

# **European Union Response to Fukushima – European Stress Tests and Peer Review**

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**38<sup>th</sup> MPA-Seminar  
October 1 and 2, 2012 in Stuttgart**

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## **Abstract**

Following the severe accidents which started in the Fukushima Dai-ichi NPP on 11 March 2011, the European Council requested that a comprehensive safety and risk assessment, in light of preliminary lessons learned, be performed on all EU nuclear plants. Therefore, stress tests and peer review assessing natural initiating events, the loss of safety systems and severe accident management have been performed in the 15 European Union countries with nuclear power plants as well as Switzerland and Ukraine.

The final peer review report of the European Nuclear Safety Regulators Group (ENSREG) highlights four main areas for improvement to be explored across Europe:

1. Development by the Western European Nuclear Regulators' Association (WENRA), with the contribution of the best available EU expertise, of a European guidance on assessment of natural hazards and margins;
2. Importance of Periodic Safety Review to be underlined by ENSREG;
3. Expedient implementation of the recognised measures to protect containment integrity;
4. Prevention of accidents resulting from natural hazards and limitation of their consequences.

The peer review of the European stress tests was completed in April 2012. In their conclusive statement issued 26 April 2012, the national European regulators and the European Commission as European Nuclear Safety Regulators Group (ENSREG) required that follow-up would occur by way of an ENSREG action plan. Country specific action plans will be developed and peer review workshop will be organised to share lessons learned on the implementation of post-Fukushima safety improvements.

## **1 Introduction / Motivation**

Following the severe accidents which started in the Fukushima Dai-ichi NPP on 11 March 2011, the European Council of 24-25 March 2011 requested that a comprehensive safety and risk assessment, in light of preliminary lessons learned, be performed on all EU nuclear plants. The request of the Council included "stress tests" performed at national level complemented by a European peer review. This was the first time that such a multilateral exercise covering over 140 reactors in all EU countries operating nuclear power plants was considered. The Council invited the national European regulators and the European Commission as European Nuclear Safety Regulators Group (ENSREG) to develop the scope and modalities for the stress tests with the support of the Western European Nuclear Regulators' Association (WENRA). WENRA drafted the preliminary stress tests specifications in April [1]. Consensus on these specifications was achieved by ENSREG and the European Commission on 24 May 2011 [2]. The Commission and ENSREG agreed that the work on the stress tests should be carried along two parallel tracks; a safety track to assess how nuclear installations can withstand the consequences of various extreme external events and a security track to analyse security threats and incidents due to malevolent or terrorist acts. The work on security was carried out by an Ad hoc Group on Nuclear Security composed of Member States experts. The present manuscript deals exclusively with the safety track of the stress tests and peer review. The specifications of the peer review [3] as well as a working paper on the transparency aspects of the EU stress tests [4] were agreed upon at the 11 October 2011 ENSREG meeting.

## **2 Full Description**

### **Stress tests and peer review organisation**

The safety track of the stress tests and peer review focused on three topics which were directly derived from the preliminary lessons learned from the Fukushima disaster and confirmed by the IAEA missions following the accident and reports from the Japanese Government. Natural hazards—including earthquake, tsunami and extreme weather—, the loss

of safety systems and severe accident management were the main topics for review. The stress tests and peer review assessed these topics in a three step process. The first step required the operators to perform an assessment and make proposals for safety improvements, following the ENSREG specifications. The second step was for the national regulators to perform an independent review of the operators' assessments and issue requirements, whenever appropriate. The last step was a European peer review of the national reports submitted by regulators [5].

The objectives of the peer review were to assess the compliance of the stress tests with the ENSREG specifications, to check that no important problem has been overlooked and to identify strong features, weaknesses and relevant proposals to increase plant robustness in light of the preliminary lessons learned from the Fukushima disaster.

The 15 European Union countries with nuclear power plants as well as Switzerland and Ukraine performed the stress tests and were subjected to the peer review. The peer review was managed by a Board that consisted of 7 senior regulators from EU countries and an EC senior manager. Each national regulator was invited to nominate one expert for each of the three topical areas. Most of the experts were experienced regulators. Knowledgeable scientists or consultants designated by regulators from nuclear and non nuclear European countries also participated. The European Commission also nominated experts. There were over 70 reviewers from 24 European countries participating in the peer review.

The peer review itself started with a desktop review of the national reports. The review was structured by the 3 topics of the stress tests: natural hazards, loss of safety systems and severe accident management. Each of the 17 countries subjected to the peer review had to make a presentation to each of the three topical teams, to answer the written questions as well as additional questions asked during presentations. The findings of the review were shared between the 3 teams at the end of the process. Finally, the results of the review were grouped country by country in order to produce draft country reports.

Then, a series of country reviews began. Each country subjected to the peer review was visited by a team of eight peer reviewers for three or four days. Complementary discussions were held in order to obtain appropriate answers to the questions left open after the topical review as well as clarification on important issues. A plant selected by the review team was also visited in each country. The reports drafted during the topical reviews were completed using additional information obtained during the visits. The 17 country reports were used by the peer review Board to refine the preliminary conclusions drawn from the topical reviews and to write the final peer review report of ENSREG [6].

Transparency and an opportunity for public involvement have been objectives of the peer review from the beginning. The public input has improved the stress test peer review process. Comments received in the public meeting influenced the structure of the final report.

### **Main results of the peer review**

The peer review concluded that all countries have taken significant steps to improve the safety of their plants, with varying degrees of practical implementation. In spite of differences in the national approaches and degree of implementation, the peer review showed an overall consistency across Europe in the identification of strong features, weaknesses and possible ways to increase plant robustness in light of the preliminary lessons learned from the Fukushima disaster. As a result of the stress tests, significant measures to increase robustness of plants have already been decided or are considered. Such measures include provisions of additional mobile equipment to prevent or mitigate severe accidents, installation of hardened fixed equipment, and the improvement of severe accident management, together with appropriate staff training measures. In many cases, important modifications are being prepared for the near future. The peer review also identified four main areas of improvement to be considered at the European level.

### **European guidance on assessment of natural hazards and margins**

Overall, the compliance of installations with their design basis for earthquake and flooding was good. However there was a lack of consistency identified with respect to natural hazards assessment where significant differences exist in national approaches and where difficulties were encountered with beyond design margins and cliff-edge effects assessments. Therefore, the peer review Board recommended that WENRA, involving the best available expertise from Europe, develop guidance on natural hazards assessments, including earthquake, flooding and extreme weather conditions, as well as corresponding guidance on the assessment of margins beyond the design basis and cliff-edge effects.

### **Periodic Safety Review**

The peer review demonstrated the positive contribution of periodic safety reviews as an efficient tool to maintain and improve the safety and robustness of plants. In the context of the peer review, this finding was especially relevant for the protection of installations against natural hazards. Therefore, the peer review Board recommended that ENSREG underline the importance of periodic safety review. In particular, ENSREG should highlight the necessity to re-evaluate natural hazards and relevant plant provisions as often as appropriate but at least every 10 years.

### **Containment integrity**

The Fukushima disaster highlighted once again the importance of the containment function, which is critical, as the last barrier to protect the people and the environment against radioactive releases resulting from a nuclear accident. This issue was already extensively considered, as a follow-up of previous accidents, and possible improvements were identified. Their expeditious implementation appeared to be a crucial issue in light of Fukushima accident. Therefore, urgent implementation of the recognised measures to protect containment integrity is a finding of the peer review that national regulators should consider. The measures to be taken can vary depending on the design of the plants. For water cooled reactors, they include equipment, procedures and accident management guidelines to:

- depressurize the primary circuit in order to prevent high-pressure core melt;
- prevent hydrogen explosions;
- prevent containment overpressure.

### **Prevention of accidents resulting from natural hazards and limiting their consequences**

The Fukushima disaster has also shown that defence-in-depth should be strengthened by taking into account severe accidents resulting from extreme natural hazards exceeding the levels taken into account by the design basis and current safety requirements applicable to the plants. Such situations can result in devastation and isolation of the site, an event of long duration, unavailability of numerous safety systems, simultaneous accidents of several plants including their spent fuel pools, and the presence of radioactive releases. Therefore, necessary implementation of measures allowing prevention of accidents and limitation of their consequences in case of extreme natural hazards is a finding of the peer review that national regulators should consider.

Typical measures which can be considered are bunkered equipment to prevent and manage severe accident including instrumentation and communication means, mobile equipment protected against extreme natural hazards, emergency response centres protected against extreme natural hazards and contamination, rescue teams and equipment rapidly available to support local operators in long duration events.

## **3 Summary and conclusion**

The peer review Board recognised that full understanding of the Fukushima accident will be a long-term process extending over several years, possibly a decade. The peer review has demonstrated the benefit of sharing between national regulators the results of the stress

tests and ideas for strengthening safety and robustness of plants. In the spirit of continuous improvement for safety, the peer review Board considered that a follow-up of the actions resulting from the present stress tests as well as future assessments would be beneficial.

One of the important results of the public interaction is a strong demand for a European initiative on off-site emergency preparedness. This subject was not part of the mandate of the peer review. However, the Board recognised importance of off-site emergency preparedness in Europe, as a followup of the Fukushima disaster.

The peer review of the European stress tests was completed in April 2012. In their conclusive statement issued 26 April 2012, the national European regulators and the European Commission as European Nuclear Safety Regulators Group (ENSREG) required that follow-up would occur by way of an ENSREG action plan. Country specific action plans will be developed and peer review workshop will be organised to share lessons learned on the implementation of post-Fukushima safety improvements. Fact-finding follow-up site visits will also be organised in order to better prepare for the peer review workshop. The post Fukushima actions will be carried out with full transparency. The outcomes of the peer review workshop will be presented to the public in the next ENSREG conference and the country-specific plans will also be publicly available.

Finally, it should be mentioned that performing such a peer review was a challenge and required very significant resources from the participating countries. In that sense, it should be considered as an exceptional exercise, which cannot be reproduced frequently. Notwithstanding, it was judged very positively by most of the participants and is expected to contribute to enhancing safety in Europe and in each European country.

## References

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