OECD/NEA Activities in the Area of Severe Accidents

Han-Chul Kim
Korea Institute of Nuclear Safety, 19 Guseong-dong Yuseong-gu Daejeon 305-338, khc@kins.re.kr

1. Introduction

The SFEAR report [1] describes severe accidents as one of key technical issues currently being investigated. The current severe-accident issues are listed in Table 1.

Table 1. Current severe accident issues

Phases	Issues
In-vessel Phenomena	• Pre-core Melt Conditions • In-vessel Melt Progression • In-vessel Fuel-Coolant Interaction • Effect of Air On Core Melt Progression • Effect of High Burnup and MOX Fuel • RPV Pressure • Maintaining RPV Integrity • Pressure Tube Integrity
Ex-Vessel Phenomena	• Ex-vessel Melt Progression and Debris Coolability • Core-Concrete Interaction • Ex-Vessel Fuel Coolant Interaction • Combustible Gas Control
Source Term	• Fission Product Chemistry and Release • Post Containment Failure FP Release to the Environment
Containment Integrity	• Containment Integrity • Containment bypass-overheating and failing steam generator tubes
Accident Management	• Coolability of Overheated Core • Accident Management Strategies

For many years important programs have been undertaken in the field of severe accidents and their results have been shared through international "networks." The Committee on the Safety of Nuclear Installations (CSNI) of the OECD Nuclear Energy Agency (NEA) has played a major role in organizing and administering cooperative research programs in this area of severe accidents. This paper deals with the NEA's working method on the severe accident and related activities. All this information was achieved while the author was working for the NEA as a cost-free expert from 2006 to 2008.

2. The NEA's Strategy concerning Severe Accidents

The detailed technical work of the CSNI is carried out by six permanent working groups, including WGRISK (Working Group on Risk Assessment) and WGAMA (Working Group on the Analysis and Management of Accidents), as shown in Figure 1. [2]

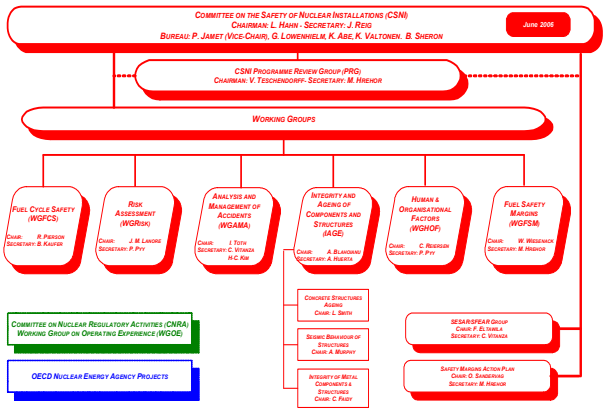

Figure 1 CSNI structure

The CSNI developed a Joint Strategic Plan together with the CNRA, which recognizes the main challenges the nuclear safety community will face over the next five years. These determine the focus of CSNI activities and include:

1. shrinking nuclear infrastructure
2. increased public expectation on safety in use of nuclear energy
3. industry initiatives to improve economics & safety performance in nuclear power production
4. necessity to ensure safety over plant lifecycle
5. new reactors and new technology

"New Risk Perspective and Safety Requirements" is a safety issue related to the fourth challenge in the above and is detailed in the Ref. 3 as follows: Long-term safety management needs to be ensured with respect to issues such as severe accidents, external events, fire safety and seismic safety analyses. Each Working Group is expected to assure that new information, experimental data, improved evaluation tools, etc. are properly taken into account.

The WGAMA was set up to assess and strengthen the technical basis needed for the prevention, mitigation of potential accidents in nuclear power plants, and to facilitate international convergence on safety issues and accident management analyses and strategies. Another Working Group, WGRisk, has the objectives to advance the PSA understanding and to enhance its utilisation for improving the safety of nuclear installations and for increasing the regulatory effectiveness through risk-informed approaches. [3]

3. NEA Activities on Severe Accidents

The WGAMA has run programs on severe accidents (see Table 2). Most of them deal with calculation tools and methods, benchmarking exercises, or the accident

progression exercise, knowledge assessment through state of the art reports, data preservation and knowledge transfer. The Group has recently discussed future activities on severe accidents promising to it; currently, the effectiveness of core-exit thermocouple measurements in accident management is being discussed. A joint effort with WGRisk on severe accident management measures and uncertainty in severe accident phenomena will also be sought by the Group. Regarding research of future reactors such as gas-cooled and sodium reactors, capability of test facilities will be discussed. [4, 5]

Table 2 WGAMA activities related to severe accidents

Item	Duration	Status
1. Accident progression benchmark exercise	2 ½ yrs	In progress
2. SERENA Phase-1	3 yrs	Completed
3. ISP-47: Containment T/H	4 ½ yrs	Completed
4. Pheno.-based validation matrix (ex-vessel)	4 ½ yrs	In progress
5. Status Report on Iodine Chemistry	2 ½ yrs	Completed
6. SOAR on Nuclear Aerosols	4 yrs	In-progress
7. THICKET- severe accident	2 yrs	In progress

The *WGRISK* deals with various kinds of PSA-relevant issues including workshops, Technical Opinion Paper and State-of-the-art report on Level-2 PSA. Severe accident management is also another subject that the Group has recently dealt with. [6]

The CNRA also has some relevant activities including preparation of a report comparing the various areas of application of risk-informed safety management in member countries, regulatory inspection to address low power and shutdown risks, fire risks. [7]

In addition, there are OECD international projects dealing with severe accidents as shown in Table 3.

Table 3 OECD Projects related to severe accidents

Title	Duration	Status
1. MASCA-2	July'03 -June'06	Completed
2. MCCI-2	April'06 –Dec'09	In progress
3. SERENA	October'07-2010	In progress
4. SETH	June'07-2010	In progress
5. THAI	Jan'07-Dec'09	In-progress
6. BIP	July'07-June'10	In progress

The MASCA-2 project is based on experiments that are mainly carried out at the Kurchatov Institute, Russia and aim to provide information on the phase equilibrium for different corium mixture compositions that can occur in water reactors. The MCCI Project aims to provide experimental data on the phenomena related to severe accident management strategies, flooding the reactor cavity in the event of an ex-vessel core melt release. The SERENA (Steam Explosion Resolution for Nuclear Applications) Project has been set up to resolve any uncertainties on fuel-coolant interaction (FCI) issues. These goals will be achieved by using the complementary features of KROTOS (CEA) for investigating corium behaviour in a one-dimensional geometry, and the TROI (KAERI) under reactor-like conditions. The SETH-2 (SESAR Thermal-hydraulics) Project has been launched with the aim of resolving key computational issues for the simulation of thermal-hydraulic conditions in reactor containments, making use of the PANDA and MISTRA facilities. The THAI (Thermal-hydraulics, Hydrogen, Aerosols, Iodine) is to provide additional experimental information from the THAI facility. The BIP (Behaviour of Iodine Project) has been created to provide separate effects and modelling studies of iodine behaviour in a nuclear reactor containment following a severe accident. The results of three radioiodine test facility (RTF) experiments will be provided.

4. Conclusion

Severe accidents are being investigated as one of key technical issues by the NEA which recognised the challenges of the next few years and developed the Strategic Plan to focus its activities on the Safety Issues and Topic. Major activities relevant to severe accidents are carried out by WGAMA, WGRISK and OECD Projects. It is expected that the programmes will be more issue-oriented in the future instead of being generic, aiming to provide answers to specific safety issues. Interaction between the working groups and the various OECD-NEA Joint Projects will constitute another important reference for future planning of the programme of work.

Acknowledgments

The author wishes to express his gratitude to J. Reig and C. Vitanza, NEA, for their support and guidance on the secretariat work during his stay at the NEA. Many parts of this paper are quoted from the NEA documents.

REFERENCES

[1] Nuclear Energy Agency, Nuclear Safety research in OECD Countries, Support Facilities for Existing and Advanced Reactors (SFEAR), NEA/CSNI/R(2007)6, p. 58, 2007.
[2] Nuclear Energy Agency, The Strategic Plan of the Nuclear Energy Agency, 2005-2009, OECD, ISBN 92-64-02081-0.
[3] Committee on the Safety of Nuclear Installations (CSNI), Operating Plan (2006-2009), NEA/CSNI/R(2007)7, 2007.
[4] Meeting of the WGAMA small expert group for defining future activities in the area of severe accidents, NEA/SEN/SIN/AMA(2007)5/Rev 1, 2007.
[5] CSNI Working Group on the Analysis and Management of Accidents (WGAMA), Integrated Plan (Draft), 2007.
[6] CSNI Working Group on the Analysis and Management of Accidents (WGRisk), Integrated Plan, 2007.
[7] Committee on Nuclear Regulatory Activities (CNRA), Operating Plan (2006-2009), NEA/CNRA/R(2006)2, 2006.