OECD

NEA

CONCLUSIONS OF THE

SPECIALIST MEETING ON OPERATOR AIDS FOR SEVERE ACCIDENT MANAGEMENT AND TRAINING (SAMOA)

Organised by
OECD NUCLEAR ENERGY AGENCY

in collaboration with
OECD HALDEN REACTOR PROJECT

Halden, Norway - 8-10 June 1993

COMMITTEE ON THE SAFETY OF NUCLEAR INSTALLATIONS
OECD NUCLEAR ENERGY AGENCY
Le Seine Saint Germain - 12 Boulevard des Iles
F-92130 Issy-les-Moulineaux (France)

ORGANISATION FOR ECONOMIC
CO-OPERATION AND DEVELOPMENT

NUCLEAR ENERGY AGENCY

STEERING COMMITTEE
FOR NUCLEAR ENERGY

RESTRICTED

Paris, drafted: 3rd May 1994
OLIS: 10-May-1994
dist.: 16-May-1994

NEA/CSNI/R(94)13

English text only

COMMITTEE ON THE SAFETY OF NUCLEAR INSTALLATIONS

SENIOR GROUP OF EXPERTS ON
SEVERE ACCIDENT MANAGEMENT (SESAM)

CONCLUSIONS OF THE SPECIALIST MEETING ON OPERATOR AIDS FOR SEVERE ACCIDENT MANAGEMENT AND TRAINING (SAMOA)

013953

FOR TECHNICAL REASONS, THIS DOCUMENT IS NOT AVAILABLE ON OLIS

OECD SPECIALIST MEETING
ON OPERATOR AIDS FOR
SEVERE ACCIDENT MANAGEMENT AND TRAINING
(SAMOA)

INTRODUCTION

The First OECD Specialist Meeting on Operator Aids for Severe Accident Management and Training (SAMOA) was held from 8th to 10th June 1993 at the OECD Halden Reactor Project in Halden, Norway. It was sponsored by the Committee on the Safety of Nuclear Installations (CSNI) and was organised in collaboration with the OECD Halden Reactor Project (OECD HRP). About fifty experts from eleven countries attended the meeting (including four from the Czech Republic). Eighteen papers were presented in three sessions. The proceedings were published by the OECD Halden Reactor Project and distributed to the participants at the beginning of the meeting.

One of the recommendations of the OECD Specialist Meeting on Severe Accident Management Programme Development held in Rome, Italy, in September 1991 was that a Specialist Meeting should be organised to discuss operator aids for severe accident management*. At the Rome meeting it was not possible to reach a clear consensus on the extent to which operator aids could and should be used. There appeared to be general agreement that simplified aids, such as graphs, precalculated parametric relationships, or simple analysis tools were useful. At the other extreme, the benefits of having sophisticated analysis tools on-line and running significantly faster than real time in order to predict possible outcomes of proposed accident management strategies were not yet clear; further investigation was recommended.

More recently, the Senior Group of Experts on Severe Accident Management (SESAM) decided to include the topic of development and implementation of engineered methods (computational aids) in the scope of the Specialist Meeting. The Specialist Meeting on Instrumentation to Manage Severe Accidents held in Cologne, Germany, in March 1992 had also stressed the importance of this topic**. Engineered methods are being developed to assist in the implementation of severe accident management strategies. Methods which include computational aids can be used to monitor the current status of the plant and to project the progression of key phenomenological events. The Specialist Meeting addressed the question of the identification of information needs not covered by the instrumentation, examined means to perform phenomenological behaviour assessments needed to support station procedures, and discussed computational aids/methods for predicting accident progression and consequences.

---

* Proceedings NEA/CSNI/R(91)16

** Proceedings NEA/CSNI/R(92)11

The scope of the Specialist Meeting had been limited to operator aids for accident management which were in operation or could be soon. Moreover, the meeting concentrated on the management of accidents beyond the design basis, including tools which might be extended from the design basis range into the severe accident area. Relevant simulation tools for operator training were also part of the scope of the meeting.

In general, the tone of the Meeting was to be rather practical, and focus on results and applications. The objective was twofold:

- exchange information on the current status of operator aids, opinions on how they could be used in severe accident situations, and possible developments in this area;

- try and understand better the need for and the usefulness of operator aids.

Demonstrations of computerised systems were organised during the Meeting.

CONCLUSIONS

A number of operator aids were presented during the meeting. Some of them were already in operation, others were under development with a view to implementation within the next 3 years. This field is very active because of real needs and the possibilities offered by computer technology.

The presentations showed that the design and implementation of operator aids were closely related to the organisation adopted by the user, whether it was a utility or a governmental agency. This had also been one of the main observations made at the Specialist Meeting on Severe Accident Management (SAM) Programme Development held in Rome in 1991. Clearly, organisation, procedures and aid tools have to complement each other to form a balanced working system.

The most common organisation is to share the management of severe accidents among two groups of people: the operating team in the Control Room (CR) and a team of specialists in a Technical Support Centre (TSC). The CR is in charge of the operation of the plant in all conditions using a set of procedures and guidelines, while the experts in the TSC are able to produce in-depth analyses of the plant state and its evolution. The responsibility is shared between the CR and the TSC during accident progression. The TSC acts as a support for the CR for reactor operation and takes charge of the predictions of radioactive releases (source term, accident progression, release and dispersion of radioactive substances, as well as the interaction with public authorities). But this type of organisation is not general and the differences can induce different approaches in the design of operator aids.

Governmental agencies usually organise Crisis Centers (CC) in accident situations. The task of these Centers is to closely follow the development of the accident and the actions taken by the operators, assess potential radiological consequences, and advise on or organise preparedness actions. They also give information, e.g. to the public. Aids intended for use in such centers must match all these tasks.

Whatever the situation of the operator aids, either in the control room, the TSC, or the CC, some general comments can be made. First, the operator aids have to be designed in strong liaison with the Emergency Operating Procedures (EOP), the SAM Guidelines, or valid instructions. If not, a counter-productive effect could be obtained. Second, as observed in Session I but valid for all operator aids, signal validation is an important concern; some solutions do exist to overcome this kind of difficulty. Third, the tools have to be extensively validated to make sure they are convenient and can deliver the expected results without negative impact. Introduction of new aids can only be done after cautious evaluation of users' needs and possible limitations.

Operator Aids in the Control Room

In accident situations, the main objective of the operator team is to prevent core damage. Consequently, many of the tools presented at the meeting were mainly oriented towards the prevention of severe accidents. These tools can be made very sophisticated by using the latest development of computer technology (see the Japanese presentations). They can be integrated in the main I/C of the plant or put in a separate form (Safety Panel). Normal operation and emergency procedure management can also be included in the system; examples were presented at the meeting. This kind of tools, carefully implemented, could provide a useful aid to operators.

Operator Aids for the TSC

These aids can be in a modular form to be used by a Crisis Team as "tool boxes". In general they present the possibility to use a PC to organise important plant technical data for quick access or to perform simple calculations formerly made by hand. These kinds of tool in the TSC, representing a comparatively simple form of operator aids, are well established in France and some US utilities. Such systems seem to offer good aid, and to be simple and reliable for their users; e.g., they can be operated on a battery-powered PC.

A step towards more sophisticated tools is to integrate all the modules into a single system, able to make a chain of calculations. Another way to enlarge the role of the system is to extend the range of operation, from disturbances and accidents towards severe accident conditions. In many situations, the system could preferably be started automatically on an actuation signal, or a combination of signals, coming from the plant instrumentation.

Most of these systems, simple or sophisticated, have two main functions:

- Tracking: Assessment of the Status of the plant, and particularly the Critical Safety Functions (CSF).

- Prediction: Faster than real time prediction of the progression of the accident, with or without taking account of operator actions.

In the development field, some other features have been explored such as a "strategy generation" module (see the CAMS presentation) and a diagnosis-prognosis expert system (see the SAMSON presentation).

All these integrated systems have in common some characteristics such as running faster than real time (about 100 times) or the number of plant parameters used (between 50 and 150).

Operator Aids for Training

Detailed training of the operators (CR or TS) on the new aids appeared to be an absolute necessity to all participants. Very sophisticated tools can certainly be used for that purpose but an important message from the meeting is that it is possible to start a training programme on severe accidents with simpler tools. The current tendency is to develop highly computerized systems entirely devoted to training. All systems are able to simulate thermal-hydraulic conditions before core degradation. At least one simulator could simulate phenomena up to core collapse. A faster than real time model of a complete severe accident sequence can be achieved today with at least one of the tools presented as an operator aid for the TSC.

Next Meeting

Based on the information presented at the Specialist Meeting and the discussions, it is concluded by the Programme Committee that another meeting on operator aids for severe accident management should be organised in two or three years.

SESSION I: OPERATOR AIDS FOR CONTROL ROOMS

Session Chairman: John Lehner (BNL, USA)

Session I dealt with calculational aids whose mission is to assist the operator in the control room to prevent and mitigate severe accidents. The six papers in the session covered a very diverse range of topics and this diversity in itself gave some indication of which aspects of severe accident management were stressed in different countries. The US presentation emphasized very simple, practical calculational aids which the operator could employ to estimate various severe accident conditions. The Canadian approach was to take measurements already obtained for off-site emergency response training and attempt to use this information to make some accident management inferences. The European and Japanese presentations, on the other hand, dealt with ambitious and complicated operator support systems, which required a substantial commitment of resources.

There also was considerable diversity in the degree to which the various presentations entered severe accident space. In many cases the emphasis was on prevention of core damage rather than the more advanced stages of severe accidents. Despite this diversity there were several presentations which dealt with very similar topics, i.e., the Japanese and Swedish/Norwegian efforts on operator support systems, which allowed comparison of the differences in approach to solving a similar problem.

Briefly, the individual papers focused on the following points:

The US presentation "Computational Aids for Severe Accident Management", authored by EPRI, SAIC and ERIN Engineering staff, discussed the simple computational aids (CA) which EPRI is developing generically and which individual US Owner Groups can adapt for their particular reactors. Computational aids here refer to nomographs or step by step instructions that can be used to estimate plant responses or conditions during severe accidents. These CAs can be used even when only simple tools, such as a battery powered computer, are available. CAs developed for estimating the needed water addition rate to the reactor vessel, and to estimate containment pressurization due to CCI were described as examples.

The Japanese presentation "Development of Computerized Supporting System for PWR Plant Emergency Response Guidelines (ERG) of Japan", from KEPCO and MAPI, discussed the development in Japan of the Function-related Emergency Operator Support System (F-EOSS) which warns the operator if the critical safety functions are threatened, and provides useful information on the need to switch from event oriented to function oriented procedures. The validation of F-EOSS, which indicated a 50% reduction in human error rates, and the plan for F-EOSS implementation was also discussed. Continued testing and validation is planned for the next 3 years, with implementation at the end of this time. It will be interesting to follow the course of this programme for the next few years.

The German (Siemens) presentation "Operator Assistance for Initiating and Performance of Secondary and Primary Side Bleed and Feed Including Unavailability Valuation for Siemens PWRs" did not deal directly with operator aids in the sense of the other papers, but described an interesting study which showed how the addition of a third grid supply could reduce the hypothetical use of the "secondary bleed" , and especially the "primary bleed", accident management strategy, and thus reduce core damage frequency even further.

The Swedish/OECD HRP presentation "SAS-II, A Computerised Operator Support System Assisting in Plant Emergency Shutdown", described the development and testing of an operator support system for the Swedish Forsmark plant, which was in some ways similar to the previously presented Japanese support system. This system also monitored critical safety functions as well as safety system activation and performance. System validation produced some complex results, difficult to interpret, and further validation, along with possible adjustments to the system, was proposed.

The second Japanese presentation was authored jointly by TEPCO, Hitachi Ltd., and Toshiba Corp. It was entitled "Development of Symptom Based Emergency Procedure Guideline Support System" and described a computerized EPG support system which is intended to support the operation of Japanese BWR plants in accordance with the already in-place symptom based EPGs. The specifications, requirements and verification for suitability of the system were discussed. Implementation is projected to take place in about 3 years.

The final paper in the session was the Canadian presentation entitled: "The Use of Simple Computerized Correlations in the Monitoring and Prediction of Accident Progression and Consequences". This presentation discussed how information currently obtained for use in offsite emergency response planning at Ontario Hydro's nuclear generating stations can play a role in accident consequence management. The paper described the type of measurements and correlations used, and why the CANDU-PHWR design, with its pressure tube reactor and multi-unit, negative pressure containment, lends itself to use the monitoring in unique ways.

During the discussion period at the end of the session, all participants seemed to agree that operator support systems should be limited to providing guidance, rather than including automatic implementation of procedures. Moreover, any operator support system should have as one of its goals the reduction of the mental stress on the operator during off-normal situations.

It also became clear that simply providing additional information to the operators was not necessarily beneficial. Care must be taken that any new tools are carefully and consistently integrated with existing ones. As was pointed out by the SAS-II validation experience, and again emphasized in the discussion at the end of Session II, additional tools require additional training of the operators and can, in some cases, be viewed as a burden rather than a help. To achieve maximum benefit of operator support systems the type of information provided, its integration with existing information systems, the end user of the information, and his or her training all must be considered. As was noted at the end of Session II, when this topic was pursued further, in some cases it may be better to supply additional information to the Technical Support Centre, or its equivalent, rather than to the operator.

Finally there was a consensus among the discussion participants that signal validation was an important concern, which cannot be overlooked, for the use of any operator support system. The use of simulators or other means to infer redundant supplementary measurements which could be used to improve confidence in the validity of input signals was briefly touched on and could provide an important topic for future discussions.

SESSION II: OPERATOR AIDS FOR TECHNICAL SUPPORT CENTRES

Session Chairmen: P. Bystedt (SKI, Sweden) and B. De Boeck (AVN, Belgium)

Session II covered eight presentations. The tools and systems presented were in use, or were under development intended for use in a variety of support centres, ranging from utility on-site centres, national utility centres and national authority centres. The tools varied also substantially in degree of integration and consequently also in need for computer power and equipment.

As a common feature, the tools use plant status data transmitted from the plant to the centre via telecommunications systems, data nets or microwave which in most cases automatically feed into the system computers.

A presentation by the Northeast Utilities in the USA, "Calculational Tools Supporting Northeast Utilities Emergency Organization", described a set of tools that since several years have been in use in the utility TSC. For the reactors operated by the utility they have, on initiative of their own, developed a set of plant specific HELP-programs. These programs, which run on PCs can provide plant data and calculate thermal-hydraulic parameters and accident progress. As an example for a PWR, based on the initial depressurisation rate in the RCS, the break size in a LOCA event can be estimated. At first, a coarse estimate is made which then gradually is adjusted when more information flows in from the plant. A demonstration was given during the presentation.

These sets of tools had been developed in response to the needs experienced in emergency drills over a 10 year period.

At present, data from the plants are transmitted to the utility main office automatically and from there manually entered into the programs as needed. One planned development step is to fully automate this transfer. Obviously, a set of very practical and useful tools have been developed and implemented by Northeast Utilities.

Two French papers presented two systems that have many similarities in development and in use, at IPSN and EDF respectively. These systems, in use for 10 years, but continuously upgraded with state-of-the-art tools, are adjusted based on experience from drills.

The IPSN/CEA presented "Methods and Related Computerised Aids for the Diagnosis and the Prognosis of the Plant Status During an Emergency on a PWR by the French Protection and Nuclear Safety Institute". This method is used by the IPSN in their Emergency Technical Centre. The role of IPSN in an accident situation is mainly to provide the safety authorities with predictions on accident development and potential releases.

The method used is to assess the status of the different safety barriers in the plant. Basically, the data received from the plant are compared to a large number of data precalculated with reference codes or by special simulation and a diagnosis of the accident at hand is made.

Then a prognosis is made and adjusted based on the trends in the incoming data. The prognosis covers the thermal-hydraulic parameters and the radioactive release into the containment and into the environment in case of core damage. Its regular use in emergency drills and in team training makes the system familiar to the users and also generates feed-back which is valuable for further development.

Another French presentation was "The EDF/SEPTEN Crisis Team Calculation Tools and Models", given by EDF/SEPTEN. It described the tools used by the EDF National Crisis Team. The main task of this team is to give advice to the operators in their efforts to prevent damage and to mitigate consequences of the accident. Furthermore the team shall give information to the authorities on the development of the accident. For these purposes EDF has developed a set of models, TOUTEC and CRISALIDE. These programs, run on PCs, permit simplified calculations of individual thermal-hydraulic variables and of some critical parameters, e.g., time to core uncovery, containment pressure and source term. Plant data are automatically transmitted to the crisis centre via a data network.

The models are purposely simplified to enable the code to run fast with only limited input of plant parameter values.

The methods used by EDF for diagnosis and prognosis have similar objectives as those used by IPSN described earlier, and close co-operation between IPSN and EDF has taken place during the development.

The tools have, when used in different exercises, been found to be user-friendly and most efficient. Further expansion of capabilities of the codes and also increased speed and accuracy are planned.

NUPEC from Japan presented "Development of the Emergency Response Support System (ERSS) and a Prototype of it". The objective is to provide MITI with sufficient information for decision making regarding protection of the public in case of an accident. Development of the system has been ongoing since 1987 and a prototype will soon be available. One PWR and one BWR are used as reference plants in this prototype. The development of a complete system is expected to take two more years.

Plant data sent via a communication network are analysed in the system computers situated at NUPEC. Results are then transmitted to the MITI Decision Making Room. A large display system shows the transmitted plant parameters and AI-processed ERSS information to provide decision makers with appropriate and understandable information.

The ERSS is developed using several calculations with the MAAP code. Other large severe accident codes, MELCOR, THALES/AT are also used to further qualify the calculations.

The Finnish VTT presentation "Recent Developments of APROS towards an On-line Simulator" described an open environment for modelling and simulation of industrial processes. APROS stands for Advanced PROcess Simulation. Applications include a tracking simulator that runs in real time and is continuously updated by plant measurements, and a predictive simulator receiving its initial conditions from the tracking simulator. The system has a broad application in normal situation, incident and accident conditions. The severe accident part is described in the third paper of Session III. It is also worth mentioning that APROS is being used in the CAMS system, described in the last paper of Session II. The intention is to add a neural network to diagnose errors in the measurements and the process itself.

The ARD presentation from the US "SAMSON - Severe Accident Management System Online Network" described a computational tool for use in the TSC. SAMSON continuously examines over 150 status points monitored by NPP process computers. When an initiation signal (e.g., reactor trip) is received, SAMSON automatically switches to accident mode. Then a rule-based expert system classifies the accident using data collected during the first four minutes of the accident. SAMSON currently recognizes LOCAs (divided in 8 break sizes) and SGTRs (1 to 8 tubes). SAMSON then makes very fast predictions about when core damage, support plate failure, and reactor vessel failure will occur. SAMSON uses expert systems as well as neural networks, and therefore does not perform any thermal-hydraulic calculations. It can also determine if a sensor has failed. For the one plant application (Zion) performed to date, the neural network has been trained on about 500 MAAP runs. The system was delivered to Commonwealth Edison Co. in March 1993.

The FAI and NU presentation, from the US, "MARS - An Accident Management System Online Network", also described a computational tool for use in the TSC. This tool actually runs MAAP in two modes: the tracking mode and the prediction mode. In the tracking mode, MARS uses on-line plant data to verify the incoming plant instrument signals and to initialise the prediction mode. In the prediction mode, MARS can perform faster than real time simulations of the future state of the plant either without, or with operator actions programmed in the system according to the emergency operating procedures. In another configuration, the MARS software can be used interactively to simulate plant accident conditions and provide training on the plant response and the appropriate operator response in a training atmosphere. In addition the MARS software can be used interactively or in a "batch" mode during emergency drills. The presentation was followed by a demonstration of the system.

The OECD-HRP presentation "CAMS: Computerized Accident Management Support" showed a different approach by first asking what sort of information does the user in the control room or in the TSC need, and then trying to find out how this information shall be structured and how it shall be displayed. The objectives of the system are:

- identification of the plant state
- prediction of the future states of the plant
- planning accident mitigation strategies.

A prototype is being developed based on the Forsmark plant, with the aim of being able to answer questions like:

- is the available information correct?
- what information can be generated about physical quantities not directly measurable?
- what will be the results of proposed interventions?

In addition to a tracking and a predictive simulator based on APROS, the prototype will include a strategy generator.

Even though better support in an accident state is the main goal of the project, it is felt to be important that the staff is familiar with the use of the system during normal operation, when they utilize the system during transients. It is also possible to use the tools for training purposes.

HIGHLIGHTS OF SESSION II

Most of the tools presented during the session rely heavily on data coming from the plant process computers. Communication links transmit the data directly to the computerized systems. The advantage of this setup is that the tools can rely on a large amount of data continuously updated. The drawback is that the support given to the TSC is dependent on the availability of the plant process computer and of the communication path. This has to be recognized when designing the system. First, the reliability of the power supply of the different parts (process computer, communication link and support system) should be of the same level. Second, the possibility of some backup functions should be considered. Some of the tools presented have the possibility to accept data manually. These data can be obtained by telephone or telefax.

When developing operator aids for the TSC, it is important to put the new systems to test during emergency planning drills as early as possible. During the session several participants stressed their good experience with this procedure. Without representative tests, it is difficult to define the amount and type of information to be presented, the right way to present this information, and the ways the user has to interact with the system. In a stressed environment, it is important that the user gets a reasonable amount of information presented in an unambiguous way. Furthermore, additional information should be accessible in a user-friendly way. The developer should therefore interact with the end users, to assess their needs and take their advice into account. This should be done not only in a quiet environment, but also during actual plant exercises.

SESSION III: SIMULATION TOOLS FOR OPERATOR TRAINING

Session Chairman: H. Tuomisto (IVO, Finland)

In Session III four papers were presented highlighting different viewpoints of developing and applying simulators to training operators and Technical Support Centre (TSC) personnel. Two major objectives can be set for severe accident management training:

- familiarization of operators and TSC personnel with the major severe accident (SA) phenomena that are expected during various scenarios,
- how to apply severe accident management (SAM) Guidelines, Procedures, and how to use instrumentation and available hardware to influence accident progression.

Three approaches were considered in Session III. First, precalculated SA analysis results can be applied to training. Visual aids (video, control panel mimics, etc.) can make training much more efficient. The second and third choices make use of simulators that are capable of SA modelling. These simulators are either 1) the demonstration type which reproduces the main severe accident sequences using simple models of the major expected physical phenomena and predefined accident management actions or 2) the prediction type which performs comprehensive physical modelling of SA progression in order to capture all physical phenomena during SA scenarios.

WESI, Belgium described in the first paper "Severe Accident Training Focusing on the Impact of Operator Actions and Modelling Sensitivities" the Westinghouse experience with operator-oriented severe accident training. In the operator oriented severe accident training organised by Westinghouse, the classroom discussions on typical severe accident phenomena are complemented with the evaluation of fully analysed accident scenarios. It was shown in this paper that it is of crucial importance for the implementation of an operator-based severe accident management programme that the operator is familiar with the major phenomena of a typical severe accident progression. He needs to realize that time is a crucial factor and that almost any action to prolong the time before core uncovery or vessel failure will be recommended. On the other hand a consciousness must be created with respect to how an operator action will influence the further accident progression and why a beneficial action for the reactor vessel might negatively impact some containment related parameters. The Westinghouse experience was gained from the extension of emergency procedures to the core damage phase for Ringhals PWRs in the form of the Beyond Emergency Response Guidelines (BERG). The development work was supported with a large number of MAAP analyses. The results supported by visual aids were then applied for training operators in the modified EOPs and BERGs. Another source of training material comes from the level 2 PSAs and IPEs carried out by Westinghouse.

Implementation of an operator training program on the French S.I.P.A. simulators were presented by staff from EdF and a demonstration of S.I.P.A. was given. The objective of the study and training simulator S.I.P.A. ("SImulateur Post-Incidentel, Post-Accidentel ou Pré-Accident-Grave") is to provide, by means of training for engineers and operation managers, crisis scenario simulations and advanced studies, better understanding of, and therefore better control over, incident or accident situations in order to prevent them from degenerating into a "severe accident", with core meltdown and its consequences.

The developmental phase of the S.I.P.A. simulator is over. The simulator has been operational for more than a year and all its specifications have been met with. Its evolutions will be numerous, involving physics (neutronics, thermal-hydraulics, severe accidents), data packages, man-machine interfaces and organisation (new types of training, use during crisis drills and modernization of data-processing architecture). S.I.P.A. does not currently simulate severe accidents, but initial thoughts were presented on the eventual future extension of S.I.P.A. to SA simulation: MAAP or ESCADRE will be the codes used. A demonstration was given following the presentation.

A paper from VTT (Finland) described a demonstration simulator concept aimed at training of operators and technical support persons of the Loviisa plant for severe accidents. The system will be accomplished by implementing severe accident models into the APROS simulation environment. The primary objective is to produce a simple system that can be used to familiarize the Loviisa VVER-440 nuclear power plant operators and technical support personnel with the plant's most important severe accident sequences, and to train them in conducting the planned accident management actions. The premiss has resulted in an approach that takes advantage of the knowledge existing at Imatran Voima Oy of the plant key severe accident events. The simulation system is not required to predict the plant behaviour in all conceivable accident sequences. Rather, it should be able to reproduce the main sequences as they are expected to progress. This implies that simple models can be used and the phenomena considered can be limited.

The system development will be focused at the first stage on the four main actions that constitute the Loviisa severe accident management plan: primary system depressurization, external cooling of the reactor pressure vessel, hydrogen control, and containment external spray. An additional objective is to develop the APROS severe accident analysis capabilities in general.

Simulations of the severe accident in-vessel phase up to core collapse were presented by S3 Technologies from the US. An advanced real time severe accident simulation code, ARTSAS, has been developed to extend, in conjunction with RETACT, the simulation capabilities of nuclear training simulators and workstations to beyond the reactor design limits and into severe accident scenarios. The simulation results obtained from the application of ARTSAS show the possibilities of extending the simulation domain of the current and newly designed full scope training simulators and work stations to include a complete core meltdown. The comparison between the ARTSAS code results and results obtained with MELCOR and STCP for a similar scenario shows that the ARTSAS code can capture the main events and predict their occurrence at comparable times.

During the discussion phase of this session the opinion was expressed that full-scope simulators that cover the physical phenomena of all SA scenarios and that also include the ex-vessel phenomena will not be available for a long time. Meanwhile, simpler simulating tools can fulfil the urgent needs for operator training. Familiarization with SA phenomena can be obtained based on pre-calculated analysis results. For training in the application of top level SAM actions, demonstration simulators capturing the main SA phenomena can be built with much less effort.

VISIT TO THE HBWR AND COMPUTER DEMONSTRATIONS

A visit to the Halden Boiling Water Reactor was organised during the meeting, as well as demonstrations of computerised systems. These were divided into two groups:

(a) OECD HRP Computer Demonstrations:

- CAMS : Computerised Accident Management Support (CAMS Man-Machine Interface and APROS; Strategy Generation)
- COPMA-II : Computerised Procedures
- SAS-II : Critical Safety Function Monitoring
- PICASSO-3 : User Interface Management System
- SCORPIO-II : On-Line Core Surveillance, Strategy Generation and Prognosis
- ISACS : Integrated Surveillance and Control
- EDF/DD : Early Fault Detection, Early Diagnosis
- SSV : Norwegian National Emergency Centre Information System
- Czech National Emergency Centre Information System

(b) Other Computer Demonstrations:

- Calculational Tool Supporting Northeast Utilities Emergency Organisation
- MARS - An Accident Management Tool
- S.I.P.A. - Simulator for Post-Accident Situations

ABBREVIATIONS

AI	Artificial Intelligence
BERG	Beyond Emergency Response Guideline
CA	Computational Aid
CSF	Critical Safety Function
EOP	Emergency Operating Procedure
EOSS	Emergency Operator Support System
EPG	Emergency Procedure Guideline
ERG	Emergency Response Guideline
ERSS	Emergency Response Support System
F-EOSS	Function-related Emergency Operator Support System
SAMG	Severe Accident Management Guidance

Members of the Programme Committee
and/or Session Chairmen

Mr. Per Bystedt (SKI, Sweden - SESAM Chairman)
Mr. Benoît De Boeck (AVN, Belgium)
Dr. John R. Lehner (BNL, USA)
Mr. Akira Omoto (TEPCO, Japan)
Mr. Fridtjov Øwre (OECD HRP, Norway - Technical Chairman)
Mr. Louis Reynes (EDF, France - General Chairman)
Dr. Harri Tuomisto (IVO, Finland)
Mr. Jacques Royen (OECD/NEA - Secretary)

APPENDIX

OECD

The Convention establishing the Organisation for Economic Co-operation and Development (OECD) was signed on 14th December 1960.

Pursuant to article 1 of the Convention, the OECD shall promote policies designed:

-- to achieve the highest sustainable economic growth and employment and a rising standard of living in Member countries, while maintaining financial stability, and this to contribute to the development of the world economy;

-- to contribute to sound economic expansion in Member as well as non-member countries in the process of economic development; and

-- to contribute to the expansion of world trade on a multilateral, non-discriminatory basis in accordance with international obligations.

The current Signatories of the Convention are Australia, Austria, Belgium, Canada, Denmark, Finland, France, the Federal Republic of Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States.

NEA

The OECD Nuclear Energy Agency (NEA) now groups all the European Member countries of OECD and Australia, Canada, Japan, the Republic of Korea and the United States. The Commission of the European Communities takes part in the work of the Agency.

The primary objectives of NEA are to promote co-operation between its Member governments on the safety and regulatory aspects of nuclear development, and on assessing the future role of nuclear energy as a contributor to economic progress.

NEA works in close collaboration with the International Atomic Energy Agency, with which it has concluded a Co-operation Agreement, as well as with other international organisations in the nuclear field.

CSNI

The NEA Committee on the Safety of Nuclear Installations (CSNI) is an international committee made up of scientists and engineers. It was set up in 1973 to develop and coordinate the activities of the OECD Nuclear Energy Agency concerning the technical aspects of the design, construction and operation of nuclear installations insofar as they affect the safety of such installations. The Committee's purpose is to foster international co-operation in nuclear safety amongst the OECD Member countries.