NRA
Nuclear Regulation Authority

How PSA Results are to be Utilized in New Nuclear Regulation in Japan

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Introduction

- ✓ NRA keeps pursuing a high level of nuclear safety after the TEPCO's Fukushima Dai-ichi accident.
- ✓ NRA is currently preparing a set of new regulatory requirements. Close attention was given to several considerations during the preparation; most importantly lessons learned from the TEPCO's Fukushima Dai-ichi accident, IAEA safety standards and guidelines, and international best practices. These lessons had to be squarely faced in the formulating new requirements.
- ✓ NRA aims at adequate control of nuclear risks, by using PSA and safety goals.

Utilization of PSA (1/3)

- ✓ NRA recognizes that the approaches in the former regulatory organizations, Nuclear Safety Commission (NSC) and Nuclear and Industrial Safety Agency (NISA), regarding the utilization of PSA remain valid even after the TEPCO's Fukushima-Daiichi accident.
  - Use of PSA and safety goals is essential.
  - Limitation of PSA, incompleteness and uncertainty, must be strictly recognized, and
  - PSA should be used to revise the existing deterministic rules as much as possible.
- ✓ Utilization of PSA and safety goals, however, had been stagnant in Japan in the past decade. NRA recently expressed its policy on the active use of PSA and safety goals.

Utilization of PSA (2/3)

- ✓ NRA is contemplating PSA utilization;
  in revision or rationalization of regulation rules, and
  in decision making for various regulatory issues.
  - A past example for the former is revision of the “Seismic Design Guideline” in NSC.
  - A past example for the latter is an examination of the adequacy of provisional countermeasures on a sump blockage problem.
- ✓ The approaches were described in NSC’s "Interim report on the investigation and review on safety goals“ and NISA documents provided for IRRS Mission to Japan.

Utilization of PSA (3/3)

- ✓ NRA is developing design requirements for;
  - Measures against significant initiators, e.g., earthquake, tsunami, and airplane crash, and
  - Measures against severe accident
- ✓ In some areas, safety assessment methodologies are not mature enough to examine the adequacy of design and to define the adequate protection. As a matter of fact, we should presume all the PSA methodologies keep being imperfect and premature.
- ✓ NRA will, however, use PSA actively in regulation, considering what can be concluded and what cannot be deduced with the current PSA methodologies.

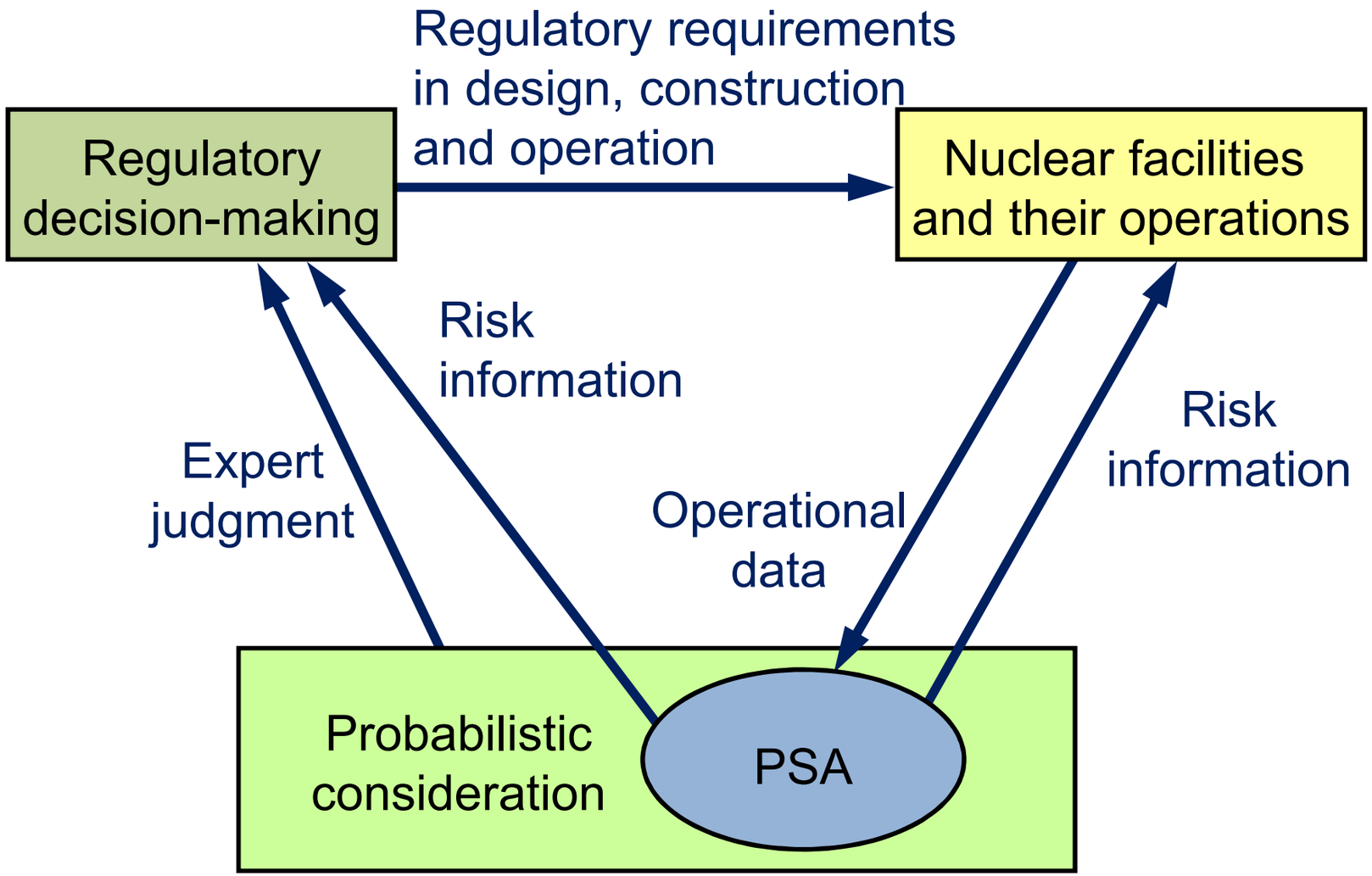
Safety Goals (1/2)

- ✓ NRA proposed safety goals based on the two reports prepared by NSC in 2003 and 2006.
- ✓ The NSC's 2003 report describes a qualitative goal as follows; "The possibility of health effects to the public caused by utilization of nuclear power should be limited to the level not to cause a significant increase in the public risk."
- ✓ In addition, by taking the environmental protection point of view into consideration, NRA introduced limits of amount and frequency of radio-material release. "The occurrence of accident resulting in Cs-137 release of 100 TBq or larger should be less than the probability of approximately 10^{-6} per year."

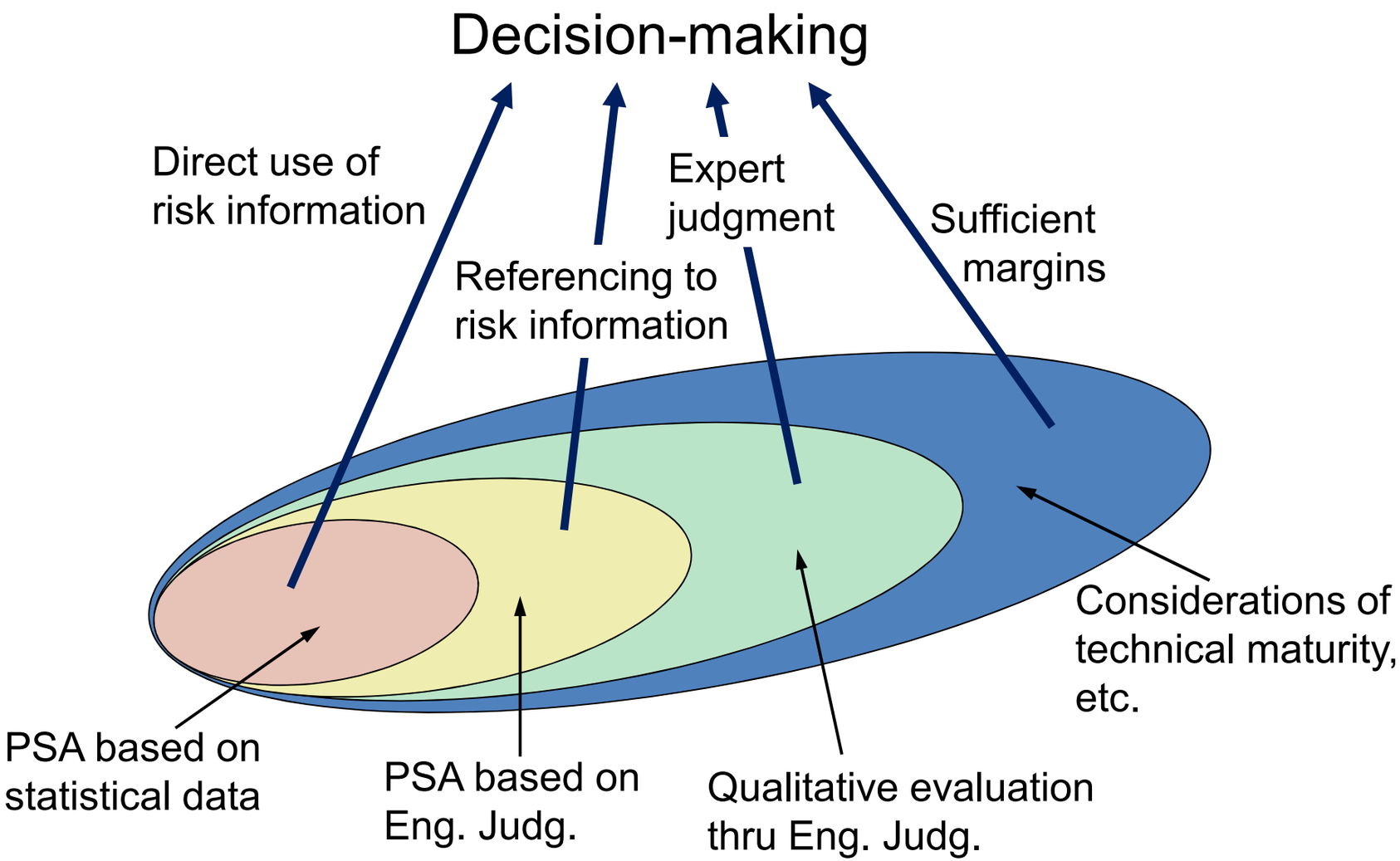
Safety Goals (2/2)

- ✓ The safety goals are not to be used for direct judgment on whether an individual NPP is safe enough or not, but are to be used to judge the adequacy of the regulation.
- ✓ When risk of an NPP exceeds the goals and those of other facilities do not, reasons resulting in such a difference will be analyzed and identified by licensee and NRA. NRA will consider rationalization and/or possible revision of the regulatory rules.

Relationship between Probabilistic Consideration and Regulation



Regulatory Decision-making under Uncertain Conditions



AESJ/NSD Report

- ✓ The Nuclear Safety Division of the Atomic Energy Society of Japan (AESJ/NSD) issued the “Report of seminars to investigate the accident at the Fukushima Dai-ichi Nuclear Power Station – What were wrong? What should be done from now on?” in March 2013.
- ✓ The report summarizes the results and findings from a series of seminars held by the division on the Fukushima Dai-ich accident, and identified numerous pending questions including those on regulation, PSA and safety goals.
- ✓ The conclusions of the report related to PSA are described in the following viewgraphs.

AESJ/NSD

Overall PSA Procedures

- ✓ The Defense-in-Depth (DiD) concept and the PSA procedure are face and back of the same coin. Serious accident is prevented due to in-depth defense. Serious accident occurs when such in-depth defense fails.
- ➡ The Defense in Depth is the most important and practical strategy for achieving a high level of safety, in turn, reducing a risk arisen from nuclear facilities and their operations.
- ✓ The Fukushima Dai-ichi accident progressed according to the scenario assumed in the PSA procedure for external initiators and it also demonstrated the importance of DiD.

AESJ/NSD

Frequency and Consequence

- ✓ Estimation of frequency of rare external initiators is extremely difficult.
- ✓ Historical records on earthquakes, tsunamis, volcanism, etc. are very limited. Extrapolation is inevitable and it accordingly gives large uncertainty.
- ✓ Estimation of accident consequence is also very difficult. For example, past PSAs in Japan did not take account of;
  - Hydrogen burning in reactor building,
  - Hydrogen transport from one unit to another, and
  - Adverse effect of external initiators and severe accident phenomena on accident management operation.

AESJ/NSD

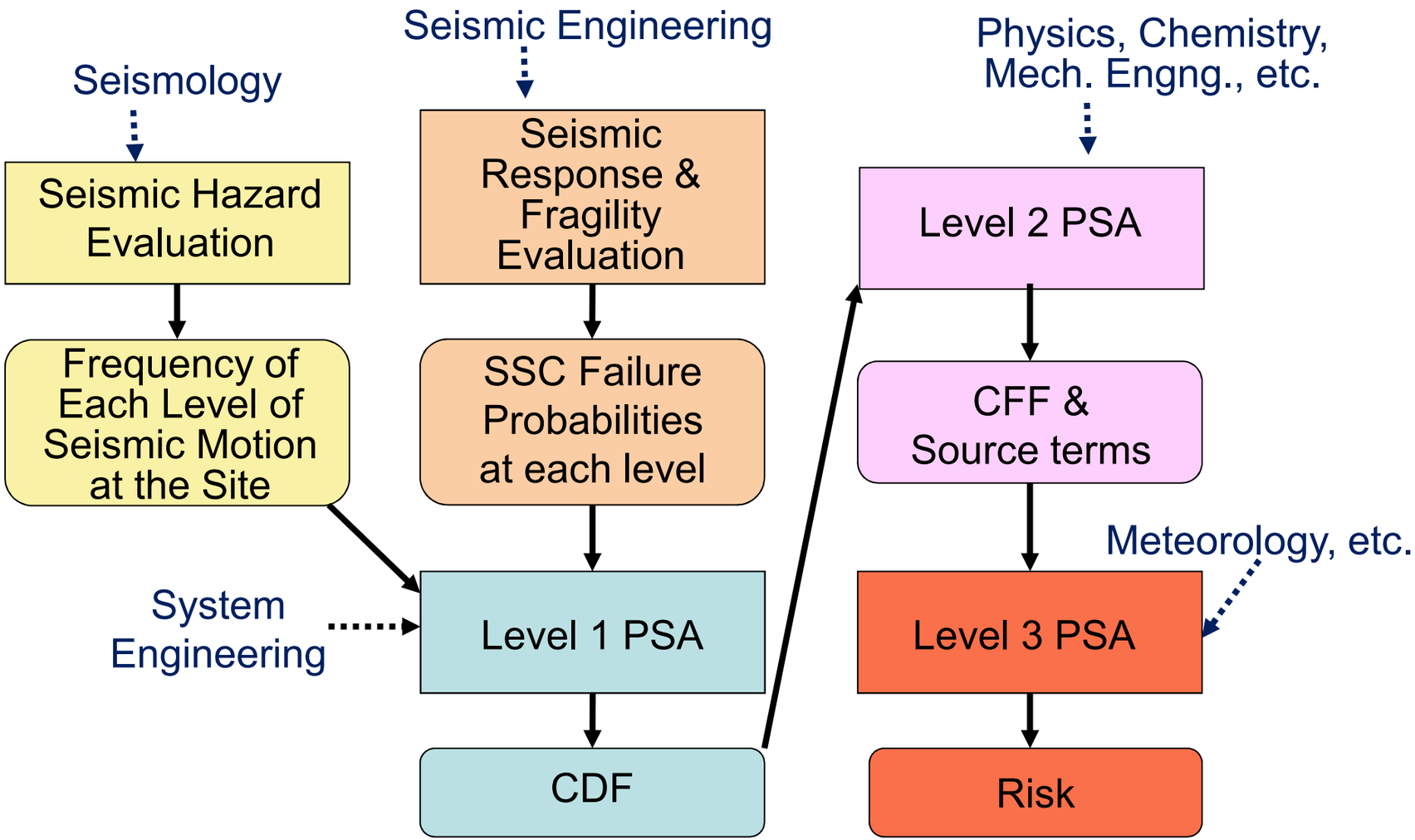
Accident Progression

- ✓ It was extremely difficult to know what was happening during the accident.
  - For example, a detonating sound, which was believed to be one from the vicinity of the suppression chamber of Unit 2, was subsequently identified as the sound of hydrogen explosion at Unit 4.
  - Most of us believed that the suppression chamber was breached at that time. We, in turn, think that the most probable leak pass is in the drywell.
- ✓ The amount of radioactive material release is quite different if the leak pass is different.

AESJ/NSD
Non-nuclear Experts

- ✓ One of the most important causes of the TEPCO's Fukushima Dai-ichi accident was the insufficient assumption of tsunami height.
- ✓ The design-basis tsunami height was decided with the method developed by Japan Society of Civil Engineers. It was much higher than that authorized in the original licensing process but still insufficient from the safety point of view.
- ✓ PSAs must be carried out for various initiators. Cooperation with non-nuclear experts is absolutely essential in order to carry out such initiator specific PSAs.

Experts Cooperation
e.g., in Seismic PSA



Panel Discussion 1 Issue

What are the most important technical issues … (1/3)

- ✓ We learned from the TEPCO's Fukushima Dai-ichi accident that we must evaluate the effects of a wide spectrum of internal and external initiators. Individual plant examination of internal and external initiators is essential.
- ✓ Regulators have to evaluate the adequacy of safety design against various initiators, even though the methodologies for those initiators are premature.
- ✓ NRA expects PSA professionals to tackle the methodology development in the area remaining premature, rather than to refine the established methodology.

Panel Discussion 1 Issue

What are the most important technical issues … (2/3)

- ✓ Different initiators bring different effects. For example, seismic motion will affect all the SSCs simultaneously. Tsunami will not influence all unless its height reaches a certain level.
- ✓ Some initiators may cause difficulties in carrying out accident management operation. Aftershocks and repetitive tsunamis are examples.
- ✓ PSA professionals are strongly asked to develop or select an analysis method suitable for an accident caused by each initiator, since they must know also the other analysis methodologies, such as Stress Test methodology, which may be more suitable for some initiators.

Panel Discussion 1 Issue

What are the most important technical issues … (3/3)

- ✓ The Defense-in-Depth concept is, of course, still valid and important. However, further discussions and clarifications are needed, in particular, when the concept is applied to protections against specific external initiators.
- ✓ The PSA methodology is very useful and applicable to develop and propose effective and efficient protections against the specific initiators. NRA highly expects contributions by PSA experts.

Panel Discussion 2 Issue

How can safety professionals be good …

- ✓ Nuclear safety professionals, including PSA experts, provide safety design, operation and regulation with adequate safety margins, taking account of the knowledge in other fields.
- ✓ Communication and cooperation between nuclear safety professionals and various fields of experts is essential to cope with various initiators.
- ✓ Since PSA professionals know well what fields of expertise is needed for evaluating the risk due to specific initiators, they can propose a forum where such interdisciplinary communication and cooperation are possible.

Concluding Remarks

- ✓ NRA promotes utilization of PSA recognizing its usefulness and limitations.
- ✓ NRA keeps pursuing more effective and efficient protections against specific initiators. Initiator specific PSAs play a big role in this challenge, and NRA highly expects contributions by PSA experts.
- ✓ Communication and cooperation between nuclear safety professionals and other field experts are essential to carry out the initiator specific PSAs and to reflect their results to regulation.

Wording

- ✓ In general, technical terms are precisely defined in PSA area. However, “initiators” and “initiating events” seem rare exceptions. External events, such as seismic motion, tsunami and aircraft crash, must be clearly distinguished from plant internal events, such as LOCAs and transients. In PRA Procedure Guide (NUREG/CR-2300), fire is an “initiator”. In European Stress Test, earthquake and flooding are “initiating events”. In International Nuclear and Radiological Event Scale (INES), LOCA and transients are “initiators” and “initiating events” (not distinguished). In this presentation, seismic motion and tsunami are initiators and LOCAs and transients are initiating events.

- ✓ I expect PSAM to define these words precisely to avoid future confusion.

Thank you for your attention.

Reference

- Nuclear Safety Commission, "Interim Report on the Investigation and Review on Safety Goals", December 2003.
- Nuclear Safety Commission, “Performance Goals for Power-producing LWR NPP", August 2006.
- Nuclear and Industrial Safety Agency, Documents provided for IRRS mission to Japan, June 2007.
- Nuclear Safety Division, the Atomic Energy Society of Japan, “Report of Seminars to investigate the accident at the Fukushima Dai-ichi Nuclear Power Station - What were wrong? What should be done from now on?”, March 2013
- Kiyoharu Abe, “Nuclear Risk and its Regulation – Part 1” (PSA Utilization Guide for NISA and NRA)