, the 3rd DSSNET 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. During a meeting in Vienna on 25 February 2002, UJD (Slovak Republic) and FZK agreed that the common exercise will be organised in the form of a simulated real-time exercise with historic meteorological data (forecasts and site measurements) used at the day of the exercise (see DSSNET(WP6)-MN(02)01). In this way, a meteorological situation could be selected which requests emergency response by many countries involved. The site of Mohovce was selected in the Slovak Republic; the assumed plant accident, its progression and the source term information was elaborated in close collaboration between the utility, VUJE and UJD. Details of the exercise were discussed during a second meeting between UJD, SHMI, VUJE and FZK at Bratislava on 11 September 2002 (see DSSNET(WP6)-MN(02)04).

Precondition for participating in the 3rd DSSNET emergency exercise was for a number of institutions the proper operation of the long range atmospheric dispersion model MATCH. As SMHI (Lennart Robertson) as developer of the model was no longer partner in any RTD project under FP5, no direct funding possibilities existed to perform additional work needed to make the MATCH code fully operational in RODOS. Therefore, a common meeting was organised at FZK on 18 September 2002 to find a solution out of this situation. The conclusions are summarised in the minutes of the meeting (see DSSNET(WP6)-MN(02)05): SMHI expressed its willingness to cure the most urgent defi-

ciencies in time before the 3rd emergency exercise, the costs were funded from the DSSNET budget.

The 4th DSSNET emergency exercise concentrated on the operational applicability and the usefulness of decision support systems and their products in the intermediate and later phases of an accident, with special emphasis on the data and information exchange between the country, where the accident was assumed to happen ("Acciland") and one neighbour country ("Neighbourland"). It should also be evaluated with respect to measure the difference between using decision support systems in the decision making process and without them, and in comparison to national support tools, if there are any in operational use. It was organised as a two days emergency exercise with senior radiological/technical advisers to decision makers involved. The teams of the operational emergency management centres provide them with data and information from their decision support systems as input to taking decisions on emergency actions and countermeasures. In that way, the performance and the technical support capabilities of the decision support systems was tested and any deficiencies or missing functions identified.

The exercise took place in each of the twelve participating countries on 30/31 August 2004. It was to a large degree organised by the national technical emergency management teams operating advanced decision support systems and national support tools; they nominated contact persons responsible for preparing and performing the exercise. In instruction documents and a preparatory meeting, FZK provided guidance and support for identifying appropriate weather situations and source terms, for simulating monitoring data, for pre-calculating the scenario specific results of the decision support systems, and for evaluating the exercise. The results of the exercise were extensively discussed during the 5th DSSNET meeting, Rhodes, Greece, 20 September 2004, and in summary presented during the "Symposium on Off-Site Emergency Management", Rhodes, Greece, 21 to 24 September 2004.

The preparation, performance and evaluation of the altogether five emergency exercises are fully documented in the six DSSNET reports DSSNET(WP1)-TN(01)01, DSSNET(WP1)-TN(02)01, DSSNET(WP1)-TN(02)02:01, DSSNET(WP1)-TN(02)02:02, DSSNET(WP1)-TN(03)01, DSSNET(WP1)-TN(04)01:01 and DSSNET(WP1)-TN(04)01:02. They can be accessed on the DSSNET Homepage. All five exercises were well received by the participating members. They provided valuable insight and lessons for operators and users of decision support systems, in particular the need for much more intensive training and exercising with decision support systems and their interaction with emergency management. The feedback received on operational aspects of decision support systems were largely translated into operational improvements; in particular, the source term input of RODOS was totally revised, an activity which was not initially planned under the RODOS migration contract. Furthermore, the data exchange capabilities of RODOS were significantly improved by providing tools for directly exchanging between decision support systems source term and meteorological files.

3.2 WP2: User interfaces, results and interaction with decision makers

3.2.1 Problem description and objectives

The main objectives of WP2 are to

- clarify what information *decision makers and stakeholders* need for their decisions on countermeasures and in which form;
- clarify how accident consequence models could be improved to better fit to decision making in various countries;
- test and identify the factors and criteria (radiological, socio-psychological, economical, feasibility) which drive decision making on protective actions in the different phases of an accident.

The focus of WP2 is how a decision support system could support the *decision-making process* in nuclear emergency management. Thus the information requirements of key players are considered, not only of nuclear emergency management experts. Key players or stakeholders comprise responsible administrators and organisations, politicians as well as representatives of the citizens affected and other persons who will and are likely to take part in decision-making in nuclear emergencies. In order to achieve these objectives, WP2 is collecting information and evaluating the experience gained from practical use of decision support systems and their graphical and alphanumeric forms of presentation. As the current decision support systems do not include tools to assess on-site events and consequences, the important role of plant status information in decision-making is not pondered.

3.2.2 Work performed and progress achieved

Two questionnaires have been prepared and distributed: the first was sent to DSSNET members prior the 1st DSSNET exercise on 24 April 2001 and the second query during the members' meeting in Copenhagen in July 2002. After the first poll it was seen appropriate to invest more effort than initially planned and to do a survey in literature in order to broaden the insight in pragmatic decision-making process.

In the first query it was asked to list of users of decision support systems and to write a short list and brief description of organisations and their duties as would be involved in an accident such as that used in the 1st DSSNET exercise. An example was annexed. In the evaluation exercises it has been proven out to be useful to list organisations that really play an important role in decision-making and their duties in the process. Some countries have also prepared this kind of information, i.e., brochures and information leaflets to be distributed generally. It has been ensured that all key parties have been involved and it was also given information to each other assuring that all know their roles and duties in the decision-making process.

Secondly, it was asked what information the interest groups need to grasp in a radiological situation, to plan and make decision on countermeasures in the situation like the 1st DSSNET exercise. It was asked to list appropriate thematic maps, tables, plots etc. for decision-making. Thirdly, it was asked against what criteria (radiological, economic, socio-psychological and others) do parties involved wish to evaluate countermeasure strategies. In comprehensive decision support systems, which comprise countermeasure evaluation modules, the most essential attributes driving decision making on protective actions could be considered. A list of attributes and their definition were annexed as a starting point in the questionnaire.

The following set of tangible attributes was identified during the work which many would like to be able to calculate with a decision support system or have information in its database:

Collective doses to the public (manSv). It could also be converted into the *expected number of fatal cancer cases* or *number of cancer incidents* to be more comprehensible for persons outside the radiation protection community. A figure to be calculated with a decision support system as an input in the decision-making process could be estimations of the additional number of cancer cases or collective doses with and without countermeasure options (i.e. avertable doses).

Individual doses to the public. This attribute could be measured with *effective external dose and/or organ dose* in normal living conditions and when an action is taken integrated over the action period (e.g. sheltering or evacuation time, units in mSv).

Number of thyroid cancers in children. A figure to be calculated: *thyroid dose in children* from intake of radioiodine in normal living conditions and when an action is taken (mGy).

Number of thyroid cancers in adults. A breakdown of the number of *thyroid cancer cases* into those expected in *children* and those in an *adult* population might be useful. A similar breakdown for other cancer types might also be helpful. A figure to be calculated: *thyroid dose in adults* from intake of radioiodine in normal living conditions and when an action is taken (mGy).

Doses to the workers. Projected individual dose received by the workers carrying out protective actions generally outdoors (mSv). If large numbers of emergency service employees are exposed to radiation (e.g., during clean-up actions) the increased number of expected fatal cancer cases in the group or their *collective dose* could also be used as an attribute (manSv). A figure to be calculated: *effective external, organ- and/or skin dose* during work hours (mSv).

Monetary Costs of actions. *Monetary unit*.

Number of statistical non-radiation fatalities or *reduced life expectancy* caused by countermeasures.

Number of individual non-radiation fatalities or *reduced life expectancy* caused by countermeasures.

Following intangible attributes have also been identified which values could be assessed by *direct rating* method: s*ocial disruption, anxiety of the population, reassurance of the population, anxiety of the workers, environmental issues, social feasibility, technical feasibility and flexibility of strategies.*

The following thematic maps, table and time plots were found to be useful both for emergency management teams and as background information for key stakeholders.

Thematic maps:

- plume arrival and leaving times;
- effective dose in normal living conditions, 1-year;
- thyroid dose in children/adults from inhalation of radioiodine in normal living conditions;
- effective dose from ground, integrated over a relatively short time;
- effective dose from cloud during plume passage;
- time integrated activity concentration of I-131in air;
- ground deposition of Cs-137 and I-131 describing accident area;
- nuclide specific concentrations in food- and feed staffs;
- population distribution;
- areas where actions are taken: sheltering, evacuation, iodine tablets, food ban areas etc;
- areas where intervention levels are exceeded: sheltering, evacuation, iodine tablets, food ban areas etc.

Tables containing:

- people most at risk/ critical groups;
- individual doses in the proposed countermeasure areas when actions are taken and when not, i.e. estimation of the avertable doses. 1-year;
- collective doses in the proposed countermeasure areas when actions are taken and when not, i.e. estimation of the avertable doses. 1-year;
- monetary cost of the actions;
- number of people affected in all and by the protective actions.

Time plots:

- nuclide specific deposited activity;
- nuclide specific activity concentration in feed and foodstuffs.

It is important to learn the actual decision-making process and pertinent key stakeholders to be supported by a decision support system both in early and later phase. The emergency plans offer a relevant basis for formal decision-making. However, in real life especially in later phase the preparation of a decision is often divided into so many phases carried out by so many people that a single decision-making point cannot be identified. Commonly, elected officials and authorities do not participate in exercises. There is also poor interaction between the expert groups and politician or higher level authorities. They don’t make consequence assessment or the preparation or evaluation of a decision; instead they expect prepared advice from experts. The advice is expected to include both alternative actions and the grounds for a decision.

Experience gained from this work supports the view that experts, emergency management teems having different expertise should make technical calculations and present reports to ensure that elected officials are able to understand the problem and the consequences of decision options. The consequence assessments must be open and transparent. To do rational choices interest groups need appropriate information on the radiological situation and on the consequences of actions, not technical or scientific discussion. Information should be comprehensive, easy to grasp and above all appropriate for decision-making. Thus the expert's role in decision-making process is essential. The input in the decision-making process could be improved by the analytical methods such as WebHIPRE, and by a fair and competent stakeholder group, but it could not be thought that careful input would overcome political forces.

Considering the development stage of the evaluation tool WebHIPRE it was not possible to gain much feedback on its operational use in this project. The involvement of the key stakeholders e.g. in a form of facilitated workshop is very useful but laborious and the facilitation profession that requires skill. Experiences in the earlier projects have demonstrated that a facilitator coming from nuclear emergency community might not be trusted and could create negative acceptance on the method. A skilled person e.g. a university professor is highly recommendable as having a certain authority. However, this doesn't remove the need to have skilled persons in emergency management teems. The efficient use of evaluation tools calls for a person who is familiar with decision analysis.

3.3 WP3: Exchange of data and information relevant for decision making

3.3.1 Problem description and objectives

Under the existing co-operation agreements between FZK acting on behalf of the RODOS Consortium, the United States National Atmospheric Release Advisory Center (NARAC) and the Japanese Atomic Energy Research Institute (JAERI), each one of them operating RODOS, ARAC and WSPEEDI, respectively, the three partners agreed to commonly develop data exchange tools and procedures, which will enable the direct data and information exchange between the three systems. During the 2nd trilateral co-operation meeting at Ljubljana, 29 June 2001, technical details were fixed on:

- the input data required for performing diagnostic and prognostic atmospheric dispersion and dose calculations for any release point in the Northern hemisphere. An example data format has been provided by FZK for

- source term information

- measured local meteorological data, and

- countermeasure information

- To explore possibilities of direct exchange of numerical weather predictions, all systems should exchange and compare example data sets of forecast data.

- a format for exchanging gamma dose rate and air concentration measurements; FZK should send out a corresponding format proposal.

- the results to be exchanged between the partners and their alphanumeric and/or graphical form of presentation. Basis for the discussions are the Web pages of the NARAC Centre and JAERI, and the RODOS Web pages for users of Categories B and C.

- The interaction and achievements under MODEM which fit under this task are:

- NARAC will provide a set of predefined source term categories as there is no link to on-line source term forecasting tools in American Nuclear power plants.

- The MODEM data and information prototype will be used by RODOS, ARGOS, RECASS, ARAC and WSPEEDI.

- Should the operator decide, results will be converted to a common format so that, all systems can easily be compared by using MODEM result browsing capability.

This work package was also intended to obtain feedback from the operational community with regard to data and information exchange, and this became more important with the start of the RTD project MODEM. The activities carried out in this work package (construction and distribution of web based questionnaires) have provided a great deal of information as to what needs to be exchanged prior, during and after an accidental release of radioactivity affecting neighbouring countries. Hence, the objectives set out for this work package are being achieved.

This work package also aims at evaluating the tools and procedures developed under MODEM through the periodic DSSNET exercises. In this regard, the second DSSNET exercise has provided valuable information to the RTD community. However, most countries are still in the process of implementing and configuring a decision support system, and therefore a full assessment of the data and information exchange protocols will have to wait until the end of this project.

It is important to note that, although a fully operational tool for data and information exchange will be available for deployment in national emergency response centres, it will be up to the political masters to decide whether sensitive information, such as the source term, will be available in a time frame that enables neighbouring countries to take appropriate action.

3.3.2 Work performed and progress achieved

It is expected that through this work package the collaboration with NARAC and JAERI will reach maturity, enabling all decision support systems to share and exchange information. The strong link with MODEM provides an excellent opportunity to include the Russian decision support system RECASS.

With regard to deliverables, this work package has produced a web based questionnaire, which has been completed by 11 countries, of which 8 completed the part that deals with information exchange during the early phase of an accident, whereas 7 completed the part dealing with communication of information in the post-plume phase. This questionnaire is still open; the preliminary results are being compiled and will be available through the DSSNET Homepage.

3.4 WP4: System functions, networks and processing of on-line data

3.4.1 Problem description and objectives

The main objectives of WP4 can be summarised in the following four bullet points:

- To evaluate the adequacy of the treatment of on-line data in the various modules of RODOS in various modes of operation through periodic communication with the RODOS users.

- To define areas for improvements in quality and in quantity of meteorological and radiological on-line data, and of the models processing them.

- To define areas that require further improvement and to provide both the RTD community and the maintenance teams with ideas how problems could be resolved.

- To evaluate the reliability and stability of the system and its network connections through periodical communication with system administrators; keep track of the system's behaviour during abnormal situations, such as data transmission gaps.

3.4.2 Work performed and progress achieved

Intensive communications with the users of the various decision support systems are important to archive the objectives. Therefore, a questionnaire was developed dealing with the objectives 1 to 3. Questions focused on incoming meteorological data, radiological data and stack monitoring. All in all institutions from 14 countries participated in answering the questionnaire. The following Table lists the individual countries and institutions which mainly contributed to the questionnaire.

Countries	**Institutions**
Austria	Forschungszentrum Seibersdorf
Czech Republic	SONS – Czech National Crisis Centre
Denmark	RISØ – Wind Energy and Atmospheric Physics Department
Finland	STUK – Radiation and Nuclear Safety Authority
Germany	BfS – Bundesamt für Strahlenschutz, Stabsstelle

Greece	NCSR “Demokritos” – Institute of Nuclear Technology and Radiation Protection
JRC – Ispra (Italy)	Environment Institute
The Netherlands	RIVM – National Institute of Public Health and the Environment
Poland	IAE – Institute of Atomic Energy
Portugal	I.C.T.E. – Institute for Earth and Space Sciences
Romania	IFIN-HH – National Institute of Physics and Nuclear Engineering “Horia Hulubei”
Slovak Republic	VUJE Trnava, Inc – Department of Accident Management and Risk Assessment
Spain	Consejo de Seguridad Nuclear

The completed questionnaires provided support in particular in the further development of the meteorological pre-processor which has been completely restructured for RODOS PV5.0. In addition, the answers on the available radiological measurements provided valuable information for the data assimilation project DAONEM; information was collected on the availability of on-line measurements all over Europe. It became obvious that gamma dose measurements of the passing cloud only are rare as the contribution from ground is also included.

Results for objectives 2 and 3 are limited. However, it turned out during the exercises that the processing of on-line data performed well. This statement however, lacks a general validity as only few of the participating organisations are connected to on-line data. In countries where the system is applied operationally, e.g. Germany, the processing of on-line data performed well.

To intensify the communication with the various systems, an operational questionnaire was developed. This includes also sections on network connections and their reliability, the fourth objective of this work package. This questionnaire was sent out on a regular basis. The evaluation of this questionnaire showed that countries that intensively used their decision support systems operated a reliable network.

The most important result from all exercises and the continuous communication with the various users and system administrators was the feedback provided, which initiated new RTD work. The meteorological pre-processor was further developed as part of the RODOS Migration project. Work on the far range atmospheric dispersion model MATCH was added to work to be performed under the EURANOS project (FI6R-CT-2004-508843) with the objective to improve the overall operability of MATCH inside RODOS. The documentation of the RODOS real-time database was extended and training courses for system administrators were introduced into the EURANOS project. Further more, the applied methodology how to estimate the source term based on stack monitoring

was confirmed and developers of data assimilation tools acknowledged the valuable information provided by the questionnaires.

Work performed under the DSSNET will not stop with the termination of the project. Important aspects of work package four were also transferred to the demonstration projects of the EURANOS project. This included demonstrations on the networking and processing of on-line data and the visualisation and evaluation of on-line data.

The evaluation of the first questionnaire is documented in the RODOS report DSSNET(WP5)-TN(01)01 and the revised questionnaire as report DSSNET(WP4)-TN(02)01.

3.5 WP5: European database

3.5.1 Problem description and objectives

A complete European database would allow the use of the RODOS system in any country in Europe without extensive customisation effort. This would facilitate the promotion of the system as it can be demonstrated on country specific scenarios, and thus, with information known to the observer. Data to be collected for this purpose can be categorised into geographical data (among others: urban areas, roads, railways, rivers and topography) and statistical data (mainly population and agricultural production data).

3.5.2 Work performed and progress achieved

With the present RODOS installation a complete set of data for the local area around Karlsruhe is provided as example to demonstrate the functionality of the system. After installation in a particular country customisation efforts have to start to collect all relevant data for its local use. However, research institutions often lack the information necessary to carry out the customisation task. This limits the use and promotion of RODOS in their home country. Very little success in data collection during the last decade led to the wish of the users to establish again a work package to collect the relevant data. One important aspect is the necessity to obtain the data either from freely available sources or to purchase them with all licenses for a small amount of money.

Geographical data were purchased and converted into the RODOS specific RIF format which allowed a free distribution to all RODOS users inside the DSSNET.

Table 1: AND Global Road Data (Level 1 – 5)

Europe					
Country name	Level 1 ca. 1:2 Mio.	Level 2 ca. 1:1.250.000	Level 3 ca. 1:750.000	LEVEL 4 about 1:400.000	Level 5 ca. 1:250.000
Europe complet	X	X	X	X	X
Albania	X	X	X	X	n.a.
Armenia	X	X	n.a.	n.a.	n.a.
Austria	X	X	X	X	n.a.
Azerbaijan	X	X	n.a.	n.a.	n.a.
Belgium (incl. L	X	X	X	X	X
Byelorussia	X	X	X	n.a.	n.a.
Bosnia and Her	X	X	X	X	n.a.
Bulgaria	X	X	n.a.	n.a.	n.a.
Croatia	X	X	X	X	n.a.
Cyprus	X	X	X	X	n.a.
Czech Republic	X	X	X	n.a.	n.a.
Denmark	X	X	X	X	X
Estonia	X	X	X	X	n.a.
Faeroe Islands	X	X	X	X	X
Finland	X	X	n.a.	n.a.	n.a.
France (incl. M	X	X	X	X	X
Georgia	X	X	X	n.a.	n.a.
Germany	X	X	X	X	X
Greece	X	X	X	X	X
Hungary	X	X	X	X	n.a.
Iceland	X	X	X	X	n.a.
Irish Republic	X	X	X	X	X
Italy (incl. Ma	X	X	X	X	X
Latvia	X	X	X	X	X
Lithuania	X	X	X	X	X
Macedonia	X	X	X	X	n.a.
Malta	X	X	X	X	X
Moldova	X	X	X	n.a.	n.a.
Netherlands	X	X	X	X	X
Norway	X	X	X	X	X
Poland	X	X	X	X	X
Portugal	X	X	X	X	X
Romania	X	X	n.a.	n.a.	n.a.
Russia	X	X	n.a.	n.a.	n.a.
Slovakia	X	X	X	X	X
Slovenia	X	X	X	X	X
Spain (incl. An	X	X	X	X	X
Sweden	X	X	X	X	X
Switzerland (in	X	X	X	X	n.a.
Turkey	X	X	X	X	n.a.
Ukraine	X	X	n.a.	n.a.	n.a.
United Kingdom	X	X	X	X	X
Yugoslavia	X	X	X	X	n.a.

Table 1 shows the European countries and the levels of detail for which information is available. The so called AND data set (purchased up to level 4) contains information on cities, political borders, roads, railways and water bodies such as rivers and lakes. In

addition, an artificial ocean layer has been added by FZK. The ***basic*** version of the converted RIF data for Europe consists of the following layers:

- Water bodies (i.e. rivers, lakes, ocean)
- Political borders (up to province borders)
- Cities (area and point objects) corresponding to AND Level 1 - 3)
- Roads (highways included based on AND Level 1, 2)

Topographical data were taken from the Internet and converted to RIF by NCSRD Demokritos, Greece. Railways were not included as well as higher levels of cities and roads.

Socio-economic or statistical data is often published on the level of administrative units. The Nomenclature of Territorial Units for Statistics (NUTS) was established by EUROSTAT to provide a single uniform breakdown of territorial units for the production of regional statistics for the European Union. Similar statistical regions have been defined for thirteen candidate countries (CC) and four EFTA states (Iceland, Liechtenstein, Norway, and Switzerland). RODOS was enhanced with the possibility to convert information provided on a NUTS level into the gridded database of the system. This adaptation was first used for the conversion of production data provided by the SAVE-IT project (Spatial and Dynamic Prediction of Radiocaesium Transfer of Products). Production data on milk (cow, sheep, goat), beef (bull), lamb, pork, chicken, eggs, potatoes, leafy vegetables, root vegetables, fruits and maize bulbs became available for the NUTS 3 level. Population data on a European level were added via various data supplier (e.g. Esri, geographical publishing house).

The final data set amounts to about 800 MB disk space and the time for visualising cannot be neglected any longer. Therefore, this data set is distributed separately and the user is free to insert it instead of the delivered area around Karlsruhe.

The complete geographical data set is available for download on the RODOS web site. This data set can be extended with country specific features; however, one has to care that the data are compatible with the existing one. The data set and its structure is described in a RODOS report RODOS(RA1)-TN(02)-03.

3.6 WP6: Management and co-ordination of the network

3.6.1 The Advisory Committee

An Advisory Committee was established at the start of the DSSNET; it consisted of the following representatives of the EC, the RODOS community, other decision support systems, and external experts:

J. Ehrhardt, FZK, Karlsruhe (chairman)

S. Hoe, DEMA, Copenhagen

G.N. Kelly, EC, DG RTD, Brussels

C. Rojas-Palma, SCK·CEN Mol (from December 2001)

V. Tanner, EC, DG TREN, Luxembourg

W. Weiss, BfS, Munich

The terms of reference for the Advisory Committee were set out by the Advisory Committee during their first meeting:

- Monitor and review progress of the DSSNET activities, in particular in the different Working Groups;
- Advice on the scope and scenarios of exercises;
- Review the results of the exercises;
- Review of any open literature publications in the DSSNET context;
- Establish and maintain links to international organisations and non-participating institutions;
- Advice on the tasks of work packages;
- Advice on the scope and content of the annual meetings;
- Take initiatives to disseminate output of the DSSNET.

Meetings of the Advisory Committee were in general held twice per year in combination with the meeting of the Task Leaders. One meeting took place during the annual meeting of the network members; a second meeting was held for accepting and preparing the annual exercises about half a year later. Altogether six meetings took place; the minutes of the meetings are documented and can be accessed on the DSSNET Homepage.

3.6.2 The Task Leaders

The Task Leaders were responsible for evaluating the experience gained with decision support systems in the operational emergency centres under the aspects of the individual Work Packages. They were supported by a second nominee from the DSSNET members (see introduction to Chap. 3.).

Altogether six meetings of the Task Leaders took place within the four contractual years of the DSSNET in combination with the meetings of the Advisory Committee (see Sect. 3.6.1). The minutes are documented and can be accessed on the DSSNET Homepage.

3.6.3 Meetings of the DSSNET

As initially planned, five meetings of the DSSNET members took place: a starting meeting at Prague in December 2000 and four meetings in Ljubljana, June 2001, Copenha-

gen, July 2002, Cracow, July 2003, and Rhodes, September 2004. The minutes of the meetings are documented and can be accessed on the DSSNET Homepage.

3.6.4 Co-ordination of the DSSNET

FZK continued to operate the RODOS secretariat established under FP4; it was responsible for all DSSNET matters, in particular the central registration of documents produced by the DSSNET, support in organising meetings, the collection of cost statements, the reimbursement of travel expenses and the maintenance of address lists (Mrs. Annemarie Weis). The DSSNET Homepage was installed by FZK as part of the RODOS Homepage (www.rodos.fzk.de).

Two new Technical Annexes were prepared by the end of September 2001 and September 2002 reflecting changes in the work programme of the DSSNET and in the membership (termination of the JRC membership, new membership of Bulgaria and Latvia).

3.6.5 The SAMEN/MOSES cluster

The DSSNET built part of the SAMEN/MOSES cluster co-ordinated by SCK·CEN Mol. As a wider community of operational emergency management centres combined with RTD institutes developing methods and tools for decision support systems, it was an excellent forum for announcing ongoing RTD activities related to emergency management, restoration and rehabilitation under other research contracts and for distributing related information. The co-ordinators of the ENSEMBLE, FARMING and STRATEGY projects were invited for the 3rd DSSNET meeting to give an overview of the objectives and the status of their work programmes. The co-ordinators of the ASTRID, STERPS and ENSEMBLE projects reported on the status of their progress achieved during the 4th DSSNET meeting. Furthermore, the members of the SAMEN/MOSES cluster were continuously informed about the DSSNET activities during their meetings.

3.6.6 Collection of intervention criteria

FZK compiled a document with all relevant information and data for calculating national intervention doses and to compare them with national intervention dose levels. Most of the European countries responded to a corresponding questionnaire and the up to now existing information is summarised in the document “Collection of European intervention criteria for radiological emergencies” (DSSNET(WP6)-TN(02)02). The data will be inserted in a corresponding data base of one of the next RODOS versions.

3.7 WP7: Hydrology

3.7.1 Problem description and objectives

The activities of the hydrological Task Group are focusing on the establishment of a close contact between the current and future users of the RODOS-HDM software and its developers.

3.7.2 Work performed and progress achieved

Questionnaires have been planned to identify new users among the DSSNET community. As a result of the contacts within the DSSNET, in October 2001 the EVANET – HYDRA network has been initiated co-ordinated by ENEA (co-coordinator) and NRG (principal contractor). This network, focusing on hydrology, has as objective:

"Assess the state of the art of existing decision support systems and to plan their necessary improvements on the basis of critical evaluations by experts and experiences gained during the processes of application and customisation by existing and potential end users"

This overall objective will be achieved by stimulating:

1. Critical evaluation and assessment of decision support systems and the relevant methodologies and codes by experts from the scientific community including developers;

2. The wide exchange and dissemination of expert knowledge and end user experiences;

3. Supporting and harmonising the customisation and application activities as performed by the user community;

4. Recommendations for decision support systems rationale and improvements from the gained experiences and the lessons learnt.

EVANET-HYDRA contains a user group for decision support systems for hydrology. During topical meetings software tests are performed and requirements of the end-users are communicated.

The updated results of these user group meetings are:

- Reports

    - User Guides. Need for improved documentation for RODOS-HDM with respect to the customisation issues such as application range of the various models.

    - Customisation Guide. Need for detailed description of minimal data sets to be collected.

- Data input with multi-level approach

- Level-1: data requirements for the most efficient operation of the models

- Level-2: Simplified data sets with the use of default data and algorithms to be used in situations of lack of data
    - Appropriate model chain definition
    - Training
    - Scenario's for model testing
    - Countermeasures. How to link RODOS output to the evaluation of countermeasures with systems such as MOIRA
    - Request to the connection of RODOS-HDM to national hydrological forecast systems

The country specific plans are refined within the user group of EVANET-HYDRA, with an emphasis on cross-border transport of radionuclides. Local, regional, and national and intra-national regions have been defined in discussions with the developers.

Regional customisation plans:

Country	NPP / source	Aquatic System
Czech Republic	Temelin	River Vltava Downstream to Orlik Reservoir
Hungary	Paks	River Danube Lake Balaton
Poland	NPP in neighbouring countries Ukraine and, the Czech Republic	Vistula, Włocławek Reservoir, Oder River, and river reservoirs, Bug River.
Portugal	NPP in Spain, and shipping accidents near Lisbon.	River Tagus
Romania	Cernovoda Bechet-Kozloduy (Bulgaria)	Danube, Danube Estuary, Danube – Black Sea Canal
Slovak Republic	Bohunice Mochovce	Vah (100 km fro Danube) Hron (75 km from Danube)

Country	NPP / source	Aquatic System
		Kralova Reservoir
Ukraine	Zaporizhe Khmelnitsky Rivno South-Ukraine	Kakhovka Reservoir Dnieper River River Pripyat watershed South Bug River, Dnieper-Bug estuary

Identified transboundary River and catchment systems:

Object	Countries	NPP's
Danube	Germany, Austria, Czech Republic, Slovak Republic, Hungary, Serbia, Croatia, Bulgaria, Romania	German NPP's Dukovany (tributary Danube), Bohunice, Mochovce, Paks, Kozluduy, Cernovoda
Bug River	Ukraine, Poland	Rivno
Oder River	Germany, Czech Republic, Poland	Temelin, Dukovany
Tisza River	Romania, Ukraine, Hungary	Cernovoda, Kmelnistky

Response between the Emergency Centres was identified as crucial for immediate decision support as well as river catchment approach instead of national approach. Within EVANET HYDRA ideas are developed to extent the national customisation programmes with inter-national aspects.

In EVANET HYDRA the different software package were compared, especially in topical meetings held in Hungary, Romania, and Poland. Besides the RODOS hydrological models LAKECO, THREETOX, RIVTOX, other decision support systems and models also have been tested by means of benchmarks: MOIRA, AQUASCOPE, CASTEAUR, etc. The final conclusion of this project was that the knowledge of the different model systems were disseminated, and MOIRA and the other models are used now in a wider communion. However the compilation of international data sets, an objective of EVANET_ HYDRA, was limited to financial constraints in the different country. This should be solved by realistic bilateral project among the countries involved in model application of transboundary catchments.

- Training Course

The European Commission granted the Training Course to be held in June 2003 in Trnava, Slovak Republic (TRAC-RODOS-HDM) for end-users and future end-users to get intensive training to work with the latest RODOS-HDM. Announcements for this course are communicated via the DSSNET network, since the training is not restricted to the countries that have elaborated plans to apply RODOS-HDM. The course took place from 15 – 19 December 2003, and 25 participants from 11 different countries attended the course. Most participants were from east and central European countries also from different emergency centre, and were users or future users of RODOS-HDM. Feedback came also on various aspects of RODOS-HDM, which are used at present for further improvement of the functionality of RODOS-HDM as well as of the user-friendliness. Among others in the EC's sixth Framework project EURANOS, there will be module to connect RODOS-HDM to hydrological institutes for direct input of hydrological conditions comparable with the link of the atmospheric dispersion module of RODOS with the meteorological networks.

- Decision makers and experts

Communication between decision makers and end-users is envisaged within the EVANET-HYDRA by inviting experts of governmental institutes to the topical and plenary meetings. Also the link with DSSNET will be used to identify interested authorities to participate in such meetings.

4 Assessment of results and conclusions

4.1 Summary evaluation and conclusions from the emergency exercises

The main deliverables of the DSSNET emerge from the evaluation of the experience gained by the operational emergency management teams with the application of decision support systems, in particular during the emergency exercises performed. The conclusions from the 5 emergency exercises are described in detail in the corresponding evaluation reports. They can be summarised as follows:

- All five exercises performed excellent and were considered as very useful by almost all participants. In particular, the 4th DSSNET exercise on intermediate / later phase issues and bi-lateral information exchange was considered necessary and helpful.
- The participating countries / institutions were very engaged in preparing, performing and evaluating the exercises (important: own exercise preparation with decision support systems during the 4th DSSNET exercise).
- The participating decision support systems (RODOS, ARGOS, RECASS) performed well during the exercises, particularly in comparison to national tools. The results of decision support systems were considered highly relevant in decision-making, what led to an increase of the acceptance of the decision support systems. In that way, the DSSNET activities helped strengthen the national emergency management arrangements.

- The Web-based B- and C- user interfaces of the RODOS system and their access within and from outside a country were successfully applied and highly appreciated by the users. The spectrum of results needs some extensions.
- The operational experience with the decision support systems increased significantly over the four years of the DSSNET. In almost all cases, the interaction between the decision support systems and the national weather services works well, however it is still not operational in a number of cases.
- A number of deficiencies, bugs and RTD needs were identified in the decision support systems. As a consequence, RTD activities were started and led to improvements, such as a new RODOS source term user interface, the initiation of a LINUX version of RODOS, and extensions to the MATCH code. Concerning RODOS, user interfaces and graphical presentations still need improvements.
- The data assimilation techniques introduced in RODOS PV6.0 are considered as highly important and the efforts should concentrate on their operational applicability. A number of members consider the operational applicability of the hydrological modules of RODOS as very important as well.
- Simulated monitoring data are extremely important in emergency exercises. Therefore, more user-friendly extraction tools are necessary. Operational data assimilation tools were considered as extremely important.
- The direct projection in the emergency management rooms of results from decision support systems was preferred by nearly all teams (but not always realised). Corresponding support tools should be developed.
- During the exercises, the direct exchange of information between neighbouring countries was increasingly used, what can be considered as a big step forward to a timely and consistent emergency response in Europe. In particular, the MODEM Server and the XML based data exchange were tested successfully and were broadly used, however together with all other kinds of tools: e-mail, phone, fax, ftp, EMERCON forms. There is an expressed need for bilateral and/or regional agreements, which of the now functioning tools to use and what to exchange between neighbouring countries.
- There is an ongoing need for intensive training of operators and users, in particular training with new tools of decision support systems (VISA in ARGOS, WebHIPRE and data assimilation in RODOS).
- The DSSNET members consider it as vital for guaranteeing a well prepared emergency management team to perform repeatedly emergency exercises, such as those under the DSSNET. The idea of “integrated exercises” was discussed, in which series of sub-exercises referring to the same accident scenario but dealing with different time phases (pre-release, release, intermediate, different points in time at later stages) are held at different times. This would make it easier to bring the people together who are responsible in the different time phases.

4.2 Functional analysis of the main deliverables of the project

With respect to the objectives set out in Chap. 4, the main aspects described in the following sub-sections can be distinguished:

4.2.1 Ensure that future RTD is more responsive to user needs

Besides the questionnaires from the individual Work Packages (see Chap. 5), some questionnaires from RTD projects were sent out to the DSSNET members to receive information as input to their working programmes:

RODOS migration:

Questionnaire on the forest module (A. Rantavaara, STUK)

Questionnaire on relocation criteria (J. Brown, NRPB)

MODEM:

Questionnaire on international data exchange (C. Rojas-Palma)

Together with the conclusions from the DSSNET exercises, the responses obtained influenced the RTD work under the contracts RODOS migration and MODEM.

4.2.2 Improve operational decision support systems from feedback of operational experience

The input of source term data caused a number of problems during the 1st emergency exercise. As a consequence, the RODOS user interface for input of release data was totally revised under the RTD contract RODOS migration; it was integrated in RODOS version PV5.0.

On request of many participants, FZK prepared a document which provides guidance for the adaptation of RODOS to national conditions.

Further request for improvements were formulated as a consequence of all emergency exercises (see the corresponding evaluation reports and the conclusions in the previous chapter).

4.2.3 Identify how information and data exchange between countries can be improved

For facilitating the direct exchange of data between decision support systems installed in neighbouring countries, the RODOS system was extended with software tools which allow for the export and import of files with source term data and meteorological site data. In this way, ACCILAND can make available for downloading their meteorological site

data and their release data immediately after having inserted them into their RODOS system. The NEIGHBOURLANDS receive the data nearly delay free and can perform their own calculations.

Furthermore, the results of RODOS calculations can be made available in a uniform Web-based user interface, developed under the MODEM contract. The NEIGHBOUR-LAND can access the results via normal Web-browsers and thus, are very quickly informed about the decision basis for emergency actions in ACCILAND.

Both tools were extensively tested during the 2nd, 3rd and 4th DSSNET emergency exercises and well received by the participants.

4.2.4 Promote greater coherence among operational decision support systems and to encourage shared development of new and improved decision support system features

Through the involvement of the three decision support systems RODOS, ARGOS and RECASS and their common participation at the emergency exercises, the process of providing common functions and tools of the systems has been started. Meanwhile, the ARGOS system integrates software modules of RODOS, and this process will continue. RECASS has developed interfaces for interpreting the source term and meteorological files provided by RODOS. Missing or incomplete input functions recognised in the three systems during the exercises were improved.

The shared use of developments was made in the area of meteorological forecast: the interface produced in the Slovak Republic between the ALADIN numerical weather forecast model and RODOS was made available for other countries using the same model predictions as input to RODOS.

4.2.5 Improve the practicability of operational decision support systems

FZK collected all those site and plant specific data of European nuclear power plants, which are required as input to the RODOS system (DSSNET(WP3)-TN(01)02. They build part of the data base in RODOS PV5.0. This will enable the RODOS users to start calculations for any European NPP without the need for collecting and inserting its site and plant data.

FZK has purchased a complete data set with geographical data of whole Europe from the DDS company in Karlsruhe, Germany, with a resolution down to 1:400’000. The costs for the data were charged to the DSSNET budget. FZK converted the data to the RODOS specific RIF format, in which they can be implemented in all RODOS systems without fees. The data are available with five levels of resolution from 1:2 Mio to 1:250'000. It is up to the individual countries to purchase the data set with the finest resolution for their national RODOS installations.

4.2.6 Inform the user community of new developments and their potential for improving emergency response

During all DSSNET meetings, the members were informed about the RTD activities of the EC in the area of emergency management and restoration and, in particular, the OSEP steps to install hardware and software for improving the technical basis for off-site emergency management in Eastern Europe, such as monitoring systems, data exchange and RODOS. To that purpose, representatives from the EC and the co-ordinators of RTD projects were invited (see also minutes of the DSSNET meetings).

4.2.7 Improvement of emergency preparedness of the operational centres

An important achievement of the DSSNET not mentioned in the initial objectives of the network was identified as a consequence of the common emergency exercises: the awareness of the operational teams that much more intensive training and exercising is required not only to make sensible use of the decision support systems, but in general to be better prepared for the case of a real accident situation either within or outside the country. The experience from the five exercises clearly shows that the practice of the emergency teams improved within the contract duration of the DSSNET, and this process will continue under the EURANOS project of FP6.

Finally another important side effect of the DSSNET should not be forgotten: the maintenance and extension of a European wide network of institutions involved in the development and operation of decision support systems and in emergency management and response in general. Considerable knowledge and experience was exchanged through the network among the partners on a bi- or multi-lateral basis what accelerated the adaptation process between East and West European countries, in particular the new members states, at least in the area of emergency management and response.

4.3 Value analysis

The progress made could only be achieved with the manpower and money invested. The preparation, performance and evaluation of five emergency exercises (instead of four initially planned) by the FZK RODOS team with long lasting experience in using the RODOS system and in developing and performing training courses and exercises guaranteed an effective use of the manpower and money invested. The feedback received from the members on the questionnaires prepared, sent out and evaluated by the Task Leaders and RTD contractors was satisfactory and demonstrated the general attitude of DSSNET members to actively contribute to its overall objectives. The practical results described above clearly demonstrated that the DSSNET gives a strong positive momentum with respect to practical improvements striving at a more harmonised European approach of reacting on radiological emergencies. This finally lead to the commitment of almost all DSSNET members, in particular the emergency management organisation, to actively contribute to the EURANOS project within the EC's 6th Framework Programme.

Therefore, the progress achieved is considered to be cost-effective; the resources spent can be considered not only as an important contribution to cure existing deficiencies and

to provide better tools for emergency management, but also as an investment for the future with more and more converging criteria and attitudes in decision making and more and more common views on IT based methods and systems. This will ultimately create initiatives on the administrative and political levels to adapt regulations, recommendations and procedure guides for emergency management and response, for bi- and multinational information exchange, and for mutual help where and when necessary.

4.4 Protection of results

Networks, and the DSSNET in particular, are in general characterised by the fact that they do not produce any tangible results, but initiate RTD work to be performed under other projects. The practical results achieved within the DSSNET were integrated in RODOS and partially in ARGOS. Both systems were distributed to the users in executable form only. All institutions operating the RODOS or ARGOS systems signed software agreements which protect the interests of the RODOS and ARGOS Consortia.

4.5 Targeted audience/recipients for dissemination

The results achieved under the DSSNET are available to all its members. Software products were implemented in RODOS and partially in ARGOS. Version PV5.0 of the RODOS system and all complementary patches released up to the availability of version PV6.0 were distributed by FZK free of charge to all institutions where previous versions have been installed and who have an expressed interest to update the RODOS software. Currently, about 17 institutions have installed the system for (test-) operational use in their national emergency centres and 10 research institutes use the system for RTD purposes; furthermore, it will be delivered in future to new user institutions in East and West Europe. The software itself is free of cost, however any installation and/or customisation work to be performed by members of the RODOS Consortium will be charged on a full cost basis.

5 References

RODOS Documents

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6 Annex 1: Summary of Final Report

6.1 Objectives

Advanced decision support systems for off-site nuclear emergency management have been developed over the past decade; they have been and will be increasingly installed for operational use in national emergency centres. Therefore, it was timely and opportune to initiate a broader discussion and interaction, both to provide essential feedback to the developers and to familiarise the operators with the functions of the systems and the end-users (and decision makers) with the nature and level of support they can expect in practice.

The DSSNET network was established in October 2000 with the overall objective to create an effective and accepted framework for better communication and understanding between the community of institutions involved in operational off-site emergency management and the many and diverse RTD institutes further developing methods and tools in this area, in particular decision support systems (DSS). In that way, well informed and consistent judgements with respect to practical improvements of emergency response in Europe should emerge. 37 institutions from 21 countries of East and West Europe were members of the network with about half of them responsible for operational emergency management. The objectives of the network were numerous and the more important ones included:

- to ensure that future RTD is more responsive to user needs,
- to inform the user community of new developments and their potential for improving emergency response
- to improve operational decision support systems from feedback of operational experience
- to identify how information and data exchange between countries can be improved,
- to promote greater coherence among operational decision support systems and to encourage shared development of new and improved decision support systems features, and
- to improve the practicability of operational decision support systems.

The establishment of an European wide network of institutions involved in the development and use of decision support systems and in emergency management and response in general, grouped around the RODOS project, and with appropriate links to the relevant institutions outside Europe, underlined not only the need for achieving a European perspective of a more harmonised emergency response to any future nuclear accident, but also the willingness of all institutions involved to actively support such a process.

6.2 Brief description of the research performed and methods/approach adopted

To stimulate the communication and feedback between the operational and the RTD community, five problem-oriented emergency exercises were performed, which covered the various time phases of an accident and which extended from the near range to farther distances

with frontier crossing transport of radionuclides. Therefore, key element of the work programme was the preparation, performance and evaluation of these emergency exercises.

In order to evaluate the experience gained with decision support systems and the information exchange between them, a structured approach was used through the establishment of Working Groups. Each Working Group addressed one of five work packages, which covered areas identified by the members of the network as relevant with respect to improving the practical applicability of decision support systems: user interfaces, results and interaction with decision-makers; exchange of data and information relevant for decision-making; system functions, networks and processing of on-line data; European database; hydrological problems. In this way, the most important interfaces between the operational community and the methods and tools for decision support systems developed by the RTD institutes were covered.

Each Working Group developed its own procedures and material, such as evaluation forms and/or questionnaires, as a basis for qualitative and quantitative statements on future practical improvements in the field of its specific topics.

Participants in the network were

- primarily nuclear off-site emergency centres with (pre-) operational installations of the RODOS, ARGOS and RECASS decision support systems, and end users of the information provided by these systems;

- R&D institutes involved in developing, customising and/or maintaining RODOS, ARGOS and RECASS.

A secretariat was established at Forschungszentrum Karlsruhe GmbH to co-ordinate and manage the network and an Advisory Committee was created to monitor progress, to advise on the scope and content of emergency exercises, work packages and annual meetings, and to act as a discussion forum for strategic aspects of off-site emergency management in Europe.

6.3 Main achievements

The main deliverables of the DSSNET emerge from the evaluation of the experience gained by the emergency management teams with the operational application of decision support systems, in particular during the five emergency exercises performed. The main conclusions can be summarised as follows:

- All five exercises performed excellent and were considered as very useful by almost all participants. The participating countries / institutions were very engaged in preparing, performing and evaluating the exercises. The operational experience with the decision support systems increased significantly over the four years of the DSSNET.

- The participating decision support systems (RODOS, ARGOS, RECASS) performed well during the exercises, particularly in comparison to national tools. The results of

decision support systems were considered highly relevant in decision-making, what lead to an increase of the acceptance of the decision support systems. In that way, the DSSNET activities helped strengthening the national emergency management arrangements.

- A number of deficiencies, bugs and RTD needs were identified in the decision support systems. As a consequence, RTD activities were started and lead to improvements, such as a new RODOS source term user interface, the initiation of a LINUX version of RODOS, and extensions to the MATCH code. Concerning RODOS, user interfaces and graphical presentations still need improvements.

- The Web based B- and C- user interfaces of the RODOS system and their access within and from outside a country were successfully applied and highly appreciated by the users. The spectrum of results needs some extensions.

- The data assimilation techniques introduced in RODOS PV6.0 are considered as highly important and the efforts should concentrate on their operational applicability. A number of members consider the operational applicability of the hydrological modules of RODOS as very important as well.

- Simulated monitoring data are extremely important in emergency exercises. Therefore, more user-friendly extraction tools are necessary. Operational data assimilation tools were considered as extremely important.

- During the exercises, the direct exchange of information between neighbouring countries was increasingly used, what can be considered as a big step forward to a timely and consistent emergency response in Europe. Software tools, in particular the XML-based MODEM Server developed under the corresponding EC contract, were tested successfully and were broadly used. What still remains to be done are bilateral and/or regional agreements on the operational application of these now functioning direct information exchange tools.

- There is an ongoing need for intensive training of operators and users, in particular training with new tools of decision support systems (VISA in ARGOS, WebHIPRE and data assimilation in RODOS).

- The DSSNET members consider it as vital for guaranteeing a well prepared emergency management team to perform repeatedly emergency exercises, such as those under the DSSNET. In addition, there is an ongoing need for intensive training of operators and end-users, in particular after the release of higher versions of decision support systems with advanced software tools.

The feedback received from the DSSNET members during the preparation, performance and evaluation of five emergency exercises (instead of four initially planned) and from the operational experience with decision support systems was satisfactory and demonstrated the general attitude of DSSNET members to actively contribute to its overall objectives. The practical results described above clearly demonstrate that the DSSNET gave a strong positive mo-

mentum with respect to practical improvements striving at a more harmonised European approach of reacting on radiological emergencies. This finally led to the commitment of almost all DSSNET members, in particular the emergency management organisation, to actively contribute to the EURANOS project within the EC's 6th Framework Programme.

Through the involvement of the three decision support systems RODOS, ARGOS and RECASS and their common participation at the emergency exercises, the process of providing common functions and tools of the systems has been started. Meanwhile, the ARGOS system integrates software modules of RODOS, and this process will continue. RECASS has developed interfaces for interpreting the source term and meteorological files provided by RODOS. Missing or incomplete input functions recognised in the three systems during the exercises were improved. The shared use of developments was made in the area of meteorological forecast: the interface produced in the Slovak Republic between the ALADIN numerical weather forecast model and the RODOS system was made available for other countries using the same model predictions as input to RODOS.

An important achievement of the DSSNET not mentioned in the initial objectives of the network was identified as a consequence of the common emergency exercises: the awareness of the operational teams that much more intensive training and exercising is required not only to make sensible use of the decision support systems, but in general to be better prepared for the case of a real accident situation either within or outside the country. The experience from the five exercises clearly shows that the practice of the emergency teams improved within the contract duration of the DSSNET, and this process will continue under the EURANOS project of FP6.

The DSSNET resources spent did not only provide an important contribution to cure existing deficiencies in decision support systems and to develop better tools for emergency management. They can also be considered as an investment for the future with more and more converging criteria and attitudes in decision making and more and more common views on IT based methods and systems, which will ultimately create initiatives on the administrative and political levels to adapt regulations, recommendations and procedure guides for emergency management and response, for bi- and multi- national information exchange, and for mutual help where and when necessary.

Finally another important side effect of the DSSNET should not be forgotten: the maintenance and extension of a European wide network of institutions involved in the development and operation of decision support systems and in emergency management and response in general. Considerable knowledge and experience was exchanged through the network among the partners on a bi- or multi-lateral basis what accelerated the adaptation process between East and West European countries, in particular the new members states, at least in the area of emergency management and response.

6.4 Exploitation and dissemination

The results achieved under the DSSNET are available to all its members. All documents are accessible on the DSSNET Homepage, which builds part of the RODOS Homepage (www.rodos.fzk.de).

Software products were implemented in the RODOS system and partially in ARGOS. Version PV5.0 of the RODOS system and all complementary patches released up to the availability of version PV6.0 were distributed by FZK free of charge to all institutions where previous versions have been installed and who have an expressed interest to update the RODOS software. Currently, about 17 institutions have installed the system for (test-) operational use in their national emergency centres and 10 research institutes use the system for RTD purposes; furthermore, it will be delivered in future to new user institutions in East and West Europe. The software itself is free of cost, however any installation and/or customisation work to be performed by members of the RODOS Consortium will be charged on a full cost basis.

7 Annex 2: Co-ordinator and members of the DSSNET

Co-ordinator: Dr. J. Ehrhardt, Forschungszentrum Karlsruhe (D)

Members:
Mol - Belgian Nuclear Research Centre (B)
RISOE National Laboratory (DK)
Forschungszentrum für Umwelt und Gesundheit (D)
Vyskumny ustav jadrovych elektrarni (SK)
Science and Production Association "TYPHOON" (RU)
National Centre for Scientific Research "DEMOKRITOS" (EL)
National Radiological Protection Board (UK) – (Radiation Protection Division of the Health Protection Agency since 1 April 2005)
Danish Meteorological Institute (DK)
"Horia Hulubei" Nat. Inst. of R&D for Physics and Nuclear Engineering (RO)
Institute of Atomic Energy (PL)
Institute of Mathematical Machines and System Problems (UA)
Nuclear Research and Consultancy Group (NL)
National Research Institute for Radiobiology and Radiohygiene (HU)
University of Manchester (UK)
Nuclear Research Institute Rez plc (CZ)
Finnish Centre for Radiation and Nuclear Safety (FIN)
National Atomic Energy Agency (PL)
Consejo de Seguridad Nuclear (E)
Direccao Geral do Ambiente (P)
Nuclear Regulatory Authority of the Slovak Republic (SK)
State Nuclear Regulatory Administration (UA)
The Secretariat of the Governmental Commission for Nuclear Emergency Preparedness (HU)
National Radiation Protection Institute (CZ)
RIVM - National Institute of Public Health and the Environment (NL)
Ministerium des Innern und für Sport (D)
Niedersächsisches Landesamt für Ökologie (D) – since 1 January 2005:
Niedersächsischer Landesbetrieb für Wasserwirtschaft, Küsten und Natur schutz (NLWKN)
Bundeskanzleramt Sektion VI (A)
Slovenian Nuclear Safety Administration ((SK)
Japan Atomic Energy Research Institute (JP)
Danish Emergency Management Agency (DK)
Radiation Protection Institute of Ireland (IRE)
Bundesamt für Strahlenschutz (D)
Institut de Protection et de Sûreté Nucléaire (F)
Austrian Research Centre Seibersdorf (A)
Committee on the Use of Atomic Energy for Peaceful Purposes (BG)
Radiation Safety Centre (LV)