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COMPARISON OF FUKUSHIMA RESPONSE IN THE UNITED STATES AND EUROPE

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ABSTRACT
The accident at the three reactor units at Fukushima Daiichi showed weaknesses in the plant coping capability for beyond design basis accidents caused by extreme external events. The weaknesses included plant design features, accident management procedures and guidance, and offsite emergency response. As a result, significant changes to plant coping capability have been made to light water reactors worldwide to enhance the coping capabilities for beyond design basis accidents. However, the response in the United States has been significantly different from that in Europe in a number of ways.

In the United States, the regulator and the industry convened separate expert panels to review the Fukushima accident and make recommendations for enhancements. On the regulatory side, a series of three Orders were issued and that required the implementation of certain enhancements (Mitigation strategies, hardened vents for certain BWRs, spent fuel pool level indication) to ensure adequate protection for the health and safety of the public. Other enhancements were subject to the “Backfit Rule” which requires that changes to regulatory requirements be shown to be cost beneficial using accepted methodologies. Simultaneously, the industry took independent steps to develop a diverse and flexible coping strategies (known as FLEX) and other enhancements. The focus in the United States was clearly on enhancements to guarantee continued core, containment and spent fuel pool cooling in the event of beyond design basis accidents, particularly those resulting from extreme external events.

In Europe, the regulatory agencies ordered the development and completion of “Stress Tests” for each reactor site. These Stress Tests were focused on identifying the capability of the plant and its staff to respond to increasingly severe external events. The Stress Tests not only examined the ability to maintain core, containment and spent fuel pool cooling but also the ability to mitigate the consequences of accidents that progress to core damage (i.e., a severe accident). Regulatory requirements were then issued by the national regulators that addressed the weaknesses identified from the Stress Tests. While many of the enhancements to the plant coping capability were similar to those in the United States, significant hardware enhancements were also required to reduce the consequences of core damage accidents including hydrogen control and containment filtered venting.

Finally, most European regulators also include severe accident management guidance (SAMG) as a regulatory requirement. In the United States, it the current direction is to maintain SAMG as a voluntary industry commitment that is subject to regulatory oversight review.

INTRODUCTION
The accidents at the three units of Fukushima Daiichi revealed weaknesses in the plant coping capability to respond to a Beyond Design Basis External Event (BDBEE). The weaknesses included plant design features, accident management procedures and guidance, and offsite emergency response [1]. As a result, significant changes to plant coping capability have been made to light water reactors worldwide to enhance the coping capabilities for beyond design basis accidents. The global response resulted in many common changes in coping capability but also many differences. The manner in which the insights from the Fukushima accident were considered in the United States and in Europe are examined in the following sections.

UNITED STATES RESPONSE
The response to the Fukushima accident in the United States started immediately after the accident and initially took two separate paths. The first path was led by the regulator, the U.S.

Nuclear Regulatory Commission (NRC), while the second path was led by the nuclear power industry under the joint auspices of the Nuclear Energy Institute (NEI), the Institute for Nuclear Power Operations (INPO) and the Electric Power Research Institute (EPRI). In the subsequent years since the accidents, the regulator and the industry have worked together to formulate a set of enhancements to the capability of plants to respond to a BDBEE.

Regulatory Response

The NRC initiated an intensive a 90-day effort to document the insights as they were known at that time and make recommendations for enhancing the plant capability to respond to BDBEE accidents [2]. The report contained twelve (12) high level recommendations with each having several unique individual recommendations. The NRC Commissioners could require safety enhancements through the use of an Order if there was not adequate protection of the health and safety of the public or the Commissioners could direct the NRC staff to initiate rulemaking to require safety enhancements. In the latter case, the safety enhancements would need to be shown to be cost beneficial using established processes [3, 4]. The Commission issued Orders EA-12-049 (Mitigation Strategies), EA-12-050 (Hardened Vents), and EA-12-051 (Spent Fuel Instrumentation), as well as a request for information (RFI) letter to licensees concerning resistance to beyond design basis seismic and flooding events [5, 6, 7, 8 respectively]. These regulatory actions addressed the most important insights from the Fukushima accident. An additional important recommendation for severe accident management guidelines (SAMG) was deferred to rulemaking for enhancements [9].

Industry Response

The industry took independent steps to develop diverse and flexible coping strategies for BDBEE, known as FLEX [10]. The focus in the United States was clearly on enhancements to guarantee continued core, containment and spent fuel pool cooling in the event of beyond design basis accidents, particularly those resulting from extreme external events. The FLEX initiative extended the added beyond design basis mitigation capability [11] previously implemented in response to the 2001 World Trade Center catastrophe. As part of "The Way Forward" [12], the industry also initiated the development of enhancements to the existing SAMG to reflect insights gained from the Fukushima accident.

Once the basis and priority for the NRC Orders and other recommendations from Reference 12 were clarified, the industry developed and documented enhancements that were submitted to the NRC for endorsement. These enhancement provided guidance for individual plants concerning acceptable methods for satisfying the issues that led to the NRC Orders and recommendations. The enhancements include:

- Enhanced mitigation capability for BDBEEs [10]
- Staffing and communications recommendations [13],
- Implementation of new spent fuel pool instrumentation [14],
- Plant walkdowns to ensure adequate flooding protection [15],
- Reliable containment venting for Mark I and Mark II BWRs [16],
- Integration of Accident Management Procedures and Guidelines [17],
- Enhanced Emergency Response Preparedness [18],
- Seismic evaluation guidance [19 and 20].
- Enhanced severe accident management guidance [21]

Safety Enhancements

The centerpiece of the enhancements for BDBEEs in the U.S. center around the FLEX concept. The FLEX concept involves strategies to maintain core, containment and spent fuel pool cooling for a wide range of BDBEEs that result in the loss of all a.c. power (onsite and offsite) as well as access to the ultimate heat sink for an indefinite period of time. The strategies rely upon a combination of fixed, in-place and portable equipment that would be protected from the BDBEE. The FLEX concept also involves, staffing, communication, procedures and guidelines, and training to assure that strategies can be implemented in a timely manner. FLEX defines three phases of response to a BDBEE: 1) initial response using fixed in-place capabilities until portable resources can be implemented, 2) portable onsite resources that are adequate until offsite equipment can be brought to the site and implemented, and 3) portable offsite resources at one of two national centers [21] that can be deployed to a site within 24 hours.

While not all of the industry activities are complete at this time, considerable progress has been made in all areas. The activities that have not been completely addressed include plant specific studies and implementation (e.g., seismic studies). Rulemaking has been initiated to codify the requirements of the two of the three Orders [22]. The new rule is applicable whenever there is irradiated fuel in the reactor vessel or spent fuel pool. However, the NRC Commission instructed the NRC staff to revise the proposed rule to eliminate SAMG based on the lack of an acceptable regulatory basis for the cost benefit analysis [23] and the industry voluntary commitment to implement and maintain SAMG [24]. The NRC also chose not to pursue rulemaking [25] for reliable hardened vents for Mark I and Mark II BWRs based on industry studies [26]. There are still a few remaining recommendations that were designated as Tier 2 or Tier 3 items [27] to be considered by the NRC including:

- Consideration of reliable vents for other than Mark I and II containments,
- Evaluation of hydrogen control and mitigation and reactor,
- Containment instrumentation enhancements for beyond design basis events, and
- Completion of seismic and flooding assessment and incorporation of insights into the BDBEE mitigation capability at each plant.

EUROPEAN RESPONSE

The regulatory situation in Europe differs from that of the U.S. since within Europe there are many countries, each with its own regulatory body. There is also a wide range of reactor designs, including LWRs of U.S. design origin, but also for example VVER reactors of Russian design origin. In recent years, significant efforts have been made to harmonize regulatory requirements. These efforts, and also the international response to the Fukushima accident have been led by international organizations including the International Atomic Energy Agency (IAEA), the Western European Nuclear Regulators Association (WENRA) and the European Nuclear Safety Regulators Group (ENSREG). The Nuclear Energy Agency (NEA) of the Organization for Economic Cooperation and Development (OECD) also makes major contributions to nuclear safety such as is their report on the Fukushima accident [27].

IAEA

The IAEA is an independent intergovernmental, science and technology-based organization, in the United Nations family, that serves as the global focal point for nuclear cooperation. One extremely important role of the IAEA in the field of commercial nuclear safety, is the development nuclear safety standards and, based on these standards, promotion of the achievement and maintenance of high levels of safety in applications of nuclear energy. Compliance with IAEA Safety Requirements and Standards is required by many national regulators worldwide.

After Fukushima, the IAEA initiated a number of important initiatives, including:

- The IAEA's Action plan on Nuclear Safety [28] was approved in September 2011. It includes 12 main actions, focusing on: safety assessments in the light of the accident at Fukushima Daiichi; IAEA peer reviews; emergency preparedness and response; national regulatory bodies; operating organizations; IAEA Safety Standards; international legal framework; Member States planning to embark on a nuclear power program; capacity building; protection of people and the environment from ionizing radiation; communication and information dissemination; and research and development. In each of these areas. Actions were defined for both member state organizations (regulators, operators) and the IAEA.
- As an example, one of the sub-areas under "communication and information dissemination" included the following action: "The IAEA Secretariat to organize international experts meetings (IEMs) to analyze all relevant technical aspects and learn the lessons from the Fukushima Daiichi nuclear power station accident. " This action resulted in the convening in Vienna of nine IEMs, each addressing a specific area.
- Another commitment of the Action Plan is the Director General’s report on the accident [29] consisting of a Report by the IAEA Director General and five technical volumes. It is the result of an extensive international collaborative effort involving five working groups with about 180 experts from 42 Member States with and without nuclear power programs and several international bodies. It provides a description of the accident and its causes, evolution and consequences, based on the evaluation of data and information from a large number of sources available at the time of writing.
- Updates to IAEA requirements and standards have been also initiated to include Fukushima lessons learned.

WENRA, ENSREG and the "Stress Tests"

WENRA is an association of the head of regulators for nuclear safety within the European Union (EU) and Switzerland, and was set up in 1999. A main objective of WENRA is "to develop a common approach to nuclear safety and to provide an independent capability to examine nuclear safety in applicant [to the EU] countries". Further, WENRA has become a network of chief nuclear safety regulators in Europe exchanging experience and discussing significant safety issues.

ENSREG is an independent, authoritative expert body created in 2007 following a decision of the European Commission. It is composed of senior officials from the national nuclear safety, radioactive waste safety or radiation protection regulatory authorities and senior civil servants with competence in these fields from all 28 Member States in the European Union and representatives of the European Commission. ENSREG’s role is to help to establish the conditions for continuous improvement and to reach a common understanding in the areas of nuclear safety and radioactive waste management.

Before Fukushima, WENRA was, through its Reactor Harmonization Working Group, and in line with its main objective, working on developing a consistent set of high level safety requirements termed "Safety Reference Levels", and several versions had been issued, together with a status report regarding the progress of member state plants in complying with the new safety reference [30, 32, 33].

Following the Fukushima accident, both WENRA and ENSREG acted quickly to specify a "stress test" to be performed by all member state plants (Switzerland and Ukraine also participated). The stress test specification drafted by WENRA [34], and endorsed and formally released by ENSREG [35]. Each national regulator in the EU states (plus Switzerland and Ukraine) then required their licensees to perform the assessments (sometimes called "complementary safety assessments").

These assessments covered three areas:

- Initiating events (earthquake, flooding and other extreme natural conditions);
- Consequential loss of safety functions (prolonged total loss of electrical power supply, prolonged total loss of the primary ultimate heat sink, combination of the two);
- Accident management issues for core melt scenarios and degraded conditions in the spent fuel pool

National reports were produced, peer reviewed, and resulted in National Action Plans for each participating state [36]. These national action plans used the results of the stress tests to identify weak points and develop solutions which increased the plant’s overall robustness in these areas of concern

In September 2014, WENRA issued the latest revision of the Safety Reference Levels, significantly updated to include the lessons learned from Fukushima [37]. In view of the significant changes/updates, additional explanatory statements/reports were issued by WENRA at this time [38, 39], and for two areas significantly modified "guidance documents" (similar to NRC Regulatory Guides, or IAEA Safety Guides), were also provided [40, 41].

Safety Enhancements

A number of safety enhancements were already being considered before the Fukushima event. For example, the importance of recovery procedures for events occurring from shutdown states, the inclusion of external events in Probabilistic Safety Analyses (PSA), the possibility of (and means to address) accidents in the spent fuel pool, the need for full scope SAMG etc., had been already recognized, but different plants and countries were at different stages in the implementation of the needed enhancements. Many plants had also improved severe accident management capabilities by installing fixed mitigation systems such as passive hydrogen recombiners and filtered vent systems. In addition, Fukushima brought new lessons: the possibility of simultaneous severe accidents in multiple units on a site, the possibility of loss of all instrumentation early in an event, and others, which now needed to be addressed. In Europe, both mobile/temporary and fixed equipment backfits were (or are in the process of being) implemented. Such backfits consider both preventive (pre-core damage) and mitigative (severe, post-core damage) measures.

The National Action Plans have addressed each plant in each country, identified the gaps against this revised set of safety enhancements, and implemented a plan, and schedule, for each plant to address its specific needs.

The lessons learned were incorporated into the 2014 WENRA Safety Reference Levels (SRL), and adoption of these SRLs by individual European regulators had led to a significant harmonization of requirements throughout Europe. Examples of requirements from the updated SRLs [37] include

- Events inside and outside the design basis must be analyzed and appropriately addressed (including the use of additional installed or temporary equipment, where appropriate). Beyond design basis accident s (BDBA) - addressed under Issue F, and now termed Design Extension Conditions (DEC) - consider those events not leading to core damage (DEC-A), and, importantly, also those events where core damage occurs - severe accidents (DEC-B). Thus the provisions of Issue F apply to both non-core damage and core damage events.
- PSA (issue O) to level 2 is required for each plant design, including appropriate treatment of shutdown operating modes and accidents in the spent fuel pool;
- EOPs and SAMGs (issues L and M) are to be provided, covering DBA and BDBA DEC A and B) events, including events from shutdown, in the SFP and considering multiple events at multi-unit sites.

In this way, the 2014 revision of the WENRA Safety Reference Levels, and their adoption by most European Regulatory Bodies, has assembled all the important lessons learned from Fukushima, and provided a consistent regulatory basis for their treatment.

COMPARISON OF ENHANCEMENTS

As described above, different approaches have been taken by the regulatory bodies in Europe and the U.S. with respect to safety enhancements for beyond design basis accidents based on insights from Fukushima. However, while the enhancements may appear to be different, there are overarching similarities including:

- Extension of regulatory authority to accident mitigation for beyond design basis events caused by external events. In the U.S and in Europe, the regulatory authority for ensuring adequate response to beyond design basis external events includes strategies to maintain core and containment cooling, protected equipment, training, staffing and communications
- Extension of regulatory consideration of severe accident mitigation including integration of severe accident management with other accident management programs at each plant.

There are also several areas in which the regulatory bodies considered the same Fukushima insights that resulted in different types of enhancements:

- The approach for specifying mitigation equipment for external events was different between the U.S. and Europe. The approach taken in the U.S. was to store mitigation equipment in protected structures and rely primarily on portable equipment stored onsite and offsite that could be quickly deployed. The European approach considered a combination of portable and additional fixed equipment that is protected from the external events under consideration.
- The approach for preserving the integrity of the primary containment was also different between the U.S. and Europe. The U.S. approach for the Mark I and Mark II BWRs relies on installation of dedicated reliable vents from the drywell and wetwell along with dedicated water management strategies to assure that any vented gases are scrubbed by water pools inside the primary containment. Additional regulatory requirements for other containment types will not be pursued [42]. In Europe, most regulatory bodies now require external containment filtered vents to assure that venting releases are scrubbed by the vent hardware.

Finally, there are areas in which the regulatory bodies considered the same Fuskushima insights and are likely to come to different requirements:

- The approach for hydrogen control to prevent catastrophic hydrogen explosions is currently quite different between the U.S and Europe. In the U.S., no additional hydrogen control measures will be required for any plants [42]. For PWRs, only the ice condenser containments have severe accident hydrogen control measures that were installed as post-TMI safety enhancements. In European PWRs, the approach is to backfit hydrogen control measures (passive autocatalytic recombiners) to maintain the accumulation of hydrogen below limits which could challenge containment.
- The approach for ensuring reliable indication of plant parameters to enable the selection of appropriate mitigation strategies is currently quite different between the U.S. and Europe. In the U.S., the plants will rely on Technical Support Guidelines [42, 43] to help the emergency response staff discern the plant conditions and implement the appropriate mitigation strategies. In Europe, the approach is to follow the IAEA guidance [44] and install instrumentation that can withstand severe accident environments.

BASIS FOR DIFFERENCES

There are several overriding considerations that contributed to the differences in approaches taken in the U.S. and in Europe:

- A key difference between the approach taken in the U.S. and Europe is the restrictions imposed by the NRC's own regulations regarding new regulatory requirements. In the U.S., except for new regulatory requirements that ensure adequate protection of the health and safety of the public, a backfit analysis is required that shows that the new requirements will provide a substantial increase in overall protection of the public health and safety and that the costs for the facility are justified in view of the increased protection [4]. The first step in such an analysis is a safety goal evaluation to determine whether the residual risk is already acceptably low by comparing the risk to the Safety Goal [45]. The safety goal evaluation is designed to eliminate some proposed requirements from further consideration because the absolute value of the risk reduction is small compared to the safety goal. The second step in the backfit analysis is to determine if the risk reduction afforded by the new requirements are commensurate with the costs of implementation. In Europe, no such formal process exists; new requirements can be imposed by the national regulators as they deem appropriate to protect the health and safety of the public. As a result, new requirements for severe accident mitigation features such as filtered containment vents, hydrogen control measures and SAMG could not be justified in the U.S. as they were in Europe.
- There is an incentive to limit the size and likelihood of fission product releases in Europe for several reasons:
    1) As a result of the proximity of nuclear plants to national political boundaries in Europe, the consequences of a significant fission product release similar to that at Fukushima might could cross national boundaries and cause evacuations and land contamination consequences.
    2) In Europe, contamination of a land area similar to that at Fukushima could have a significant impact on the economy of that country.
    3) While there are not large differences in population densities near nuclear plants between the U.S. and Europe [46] the potential for evacuation of significant people (78,000 within 20 km at Fukushima according to Reference 1) was taken into consideration in Europe,

The European regulators took these factors into consideration in making decisions regarding additional severe accident mitigation equipment. In the U.S., the NRC was bound by their own regulations concerning new regulatory requirements. The cost benefit analysis does not include factors such as evacuation costs, relocation costs for evacuated persons, reduction in national economy due to contamination. In addition, the implementation of the requirements from the NRC Order (which met the adequate protection criterion) that resulted in FLEX significantly reduced the probability of an accident that results in a large release of radioactivity. Thus, additional mitigation equipment and SAMG could not be justified under the Backfit Rule.

CONCLUSIONS

The industry and regulatory bodies in the US and Europe generally took different approaches based on the same sets of insights from the Fukushima accident. This resulted in different sets of safety enhancements to respond to beyond design basis external events.

The approach in Europe, which was generally unconstrained by other regulatory requirements, resulted in a combination of new requirements for prevention of core damage accidents due to design extension conditions and for mitigation of the consequences of an accident if it should progress to core damage.

The approach in the U.S. was constrained by existing regulatory requirements to justify additional regulatory requirements based on ensuring adequate protection of the health and safety of the general public or an analysis that shows the additional requirements provide a substantial risk reduction and are cost effective. This resulted in additional regulatory requirements that focused on prevention of core damage accidents.

In both cases, the overall level of safety for accidents caused by beyond design basis external events has been significantly enhanced.

REFERENCES

1. IAEA, “The Fukushima Daiichi Accident: Report by the Director General”, Publication 1710, International Atomic Energy Agency, 2015.
2. U.S. NRC, “Near-Term Report and Recommendations for Agency Actions Following the Events in Japan”, SECY-11-0093, U. S. Nuclear Regulatory Commission, July 2011.
3. U.S. NRC, “Title 10 of the Code of Federal Regulations, Part 50.109, Backfitting” Nuclear Regulatory Commission.
4. U.S. NRC, “Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission,” Revision 4 to NUREG/BR-0058, September 2004.
5. U.S. NRC, “Issuance Of Order To Modify Licenses With Regard To Requirements For Mitigation Strategies For Beyond-Design-Basis External Events”, EA-12-049, March 2012.
6. U.S. NRC, “Issuance Of Order To Modify Licenses With Regard To Reliable Hardened Containment Vents”, EA-12-050, March 2012.
7. U.S. NRC, “Issuance of Order to Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation”, EA-12-051, March 2012 and “Order EA-13-109, “Issuance of Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions,” June 2103” .
8. U.S. NRC, “Request For Information Pursuant To Title 10 Of The Code Of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3, Of The Near-Term Task Force Review Of Insights From The Fukushima Dai-Ichi Accident”, March 2012.
9. U.S. NRC “Prioritization Of Recommended Actions To Be Taken In Response To Fukushima Lessons Learned”, SECY-11-0137, October 2011.
10. NEI, “Diverse and Flexible Coping Strategies (FLEX) Implementation Guide”, NEI 12-06, Nuclear Energy Institute, August 2012.
11. NEI, “B.5.b Phase 2 & 3 Submittal Guideline” Nuclear Energy Institute, Revision 2, December 2006.
12. NEI, “The Way Forward”, Nuclear Energy Institute, The Institute for Nuclear Power Operations and Electric Power Research Institute, June 2011.
13. NEI, “Guideline for Assessing Beyond Design Basis Accident Response Staffing and Communications Capabilities”, NEI 12-01, Nuclear Energy Institute, May 2012.
14. NEI, “Industry Guidance for Compliance with NRC Order EA-12-051, “To Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation””, NEI 12-02, Nuclear Energy Institute, May 2012.
15. NEI, “Guidelines for Performing Verification Walkdowns of Plant Flood Protection Features”, NEI 12-07, Nuclear Energy Institute, May 2012.
16. NEI, “Industry Guidance For Compliance With Order EA-13-109”, NEI 13-02, Revision 1, Nuclear Energy Institute, April 2015.
17. NEI, “Emergency Response Procedures and Guidelines for Extreme Events and Severe Accidents”, NEI 14-01, Nuclear Energy Institute, September 2014.
18. NEI, “Enhancements to Emergency Response Capabilities for Beyond Design Basis Events and Severe Accidents”, NEI 13-06, Nuclear Energy Institute, March 2014.
19. EPRI, “Seismic Evaluation Guidance”, EPRI Report 3002000704 Draft, Electric Power Research Institute, April 2013.
20. EPRI, “Fleet Seismic Core Damage Frequency Estimates for Central and Eastern U.S. Nuclear Power Plants Using New Site-Specific Seismic Hazard Estimates” Letter to Nuclear Energy Institute, March 2014.
21. NEI, “White Paper: National SAFER Response Centers”, Nuclear Energy Institute, September 2014.
22. NRC, Mitigation Strategies for Beyond Design Basis Events, NRC-2014-0240, November 2015.
23. NRC, “Staff Requirements – SECY-15-0065 – Proposed Rulemaking: Mitigation Of Beyond-Design-Basis Events”, August 2015.
24. NEI, “Industry Initiative to Maintain Severe Accident Management Guidelines”, Letter to NRC, Nuclear Energy Institute, October 2015.
25. NRC, “Evaluation Of The Containment Protection And Release Reduction For Mark I And Mark Ii Boiling Water Reactors Rulemaking Activities”, SECY-15-0085 and SRM-SECY-15-0085, 2015.
26. EPRI, “Technical Basis for Severe Accident Mitigating Strategies”, EPRI Report 3002003301, April 2015.
27. Organisation for Economic Cooperation and Development - Nuclear Energy Agency, "The Fukushima Daiichi Nuclear Power Plant Accident - OECD/NEA Nuclear Safety Response and Lessons Learned", 2013.
28. IAEA Action Plan on Nuclear Safety, September 2011.
29. International Atomic Energy Agency, "The Fukushima Daiichi Accident", STI/PUB/1710, 2015.
30. Western European Nuclear Regulators’ Association, Reactor Harmonization Working Group, "Harmonization of Reactor Safety in WENRA Countries", January 2006.
31. Western European Nuclear Regulators’ Association, Reactor Harmonization Working Group, "WENRA Reactor Safety Reference Levels", January 2007.
32. Western European Nuclear Regulators’ Association, Reactor Harmonization Working Group, "WENRA Reactor Safety Reference Levels", January 2008.
33. Western European Nuclear Regulators’ Association, Reactor Harmonization Working Group, "Progress towards Harmonisation Of Safety For Existing Reactors In WENRA Countries", January 2011.

34. "Stress tests" specifications: Proposal by the WENRA Task Force 21 April 2011
35. ENSREG, Annex 1 to the Declaration of ENSREG: "EU Stress Tests Specification", May 2011.
36. Country specific reports at: http://www.ensreg.eu/EU-Stress-Tests/Country-Specific-Reports
37. Western European Nuclear Regulators' Association Report, "WENRA Safety Reference Levels for Existing Reactors. Update in Relation to Lessons Learned from TEPCO Fukushima Daichi Accident", 24 September 2014
38. Western European Nuclear Regulators' Association Report, "Updating WENRA Reference Levels for existing reactors in the light of TEPCO Fukushima Dai-ichi accident lessons learned", September 2014.
39. WENRA Statement regarding the revision of the Safety Reference Levels for existing reactors taking into account the lessons learned from the TEPCO Fukushima Dai-ichi Nuclear Accident, October 2014.
40. Western European Nuclear Regulators' Association Guidance Document, Issue F: Design Extension of Existing Reactors, 29 September 2014.
41. Western European Nuclear Regulators' Association Guidance Document, Issue T: Natural Hazards, Head Document, 21 April 2015.
42. NRC, "Proposed Plans For Resolving Open Fukushima Tier 2 And 3 Recommendations", SECY-15-0137, October 2015.
43. R. Lutz and B. Williamson, "The Importance of Reliable Indication for Accident Management, ASME International Congress on Nuclear Energy, ICONE 24, June 2016.
44. International Atomic Energy Agency, Accident Monitoring Systems for Nuclear Power Plants, IAEA Nuclear Energy Series Report No. NP-T-3.16, 2015.
45. NRC, "Policy Statement on Safety Goals for the Operation of Nuclear Power Plants", Nuclear Regulatory Commission, August 1986..
46. Nature, "Reactors, Residents and Risks", Nature.com, April 21, 2011.