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SUMMARY REPORT FOR THE SECOND TÜV-WORKSHOP PROCEEDINGS ON LIVING PSA APPLICATION

Issued January 1991

A Report Prepared by a Task Force of Principal Working Group No.5 of the NEA Committee on the Safety of Nuclear Installations

COMMITTEE ON THE SAFETY OF NUCLEAR INSTALLATIONS
OECD NUCLEAR ENERGY AGENCY
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COMMITTEE ON THE SAFETY OF NUCLEAR INSTALLATIONS

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 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 cooperation in nuclear safety among the OECD Member Countries.

The CSNI constitutes a forum for the exchange of technical information and for collaboration between organizations which can constitute, from their respective backgrounds in research, development, engineering or regulation, to these activities and to the definition of its programme of work. It also reviews the state of knowledge on selected topics of nuclear safety technology and safety assessment, including operating experience. It initiates and conducts programmes identified by these reviews and assessments in order to overcome discrepancies, develop improvements and reach international consensus on technical issues of common interest. It promotes the coordination of work in different Member Countries including the establishment of cooperative research projects and international standard problems, and assists in the feedback of the results to participating organizations. Full use is also made of traditional methods of cooperation, such as information exchanges, establishment of working groups, and organization of conferences and specialist meeting.

The greater part of the CSNI's current programme of work is concerned with safety technology of water reactors. The principal areas covered are operating experience and the human factor, reactor coolant system behavior, various aspects of reactor component integrity, the phenomenology of radioactive releases in reactor accidents and their confinement, containment performance, risk assessment, and severe accidents. The Committee also studies the safety of the nuclear fuel cycle, conducts periodic surveys of reactor safety research programmes and operates an international mechanism for exchanging reports on safety related nuclear power plant incidents.

In implementing its programme, the CSNI establishes cooperative mechanisms with NEA's Committee on Nuclear Regulatory Activities (CNRA), responsible for the activities f the Agency concerning the regulation, licensing and inspection of nuclear installations with regards to safety. It also cooperates with NEA's Committee on Radiation Protection and Public Health and NEA's Radioactive Waste Management Committee on matters of common interest.

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SUMMARY REPORT FOR
PROCEEDINGS OF THE SECOND TÜV-WORKSHOP ON LIVING PSA APPLICATION

held in

Hamburg, Germany
7th - 8th May 1990

REPORT BY TASK FORCE 10 OF

PRINCIPAL WORKING GROUP NO.5 (RISK ASSESSMENT) OF

COMMITTEE ON THE SAFETY OF NUCLEAR INSTALLATIONS

NUCLEAR ENERGY AGENCY

ORGANISATION FOR ECONOMIC COOPERATION AND DEVELOPMENT

1.0 GENERAL REMARKS

This workshop on Living PSA Application was organized by Technischer Überwaschungs-Verein (TÜV) Norddeutschland e.V. to support the OECD/NEA CSNI-Principal Working Group No.5 on "Risk Assessment" for an international exchange of experience on living PSA application. It followed on from a related first workshop on Program Systems and Computer Codes for Living PSA Application held in Hamburg from 26th to 28th September 1988.

The first session was devoted to Living PSA Applications and the second session to Tools for Living PSA:

Living PSA Applications

- Reasons for performing PSA
* Regulatory requirement, targets
* Corporate requirement, targets
* Safety related activity prioritisation
* Other

- Logistic of Living PSA Management
* Corporate management involvement
* Decision making levels and guidance
* Plant level involvement
* Required personnel commitment
* Frequency and extent of requantification of PSA
* Types of safety/risk parameters to be monitored
* Quality assurance on maintaining Living PSA

- Examples of Application
* Experiences of application
* State of Living PSA/e.g. all accident sequences involved
* Details of component level involvement

Tools for Living PSA

- Data Collection Systems and Codes
* Source and type of data collected
* Probabilistic parameter quantification
* Interface to basic event data
* Data code systems

- Living PSA Codes
* Event and fault tree data base management
* Data shortage and retrieval
* Graphical presentations of ET/FT

- Special Support Codes
* Automated fault tree construction
* Human reliability quantification
* Uncertainty analysis

Twenty four papers were presented and Software Demonstration was made on individual request in the Open Session of the final day. The second workshop was focused on how living PSA is currently performed, e.g. within what framework and with which tools. The insights from this workshop will be used for the CSNI-PWG5/Task 10, "Fundamental Principles of Living PSA for NPP Safety Management".

This summary report includes the workshop programme and Executive Summary of the Workshop along with a summary and conclusions edited by H.-P. Balfanz, program chairman of the workshop. The workshop proceedings which have been produced by TÜV-Norddeutschland e.V. can be obtained from the NEA Secretariat on request.

2.0 WORKSHOP PROGRAMME

1ST SESSION
LIVING PSA APPLICATIONS

Chairman
P.M. HERTTRICH (Germany)

1. **STATUS OF PSA APPLICATION IN FRG AND OF OECD/CSNI-PWG5 ACTIVITIES ON LIVING PSA APPLICATION**
   P.M.Herttrich (FRG) and M.Bonaca (United States)

2. **LIVING PROBABILISTIC SAFETY ASSESSMENT OF A FRENCH 1300 MWe PWR NPP UNIT: METHODOLOGY, RESULTS AND TEACHINGS**
   A.Villemeur, J.P.Berger, A.Dubreuil-Chambardel and J.M. Moroni (France)

3. **USES OF PRA, INCLUDING SEVERE ACCIDENT POLICY RESOLUTION**
   J.R.Chapman (United States)

4. **PSA BASED ELEMENTS OF THE REACTOR SAFETY OPERATIONAL RELIABILITY PROGRAM AT ONTARIO HYDRO**
   P.N.Lawrence and S.Petrella (Canada)

5. **EVOLUTION OF PSA TOOLS AND TECHNIQUES - A UTILITY'S EXPERIENCE**
   E.M.Chan, P.A.Webster, L.W.Beam and V.M.Raina (Canada)

6. **SAFETY ANALYSIS AND INFORMATION SYSTEM (SAIS) - A SOFTWARE SYSTEM TO SUPPORT NPP-SAFETY MANAGEMENT**
   H.-P.Balfanz, Dr.Bohme, St.Dinsmoore and W.Musekamp (FRG)

7. **SAIS - A SOFTWARE SYSTEM FOR LIVING PSA**
   A.Behr and U.Hussels (FRG)

8. **THE NEW APPROACH TO A LIVING PSA**
   H.Ohlmeyer and E.Schubert (FRG)

9. **LIVING PSA - A COMMUNICATION TOOL BETWEEN REGULATOR AND UTILITIES**
   R.Virolainen (Finland)

10. **PROPERTIES OF FINNISH STUK PSA-CODE**
    I. Niemela (Finland)

11. **ONGOING ACTIVITIES OF TECHNICAL RESEARCH CENTRE OF FINLAND FOR NUCLEAR POWER PLANT'S OPERATIONAL SAFETY ASSESSMENT AND MANAGEMENT**
    J.Holmberg, K.Laakso, E.Lehtinen and U.Pulkkinen (Finland)

2ND SESSION
TOOLS FOR LIVING PSA

Chairman
H.-P. BALFANZ (Germany)

12. CURRENT STATUS ON LIVING-PSA RELATED ACTIVITIES IN JAPAN
    K.Aizawa (Japan)

13. DEVELOPMENT OF LIVING PSA TOOL FOR AN LMFBR PLANT
    R.Nakai, Y.Kani and K.Aizawa (Japan)

14. EXPERIENCE IN THE APPLICATION OF PSA TECHNIQUES TO OPERATION OF A NUCLEAR ELECTRIC POWER STATION
    J.N.Evans (United States)

15. TOOLS FOR PLANT-SPECIFIC DATA ANALYSIS IN LIVING PSA
    A.S.McClymont (United States)

16. RELIABILITY DATA COLLECTION SYSTEM AND TREATMENT FOR PSA APPLICATIONS
    P.Homke and C.Verstegen (FRG)

17. USING FAULT/EVENT TREES TO CONSTRUCT ALARM PATTERN RECOGNITION EXPERT SYSTEMS
    J.Arellano, Y.Galicia and E.Ramirez (Mexico)

18. APPLICATIONS AND IMPLICATIONS OF THE LIVING PSA CONCEPT
    S.Hirschberg (IAEA)

19. SUPER-NET, A PC-BASED TOOL FOR LIVING PSA APPLICATIONS
    S.Bjore, S.Hirschberg, A.Laryd and L.Olsson (Sweden)

20. PSA PACK: A PC-BASED PROGRAM FOR USING PSA AS A TOOL FOR OPERATIONAL SAFETY MANAGEMENT
    A.Boiadjiev, H.Vallerga and L.Lederman (IAEA)

21. FROM PRISM TO IRRAS/SARA: LESSONS LEARNED IN LIVING PSA
    M.B.Sattison and H.J.Reilly (United States)

22. REALIZATION OF TRUE LIVING PSA: A CHALLENGING SOFTWARE DEVELOPMENT TASK
    U.Berg (Sweden)

23. THE INDIVIDUAL PLANT EXAMINATION FOR SURRY NUCLEAR POWER PLANT - A LIVING PRA
    M.G.K.Evans and D.M.Bucheit (United States)

24. PROBABILISTIC ANALYSIS OF DESIGN AND OPERATIONAL SAFETY OF NUCLEAR POWER PLANTS
    A.N.Roumiantsev (U.S.S.R.)

3.0 EXECUTIVE SUMMARY OF THE 2nd TÜV-WORKSHOP ON LIVING-PSA APPLICATION

LIVING PSA APPLICATION:

The most common living PSA application in the countries with NPP in operation is based on a continuation of already performed work on PSA of NPPs for system safety assessment. Examples of this application were presented by France with PSA of their 900 and 1300 MWe PWR plant series, from Canada of the plant specific PSA of their CANDU-NPPs, by Finland and Sweden of their national PSA programs.

In this context individual contributions of living PSA programs and applications were presented also from a German utility and from US-NPPs. The latter stated their experience, which the editor regards to be a general, common and important statement of PSA application for the plant engineers as the end use of living PSA:

> The experience at Virginia Power is that neither the WASH-1400 study nor the NUREG-1150 study of Surry have been able to provide answers to the day to day operations which arise in the areas of safety and risk assessment. The studies are too far removed from plant specific information and personnel involvement. The now available living PSA software will help to meet the in-house operational and accident management needs.
>
> The true test of a living PSA is the answer to the following questions. Can the results of the PSA be reproduced by an engineer who was not involved in the performance of the study and can the same engineer determine the impact of a change in operational procedures or system design on core damage frequency and the relative contribution to this components, systems, maintenance, etc. following this change?

Different specific types of living PSA application were presented at the workshop:

The Finnish Authority is now performing development and implementation of a living PSA program for their in-house PSA application. This program will result in a communication network of living PSA tools, modules and data between authority and utilities.

The British utility presented a PSA based model "Essential System Status Monitor (ESSM)" which is installed at Heysham 2 AGR in an on-line mode. It is a computerized interactive operator aid and based on the fault tree models of the plant safety systems. It monitors and records the system outages due to maintenance and calculates the current system failure frequencies. By these data the operator obtain information on possible undesired high points intime system failure frequency and can set priorities on maintenance actions or use this information for planning efficient maintenance and testing strategies in advance.

A PSA based "Alarm Pattern Recognition Expert System (APRES)" was presented from Mexico. The system shall interpret in the course of an accident the high number of alarms and measured values presented to the operator and selects the most critical parts by the use of event and fault tree models and the minimal cut sets of failed components.

In a German research project a computerized "Safety Analysis and Information Systems (SAIS)" is under development to support plant safety management. The system contains the PSA models and tools, a plant specific event and reliability databank and safety important parameters of systems and components. The data are stored and recallable for direct information needed for safety assessment in general and for immediate identification of PSA parameters and assumptions of models, e.g. uncover the hidden assumptions of analysis. This part of the system is already in use as training material for plant operators in order to get familiar with the safety important features of plant systems and components.

PROBABILISTIC DATA COLLECTION SYSTEMS:

The experience of reliability data collection systems and codes was presented both from the USA and Germany. These experiences show that for adequate data assessment specific technical information and event classification are necessary e.g. component boundary definitions, design parameters, operational profiles, failure modes, cause and types of failure detection and restoration.

TOOLS FOR LIVING PSA:

As with the development of Living PSA Program in general, the development of supporting tools is an on-going process. A number of organizations are continuing development of integrated tools to both perform and use PSA and, in some cases, provide a systematic interface to additional, qualitative information. The following PSA computer codes were presented:

In Canada a set of codes was developed on a CDC Cyber minicomputer including INPUT and MOD for preparing and simplifying input files for the SETS fault tree reduction and quantification code, SIMPLE to help run SETS, and TABLES to generate quality reports.

Within the framework of the German research project of the Safety Analysis and Information System (SAIS), which runs on a UNIX-Workstation, graphical fault (FEDIT) and event (EEDIT) tree manipulation and quantification codes are developed and will be interfaced to a data base with qualitative (including graphical) information describing the design and safety related characteristics of NPP systems and components, including items not modelled in the PSA.

In Finland the IBM PS/2 based STUK PSA (SPSA) codes are under development. In addition to graphical fault and event tree manipulation and quantification, a hyper-text system includes the ability to expand on any item (i.e., a basic event) by calling up a variety of documentation sheets (including graphics) with a simple key-stroke and eventually returning along the same path to the original screen.

In Japan a PC code network during a PSA was developed for the prototype liquid metal fast breeder reactor. Including are: IEIQ (Initiating Event Identification and Quantification), MODESTY (Modular Event Description for a Variety of Systems), FAUST (Fault Summary Tables Generation Program), and ETAAS (Event Tree Analysis Systems). The QUEST code system includes the logical models and is intended for use by PSA analysts. The LIPSAS system includes only the cut set lists and a limited range of functions and is intended for use by non-PSA specialists at the plants.

In Sweden the SUPER-NET code is in use which provides a database and graphical editing tools for fault tree handling (input, editing, and modification) and quantification (including sensitivity analysis, importance measures, and statistical uncertainties). Also included are modules for time dependent and life cycle cost analysis. Also in Sweden, a similar, PC-based RELTREE-code has been developed, used to perform a level 1 PSA. The code system includes graphical fault tree construction and quantification.

In the USA the PC code package NUPRA was developed for fault and event tree construction and quantification which was used for the Surry Plant PSA. The storage space of a level 1 PSA for one plant including all data base and print files is up to 32 MBytes. The code is intended for use on an day to day basis at the plant to determine the impact of maintenance on the potential risk, and the relative importance of those components not in maintenance.

The IRRAS/SARA codes have been developed in the USA and were used in the NUREG-1150 study. The IRRAS system includes graphical fault tree manipulation as well as various reduction and quantification options, sequences are quantified by combining cut sets at the function level. IRRAS is intended to be used with the full PSA level 1 models.

CONCLUSIONS:

The workshop gives a broad international view of the different disciplines of living PSA application for NPP in operation and of the living PSA codes and those under development.

Compared to the 1st workshop in Hamburg on the same subject two years ago it can recognize that both living PSA application and cede development increase strongly. When starting with the 1st Workshop it was thought to be necessary to clarify the questions: What is a living PSA. By whom and how a living PSA should be performed? Today, these questions are already well answered by the current experience with the methods presented in the 2nd Workshop.

It is evident that this PSA application has developed considerably supporting plant safety management and it is on the right way and will help to maintain and increase the safety of NPP in operation.