FINAL TECHNICAL REPORT

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TITLE : **Information Requirements and Countermeasure Evaluation Techniques in Nuclear Emergency Management**

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Part 1: Publishable Final Report

1.1 Executive publishable summary

EVATECH, *Information Requirements and Countermeasure Evaluation Techniques in Nuclear Emergency Management*, was a research project aiming for the enhancement of the quality and coherence of the response to nuclear and radiological emergencies in Europe. The project was carried out within the key action “Nuclear Fission” in the fifth Euratom Framework Programme (FP5). The objective of EVATECH was to improve the decision support methods, models and processes in ways that take into account the expectations and needs of different stakeholders participating in decision making to protect members of the public and workers in a nuclear emergency situation. The project had ten partners from seven European countries.

The project was divided into four work packages dealing with; (1) development of evaluation tool(s) for the decision support systems (RODOS and ARGOS) that can be used to find the most practicable protective actions in a reliable and transparent way, (2) description of emergency management processes in a few European countries by a modern process modelling technique to clarify the decision making processes used and to explore the best practices, (3) development of methodologies to conduct scenario-focused decision making workshops with participation of relevant stakeholders, and (4) arranging of national decision making workshops in the seven participating countries to identify feasible countermeasures for clean-up of contaminated inhabited environments after a nuclear accident and the factors that drive the decisions made.

The project commenced on 1 December 2001 and the originally planned activities ended on 30 November 2004. In September 2004 the Project Consortium applied for an extension of five months to the project in order to disseminate the achievements to a wider audience responsible for nuclear emergency management in Europe. The Commission approved the extension and the project finished at the end of April 2005.

In the beginning of 2003, a decision on the new evaluation software to be included in RODOS was made. Instead of continued development of the integrated evaluation subsystem (ESY) built within a Motif environment in RODOS, it was decided to adopt a generic Java-based multi-attribute evaluation tool Web-Hipre (HIerarchical PREference analysis in the World Wide Web). The decision was made to use a standard windows-based multi-attribute evaluation tool VISA (Visual Interactive Sensitivity Analysis) with the other decision support system, ARGOS.

The nuclear emergency management process was modelled in the UK using a modern process modelling software, Process Navigator**.** Similar process modelling was also performed in Belgium, Slovak Republic and in Germany.

A training seminar on the organisation and running of facilitated workshops was arranged in Finland in May 2003. The project partners were introduced to decision analysis and facilitated workshop skills, and were trained to conduct this kind of workshops, where representatives from different organisations gather around the same table to find the most practicable solutions to a problem, in this case countermeasures in an inhabited area following an emergency situation. Nine national workshops on clean-up actions in inhabited areas took place between November 2003 and May 2004 in all of the seven participating countries.

The project duration was extended by five months in order to disseminate achievements of the project to a wider audience, especially to European end-users of emergency management tools. The dissemination seminar was arranged on 20 April 2005 in Brussels. About 50 participants from 17 countries attended the seminar.

1.2 Publishable synthesis report

1.2.1 Introduction

EVATECH, *Information Requirements and Countermeasure Evaluation Techniques in Nuclear Emergency Management*, was a research project in the key action "Nuclear Fission" of the fifth Euratom Framework Programme (FP5). The overall objective of the project was to enhance the quality and coherence of response to nuclear emergencies in Europe by improving the decision support methods, models and processes in ways that take into account the expectations and concerns of the many different parties involved - stakeholders both in managing the emergency response and those who are affected by the consequences of nuclear emergencies. The project had ten partners from seven European countries. The partners were;

1. Radiation and Nuclear Safety Authority (STUK, coordinator) - Finland
2. Manchester Business School of the Victoria University of Manchester (MBA)- United Kingdom
3. National Radiological Protection Board (NRPB) - United Kingdom
4. Forschungszentrum Karlsruhe GmbH (FZK) - Germany
5. Universitaet Karlsruhe (UNIKARL)- Germany
6. Bundesamt fuer Strahlenschutz (BfS)- Germany
7. Danish Emergency Management Agency (DEMA)- Denmark
8. VUJE Trnava Inc. (VUJE) - Slovakia
9. Belgian Nuclear Research Centre (SCK•CEN)- Belgium
10. Institute of Atomic Energy (IAE)- Poland

The development of the real-time online decision support system RODOS has been one of the major items in the area of radiation protection within the European Commission's Framework Programmes. The main objectives of the RODOS project have been to develop a comprehensive and integrated decision support system that is generally applicable across Europe and to provide a common framework for incorporating the best features of existing decision support systems and future developments. Furthermore the objective has been to provide greater transparency in the decision process to: improve public understanding and acceptance of off-site emergency measures, to facilitate improved communication between countries of monitoring data, predictions of consequences, etc., in the event of any future accident, and to promote, through the development and use of the system, a more coherent, consistent and harmonised response to any future accident that may affect Europe.

RODOS provides support ranging from largely descriptive reports (Levels 0-2) to a detailed evaluation of the benefits and disadvantages of various strategies and their ranking with respect to the societal preferences expressed by the decision makers (Level 3). The system uses monitoring data and field measurements to improve the accuracy of its modelling of atmospheric and hydrological dispersion and radioecological processes. The system operates at four levels;

- **Level 0:** acquisition and checking of radiological data and their presentation, directly or with minimal analysis, to decision makers, along with geographical and demographic information.
- **Level 1:** analysis and prediction of the current and future radiological situation (i.e., the distribution over space and time in the absence of countermeasures) based upon information on the source term, monitoring data, meteorological data and models.
- **Level 2:** simulation of potential countermeasures (e.g., sheltering, evacuation, issue of iodine tablets, relocation, decontamination and agricultural countermeasures), in particular, information on their likely feasibility and quantification of their benefits and disadvantages.
- **Level 3:** evaluation and ranking of alternative countermeasure strategies by balancing their respective benefits and disadvantages (e.g., costs, averted dose, stress reduction, social and political acceptability) taking account of societal preferences as perceived by decision makers.

EVATECH was a project focusing on the last level of the system (Level 3). Also another decision support system ARGOS, developed originally by the Danish Emergency Management Agency, was included in the EVATECH project. The aim was to utilise the work done with the RODOS system also in the development of ARGOS.

The EVATECH project was divided into four work packages dealing with;

1. Development of evaluation tool(s) for the decision support systems (RODOS and ARGOS) that can be used to find out the most practicable protective actions in a reliable and transparent way,
2. Description of emergency management processes in a few European countries by a modern process modelling technique to clarify the decision making processes used and to find out the best practices,
3. Development of methodologies to conduct scenario-focused decision making workshops with participation of relevant stakeholders, and
4. Arrangement of national decision making workshops in the seven participating countries to identify feasible countermeasures for clean-up of contaminated inhabited environments after a nuclear accident and the factors that drive the decisions made.

1.2.2 Evaluation tools for the decision support systems RODOS and ARGOS

Due to architectural constraints of the RODOS system the EVATECH consortium decided not to continue development of the integrated Evaluation Sub-system (ESY) built within a Motif environment in RODOS, but to integrate a generic Java-based multi-attribute evaluation tool Web-Hipre (HIerarchical PREference analysis in the World Wide Web) into RODOS. The major reasons for the integration of Web-Hipre were:

1. its web-interface provides a flexible tool for use with decision makers in the emergency management process;

2. it provides a number different multi-attribute evaluation methods within the same package;

3. it offers the means to edit and restructure the decision model, including addition of new strategies and attributes;

4. the availability of online training courses using web space provided by from Helsinki University's Technology's Systems Analysis Laboratory;

Since February 2003 this integration has been accomplished. The modification and integration of the Web-Hipre code was undertaken at UNIKARL and generic links between the Countermeasure Sub-system (CSY) of RODOS and Web-Hipre developed at MBS, working with NRPB. Following the running of facilitated decision making workshops (see Section 1.2.5), further improvements to the Countermeasure Sub-system (CSY) of RODOS were identified. These were prioritised and changes made to the software and associated documentation of RODOS.

Regarding ARGOS, the decision was to bind a standard windows-based multi-attribute evaluation tool VISA (Visual Interactive Sensitivity Analysis) more loosely with ARGOS.

The both decision analysis tools (Web-Hipre and VISA) enable the users ("decision makers" or stakeholders participating in decision making) to value the importance of different kind of factors against each other in an emergency situation in a simple and transparent way. The countermeasure sub-systems of RODOS and ARGOS are assumed to provide the so called objective ("hard") attributes to the evaluation tools. In a real decision making situation, also subjective ("soft") attributes will be involved. The subjective attributes may be personal preferences of the participating stakeholders and normally are not measurable in numerical values. To be able to elicit preferences between different types of objective measurable attributes on one hand and between objective and subjective attributes on the other hand, the participating stakeholders must have some tool to make these kind of trade-offs possible.

Web-Hipre contains several different ways of preference elicitation (direct rating, weight elicitation, SMART and AHP) to balance the importance of the different criteria selected (attributes).

The decision analysis tool Web-Hipre can be used either by a single user or in a group comprising representatives of relevant stakeholders of the problem. In both cases the first task is to define the factors (attributes or values) which are driving the decision making. In the case of the off-site management of a nuclear accident, there is a great variety of factors which can affect the decision making. The factors are related to the environmental radiation situation (public and workers' exposure to radiation, environmental contamination, radiation protection principles and legislation, etc.), health effects of radiation (cancer and death incidences caused by radiation exposure, other health effects caused by radiation, mental health effects, etc.), psycho-social consequences, socio-political issues, economic factors, etc.

The next step is to consider what countermeasures are available for protection of the public and how feasible these measures are. Different potential countermeasure strategies can be compiled for more detailed evaluation. In ranking the strategies, the participants have to make difficult trade-offs in relation to the emphasis given to public perception and indirect economic impacts as against more 'objective' criteria, such as radiation health effects and direct costs. However, the adopted evaluation tool Web-Hipre enables this kind of ranking in a relatively simple way. The aim is to find the most feasible countermeasures which can be also explained to the general public.

Figure 1 shows an example of the value tree created with Web-Hipre in one of the exercises performed in EVATECH. The rightmost column contains protective actions which can be implemented following a nuclear accident. The alternatives (yellow column) are the selected strategies containing one or more of the potential protective actions. The next column (Criteria 2) shows the lower level attributes selected by the participants. These lower level attributes are further grouped into the higher level attributes (Criteria 1). The leftmost column indicated the overall goal of the decision making panel, in this case it is called "normal living conditions". The panel has to identify the strategy which leads as close to the overall objective as possible, taking into account the values brought by the participants into the discussion.

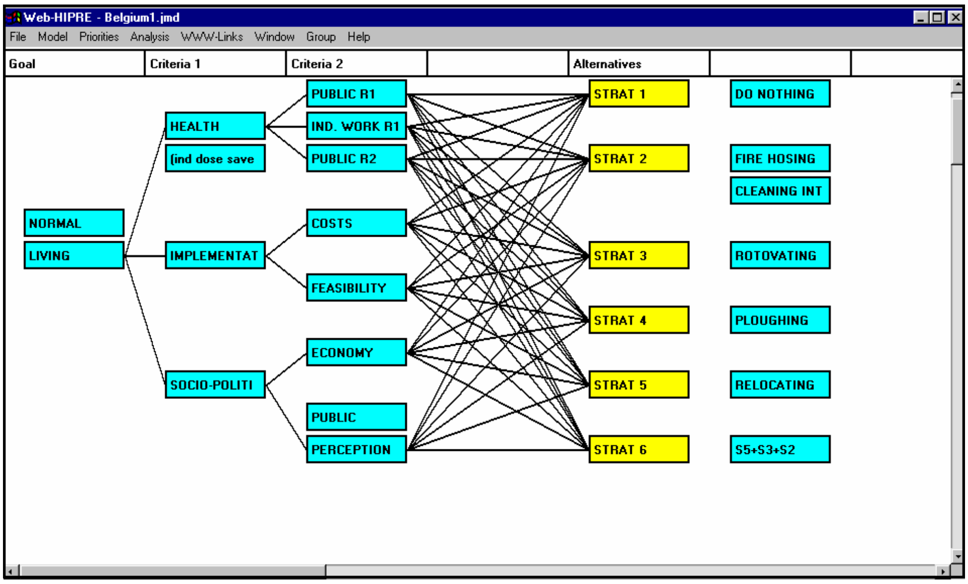

Figure 1: Example of the value tree produced with Web-Hipre in one of the decision making workshops of EVATECH.

1.2.3 Emergency management processes

The process of management of nuclear emergencies was surveyed and documented in the UK, Belgium, Germany and Slovak Republic. Modern process modelling techniques were used to produce a generic model to describe the emergency management processes in these countries. The modelling was done to survey, document and compare the duties and emergency management processes in several countries and to define information and other support needs at various stages of the process. The objective was also to study whether information and DSSs can be used more effectively and to identify differences between countries, understanding the structural reasons for these, and to suggest practices which might be shared.

The following provides a description of the key levels and areas involved in each of the four models.

- The Belgian emergency management has the Provincial level that implements the countermeasure decisions made by the Federal level. The related centres of activity are the Provincial Coordination Committee and the Crisis Coordination Centre of Government (CGCCR). The CGCCR consists of the Measurement Cell, the Evaluation Cell, the Socio-Economic Cell, the Federal Coordination Committee and the Information Cell.

- The German model has the State (Land) level responsible for the decision-making and implementation, and the Federal (Bund) level, which provides supervision and advice. The Federal level involves the Federal Ministry of Environment, Nature Conservation and Nuclear Safety (BMU) and the Federal Ministry for Radiation Protection (BfS) and the Federal Ministry of Interior (BMI). There is also the Integrated Measurement and Information System for the Surveillance of Environmental Radioactivity (IMIS), which is the federal measurement and information system. IMIS has participants both at federal and state level and is overseen by BfS. The State level includes the Local Disaster Control Management (KatSL), the relevant State Authority (nuclear supervisory and radiation protection) with its affiliates, and the relevant state authorities for disaster control (District Authority, State Ministry for the Interior (NMI)).

- The Slovak model has a Local level that coordinates and implements the countermeasure decisions made at the National level, providing feedback to the National level. On the Local level there are the Civil Protection Crisis Staff of the County, the District and the Municipality (CSC, CSD and CSM). On the National level there are the Central Crisis Staff of the Slovak Republic (CCS) and the National Emergency Commission for Radiation Accidents (NECRA) working together. NECRA includes a group called the technical operations management group (ORS) who are sent to a support centre, the Emergency Response Centre (ERC) of the Nuclear Regulator (UJD). In the Slovak process model there is also a level referred to as ‘Technical support and advice’. The technical support and advice is provided by the ERC, the Slovak Radiation Monitoring Network (SORAMON) and Information Services.

- The UK model has a Local level, which focuses on the release and the offsite implications, and a National level, which focuses on the national and international response. The related centres of activity are the Local Emergency Centre (LEC) and the National Emergency Briefing Room (NEBR). Located close to the LEC is the Media Briefing Centre (MBC). In the UK process model there is another area referred to as Organisations sites, which relates to the provision of technical support, and activities coordinated by organisations headquarters and other centres.

The overall conclusion was that the four emergency management process models are substantially different in their organisational structures and differences were identified in communication style, where decisions are made and the management of advice. The observation was made that practices that work very well in one country’s model may not work in another It is therefore not possible to suggest practices that may be shared.. Therefore the focus for ‘sharing’ should be the recognition that there are a variety of effective approaches that can be adopted in emergency management. Countries with different approaches need to respect each other’s approach and focus on establishing methods for working together that embrace, rather than deny, these differences.

1.2.4 Methods to conduct facilitated decision making workshops

International organisations have for many years recommended that key players (stakeholders), e.g., authorities, expert organisations, industry, producers of foodstuffs and even the public should be involved in the national planning for protective actions in a case of a nuclear accident. The wider stakeholder involvement was included in EVATECH and its work package 3 focused on training the project partners in decision analysis and potential methodologies for stakeholder involvement in the decision making workshops.

The training seminar dealt with basics of radiation protection, principles of intervention in nuclear or radiological emergencies, off-site protective actions in nuclear accidents, decision analysis principles, evaluation tools developed for aiding decision making, and practical guides for facilitating workshops in which protective actions are planned. Seventeen experts from the seven countries participating in EVATECH attended the seminar. The hands-on evaluation exercises trained the experts and facilitators from each participating partner country in EVATECH to conduct scenario-focused workshops in their own countries.

The seminar was arranged by STUK in close co-operation with the Helsinki University of Technology (HUT), a subcontractor to EVATECH. Lecturers came, in addition to these organisations, from the Manchester Business School (MBS) and the National Radiological Protection Board (NRPB) in UK.

Most of the participants were experts on radiation protection and/or emergency management and few participants represented the decision analysis society. That is why the programme covered the both disciplines, radiation protection and decision analysis. The main emphasis was however in decision analysis techniques and in tools used for facilitating of decision workshops or meetings where stakeholders representing different interest groups try to find the best solution(s) to a given problem.

A Decision making problem was defined as *“Decision making is what you do when you are not sure what to do”*. Different types of decision making were briefly introduced (intuitive, programmed and analytical) and then different methods of the analytical decision making process were dealt with in more detail. One important message of the seminar was that when decision analysis is utilised there is not always a single right decision - there can be several good ones.

Formats of facilitated workshops and tips and tricks for running these were introduced. This was especially designed for those participants who were planning to facilitate the national workshops in WP4 of EVATECH. The presentation focused on practical pieces of advice to facilitators in order to make a facilitated workshop successful. The main message to facilitators was to focus on the process of the facilitated workshop, not on the content of the problem being discussed. The Facilitator has a specific role and tasks in driving the meeting but he/she should not lead the process and discussion. In facilitating the meeting, the facilitator can utilise specific decision aiding tools (like Web-Hipre or VISA) in formulation of the problem, creation of the strategies and attributes and in making the overall problem understandable and visible to the participants.

Web-Hipre (Hierarchial Preference Analysis in the World Wide Web) was introduced to the participants. A special web-site (http://www.evatech.hut.fi/training) was established before the seminar and an e-learning possibility to study Web-Hipre and theory of decision analysis was offered to the participants.

At the end of training seminar, a hands-on exercise was arranged with the case of clean-up actions in an inhabited environment. The participants were divided into small groups to discuss the potential countermeasures, one participant facilitating the discussion.

The general conclusion from the seminar was that, after the seminar, the trained experts were capable to conduct their national workshops arranged as a part of work package 4 of EVATECH.

1.2.5 National facilitated decision making workshops

Work package 4 dealt with the facilitated workshops on clean-up actions in an inhabited area after a nuclear_accident. The workshops were facilitated by those experts who were trained at the seminar arranged in WP3. Background material for the workshops was prepared by STUK and distributed to all participants. Following a release of radioactivity that results in contamination of the environment, an appropriate protective response would be required. During the release, and until the source of the release has been brought under control, emergency countermeasures might be required to protect the public from short term, relatively high exposures to radiation. In the longer term, or recovery phase, a response strategy would need to be developed with the two aims of protecting people from continuing exposure and of enabling lifestyles and economic activity to return to normal. Since radioactivity can be measured down to levels well below those that pose a significant health hazard, it is unlikely that it would be a practical goal to remove from the environment all measurable radioactivity resulting from the accident. Therefore a balance would need to be struck between the desire to reduce exposures and the need to conserve resources and enable an area to return to normality, albeit not necessarily quite the same ‘normality’ as existed before the accident.

The objectives for the workshops were:

- to identify and verify the factors driving decision making during the recovery phase of a radiological emergency situation (for a specific scenario);
- to explore the information needs of all parties involved in decision making at the workshop;
- to identify the forms of strategy that relevant organisations wish to consider for recovery in inhabited areas,

- to clarify the needs for the further improvement of the evaluation tools of the RODOS and ARGOS decision support systems.

Within this context, nine facilitated workshops were arranged in the countries participating in the EVATECH project, three workshops in the UK and one in the other countries; Belgium, Denmark, Finland, Germany, Poland and Slovak Republic. The workshops were run to understand the information and decision support needs of decision makers a few days after a radioactive release from a nuclear accident when considering the choice and implementation of recovery actions in inhabited areas. Some remarks on the workshops are given in the following text.

The original intent was to use the same accident scenario for all workshops with the 'footprint' of the accident being transposed onto nuclear sites in each country. The original aim was also to select the accident sites in different countries so that the populations affected by the accident would be comparable. However, in some countries the scenario was changed to be more appropriate for the scale of accident that decision makers were likely to have to manage or to address the sensitivities of the nuclear operators. This means that direct comparisons of the selected countermeasures in different countries cannot be made. However, the exercises were very useful for the identification of the needs of the participating stakeholders, ~~and~~ the values that drive the decision making process and discussion of issues.

The accident scenario for the workshops was applied to nuclear power plant sites in each country. In addition, the UK also applied the scenario to a nuclear submarine base to address issues with the accident occurring close to a densely populated inhabited area. In Poland, the scenario was based on the Swierk Centre nuclear research reactor.

The RODOS system was used to produce the necessary information about the accident consequences and demographic data in six of the participating countries. The ARGOS system was used only in Denmark. The Decision analysis software Web-Hipre was used with RODOS to make an evaluation of the clean-up strategies. The Decision analysis software, VISA, was available in the Danish workshop but formal evaluation of strategies was not carried out due to time constraints.

The first task was to identify what criteria or values should be taken into account when evaluating the feasibility of clean-up actions in different areas. In all workshops the contaminated areas were broken down into sub-areas according to the contamination patterns and land use. Each participant had an opportunity to express what criteria and values would drive his/her choices between different possible clean-up actions. These criteria varied from hard economic values to more soft personal preferences and social values. However it was interesting to see that almost the same values were discussed in all the workshops.

The next step was to identify appropriate and effective actions for clean-up of the contaminated areas. A lot of technical actions were introduced in the information package provided beforehand to the participants and several additional actions were discussed in the workshops. The stakeholder panels also discussed about the importance of extensive public information and food countermeasures and these were included in several scenarios.

After discussion, the stakeholders found a consensus about the attributes to be taken into further discussion. The attributes were classified according to their mutual importance and lower level attributes were grouped under relevant higher level attributes, where appropriate. In this way the workshops developed the value or attribute tree for the evaluation.

The values or criteria (also called as attributes) discussed in the national stakeholder workshops were surprisingly similar. The main groups under which almost all the discussed criteria can be classified were;

- Health related issues (public/workers' radiation doses, workers' physical safety, etc.)
- Social/political aspects (political acceptability, public reassurance and confidence, socio-psychological effects, equity, environmental protection, etc.)
- Technical feasibility (costs, available resources, waste management, etc.)

The mutual weights of the criteria understandably varied depending on the level of contamination being used in the scenario, the total area to be cleaned up, resources available and the number of people affected. If the contamination and the consequent radiation doses were not very high, social and political aspects got a greater weight than health related issues: on the other hand, if the contaminated area was very large, technical feasibility and costs had a greater importance.

It became clear at the workshops that decision makers would need to make difficult trade-offs in relation to the emphasis given to public perception and indirect economic impacts as against more 'objective' criteria, such as radiation health effects and direct costs. When contamination of the environment was relative small, the general conclusion was that strategies involving cheap and non-disruptive clean-up options such as grass cutting and vacuum sweeping together with extensive monitoring offer the best balance of response in reassuring the public. More substantive and costly measures such as soil skimming did not seem justified unless waste disposal issues could be dealt with more cost-effectively than envisaged. It was recognised that these conclusions were based on the groups' assessment of public perception. However, the participants felt that, in the event of an accident, there would be time to engage the public in debate about the potential benefits of more resource intensive options and waste disposal issues.

Although public perception and political acceptance were mentioned very often in the discussions, some people expressed the view that these should not drive the decision making. Rather, the clean up strategy decided on should and would be complemented by a full and open public information strategy, which participants felt would elicit the necessary public support.

Most of the workshops participants were very grateful for the opportunity to explore recovery issues in the framework of a workshop and they felt that the Web-Hipre decision software was a useful input into the process. Many of participants expressed the need of similar workshops for training purpose with the invitation of other specialists from different disciplines and with a focus not only on advisors but also on leaders who are the members of the emergency commissions at different levels and on residents who may (it is expected) execute some of the countermeasures.

1.2.6 Dissemination of the achievements

The results of the project were presented at a Symposium on Off-site Nuclear Emergency Management in Rhodes on 21-24 September and those participants who were not involved in the project expressed a strong wish to have an opportunity to get closer acquainted with the new method to evaluate the countermeasure strategies. Also the European Commission encouraged the EVATECH team to arrange an additional seminar to disseminate the results of project to a wider audience. The project consortium applied for an extension to the project in order to arrange a dissemination seminar to real end-users of emergency management tools and methods. An Extension of five months was accepted by the Commission and the seminar arrangements started in late autumn 2004.

The dissemination seminar with a title of 'Transparent and Traceable Decision Making in Off-site Nuclear Emergency Management' was arranged in Brussels on 20 April 2005. The seminar was jointly sponsored by two of the DGs concerned with nuclear emergency management in the European Commission, namely DG Research and DG Energy and Transport. The seminar was directed at end-users of decision support systems, i.e. those who are participating in decision making, preparing recommendations for decision makers, and those who are using or are supposed to use this kind of supporting tools. It was attended by the technical community (in particular those responsible for providing decision support in a radiological emergency and developing tools for this purpose), by those responsible for policy and those with an operational function. About 50 participants attended the seminar, half of them represented responsible authorities in nuclear emergency management, and another half the technical community (research institutes and technical support organisations).

Seven high level presentations were given in the seminar starting from general requirements needed for effective emergency management and ending with the experiences gained in the EVATECH project from using decision analysis in the facilitated stakeholder workshops. At the end of the seminar, a panel discussion was arranged to hear experiences and feedback from those end-users who attended the national workshops arranged by EVATECH.

Part 2: Detailed Final Report

2.1 Objectives and strategic aspects

The development of the Real-time online decision support system RODOS has been one of the major items in the area of radiation protection of the European Commission's Framework Programmes. The main objectives of the RODOS project have been to develop a comprehensive and integrated decision support system that is generally applicable across Europe and to provide a common framework for incorporating the best features of existing decision support systems and future developments. Furthermore the objective has been to provide greater transparency in the decision process as one input to improving public understanding and acceptance of off-site emergency measures, to facilitate improved communication between countries of monitoring data, predictions of consequences, etc., in the event of any future accident, and to promote, through the development and use of the system, a more coherent, consistent and harmonised response to any future accident that may affect Europe.

RODOS provides support ranging from largely descriptive reports (Levels 0-2) to a detailed evaluation of the benefits and disadvantages of various strategies and their ranking to the societal preferences expressed by the decision makers (Level 3). The system uses monitoring data and field measurements to improve the accuracy of its modelling of atmospheric and hydrological dispersion and radioecological processes. The system operates at four levels;

- **Level 0:** acquisition and checking of radiological data and their presentation, directly or with minimal analysis, to decision makers, along with geographical and demographic information.

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- **Level 3:** evaluation and ranking of alternative countermeasure strategies by balancing their respective benefits and disadvantages (e.g., costs, averted dose, stress reduction, social and political acceptability) taking account of societal preferences as perceived by decision makers.

EVATECH was a project focusing on the last level of the system (Level 3). Also another decision support system ARGOS, developed originally by the Danish Emergency Management Agency, was included in the EVATECH project. The aim was to utilise the work done with the RODOS system also in development of ARGOS.

The overall objective of EVATECH was to enhance the quality and coherence of response to nuclear emergencies in Europe by improving the decision support methods, models and processes in ways that take into account the expectations and concerns of the many different parties involved - stakeholders both in managing the emergency response and those who are affected by the consequences of nuclear emergencies.

This objective is one step towards the vision, where all European countries have a joint platform in emergency management to exchange information about the emergency situation and implemented protective actions in a way which is reliable and understandable to all parties involved. To achieve this goal, the national and international responses to nuclear accidents need to be coherent, harmonised and sensitive to different stakeholder perceptions if they are to achieve public confidence and so attain the high level of protection and remediation intended.

Over the past decade, there have been many developments in the provision of decision support systems (DSSs) – some complex and comprehensive, some more focused – to support emergency management decisions over all ranges and phases of an accident. Both radiological and non-radiological factors have been addressed, and many detailed transport and consequence models developed to predict the evolution of the accident. In the majority of cases, the development of DSSs has been driven primarily from the R&D community, and not the operational emergency management community nor the decision-makers (DMs). Moreover, the emergency management processes which involve many interactions between DSS operators, emergency managers, stakeholders and other DMs (e.g. politicians) have been designed or evolved for an era before such technological DSSs were available. These facts formed the basis for the strategy of this project and for planning of the work programme.

The strategic aspects, which channelled the project planning and content of the work packages, can be described as follows:

- there is a real need to tailor the decision support systems (DSSs) and the emergency management processes which they support to the needs of a broad range of users within the emergency management processes;
- a further challenge to comprehensive decision support is the flexibility required to guide local, regional and national decision making levels as the accident progresses;
- many decision makers (DMs) and their advisors will be involved in a range of decisions ranging from recommendations on protective actions in the early phase to complex stakeholder based decisions in the recovery phase. The enhanced European coherence in off-site nuclear emergency management should cover all these phases.

The more concrete objectives were defined as follows:

1. To enhance the countermeasure evaluation tools of RODOS and ARGOS systems to help the DMs judge the relative merits of different strategies, through the provision of better tools;
    - to compare in an easy and understandable way the consequences of possible countermeasures;
    - to identify potential countermeasure strategies and, conversely, screen out poor strategies;

- to rank feasible strategies and to perform informative sensitivity analysis.

2. To survey, document and compare the emergency management processes and duties of the parties involved in several countries with a view to:

- refining information and other support needs at the various stages of the process;
- identifying whether information and DSSs may be used more effectively;
- identifying differences between countries, understanding the structural reasons, if any, for these and suggesting practices which might be shared.

3. To define the information needs of the variety of users of DSSs within the emergency management process. Specifically,

- what data should be provided to users and in what formats to enable them to develop their understanding of the evolving situation and the potential responses?
- what quantities calculated by the various transport and consequence models are of most value and in what formats and to what accuracy are they most valuable?
- how should the modelling assumptions be conveyed to the users so that they can best appreciate the inherent quality – and uncertainties – of the forecasts?
- what strategies and, particularly, what combinations of strategies in relation to the affected areas do the DMs wish (and need) to consider?

4. To deepen insight on value judgements that are brought into play by the stakeholders (radiation safety, healthcare professionals, social services, industry, etc.) and DMs at various stages of the emergency management in deciding between potential countermeasure strategies: specifically,

- deepening insight on the factors (radiological, socio-psychological, economic, etc.) which different stakeholders considered relevant in their own decision making;
- exploring how these factors relate to the bases for international (generic) guidance on intervention;
- eliciting the relative importance of the factors in a range of accident scenarios and how these change during the course of an accident.

5. To develop methods for stakeholder involvement in exercises and emergency planning which will enhance public confidence and understanding in relation to nuclear emergency management, especially by;

- improving planning and communication methods, especially for the early phase of an accident;
- enhancing negotiation methods for the later phase of an accident;
- gaining experience on countermeasure evaluation systems developed in the project.

2.2 Scientific and technical description of the results

2.2.1 Development and improvement of the software for evaluation subsystem and its integration specifically into RODOS and ARGOS (WP1)

In the Annex I of the EVATECH contract, the objectives of this work package were defined as:

- To enhance the countermeasure evaluation subsystems (ESY) included in RODOS and other DSSs to help the DMs judge the relative merits of different strategies
- To provide tools to compare in easy and understandable way the consequences of possible countermeasures
- To identify potential strategies and, conversely, screen out poor strategies
- To rank feasible strategies and perform sensitivity analysis

2.2.1.1 Overview

This work package aimed at development of evaluation tools to the decision support systems RODOS and ARGOS. During the previous framework programmes an evaluation subsystem (ESY) was developed to RODOS but ARGOS system was totally missing a tool with which different countermeasure strategies could be evaluated and ranked. However, the ESY had not such features which are needed in decision analysis of countermeasures in emergency situation, and further development was necessary. The RODOS system has a modular structure, implemented on a UNIX platform because, at the time of its design, only UNIX provided a sufficiently transportable, stable and cost effective operating system that could support systems with a client-server architecture and distributed databases.

The architecture of RODOS is split conceptually into three distinct families of modules:

- *Analysing Subsystem* (ASY) modules process incoming data and forecast the location and quantity of contamination including temporal variation; i.e. the ASY modules forecast the evolution of the situation according to the best scientific understanding of the processes involved.
- *Countermeasure Subsystem* (CSY) modules suggest possible countermeasures, check them for feasibility, and calculate their expected benefit in terms of a number of attributes; the CSY modules predict the effects of potential countermeasures in ameliorating the consequences of the accident.
- *Evaluation Subsystem* (ESY) modules rank countermeasure strategies according to their potential benefit and preference weights provided by the DMs.

The interconnection of all program modules, the input, transfer and exchange of data, and interactive and automatic modes of operation are controlled by the RODOS operating system (OSY), a layer built upon the UNIX operating system of the host computer. Interaction with users and display of data takes place via a graphical subsystem (GSY), which includes a purpose-built geographical information system (ROGIS). As time passes, RODOS will arrive at different decision points where it must select three modules to form an ASY-CSY-ESY chain appropriate to the context of the decision. The ESY was designed during Frameworks 3 and 4 to be generic to all phases of an accident: i.e. it can fit into any ASY-CSY-ESY chain provided that CSY provides information in the right data structures.

One of the key constraints on the design of the ESY is the 'push' architecture of RODOS. The OSY assumes that all modules in a model chain run sequentially and information flows from the earlier modules to the latter with no opportunity for looping. Thus in the implementation of a generic ASY–CSY–ESY chain, it is not possible for the ESY to request a (re)run of one or more earlier modules in order to calculate certain impacts (doses, costs or whatever). All data required by an ESY run has to be prepared in advance of that run using the interfaces and command structures of earlier modules. If it becomes necessary to calculate some further quantities during an ESY run, for example, to investigate a strategy in which the areas concerned have been modified, the current run must be abandoned and the CSY and possibly the ASY modules rerun. This also means that the structure of the decision problem – attributes, strategies, etc. – has to be largely defined by the early modules in the ASY-CSY-ESY chain: *not* in the ESY module.

For this reason, the ESY assumes that it runs will be initiated with list of strategies, a comprehensive attribute tree and a consequence table giving the impacts for each attribute under each strategy.

Instead of continued development of the integrated ESY built within a Motif environment for RODOS, it was decided in the EVATECH project to replace the software with Web-Hipre software (HIerarchical PREference analysis in the World Wide Web), a generic Java-based multi-attribute evaluation tool, developed at Helsinki University of Technology. The major reasons for the integration of Web-Hipre were:

5. its web-interface allows a flexible use with decision makers in the emergency management process;

6. it provides a number different multi-attribute evaluation methods within the same packages;

7. it offers the means to edit and restructure the decision model, including addition of new strategies and attributes;

8. the availability of online training courses using web space from Helsinki University of Technology's Systems Analysis Laboratory;

Since February 2003 this integration has been accomplished. The modification and integration of the Web-Hipre code was undertaken by DFIU at the University of Karlsruhe and generic links between CSY modules and Web-Hipre developed at MBS, working with NRPB (ref XX).

Regarding ARGOS the decision was to bind a standard windows-based multi-attribute evaluation tool VISA (Visual Interactive Sensitivity Analysis) more loosely with ARGOS.

2.2.1.2 Interface between CSY and ESY in RODOS

Users who have not worked with Web-Hipre before should have a look at one of several online training courses that supply various case studies (using web space from the Systems Analysis Laboratory (SAL), Helsinki). These courses (available at http://www.mcda.hut.fi/) offer an excellent opportunity to become acquainted with the basic functionality of Web-Hipre. A slide show providing helpful information on the use of Web-Hipre can be found at http://www.mcda.hut.fi/value_tree/learning-modules/short_intro/slides/index.htm. A video clip with basic information about working with Web-Hipre is available at http://www.mcda.hut.fi/value_tree/videos/. This web site also offers other video clips illustrating the various features of Web-Hipre.

Extensive background information and theory in the area of decision support can be found at http://www.sal.hut.fi and http://www.decisionarium.hut.fi.

The following Figure 1 shows the hierarchical principle of Web-Hipre (applied to off-site nuclear emergency management) and gives an insight into the basic terminology. The abbreviations "a.c. dose" and "a.i. dose" in the decision tree mean "averted collective dose" and "averted individual dose" respectively.

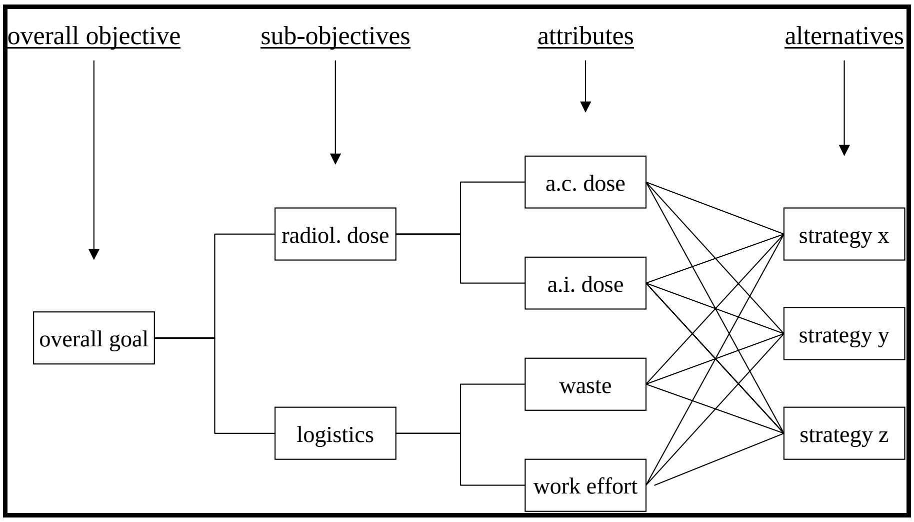


Figure 1: Hierarchical principle of Web-Hipre decision analysis software.

Within the EVATECH project a new module was integrated into Web-Hipre, which allows import of ESY-files ("RODOS output files"), which contain a selection of appropriate attributes. The user can reach the module by clicking on "File" in the main toolbar and then on "Import RODOS Model". The standard Open-Dialogue of Web-Hipre appears in modified form for the import of ESY-files. Only files with the ".esy"-ending are shown in the dialogue box. The user system of Web-Hipre is used for importing ".esy"-files and saving ".jmd"-Web-Hipre model files.

The requirement for implementation is an interface between the "old-ESY", which is still necessary for the user driven selection of appropriate attributes, and Web-Hipre. Therefore, a new module was integrated into Web-Hipre, which allows the import of these ESY-files.

The pre-processor of last version of the ESY (EsyMedium 6.0) was modified to allow the link with Web-Hipre. Web-Hipre is provided with an attribute tree, list of strategies and a table of 'scores' of the strategies against each attribute from LCMT. Now, it is possible to add a sub-tree of subjective attributes (qualitative information) to the attribute tree provided by the CSY module. In addition, data from the economic and health modules (e.g. costs, health effects, etc.) can be grafted on as a sub-tree.

The interface begins by offering the user an 'attributes window', which displays the full attribute tree and allows the user to select which of these should be passed forward to Web-Hipre for further analysis. The interface then filters out the remaining attributes. For example, the CSY module LCMT passes over 100 attributes to the ESY, from which one would expect the analyst/DMs to select maybe 10 to 15 for the evaluation. Once the selection finished, the interface writes a file for Web-Hipre containing the following data: the format of the tree, the names and weights (all zeroes) of the attributes, the list of strategies and a table of 'scores' of the strategies against each selected attribute.

NRPB modified LCMT CSY output at the same time, following interaction with other partners, to reflect a new agreed range of attributes, including doses to workers implementing countermeasures, the latter reflecting enhancements to the RODOS system. Following the facilitated workshops and a review of them by those who organised the workshops in each country, a number of improvements to the LCMT module and the endpoints calculated were identified. These were prioritiesd and a number of improvements included in the RODOS system to facilitate the use of data in the ESY and evaluation of countermeasure options.

2.2.1.3 Integration of Web-Hipre

Web-Hipre is now integrated into the RODOS system. The standard Open-Dialog of Web-Hipre appears in modified form for the import of ESY-Files: see the illustration in Figure 2.

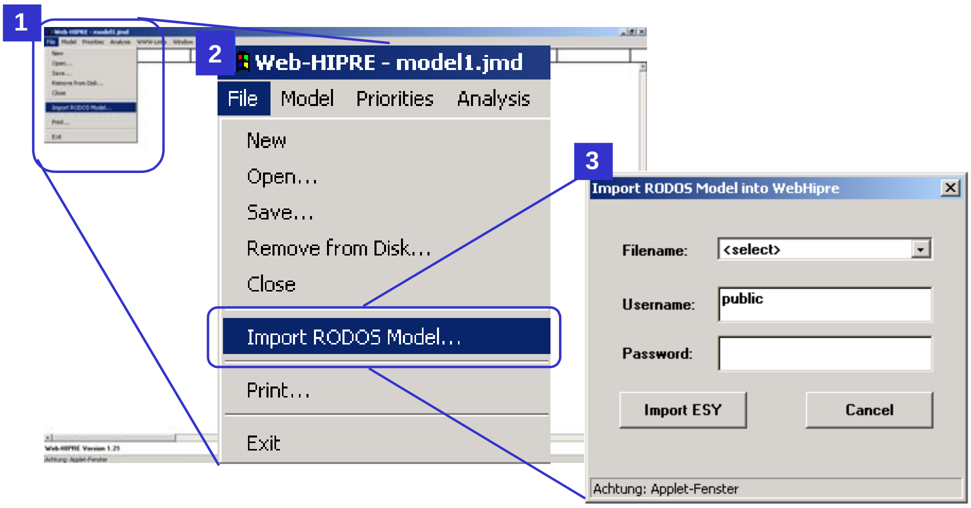


Figure 2: Screenshots on importing of ESY *files from* RODOS *to Web-Hipre.*

The imported file contains all information in an aggregated format. The entire tree structure of the selected attributes (not more than 30) and in the second part all data for the decision table are imported and converted into the appropriate Web-Hipre format. The main objective, secondary goals, criteria and alternatives are ordered according to their position in the decision tree (Figure 3).

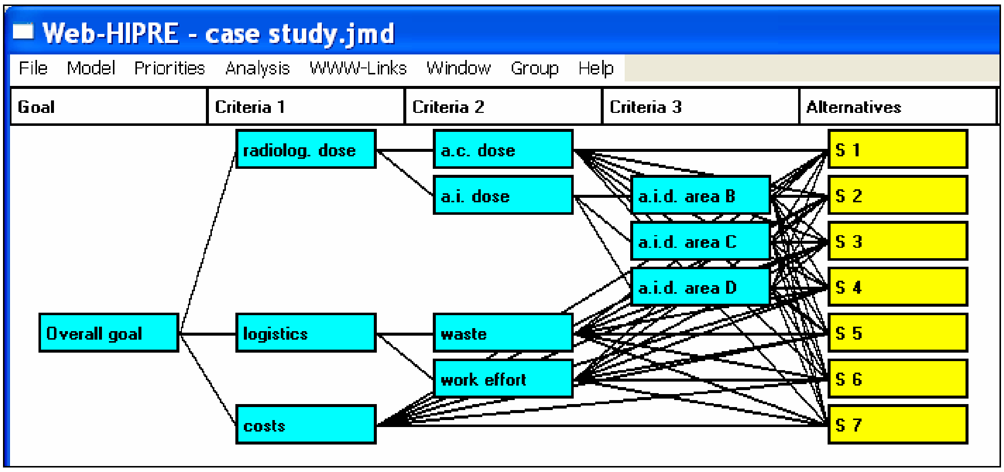
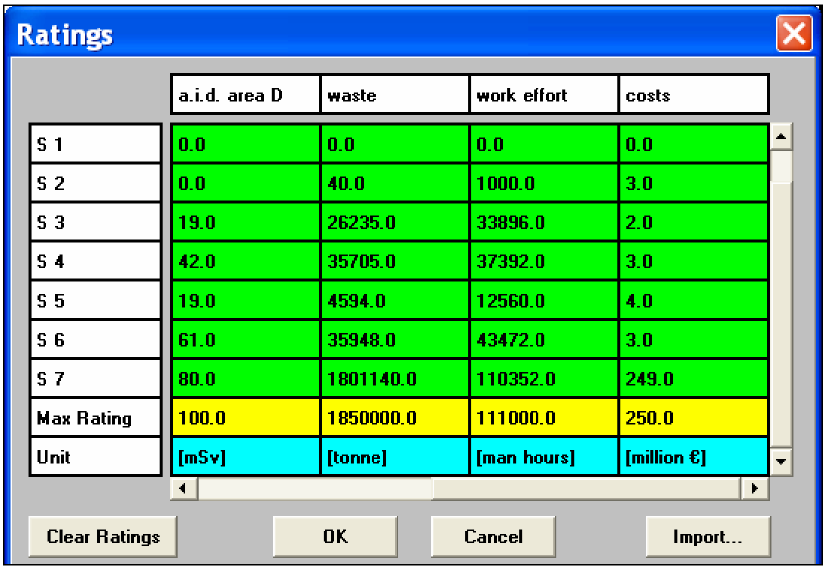


Figure 3: Screenshot showing the general structure of the value tree of Web-Hipre.

At http://www.mcda.hut.fi/value_tree/learning-modules/short_intro/slides/sld011.htm, information on entering the consequences of different alternatives can be found. The following screenshot shows an example of decision table which can be accessed by choosing “Ratings” from the “Priorities” menu.



	a.i.d. area D	waste	work effort	costs
S 1	0.0	0.0	0.0	0.0
S 2	0.0	40.0	1000.0	3.0
S 3	19.0	26235.0	33896.0	2.0
S 4	42.0	35705.0	37392.0	3.0
S 5	19.0	4594.0	12560.0	4.0
S 6	61.0	35948.0	43472.0	3.0
S 7	80.0	1801140.0	110352.0	249.0
Max Rating	100.0	1850000.0	111000.0	250.0
Unit	[mSv]	[tonne]	[man hours]	[million €]

Figure 4: Example on how the decision table can be structured of the available alternatives (strategies S1 to S7) and the selected attributes.

If you make use of the method “Import RODOS Model”, all values of the “hard” attributes will be imported automatically from the decision table. Before the decision analysis can be performed correctly, the forms of the value functions must be determined. In order to do so, you must highlight an attribute and then choose “Value Function” from the menu “Priorities” of Web-Hipre.

In the example of Figure 4, all the attributes are so called objective (“hard”) attributes which are supposed to be provided by RODOS (or ARGOS). In a real decision making situation, also subjective (“soft”) attributes will be involved. The subjective attributes may be personal preferences of the participating stakeholders and normally are not measurable in numerical values. To be able to elicit preferences between different types of objective measurable attributes on one hand and between objective and subjective attributes on the other hand, the participating stakeholders must have some tool to make this kind of trade-offs possible. Web-Hipre contains several different ways of the preference elicitation (direct rating, weight elicitation, SMART and AHP) to balance the importance of the different criteria (attributes). The following screenshot exemplarily shows the direct weighting of the attributes “radiological data”, “logistics” and “costs”.

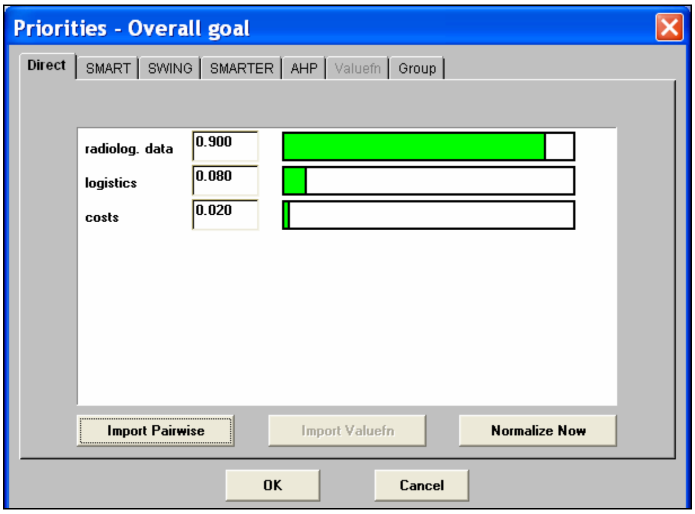


Figure 5: An example of the direct weighting of the higher level attributes "radiological data", "logistics" and "costs" of the value tree shown in Figure 3.

Once all the above steps have been carried out the results can be illustrated by choosing "Composite Priorities" from the "Analysis" menu. An example in Figure 6 shows a scoring of the seven strategies and proportion of the different criteria in the scoring. The figure indicates that, in this example, the strategy 7 is the most feasible with the used criteria and preferences given by the participating stakeholders. It also shows that radiological data was the dominating attribute in this analysis.

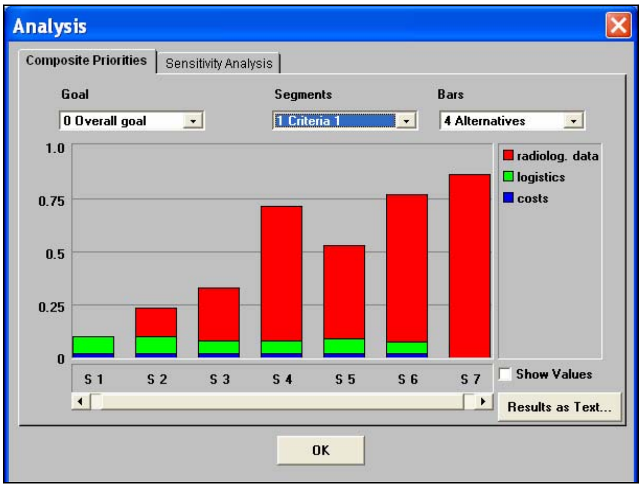


Figure6: Scoring of different strategies including relative importance of the selected criteria.

2.2.1.4 Sensitivity Analysis

It is possible to analyse the results with respect to their robustness by making a sensitivity analysis. That means analysis on how sensitive the results are to changes in values of the selected attributes. In Web-Hipre the sensitivity analysis can be done by changing the value of one attribute at time. This is an important feature because most of objective attributes in nuclear emergency situation contain remarkable uncertainties. Significance of the uncertainties can be studied with the sensitivity analysis. Figure 7 illustrates how sensitive the seven strategies of Figure 3 are against changes in costs of the countermeasures. With the selected weight of costs the strategy #7 has the highest score, but if the weight would increase the strategy #6 would be more feasible.

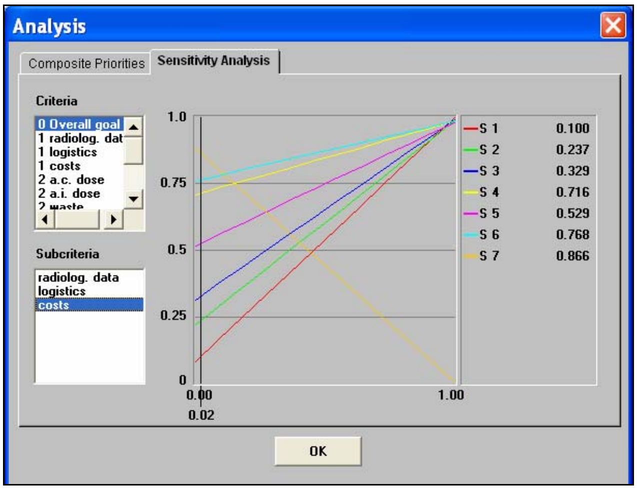


Figure 7: A screenshot of the sensitivity analysis of Web-Hipre.

2.2.1.5 Group decisions

In stakeholder workshops, several “decision makers” are structuring the problem solution and the decision analysis tool is used to find a consensus through discussion. In this way the whole group is one decision maker. Web-Hipre offers also another approach to find the final solution, so called *group decision process*. In this approach each of the participants makes his/her own decision analysis as a single person and saves the result in the system. The strategies have to be agreed before that and all the participants handle the same strategies. After that a group hierarchy must be created. Each of the participants is represented as an element of this hierarchy. These elements can be weighted with any weighting method available in Web-Hipre. In this way the participants are treated as “attributes” in the decision analysis. Also sensitivity analysis can be performed to see how sensitive the results of group are to changes in weights of different participants.

The evaluation software Web-Hipre was tested in a number of stakeholder workshops in six of the participating countries and the first experiences were positive. The participants welcomed this kind of evaluation tool which enables difficult trade-offs in relation to the emphasis given to public perception and political acceptability (so called subjective attributes) against more objective criteria, such as radiation health effects and costs. Especially Web-Hipre was recognised useful in later phases of a radiological emergency situation when stakeholders have enough time to make necessary preparations and to seek adequate support from their own organisations. It was also noticed that RODOS together with Web-Hipre can be utilised in training and in exercises where ‘what if’ scenarios can be exercised. It is also useful in emergency planning.

2.2.1.6 Provision of ESY functionality in ARGOS

The evaluation module VISA is more loosely integrated in ARGOS. An excel spreadsheet has been developed to act as a suitable interface between ARGOS and VISA.

2.2.2 Interviews and questionnaire based surveys of the operational emergency management processes in several European countries (WP2)

This work package is described in the Annex I of the Contract FIS5-2001-00113 as; ‘*The processes of management of nuclear emergencies will be surveyed and documented in four participating countries. Modern process modelling techniques will be used to produce a generic emergency management process model, which will be used for describing the emergency management processes in the UK, Belgium, Germany and Slovak Republic*.’

The objectives of this work package were defined as:

- to survey, document and compare the duties and emergency management processes in several countries;
- to define information and other support needs at various stages of the process;
- to study whether information and DSS may be used more effectively; and
- to identify differences between countries, understanding the structural reasons for these and to suggest practices which might be shared.

In order to fully explore the process models it is necessary to take different viewpoints, to emphasis different features. In EVATECH, two key aspects of the process models were chosen to explore, the structure of the model and the key activities involved. Each country’s model was considered for both of these aspects.

The structure of the process model relates to the layout. This is affected by the interaction between different areas (centres, institutions, government departments etc.) involved in the process model and their responsibilities. To explore emergency management structure, a network diagram for each country was used, which illustrate the interactions in the process model.

The aim through understanding emergency management processes and their differences is to better design DSS. Findings made in the four countries were discussed and the implications for future development of DSS were presented.

A key determinant of the process model layout is the different groups involved in the emergency management. The existence of different centres of activity, involved in the offsite emergency management, gives the model its interactions. These interactions relate to communication and the exchange of information.

The following provides a description of the key levels and areas involved in each of the four models.

- The Belgian emergency management has the Provincial level that implements the countermeasure decisions made by the Federal level. The related centres of activity are the Provincial Coordination Committee and the Crisis Coordination Centre of Government (CGCCR). The CGCCR consists of the Measurement Cell, the Evaluation Cell, the Socio-Economic Cell, the Federal Coordination Committee and the Information Cell.

- The German model has the State (Land) level responsible for the decision-making and implementation, and the Federal (Bund) level, which provides supervision and advice. The Federal level involves the Federal Ministry of Environment, Nature Conservation and Nuclear Safety (BMU) and the Federal Ministry for Radiation Protection (BfS) and the Federal Ministry of Interior (BMI). There is also the Integrated Measurement and Information System for the Surveillance of Environmental Radioactivity (IMIS), which is the federal measurement and information system. The IMIS has participants both on federal and state level and is overseen by BfS. The State level includes the Local Disaster Control Management (KatSL), the relevant State Authority (nuclear supervisory and radiation protection) with its affiliates and the relevant state authorities for disaster control (District Authority, State Ministry for the Interior (NMI)).

- The Slovak model has Local level that coordinates and implements the countermeasure decisions made by the National level, providing feedback to the National level. On the Local level there are the Civil Protection Crisis Staff of the County, the District and the Municipality (CSC, CSD and CSM). On the National level there are the Central Crisis Staff of the Slovak Republic (CCS) and the National Emergency Commission for Radiation Accidents (NECRA) working together. NECRA includes a group called the technical operations management group (ORS) who are sent to a support centre, the Emergency Response Centre (ERC) of the Nuclear Regulator (UJD). In the Slovak process model there is also a level referred to as Technical support and advice. The technical support and advice is provided by the ERC, the Slovak Radiation Monitoring Network (SORAMON) and Information Services.

- The UK model has a Local level, which focuses on the release and the offsite implications, and a National level, which focuses on the national and international level. The related centres of activity are the Local Emergency Centre (LEC) and the National Emergency Briefing Room (NEBR). Located close to the LEC is the Media Briefing Centre (MBC). In the UK process model there is another area referred to as Organisations sites, which relates to technical support, and activities coordinated by organisations headquarters and other centres.

All the models are organised with a national and local level activity. The Belgium model has Provincial and Federal levels, the German model has State and Federal levels, and Slovakia and the UK have Local and National levels. When discussing a single model these terms will be used; for the later comparison discussion we will refer to these levels as Local and Federal/National levels.

One of the main differences in the models is how the responsibilities are distributed. In order to explore the responsibilities for each country, there is a short description of the process and then a table discussing the responsibilities for each of the following activities, which have been identified as the key activities involved in the models.

- Monitoring
- Assessment and Technical support
- Evaluation/Recommendation/Advice
- Decision-making
- Implementation of countermeasures
- Communication to public and media
- Communication internationally

There are two types of communication and interaction in the process models; firstly communications and interactions between the responsible agencies involved in the process, and secondly there is communication and interaction between these and the public, media and internationally.

To explore the communication and interactions the linked deliverables in the process models, which indicate communication and interactions have been considered. In addition, to provide a richer picture, the whole process models have been studied to find other interactions, and input from the other EVATECH participants has been used.

In order to make the emergency management processes easier to understand, the different main activities were categorised (Table 1). The categories are; providing information, assessment, support and advice; providing the countermeasure decision; coordinating the provision of information to the public and media, and internationally; and implementing countermeasures and providing feedback.

The first category is the support network to provide information, assessment, advice and supervision to those making decisions and those implementing countermeasures, ensuring everyone involved in the emergency management has the information available. The distinction between assessment and advice can be explained considering the four levels of decision support acknowledged by RODOS . In this case assessment is the provision of data, forecasts and the analysis of consequences (relating to Level 0 – 2 in RODOS) and advice is the suggestion of countermeasures based on evaluation of consequences (relating to Level 3 in RODOS).

The countermeasure decision links the communication between those making the decision and those implementing it, where appropriate. The third category relates to the coordination of the information and communication to those outside of the emergency management structure. Those providing information to the public and media, and internationally will need to collaborate and communicate with those involved in the emergency management, in order to provide both up to date information and a coherent message. The final category relates to the implementing of countermeasures and providing status reports to others.

Table 1: Categories and activities in modelling of off-site emergency management

Providing information, assessment, support and advice
Site technical information
Monitoring results
Liaison and requesting information
Assessment and technical support
Advice
Supervision
Providing the countermeasure decision
Countermeasure Decision
Coordinating the provision of information to the public and media, and internationally
Information and collaboration to provide communication to the public and media, and internationally
Information to the public and media, internationally
Implementing countermeasures and providing feedback
Implementing countermeasures
Status reports and giving feedback

2.2.2.1 The Belgian Model structure

The main decision making centre is the CGCCR; the Provincial Coordination Committee will follow plans and advice to coordinate and implement the countermeasures.

The CGCCR is made up of 4 cells and a coordination committee.

- *Measurement Cell* - The Measurement Cell will coordinate all of the activities related to the gathering of field radiological information.

- *Evaluation Cell* - The Evaluation Cell will evaluate the installation status and its estimated time evolution in order to assess the real or potential impact of the event. They will advise the Federal Coordination Committee on the actions needed to protect the population and the environment.

- *Socio-Economic Cell* – The Socio-Economic Cell will advise the Federal Coordination Committee on the consequences of the decisions made or to be made. They will also advice the Federal Coordination Committee on the follow up of decisions in affected sectors.

- *Information Cell* - The Information Cell will coordinate the communications with the media, international organisations (IAEA, EC) and neighbouring countries. The content of the information is determined in consultation with the Federal Agency for Nuclear Control (FANC).

- *Federal Coordination Committee* - The Federal Coordination Committee is the official lead in the emergency management. They will decide upon the countermeasures on the basis of advice from the Evaluation Cell and the Socio-Economic Cell.

In the vicinity of the accident the Provincial Authority will set up a *Provincial Coordination Committee*, led by the Governor of the Province to implement countermeasures.

The NPP will provide technical and predicted offsite radiological impact information to the CGCCR, and control the onsite situation.

If an accident requires urgent and immediate protective measures for the population, the emergency management process changes. In this case the NPP will alert the Governor of the Province who will implement “reflex actions” before the CGCCR is formed. When the CGCCR is formed they will take over the emergency management, reverting to the normal process.

Table 2: Responsibilities in the Belgian off-site emergency management.

Responsibilities	**Belgium**
Monitoring	The Measurement Cell coordinates the Monitoring.
Assessment and Technical support	The Evaluation Cell provides assessment and evaluation.
Evaluation / Recommendation / Advice	The Evaluation Cell provides evaluation and recommendations. Socio-Economic Cell provide an economic and social evaluation of countermeasures
Decision-making	The Federal Coordination Committee makes the countermeasure decisions.
Implementation of countermeasures	The Provincial Coordination Committee implements the countermeasures.
Communication to public and media	The Information Cell coordinates the communication to the public and media.
Communication internationally	The Information Cell coordinates the international communication.

2.2.2.2 The German Model structure

As Germany is a federal system the emergency management might differ, depending on which Land (State) is affected by a nuclear emergency. Independend of this it consists of both disaster control and radiation protection and hence involves authorities for both. The process modell used is based on the situation in 2003 in the State Lower Saxony (Bundesland Niedersachsen), which is subdivided in districts, which are further divided in areas.

In the emergency phase there is one decision-making centre KatSL, set up and coordinated by the affected Area Authority. At KatSL there will be local representatives and experts to make decisions. They will receive information and prognosis both from the NPP and other radiation protection expert advisors (the State Agency for Ecology (NLOe), the German Weather Services (DWD), Technical Supervisory Authority (TÜV)). They will also have access through the NLOe to the environmental monitoring data and information in IMIS, run by BfS, with data provided and entered by several organisations.

The relevant District Authority will provide assistance and supervision to the affected and other Area Authorities in the district. It will also provide information to the State Ministry of Interior (NMI), who informs the Federal Ministry of Interior (BMI). On the federal level BMI and BMU will liase.

The State Ministry of Environment (NMU), acting as State Authority for Radiation Protection and nuclear supervisory authority, will receive information from the KatSL and assessment from the NLOe and provide information to BMU. The NMU evaluates the situation and supervises the area level. In the recovery phase NMU will coordinate the recovery activity and implement the countermeasures in the State.

The BfS RODOS centre will provide assistance to the NLOe and will provide information and assessment to BMU. In the emergency phase BMU will evaluate the situation and supervise, in the recovery phase it will provide recommendations to NMU. If appropriate, in either phase, BMU will get advice from the radiation protection advisory board (SSK) and the nuclear safety advisory board (RSK). BMU will inform the public and is competent authority for international information.

Table 3: Responsibilities in the German off-site emergency management.

Responsibilities	**Germany**
Monitoring	Several Federal agencies and ministries, and NLOe conduct monitoring, and BfS have the responsibility for the data transfer system IMIS.
Assessment and Technical support	NLOe provide prognosis and recommendations to KatSL. If necessary BfS provide technical support to the NLOe.
Evaluation/ Recommendation/ Advice	Experts at the KatSL provide recommendations. BfS provide evaluation to BMU. If appropriate advisory boards SSK and RSK will form to provide advice to BMU. The former particularly provide advice in the emergency phase if it is a large-scale event needing Federal management. BMU provide recommendations to NMU in the recovery phase.
Decision-making	The KatSL coordinate decision making in the emergency phase. NMU coordinate decision-making in the recovery phase.
Implementation of countermeasures	KatSL coordinate the implementation of countermeasures in the emergency phase. NMU coordinate the implementation of countermeasures in the recovery phase.
Communication to public and media	The State inform the public in the State. The Federal level inform the general public and the media.
Communication internationally	BMU inform the EC, IAEA and neighbouring countries according to agreements. The State also has specific bi-lateral agreements with their neighbours, which they fulfil.

2.2.2.3 The Slovak Model structure

The NPP will provide notification and initiate the emergency response structure (ERO), which involves the initiate of an NPP emergency commission and the ERC of UJD. There are two phases of ERO activity onsite, in the first phase the shift supervisor will take control until the NPP emergency commission is set up, for the second phase. The NPP will also provide advice on countermeasures to the CSC, CSD & CSM and UJD.

CCS & NECRA will assemble to provide coordination of the emergency management. They will send the ORS group, who provides common advice to CCS&NECRA, to the ERC of UJD. The coordination and advice from CCS & NECRA will continue throughout the process.

The CSC, CSD & CSM are responsible for implementation. In the threat phase they will prepare for a potential release, evaluating the situation and informing local population. In the early, intermediate and late phase they will implement countermeasures under the advice of CCS & NECRA and the NPP, with assistance from UJD and government ministries.

In all of the phases there will be technical support and advice. The ERC at UJD will provide an overall assessment and technical support; they work closely the ORS group of NECRA to assist in the preparation of advice for CCS & NECRA. There will be meteorological and radiological information from the Slovak Hydro-meteorological Institute (SHMI) who are responsible for SORAMON and there will also be coordination of the Information Services from NECRA, UJD and all government ministries.

Table 4: Responsibilities in Slovak off-site emergency management.

Responsibilities	**Slovakia**
Monitoring	SORAMON coordinates the monitoring.
Assessment and Technical support	The UJD staff at the ERC provide technical support for the ORS group, performing technical analysis.
Evaluation/ Recommendation/ Advice	The NPP provide the first evaluation, recommendation and advice to CSC, CSD & CSM and UJD. UJD at the ERC provide an overall situation report to CCS & NECRA and the CSC, CSD & CSM. The ORS group provide common advice to CCS & NECRA.
Decision-making	CCS & NECRA coordinate the decision-making and provide a recommendation to the CSC, CSD & CSM.
Implementation of countermeasures	CSC, CSD & CSM implement countermeasures in cooperation with UJD, Ministry of Interior and Ministry of Health.
Communication to public and media	CSC, CSD & CSM communicate to the local population. Information services coordinate the communication from CCS & NECRA, UJD and all government ministries.
Communication internationally	UJD coordinate the communication to international organisations.

2.2.2.4 The UK Model structure

In the emergency phase, when an offsite release in the UK is declared, the police will establish the LEC and organisation with offsite responsibilities will be called to the LEC (Local Emergency Centre). At the LEC the police are the ultimate decision makers in the emergency phase. There will be a Government Technical Advisor (GTA) assigned by the Department of Trade and Industry (DTI) to provide independent and authoritative advice. The police will receive advice from the GTA and the representatives and groups at the LEC. There will be two advisory groups established at the LEC, the Joint Health Advisory Group (JHAG) and the Recovery Working Group (RWG).

The police will also set up the MBC (Media Briefing Centre) usually at or close to the LEC; the MBC will coordinate the communication to the public and media and work closely with those at the LEC.

The DTI will activate arrangements as a precautionary measure, setting up the NEBR and informing other central government departments. In an emergency, representatives from the central government departments will be called to the NEBR.

The organisations with representatives at the LEC and the NEBR will also set up emergency rooms and technical centres, to provide back up and technical information for the representatives, Organisations sites.

There will be offsite environmental monitoring; the operator will be the first to carry out local monitoring and subsequently national bodies with their own statutory requirements will undertake their own monitoring. The National Radiation Protection Board (NRPB) will coordinate any additional environment monitoring resources. The Primary Care Trust (PCT) will coordinate the people monitoring with NRPB assistance. Organisations will be providing information to the public and media as part of their remit, in particular the Environment Agency (EA) will produce advice on public drinking water supplies and the Food Standards Agency (FSA) will produce food restrictions.

In the recovery phase the police and the Local Authority (LA) will organise the hand over of control to the LA; in the recovery phase the LA are the ultimate decision makers. There will be strategies for remediation and for health treatment. Eventually, organisations will retreat to their own headquarters and will become involved as and when necessary.

*Table 5: Responsibilities in UK off-site emergency management**.

Responsibilities	**UK**
Monitoring	The NPP and organisations conduct their own environmental monitoring and NRPB coordinate the additional environmental monitoring. There is also the Radioactive Incident Monitoring Network (RIMNET), which monitors radioactivity at fixed sites around the country. This is available, through terminals, at the LEC, NEBR and organisations technical centres and headquarters.
Assessment and Technical support	Organisations sites provide assessment and technical support to their representatives at the LEC and NEBR.
Evaluation/ Recommendation/ Advice	Organisations' representatives provide evaluation and advice at the LEC and NEBR. At the LEC there are also two working groups, which provide advice and evaluation the RWG and JHAG. At the LEC there is a GTA present to provide independent and authoritative advice to the police, from the advice of the representatives and groups.
Decision-making	The LEC is the strategic centre involved in decision-making; in the emergency phase the police are the ultimate decision makers and this passes to the LA in the recovery phase.
Implementation of countermeasures	The relevant local bodies implement countermeasures on the advice of the LEC.
Communication to public and media	MBC coordinate the communication to the public and media. Organisations' own Headquarters will also communicate directly to the public.
Communication internationally	NEBR conduct international notification and information.

* This broad structure is followed for UK accidents

The following Table provides an illustration of where the main responsibility for task lies, either on a Local and/or a Federal/National level. Though this may over simplify the real world situation, making no distinction between the phases[1] or the scale[2], it shows that there

[1] In Germany there is a clear distinction, as the disaster control (general) is governed locally or by the state, whereas the federal level is much more involved in radiation protection measures.

are indeed differences present in the different countries approaches to emergency management.

Table 6: - Summary of Responsibilities

Responsibilities	**Belgium**	**Germany**	**Slovakia**	**UK**
Monitoring	Federal	Federal & State	National & Local	National & Local
Technical support	Federal	Federal & State	National	National & Local
Evaluation / Recommendation / Advice	Federal & Provincial	Federal & State	National & Local	National & Local
Decision-making	Federal	Local/State, State/Federal	National	Local & National[3]
Implementation of countermeasures	Provincial	Local/State	Local	Local
Communication to public and media	Federal & Provincial	Federal & State	National & Local	National & Local
Communication internationally	Federal	Federal & State	National	National

2.2.2.5 Differences in the emergency management models

In considering the differences between the models it seems that the networks of involved organisations can be summarised by two general networks. Figure 8 illustrates these two general networks observed, the first referred to as *Centralised Decision Making and Evaluation* and the second *Interaction between two levels*. These models are derived from the observations that

1. The Belgian and the UK models are similar in that they have one main decision making centre, at which there is evaluation and advice from different cells or groups.

2. The German and Slovak models are similar having a lot of interactions between the Federal/National and Local level.

[2] The scale of an event will dictate how many different states, provinces or local areas are affected, hence involved in the local emergency management

[3] Decision making on food countermeasures is taken nationally

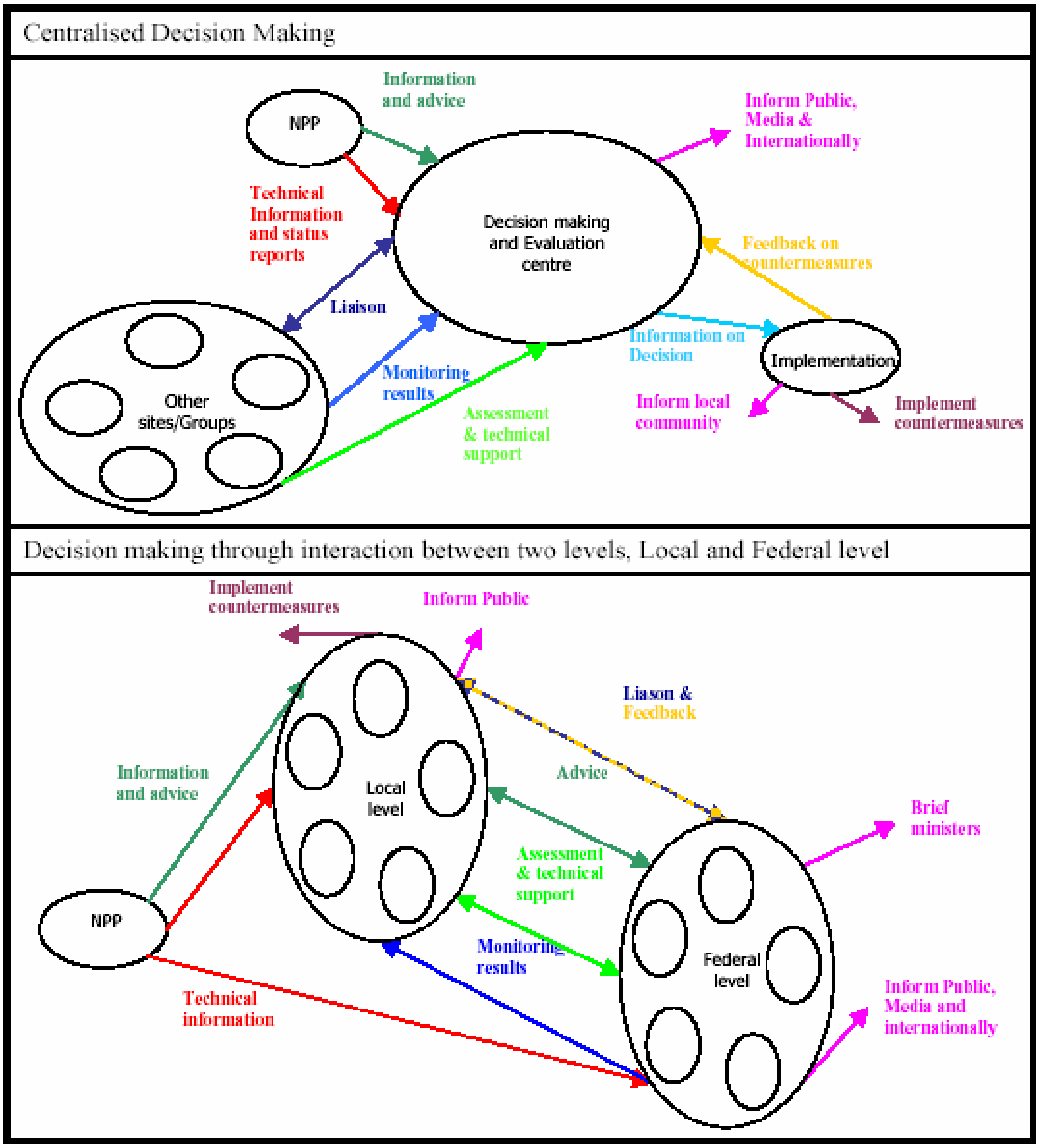


Figure 8: Network diagrams representing two different generic models of emergency management.

These two networks are presented to highlight the difference in the structures and do not necessarily form a true representation of any of the discovered processes.

If we first consider the *Centralised Decision Making and Evaluation*, this shows a centre that receives information and advice from the NPP and information and support from potentially several other sites in order to evaluate the situation and make decisions. The decisions made are given to an implementation centre, team or organisation who implement the countermeasures and provide feedback on the process. The main group will be providing information to the public, media and internationally, or possibly giving the relevant information and support to another centre or organisation.

For the Belgian model, the main centre is the Crisis Coordination Centre of Government (CGCCR). The other sites providing support include the Measurement Cell providing monitoring information. There may also be other sites supporting the main centre, such as the Association Vinçotte Nuclear (AVN) Headquarters Emergency Centre (HEC). Also if the Socio-Economic cell is not called to the CGCCR the members will be contacted at their organisations for information and evaluation. The implementation group is the Provincial Coordination Committee.

For the UK model, the main centre is the Local Emergency Centre (LEC). The other sites include all the organisations sites providing support and the National Emergency Briefing Room (NEBR). The implementation is coordinated by members of the LEC. Informing the public and media is coordinated by the Media Briefing Centre (MBC) who have close liaison with the LEC, and the NEBR informs international organisations.

In the consideration of these two models we observe that an important difference in this approach may be the number of organisations sites and other groups involved. In both models it is seen that there are clearly established links between the main centre and these other sites, often through the organisations' representative at the main centre. Hence, it can be considered that having more organisation sites involved does not necessarily increase the complexity of the coordination, if well managed, as it is a different individual or group responsible for each of the interactions, not through one communication channel. In both models it is also seen that there are close links and collaboration between the decision-making and the communication, either through the MBC or the Information Cell.

The *Interaction model* shows two levels working on the emergency management with regular liaison, advice, assessment and technical support, monitoring results and feedback between the two levels. The NPP will provide technical information and advice on the implementation of countermeasures to the local level. The Federal/National level may receive this technical information directly from the NPP or via institutions or authorities at the local level. The Local level will implement countermeasures and inform the local public. The Federal/National level will brief ministers and inform the public, media and internationally.

For Germany the Local level make decisions and the Federal level supervise and provide assistance and advice. In the Slovak model the National level is making the countermeasure decisions and the Local level coordinate the implementation. In both these models there may be different local centres set up for different areas within a region and there are also higher-level centres involved. It seems in both models there is a lot of structured communication and appropriate redundancy in the communication channels.

If we consider both networks, they are a high level abstraction of the potential interactions, and contain speckled ovals, which represent a possible high number of groups or organisations interacting. Both networks show the majority of the same types of interaction, on this high level, technical information, information and advice, liaison and feedback, monitoring results, assessment and technical support, and information to the local public, media and internationally.

The centralised model needs a good communication network to get information to the main decision-making centre. Within the main centre there is more flexibility and communication and meetings between different groups, liaison representatives and the whole centre can be arranged as appropriate. The two-level model, will probably have many interactions both within the Local and Federal/National level and across the two. Usually this will need a more robust communication network throughout the emergency management. The latter model may also need more abundant communication channels than the centralised model due to more communication across centres and sites.

2.2.2.6 Use of decision support systems

Regarding information and decision support, the conclusion was that although there are different organisational structures the models share common main activities and, although these may be approached differently, they have similar information and support needs. When exploring the use of DSS in the process models the following points arose;

- Currently it is technical experts and not decision makers that use the DSSs in the processes; this raises a couple of issues. Firstly, it needs to be ensured that there is sufficient emphasis given to the uncertainty when experts interact with DMs. Secondly, the level 3 supports (evaluation of countermeasure strategies) that the DSS provides needs to be incorporated into the emergency management process. In line with the findings from the national EVATECH workshops, (see EVATECH(WP4)-TN(04)-08) the conclusion was that although decision conferences may not always be appropriate in the emergency phase they could be useful to support decision making in the recovery phase.

- In a complex unanticipated emergency the models within a single DSS may not immediately provide all the information that is required. For this reason, there is the need to enable the results of other models or ad hoc calculations to be assimilated into the DSS model chain and database.

- For the implementation of countermeasures, there is the need to explore the interface between the DSS available and implementation registers. A long-term vision for RODOS and ARGOS may be to incorporate an implementation register.

- There has been work on communication between organisations involved in emergency management, for example the MODEM project provides standards and technology for communication internationally. There is also recognition in all the processes that there is a need to have good public relations. Now there is a need for DSS to focus on communication with the public and providing ‘simplified’ easily comprehensible plots.

2.2.3 Methodologies for conduction scenario-focused workshops (WP3)

The objectives of this work package were written as follows:

- To improve planning and communication methods, especially for the early phase of an accident

- To enhance negotiation methods for the later phase of an accident

- To gain experience on countermeasure evaluation systems developed in the project

International organisations have for many years recommended that key players, e.g., authorities, expert organisations, industry, producers of foodstuffs and even 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.

According to the decisions taken in the contractors' meeting in November 2002 a training seminar on facilitated workshops was arranged at STUK in 12-14 May 2003. The Objective of the seminar was to train people to facilitate the workshops that were to be arranged in all the seven countries participating in the EVATECH project. The seminar dealt with basics of radiation protection, principles of intervention in nuclear or radiological emergencies, off-site protective actions in nuclear accidents, decision analysis principles, evaluation tools developed for aiding decision making, and practical guides for facilitating workshops in which protective actions are planned. Seventeen experts from all the seven EVATECH countries attended the seminar.

One of the main objectives of EVATECH is to develop an evaluation software for the decision support systems RODOS and ARGOS to rank various countermeasure strategies in an event of nuclear or radiological emergency. The seminar exposed experts from all countries participating in EVATECH to this type of evaluation tool and to how to conduct-facilitated workshops using these tools. The trained experts were supposed to facilitate their national workshops in the later part of EVATECH project.

In the seminar participants were acquainted with techniques and methodologies for conducting facilitated workshops. The seminar dealt with issues in emergency management, procedures for running facilitated workshops, multi-attribute decision models and the use of evaluation software. The hands-on evaluation exercises trained the experts and facilitators from each participating partner in EVATECH to conduct scenario-focused workshops in their own countries. The national workshops held in the work package 4 of the project focused on later phase countermeasures in an inhabited environment.

The seminar was arranged by the Finnish Radiation and Nuclear Safety Authority (STUK) in close co-operation with the Helsinki University of Technology (HUT), a subcontractor to EVATECH. Lecturers came, in addition to these organisations, from the Manchester Business School (MBS) and the National Radiological Protection Board (NRPB) in UK.

Most of the participants were experts on radiation protection and/or emergency management and few participants represented decision analysis society. That is why the programme covered the both disciplines, radiation protection and decision analysis. The main emphasis was however in decision analysis techniques and in tools used for facilitating of decision workshops or meetings where stakeholders representing different interest groups try to find the best solution(s) to a given problem.

The programme contained lectures on radiation protection, decision analysis, decision analysis techniques and on recovery actions in inhabited areas following a nuclear emergency. Special attention was paid to how to conduct facilitated workshops by exercising planning of early phase protective actions in an inhabited environment.

The first lecture, given by Dr. Raimo Mustonen, dealt with the basics of radiation, health effects of radiation and radiation protection and principles of intervention in an event of nuclear accident to protect the public. It was concluded that this type of introduction to radiation protection issues might be necessary in the facilitated workshops where representatives from different walks of life are required to prepare protective actions in a radiological emergency situation. It was assumed that stakeholders not familiar with radiation protection issues would need some basic information about the principles of radiation protection and harmful effects of radiation in a radiological emergency situation.

Decision analysis was introduced by Prof. Raimo Hämäläinen who crystallized the decision making problem by saying that "Decision making is what you do when you are not sure what to do". Different types of decision making were briefly introduced (intuitive, programmed and analytical) and then different methods of analytical decision making process were dealt more detailed. Also societal branches where decision analysis for planning has been applied most frequently were discussed (resource management, energy policy, environmental issues, etc.). One important message of the presentation was that when decision analysis is utilised there is not always a single right decision - there can be several good ones.

Formats of the facilitated workshops and tips and tricks for running meetings were presented by Prof. Simon French. This presentation was especially designed for those participants who were planned to facilitate the national workshops in WP4 of EVATECH. The presentation focused on practical pieces of advice to facilitators in order to make a facilitated workshop successful. The main message to facilitators was to focus on the process of the facilitated workshop, not on the content of the problem. A Facilitator has a specific role and tasks in driving the meeting but he/she should not lead the process and discussion. In facilitating of the meeting, the facilitator can utilise specific decision aiding tools in formulation of the problem, creation of the strategies and attributes and in making the overall problem understandable and visible to the participants.

The facilitated workshop on handling of contaminated milk, held in Finland in 2000, was introduced as a hands-on exercise of the use of facilitated workshops after a nuclear accident. 14 representatives of farming, food industry and radiation safety and rescue authorities attended the workshop aiming at finding the most practicable solution on how to handle the contaminated milk. A decision analysis tool Web-Hipre was used in the exercise, the same tool which was decided to implement also in the RODOS system.

Web-Hipre (Hierarchial Preference Analysis in the World Wide Web) was introduced to the participants by Prof. Hämäläinen who originally had designed the software. A special web-site (http://www.evatech.hut.fi/training) was established before the seminar and a e-learning possibility to study Web-Hipre and theory of decision analysis was offered to the participants.

Introduction to clean-up actions in urban environment after a nuclear accident was given by Dr. Joanne Brown. She presented the international guidance for countermeasure criteria in events of nuclear accident and the strategic approach taken in preparing the Recovery Handbook for Response to Radiation Incidents in the UK. The presentation gave an excellent overview of the complexity of problem faced by the decision makers in nuclear emergencies.

The accident scenario to be used in the Finnish workshops in WP4 of EVATECH was introduced by Mr. Michael Ammann. This scenario was also a template for accidents to be dealt in other national workshops in EVATECH. The accident at a Finnish nuclear power plant was assumed to start from a fire in the electrical cabinet leading finally a hydrogen combustion and a large release of radionuclides into the environment. Precautionary evacuation of population in the nearby areas was implemented during the threat phase. The national workshops focus on clean-up actions in inhabited areas one week after the accident. Objectives of the workshops were to test the decision aiding tools and to expose different stakeholders to working routines of facilitated workshops. The accident scenarios were selected to be comparable in order to find out similarities and differences of the countermeasures decided in the workshops.

At the end of training seminar, a hands-on exercise was arranged for the case of clean-up actions in an inhabited environment. The participants were divided into small groups to discuss the potential countermeasures, one participant facilitating the discussion.

The general conclusion from the seminar was that, after the seminar, the trained experts were capable to conduct their national workshops to be arranged as a part of work package 4 of EVATECH.

Perhaps one of the most important results was that some of the participants realised the meaning and aims of such kind of facilitated workshops for the first time. Some participants also acquainted themselves with decision analysis and with evaluation tools developed for facilitated workshops for the first time. Because the participants were those who will conduct the national workshops later in the project, it was important that they were all exposed to these issues.

After the seminar those participants who were nominated as facilitators in their own national workshops were competent enough to conduct the workshops. The seminar gave a lot of background material for decision analysis and guidance on facilitating workshops, which together with a possibility to use the e-learning technique through the seminar web-site offered good capabilities to the facilitators to manage the national workshops.

All the material prepared for the training seminar and/or presented at the seminar are available at the web-site; http://www.evatech.hut.fi/training.

2.2.4 National scenario-focused workshops (WP4)

The objectives of this work package for the second year:

- 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 explore how uncertainty could be incorporated in decision making
- To identify the forms of strategy that relevant organisations wish to consider

The work package 4 dealt with the facilitated workshops on clean-up actions in an inhabited area after a nuclear accident. Background material for the workshops was prepared by STUK and distributed to all participants. Following a release of radioactivity that results in contamination of the environment, an appropriate protective response would be required. During the release, and until the source of the release had been brought under control, emergency countermeasures might be required to protect the public from short term, relatively high exposures to radiation. In the longer term, or recovery phase, a response strategy would need to be developed with the two aims of protecting people from continuing exposure and of enabling lifestyles and economic activity to return to normal. Since radioactivity can be measured down to levels well below those that pose a significant health hazard, it is unlikely that it would be a practical goal to remove from the environment all measurable radioactivity resulting from the accident. Therefore a balance would need to be struck between the desire to reduce exposures and the need to conserve resources and enable an area to return to normality, albeit not necessarily quite the same 'normality' as existed before the accident.

The objectives for the workshops were:

- to identify and verify the factors driving decision making in a radiological emergency situation;

- to explore the information needs of all parties involved in decision making at the workshop;

- to identify the forms of strategy that relevant organisations wish to consider for recovery in inhabited areas,

- to clarify the needs in further improvement of the evaluation tools of RODOS and ARGOS decision support systems.

The workshops were facilitated by those experts who were trained at the seminar arranged in WP3. Practical arrangements of the workshops were discussed in the training seminar of WP3 in May 2003 in Helsinki and later in the DSSNET meeting in Cracow in July. Input data for the source term of the accident was distributed to the partners by STUK. The need to arrange an introductory meeting (3-4 hours) for the participating stakeholders before the actual workshop was also discussed. It was strongly recommended that such a pre-meeting should be organised but the decision was left to the national person in charge of the project. Nine national workshops were organised between November 2003 and May 2004.

The EVATECH partners in Crakow agreed that STUK would prepare a template for reporting the results and conclusions of the discussions held in the national workshops in order to facilitate the final conclusions of all arranged workshops. It was distributed to partners. The workshops were reported as deliverables of the project [deliverables 15-21]. An additional report was also produced to summarise the experiences in different workshops [deliverable 13].

2.2.4.1 The workshops

Within this context, nine facilitated workshops were arranged in the countries participating in the EVATECH project, three workshops in the UK and one in the other countries; Belgium, Denmark, Finland, Germany, Poland and Slovak Republic. The workshops were run to understand the information and decision support needs of decision makers a few days after a radioactive release from a nuclear accident when considering the choice and implementation of recovery actions in inhabited areas. Some remarks on the workshops are given in the following text. The workshops are described in more details in the Deliverables 15-21 (References 6-12) and in the summary report in Ref. 13.

The original intent was to use the same accident scenario for all workshops with the 'footprint' of the accident being transposed onto nuclear sites in each country. The original aim was also to select the accident sites in different countries so that the populations affected by the accident would be comparable. However, in some countries the scenario was changed to be more appropriate for the scale of accident that decision makers were likely to have to manage or to address the sensitivities of the nuclear operators. This means that direct comparisons of the selected countermeasures in different countries cannot be made. However, the exercises were very useful for the identification of the needs of the participating stakeholders, the values that drive the decision making process and discussion of issues.

The accident scenario for the workshops was applied to nuclear power plant sites in each country. In addition, the UK also applied the scenario to a nuclear submarine base to address issues with the accident occurring close to a densely populated inhabited area. In Poland, the scenario was based on the Swierk Centre nuclear research reactor. To show the differences in the scenario used in the different countries, Table 1 summarizes information about the exercised scenarios and levels of maximum individual doses in the investigated areas. The doses are not directly comparable since they are assessed for different time periods and some of them are estimated for normal living conditions and some others for staying outdoors. The table also shows the number of participants in the workshops.

Table 7. General information about the accident scenarios used in the workshops.

Workshop	**Number of participants** *)	**Accident facility**	**Maximum doses**
Portsmouth, UK (UK1)	31	Nuclear-powered submarine	~ 2 mSv / 1st year normal living (20mSv / 1st year Outdoor)
Hartlepool, UK (UK2)	15	Nuclear power plant	2 mSv / 1st year normal living (20mSv / 1st year Outdoor)
Sizewell, UK (UK3)	13	Nuclear power plant	2 mSv / 1st year normal living (20mSv / 1st year Outdoor)
Unterweser, Germany (GE)	13	Nuclear power plant	~ 30 mSv/month
Swierk Centre, Poland (PO)	13	Nuclear research reactor	~ 500 mSv/lifetime
Copenhagen, Denmark (DK)	10	Nuclear power plant	~ 100 mSv/a
Mochovce, Slovak Republic (SK)	21	Nuclear power plant	~ 250mSv/lifetime
Dorango, Belgium (BE)		Nuclear power plant	~ 100 mSv/a
Loviisa, Finland (FI)	13	Nuclear power plant	~ 50 mSv/a

*) Facilitators and assisting personnel not included

The workshop participants represented relevant stakeholders in all countries. Most of them were experts or advisers preparing decisions for real decision makers in this kind of emergency situations. The following stakeholder groups were represented in most of the workshops:

- Ministries of interior, public health, environment, economy, defence
- Provincial governments
- Affected cities
- Environmental protection and soil management
- Waste management
- Consumer services

- Police
- Rescue services
- Nuclear power companies
- Radiation protection authorities
- Nuclear safety authorities
- Health authorities
- Defence forces
- Food control
- Local government and agencies

The workshops were facilitated by the experts trained in the earlier phase of the project. The facilitator was assisted by an analyst, who made analyses with the available decision support system (RODOS or ARGOS) and/or presented analysis results calculated beforehand. Also other assisting persons were present in many of the workshops (e.g. technical expert and secretary).

The facilitator is a key person in this kind of discussions. His/her role is important and demanding because a facilitated workshop is an interactive event. The facilitator is not a chairperson or a group leader. He/she should not share the problem and should concentrate on the process, not on the content, which is left to the participants. The facilitator is a person raising issues neutrally and asking simple questions to ensure that all have understood the points being made.

The RODOS system was used to produce the necessary information about the accident consequences and demographic data in six of the participating countries. The ARGOS system was used only in Denmark. The Decision analysis software Web-Hipre was used with RODOS to make an evaluation of the clean-up strategies. The Decision analysis software, VISA, was available in the Danish workshop but formal evaluation of strategies was not carried out due to time constraints.

2.2.4.2 Clean-up strategies

The aims of the workshops were to develop methods for stakeholder involvement in exercises, to verify the factors driving decision making, and to explore the information needs of the participating stakeholders. The intention was also to explore how uncertainties could be incorporated in decision making. The workshops helped people explore the types of strategy that they may wish to consider having taken into account a range of factors likely to drive the decisions. They only came up with preliminary options, i.e. a first attempt and it has to be recognised that these were just for this scenario and not a general conclusion.

The first task was to identify what criteria or values should be taken into account when evaluating the feasibility of clean-up actions in different areas. In all workshops the contaminated areas were broken down into sub-areas according to the contamination patterns. Each participant had an opportunity to express what criteria and values would drive his/her choices between different possible clean-up actions. These criteria varied from hard economic values to more soft personal preferences and social/political values. However it was interesting to see that almost the same values were discussed in all the workshops. The list of the criteria and values (attributes) discussed is summarised below. It should be noted that some criteria were given different names in different workshops.

- Health, radiation doses
- Comparison with doses from natural radiation
- Safety – worker safety, public safety, children
- Costs
- Compensation
- Logistics
- Practicality and feasibility
- Resources
- Leadership
- Timescale
- Benefit
- Political acceptability
- International issues
- Public reassurance and trust issues
- Equity
- Socio-psychological consequences
- Convertibility in the future
- Waste disposal
- Effectiveness
- Environmental conservation
- Protection of animals
- Extensive monitoring
- Extensive public communication
- Food production and safety

The next step was to identify appropriate and effective actions for the clean-up of the contaminated inhabited areas. A lot of technical actions were introduced in the information package provided beforehand and several additional actions were discussed in the workshops. Table 8 shows the actions which were investigated in more detailed in the workshops. Relocation is included in this list because in some scenarios people were temporarily relocated from the most contaminated areas and there was a need to continue relocation during the cleaning these areas or it was considered as an additional requirement while clean-up was implemented. In most of the cases people had also been sheltered during the passage of plume and/or iodine prophylaxis had been implemented. The stakeholder panels also discussed about the importance of extensive public information and food countermeasures and these were considered in several of the workshops.

Table 8. Investigated actions in the national workshops.

Investigated actions *)	**Workshop**								
	UK1	**UK2**	**UK3**	**GE**	**PO**	**DK**	**SK**	**BE**	**FI**
Relocation	X	X	X	X	X		X	X	X
No actions	X	X	X	X	X			X	X
Grass cutting	X	X	X	X	X		X	X	X
Soil removal	X	X	X		X	X	X	X	X
Ploughing	X	X	X		X		X	X	
Fire-shooting	X	X	X	X	X	X	X	X	X
Vacuum sweeping	X	X	X		X	X	X	X	X
Road planing	X	X	X	X	X	X		X	
Tree removal	X	X	X	X	X			X	X
Cleaning interiors	X	X	X		X	X	X	X	
Sandblasting building	X	X	X		X			X	
High pressure hosing	X	X	X	X	X	X	X	X	X

*) Emergency countermeasures (sheltering, and iodine prophylaxis) and food countermeasures not included

After discussion, the stakeholders found a consensus about the attributes to be taken into further discussion. The attributes were classified according to their mutual importance and lower level attributes were grouped under relevant higher level attributes, where appropriate. In this way the workshops developed the value or attribute tree for the evaluation. Figure 9 shows an example of the value trees developed in one of the UK workshops.

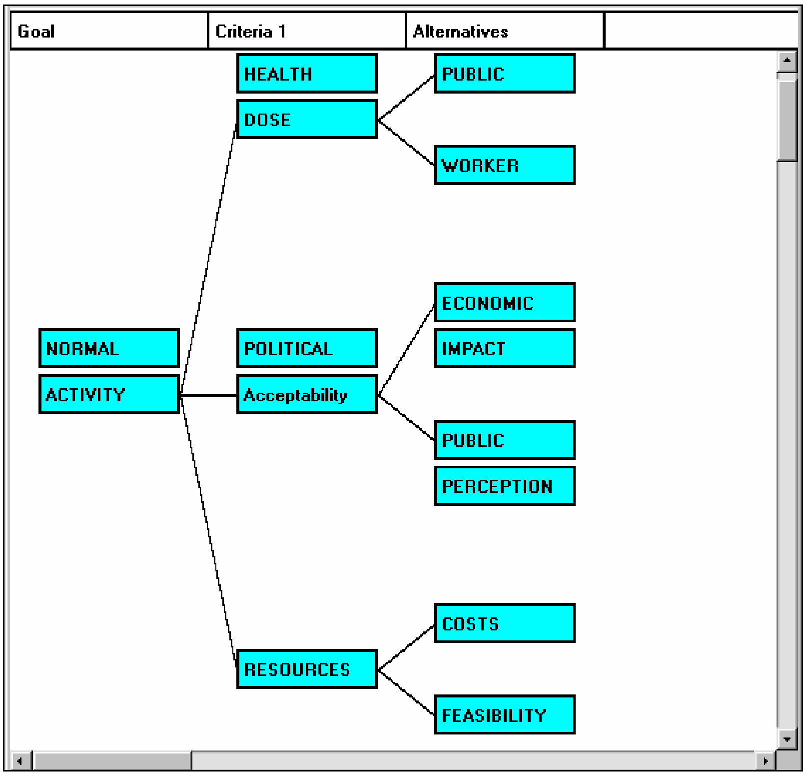


Figure 9: A typical value tree developed in the EVATECH *workshops.*

The next step was to identify combinations of different clean-up actions for each of the identified sub-areas within the inhabited area being considered in the scenario and a number of different strategies were constructed for consideration using the Web-Hipre software. A recovery strategy could contain several sub-areas with different clean-up actions or combinations of actions being implemented in each sub-area and/or extension or implementation of temporary relocation. The number of selected strategies evaluated is given in Table 9.

Table 9: Number of selected strategies whose feasibility was evaluated in the workshops. In Denmark a formal decision analysis with VISA software was not done

Workshop	**Number of strategies**
UK1	7
UK2	7
UK3	6
GE	7
PO	8
DK	Not analysed
SK	6
BE	6
FI	7

The clean-up strategies selected were then scored against the selected attributes (criteria and values)(see Figure 4 for an example). For some of the attributes the scoring was quite straightforward because the relative magnitude of these objective attributes could be directly estimated (e.g. doses, costs, volumes of wastes). For less objective (or more subjective) attributes like public reassurance or political acceptability the scoring of the strategies had to be done by finding a consensus amongst the participants of a workshop.

The next step was to weight the attributes against each other. The weighting was done firstly for those attributes being under the same higher level attributes and finally by weighting between the higher level attributes. In this way the selected clean-up strategies were scored resulting normally in 1 or 2 strategies with clearly higher scores than the others, i.e. the strategies which should be considered further. Figure 10 gives an example of the final ranking of the strategies selected in one of the UK workshops.

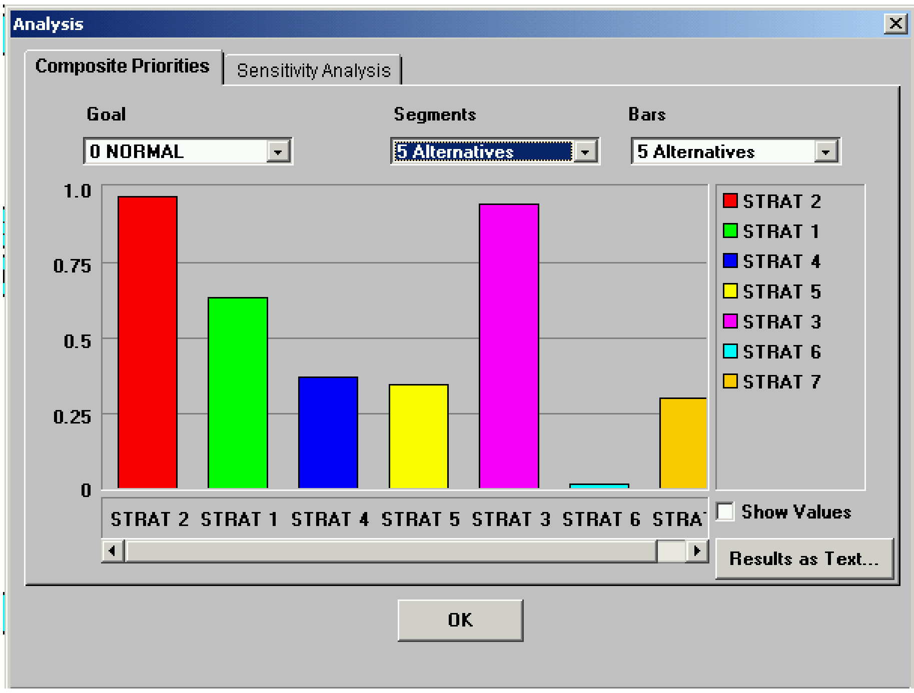


Figure 10: The overall ranking of the clean-up strategies in one of the UK workshops. This result indicates that the strategies 2 and 3 are almost equally feasible and the decision makers could select either to be implemented.

2.2.4.3 Values driving the decisions

The values or criteria (also called as attributes) discussed in the national stakeholder workshops were surprisingly similar. The main groups under which almost all the discussed criteria can be classified were;

- Health related issues (public/workers' radiation doses, workers' physical safety, etc.)
- Social/political aspects (political acceptability, public reassurance and confidence, socio-psychological effects, equity, environmental protection, etc.)
- Technical feasibility (costs, available resources, waste management, etc.)

The mutual weights of the criteria understandably varied depending on the level of contamination being used in the scenario, the total area to be cleaned up, resources available and the number of people affected. If the contamination and the consequent radiation doses were not very high, social and political aspects got a greater weight than health related issues: on the other hand, if the contaminated area was very large, technical feasibility and costs had a greater importance.

The values driving decisions in the workshops can only be compared in general terms as their importance will depend on scenario. As an example, Figure 11 shows how the different criteria contributed to the scoring of the strategies discussed at one of the UK workshops. In this scenario, the predicted radiation doses in the first year after the accident to the population were similar to natural background radiation for most of people (i.e. direct health effects were small) and the political and economic aspects got greater weights. Another example is given in Figure 12 (German workshop). In this scenario the estimated population doses were much higher than in the UK scenario, and consequently prevention of direct health effects (radiological issues) gained the highest importance.

Table 10 summarizes the criteria having the greatest influence on selection of the strategies selected in the different workshops. As said before, direct comparison of the values in different workshops is not meaningful as the scenarios differed from each other. The more important outcome of the workshops was that similar values were brought into discussion in most of the workshops.

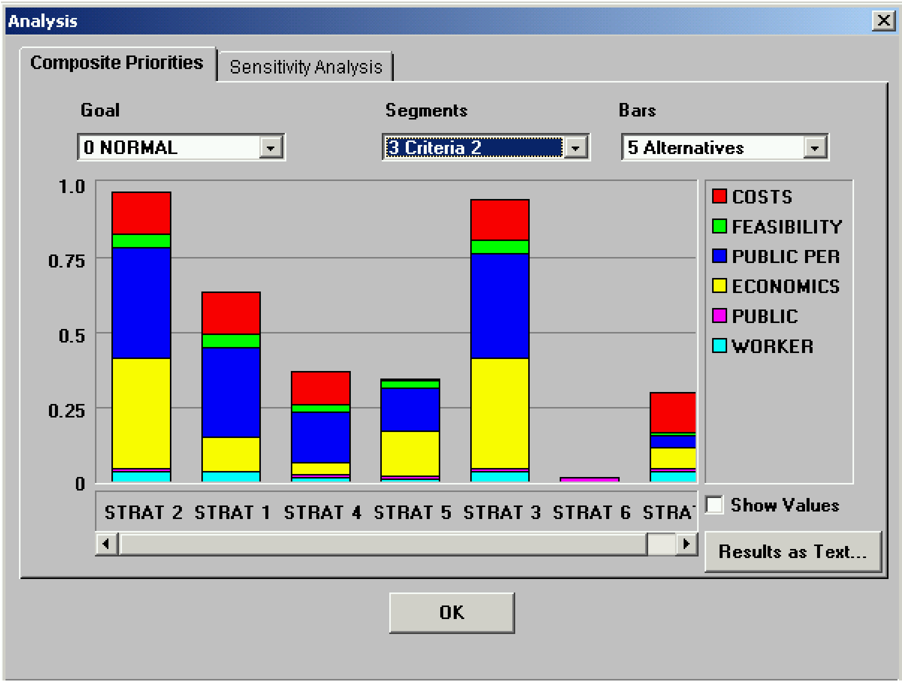


Figure 11: Composite priorities of the strategies discussed at one of the UK workshops, showing the proportion of scores on different attributes (see also Figure 10).

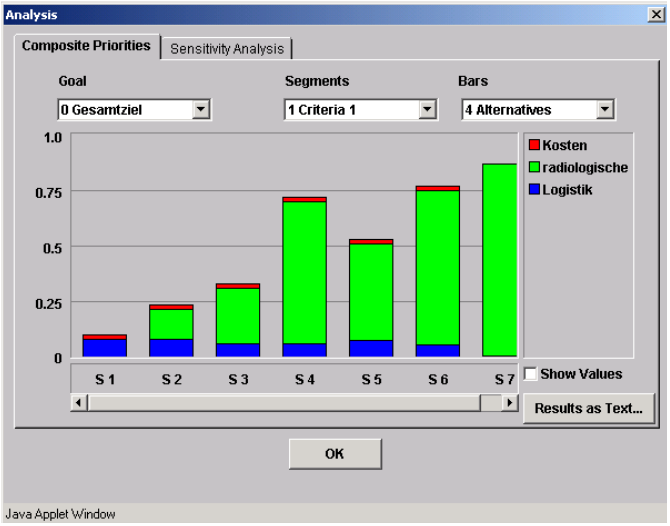


Figure 12: Composite priorities of the strategies discussed at the German workshop. Doses averted by the clean-up actions had the main role in selection of the most suitable strategy.

Table 10: Criteria driving the decision making in the national workshops performed in EVATECH project.

Workshop	Main criteria driving decisions on a strategy *
UK1	Political acceptability, public perception
UK2	Feasibility, reassurance
UK3	Costs, health, wastes
GE	Exposure to radiation, safety of workers
PO	Health, feasibility, political acceptability
DK	Not analyzed
SK	Health effects Forces and resources Costs Socio-psychological effects Waste
BE	Socio-political aspects, feasibility, costs
FI	Health, public reassurance

*) In all workshops effective and open public information is supposed to be implemented

2.2.4.4 Remarks

It became clear at the workshops that decision making would need to make difficult trade-offs in relation to the emphasis to give to public perception and indirect economic impacts as against more ‘objective’ criteria, such as radiation health effects and direct costs. When contamination of the environment was relative small, the general conclusion was that strategies involving cheap and non-disruptive clean-up options such as grass cutting and vacuum sweeping together with extensive monitoring offer the best balance of response in reassuring the public. More substantive and costly measures such as soil skimming did not seem justified unless waste disposal issues could be dealt with more cost-effectively than envisaged. It was recognised that these conclusions were based on the groups’ assessment of public perception. However, the participants felt that, in the event of an accident, there would be time to engage the public in debate about the potential benefits of more resource intensive options and waste disposal issues.

Although public perception and political acceptance were mentioned very often in the discussions, some people expressed the view that these should not drive the decision making. Rather, the clean up strategy decided on should and would be complemented by a full and open public information strategy, which participants felt would elicit the necessary public support.

Most of the workshops participants were very grateful for the opportunity to explore recovery issues in the framework of a workshop and they felt that the Web-Hipre decision software was a useful input into the process. The view was expressed that they foresaw the need to have ‘experts’ on hand to set up and run the software to support decision making for recovery measures.

Many of participants expressed the need for similar workshops for training purpose with the invitation of other specialists from different disciplines and with the focus not only on advisors but also on leaders who are the members of the emergency commissions at different levels and on residents who will (is expected) execute some of the countermeasures. The facilitated workshop was perceived to be too democratic for many of participants. They feel that in case of an emergency there will be less democracy and more command.

All participants expressed the view that the facilitated workshop and work in such multidisciplinary group was challenging for them.

After the workshops a questionnaire was distributed to the organisers in order to identify the advantages and disadvantages of such workshops and also to identify needs for further development of the whole decision support systems. Based on the review of these requirements, key areas were identified in which the CSY endpoints and structure could be improved to help support the process of decision making on long-term countermeasures. This information was fed back into WP1.

2.2.5 Dissemination of the results of EVATECH

The results of the project were presented in the Symposium on Off-site Nuclear Emergency Management in Rhodes on 21-24 September and those participants who were not involved in the project expressed a strong wish to have an opportunity to get closer acquainted with this approach to evaluate countermeasure strategies. Also the European Commission encouraged the EVATECH team to arrange an additional seminar to disseminate the results of the project to a wider audience. The project consortium applied for an extension to the project in order to arrange a dissemination seminar to real end-users of the emergency management tools and methods. An Extension of five months was accepted by the Commission and the seminar arrangements started in late autumn 2004.

The dissemination seminar with a title of ‘Transparent and Traceable Decision Making in Off-site Nuclear Emergency Management’, was arranged in Brussels on 20 April 2005. The seminar was directed at end-users of decision support systems, i.e. those who are participating in decision making, preparing recommendations for decision makers, and those who are using or are intended to use this kind of supporting tools. It was attended by the technical community (in particular those responsible for providing decision support in a radiological emergency and developing tools for this purpose), by those responsible for policy and those with an operational function. About 50 participants attended the seminar, half of them represented responsible authorities in nuclear emergency management, and the another half the technical community (research institutes and technical support organisations).

Seven high level presentations were given in the seminar starting from general requirements needed for effective emergency management and ending with experiences gained in the EVATECH project about using decision analysis tools within the facilitated stakeholder workshops. At the end of the seminar, a panel discussion was arranged to hear experiences and feedback from those end-users who attended the national workshops arranged by EVATECH. The seminar programme is given below.

Time	Programme of the dissemination seminar, 20 April 2005
08.00	**Registration and coffee**
09.00	**Welcome and introduction to the seminar** R. Mustonen
09.30	**Decision making processes and decision makers in different phases of a nuclear emergency situation** S. French, E. Carter, S. Baig, C. Hoebler, J. Brown, T. Duranova and C. Rojas Palma
10.15	**Coffee break**
10.45	**Information being available to decision makers in different phases of a nuclear emergency** W. Raskob, S. Baig, T. Duranova, S. Hoe, S. Potempski and C. Rojas-Palma
11.20	**Use of decision analysis in nuclear emergencies** R. Hämäläinen, J. Geldermann, V. Bertsch, M. Treitz and O. Rentz
12.00	**Lunch**
13.30	**Facilitated workshop -a method to involve key players in decision-making** K. Sinkko and R. Hämäläinen
14.10	**Experiences gained from facilitated stakeholder workshops and the application of decision analysis tools** J. Brown, S. Baig, V. Bertsch, T. Duranova, S. French, S. Hoe, A. Mrskova, S. Potempski, C. Rojas-Palma and K. Sinkko
14.50	**End-users' panel discussion** chaired by C. Rojas Palma.
16.00	**EURANOS, integrated research project in the area of nuclear and radiological emergency management in Europe, including rehabilitation of contaminated areas (2004 - 2009)** J. Ehrhardt and W. Raskob
16.20	**Closing Session**

Feedback about the seminar was very positive. Most of the participants were aware of the decision support systems developed in Europe after the Chernobyl accident, but about half of them heard about real possibilities to involve different stakeholders in decision making of countermeasures in a nuclear emergency for the first time. Modern process modelling tools, decision analysis tools and methods of facilitated workshop together enable decision makers to gather relevant stakeholders around the same table and to find out the most feasible countermeasures within a short period of time.

Also feedback from those end-users who attended earlier in the national workshops was mainly positive. They saw that the presented tools and methods are especially valuable in emergency planning. They also expected a similar approach to be applicable in a real situation, especially in a later phase of emergency situation, although its suitability was not rated as highly as for planning. Of course there were also sceptical opinions on the usability of these tools and methods, particularly in situations where political values are brought into the discussion. However, the main message was that the technical community should continue to develop the support system and to make them even more user-friendly and flexible.

2.3 Assessment of Results and Conclusions

To summarise, the EVATECH consortium had four main tasks in assisting the further development of the RODOS and ARGOS systems as operational decision support systems;

1. to develop and install countermeasure evaluation tools into both systems (WP1)
2. to train emergency management experts to use such tools and to facilitate decision making workshops in nuclear emergencies (WP3)
3. to test the new evaluation tools in national stakeholder workshops in the seven participant countries (WP4), and
4. to model nuclear emergency management processes in four countries (WP2)

In general terms all these tasks have been fulfilled, but there is still a lot of work to be done in order to create fully operational European platform for the management of off-site consequences of nuclear emergencies. In the following, a brief summary on each of these issues is given, together with judgments on needs for future work.

2.3.1 Countermeasure evaluation tools

A Java-based evaluation software Web-Hipre was integrated into RODOS system and it was shown to be a suitable tool for evaluation and ranking of countermeasure strategies. The VISA software was selected as an evaluation tool to be used with ARGOS system but unfortunately it was not possible to test its usefulness in the project.

The requirement for implementation of Web-Hipre was to build an interface between the RODOS “old-ESY”, which is still necessary for the user driven selection of appropriate attributes, and Web-Hipre. Therefore, a new module was integrated into Web-Hipre, which allows the importation of these ESY-files. The interface begins by offering the user an ‘attributes window’, which displays the full attribute tree and allows the user to select which of these should be passed forward to Web-Hipre for further analysis.

Although the results available from RODOS provided a very valuable starting point, the data available do not match all the needs of the “decision maker”. In the testing of Web-Hipre and RODOS in the workshops, sensible combinations of different countermeasures and decontamination techniques and a user selection of the areas, where the results should be calculated were the most important deficiencies. Additionally, the methods and tools used were not able to reflect the sequential and iterative process of decision making in real life.

As a summary we can say that the project succeeded to achieve the main objective - to install countermeasure evaluation tools both in RODOS and ARGOS systems. The experiences gained with the RODOS evaluation tool however indicated that more work is still needed to make the interface between Web-Hipre and the Countermeasure Sub-system (CSY) of RODOS more flexible and user-friendly. At the moment too many additional calculations have to be done, for example by Excel, before data can be transformed into Web-Hipre.

2.3.2 Modelling of the emergency management processes

The emergency management processes were modelled in four of the participating countries. It was observed that the processes in the four countries are substantially different in their organisational structures and differences were identified in communication style, where decisions are made and the management of advice. Unfortunately, for this reason, it was not possible to suggest practices that may be shared, as practices that work very well in one country's model may not work in another. Therefore the focus for 'sharing' of good practices should be the recognition that there are a variety of effective approaches that can be adopted in emergency management. Countries with different approaches need to respect each other's approach and focus on establishing methods for working together that embrace, rather than deny, these differences.

Regarding information exchange and decision support, the observation was made that, although there are different organisational structures, the processes share common main activities and, although these may be approach differently, they have similar information and support needs. When exploring the use of a DSS in the process models the following points arose.

- It is currently technical experts and not decision makers that use the DSS in the emergency management processes; this raises a couple of issues. Firstly, it needs to be ensured that there is sufficient emphasis given to the uncertainty associated with the advice given when experts interact with DMs. Secondly, evaluation of countermeasure strategies presumes the DSS provides data to be incorporated into the emergency management process. In line with the findings from the EVATECH workshops (see EVATECH(WP4)-TN(04)-08), we can conclude that although decision conferences may not always be appropriate in the emergency phase they could be useful to support decision making in the recovery phase.

- In a complex unanticipated emergency the models within a single DSS may not immediately provide all the information that is required. For this reason, there is the need to enable the results of other models or ad hoc calculations to be assimilated into the DSS model chain and database.

- There has been work on communication between organisations involved in emergency management, for example the MODEM project provides standards and technology for communication internationally. There is also recognition in all the processes that there is a need to have good public relations. Now there is a need for DSS to focus on communication with the public and providing 'simplified' easily comprehensible plots.

The modelling of emergency management processes is a useful exercise because it may betray deficiencies or conflicts in authorisation, execution of responsibilities or in communication.

2.3.3 Training of emergency management expert to use of decision analysis tools and to facilitate decision making workshops

One of the main objectives of EVATECH was to develop evaluation software for the decision support systems RODOS and ARGOS which could rank various countermeasure strategies in the event of a nuclear or radiological emergency. The project organised a training seminar in order to expose experts from all countries participating in EVATECH to this type of evaluation tool and the conducting of facilitated workshops using these tools. In addition to the traditional training seminar, the experts had, and still have, a possibility to use a modern e-learning method in the web-site of the Helsinki University of Technology (HUT), http://www.evatech.hut.fi/training. This e-learning method is a valuable tool in getting acquainted with a new subject because it is not tied to time and place and the content of this e-learning site is extensive and its exercises are illustrative.

The training was a response to the recommendation of several international organisations that key players or stakeholders (e.g., authorities, expert organisations, industry, producers and even the public) should be involved in the national planning for protective actions and in decision making on countermeasures in a case of a nuclear accident. Facilitated workshops provide a potential methodology for their involvement. The partners, however, required training in order to deliver these workshops effectively.

After the training seminar, the trained experts became familiar with decision analysis and they were more competent to facilitate panels or workshops where representatives of different stakeholders worked together to identify feasible protective actions in a nuclear emergency situation.

2.3.3 National stakeholder workshops

Nine facilitated workshops on selection of strategies to clean-up of contaminated inhabited environments were run in seven European countries within the EVATECH project. The Aim of the workshops was to clarify the information and decision support needs of decision makers a few days after a radioactive release from a nuclear accident when considering the choice and implementation of recovery actions in inhabited areas. The workshops were conducted in 2003 and 2004 in UK, Germany, Denmark, Poland, Slovak Republic, Belgium and Finland. In addition to these workshops planned in the project contract, a few workshops were arranged afterwards as a result of good experiences gained in the EVATECH project.

The workshops, in which relevant stakeholders together focused on the same problem, were the first attempt, on a European scale, to use decision analysis tools together with RODOS and ARGOS to test their usability and to identify further development needs of the decision support systems. The decision analysing tool used was Web-Hipre which was chosen to be the tool used with RODOS.

The workshops demonstrated that difficult trade-offs in relation to the emphasis given to public perception and political acceptability (so called subjective attributes) against more objective criteria, such as radiation health effects and costs, have to be done. It was also demonstrated that this kind of facilitated workshop is useful in later phases of a radiological emergency situation when stakeholders have enough time to make necessary preparations and to seek adequate support from their own organisations. It was also noticed that RODOS together with Web-Hipre can be utilised in training and in exercises where 'what if' scenarios can be exercised.

From a technical point of view, the workshops clearly showed that improvements are still needed in the RODOS and ARGOS systems and in their capability to produce the necessary data needed in decision analysis. It is recognised that some of the information required to aid the decision making process will not be available from such systems in the event of an accident, e.g. local issues, acceptability of different countermeasure options etc. Development needs were identified soon after the workshops. Some of them are already implemented in RODOS and ARGOS and most of them are included in the EURANOS project in FP6.

2.3.4 Dissemination of the results and feedback from end-users

Results of the project were presented to a wider audience in the dissemination seminar arranged on 20 April 2005 in Brussels. The seminar, with a title of 'Transparent and Traceable Decision Making in Off-site Nuclear Emergency Management', was directed at end-users of decision support systems, i.e. those who are participating in decision making, preparing recommendations for decision makers, and those who are using or are intended to use this kind of supporting tools. Feedback about the seminar was very positive. Most of the participants were aware of the decision support systems developed in Europe after the Chernobyl accident, but about half of them heard about the real possibilities to involve different stakeholders in decision making of countermeasures in a nuclear emergency for the first time. Modern process modelling tools, decision analysis tools and methods of facilitated workshop together enable decision makers to gather relevant stakeholders around the same table and to find out the most feasible countermeasures within a short period of time.

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2.4 Acknowledgements

More than 130 representatives from about 95 organisations in seven countries participated in the national workshops arranged by the project. The whole EVATECH consortium is grateful to all the participants for giving so freely of their time and entering into discussion so enthusiastically. As the participants represented real key players in emergency management their feedback to the workshops organisers was of supreme importance.

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