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Preliminary Expert Assessment of the Fukushima Accident

Mike Weightman, United Kingdom
HM Chief Inspector of Nuclear Installations
Executive Head of the Office for Nuclear Regulation (ONR)

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International Atomic Energy Agency

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Background - General

- 11 March 2011
  - Magnitude 9 earthquake
  - Tsunami up to 40m
  - 10s of thousands lost and missing
  - Severe impairment of infrastructure

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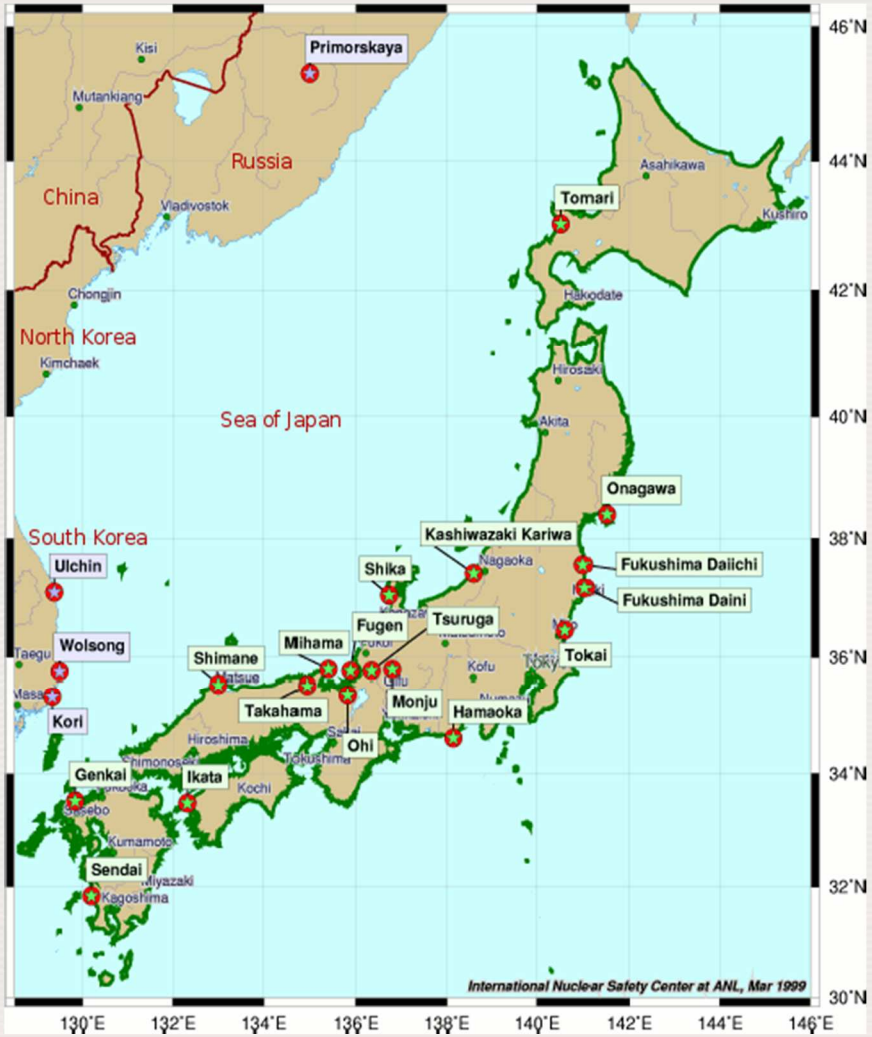
Background - NPP

- East Coast NPP affected
  - Tokai, Higashi Dori, Onagawa, Fukushima Dai-ichi and Dai-ni
- Shutdown following ground motion
- All affected by tsunami to lesser or greater extent



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Background – Fukushima Dai-ichi

- Catastrophic, unprecedented scenario
  - Overwhelmed by 14m tsunami
  - Extensive damage across multiple units
  - Loss of all external power and all but 1 DG
  - Loss of safety systems
  - Prolonged Station Blackout situation
  - Series of massive explosions
  - Contamination & high radiation field

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IAEA Expert Team

- IAEA – GoJ agreement to fact finding mission

- Team of world experts
- Find facts, identify lessons
- Gain appreciation of situation
- 24 May – 1 June

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Activity - General

- Open provision of information
  - Operators, Regulators, Government
- Ministerial Meetings

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Activity – Site Visits

- Tokai 2
- Fukushima Dai-ni
- Fukushima Dai-ichi

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Activity – Site Visits – J Village

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Activity – Site Visits – Dai-ni

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Activity – Site Visits – Dai-ni

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Activity – Site Visits – Dai-ichi

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Activity – Site Visits – Dai-ichi

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Activity – Site Visits – Dai-ichi

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Activity – Site Visits – Dai-ichi

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Activity – Site Visits – Dai-ichi

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Activity – Presentation to PM office

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Outcome - General

- Appreciation of situation
- Knowledge of facts - openly provided
- Preliminary assessment
  - 15 conclusions
  - 16 lessons
  - Relevant to Japan, IAEA and worldwide nuclear community
  - Report based on IAEA Safety Standards – Fundamental Principles, safety recommendations and guides, safety services

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Mission Conclusions

- **Conclusion 1: The IAEA Fundamental Safety Principles provide a robust basis in relation to the circumstances of the Fukushima accident and cover all the areas of lessons learned from the accident.**
- **Conclusion 2: Given the extreme circumstances of this accident the local management of the accident has been conducted in the best way possible and following Fundamental Principle 3.**
- **Conclusion 3: There were insufficient defence-in-depth provisions for tsunami hazards.**
- **Conclusion 4: There is a need for short term evaluation, plans and implementation to secure safety for Tokai, Fukushima Dai-ichi and Dai-ni.**

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Mission Conclusions

- **Conclusion 5: An updating of regulatory requirements and guidelines should be performed reflecting the experience and data obtained during the Great East Japan Earthquake and Tsunami, based on IAEA Safety Standards, using latest R&D in related fields.**

- **Conclusion 6: Japan has a well organized emergency preparedness and response system as demonstrated by the handling of the Fukushima accident. Nevertheless, complicated structures and organizations can result in delays in urgent decision making.**

- **Conclusion 7: Dedicated and devoted officials and workers, and a well organized and flexible system made it possible to reach an effective response even in unexpected situations and prevented a larger impact of the accident on the health of the general public and facility workers.**

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Mission Conclusions

- **Conclusion 8: A suitable follow up programme on public exposures and health monitoring would be beneficial.**
- **Conclusion 9: There appears to have been effective control of radiation exposures on the affected sites despite the severe disruption by the events.**
- **Conclusion 10: The IAEA Safety Requirements and Guides should be reviewed to ensure that the particular requirements in design and severe accident management for multi-plant sites are adequately covered.**

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Mission Conclusions

- **Conclusion 11: There is a need to consider the periodic alignment of national regulations and guidance to internationally established standards and guidance for inclusion in particular of new lessons learned from global experiences of the impact of external hazards.**

- **Conclusion 12: The Safety Review Services available with the IAEA's International Seismic Safety Centre (ISSC) would be useful in assisting Japan's development in the following areas:**
  - **External event hazard assessment;**
  - **Walk downs for plants that will start up following a shutdown; and**
  - **Pre-earthquake preparedness.**

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Mission Conclusions

- **Conclusion 13: A follow-up mission including Emergency Preparedness Review (EPREV) should look in detail at lessons to be learned from the emergency response on and off the site.**

- **Conclusion 14: A follow-up mission should be conducted to seek lessons from the effective approach used to provide large scale radiation protection in response to the Fukushima accident.**

- **Conclusion 15: A follow-up mission to the 2007 Integrated Regulatory Review Service (IRRS) should be conducted in light of the lessons to be learned from the Fukushima accident and the above conclusions to assist in any further development of the Japanese nuclear regulatory system.**

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Mission Lessons

- **Lesson 1: There is a need to ensure that in considering external natural hazards:**
  - **the siting and design of nuclear plants should include sufficient protection against infrequent and complex combinations of external events and these should be considered in the plant safety analysis – specifically those that can cause site flooding and which may have longer term impacts;**
  - **plant layout should be based on maintaining a 'dry site concept', where practicable, as a defence-in-depth measure against site flooding as well as physical separation and diversity of critical safety systems;**
  - **common cause failure should be particularly considered for multiple unit sites and multiple sites, and for independent unit recovery options, utilizing all on-site resources should be provided;**
  - **any changes in external hazards or understanding of them should be periodically reviewed for their impact on the current plant configuration; and**
  - **an active tsunami warning system should be established with the provision for immediate operator action.**

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Mission Lessons

- **Lesson 2: For severe situations, such as total loss of off-site power or loss of all heat sinks or the engineering safety systems, simple alternative sources for these functions including any necessary equipment (such as mobile power, compressed air and water supplies) should be provided for severe accident management.**

- **Lesson 3: Such provisions as are identified in Lesson 2 should be located at a safe place and the plant operators should be trained to use them. This may involve centralized stores and means to rapidly transfer them to the affected site(s).**

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Mission Lessons

- **Lesson 4: Nuclear sites should have adequate on-site seismically robust, suitably shielded, ventilated and well equipped buildings to house the Emergency Response Centres, with similar capabilities to those provided at Fukushima Dai-ni and Dai-ichi, which are also secure against other external hazards such as flooding. They will require sufficient provisions and must be sized to maintain the welfare and radiological protection of workers needed to manage the accident.**

- **Lesson 5: Emergency Response Centres should have available as far as practicable essential safety related parameters based on hardened instrumentation and lines such as coolant levels, containment status, pressure, etc., and have sufficient secure communication lines to control rooms and other places on-site and off-site.**

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Mission Lessons

- **Lesson 6: Severe Accident Management Guidelines and associated procedures should take account of the potential unavailability of instruments, lighting, power and abnormal conditions including plant state and high radiation fields.**

- **Lesson 7: External events have a potential of affecting several plants and several units at the plants at the same time. This requires a sufficiently large resource in terms of trained experienced people, equipment, supplies and external support. An adequate pool of experienced personnel who can deal with each type of unit and can be called upon to support the affected sites should be ensured.**

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Mission Lessons

- **Lesson 8: The risk and implications of hydrogen explosions should be revisited and necessary mitigating systems should be implemented.**

- **Lesson 9: Particularly in relation to preventing loss of safety functionality, the robustness of defence-in-depth against common cause failure should be based on providing adequate diversity (as well as redundancy and physical separation) for essential safety functions.**

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Mission Lessons

- **Lesson 10: Greater consideration should be given to providing hardened systems, communications and sources of monitoring equipment for providing essential information for on-site and off-site responses, especially for severe accidents.**

- **Lesson 11: The use of IAEA Safety Requirements (such as GS-R-2) and related guides on threat categorization, event classification and countermeasures, as well as Operational Intervention Levels, could make the off-site emergency preparedness and response even more effective in particular circumstances.**

- **Lesson 12: The use of long term sheltering is not an effective approach.**

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Mission Lessons

- **Lessons 13: The international nuclear community should take advantage of the data and information generated from the Fukushima accident to improve and refine the existing methods and models to determine the source term involved in a nuclear accident and refine emergency planning arrangements.**

- **Lesson 14: Large scale radiation protection for workers on sites under severe accident conditions can be effective if appropriately organized and with well led and suitable trained staff.**

- **Lesson 15: Exercises and drills for on-site workers and external responders in order to establish effective on-site radiological protection in severe accident conditions would benefit from taking account of the experiences at Fukushima.**

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Mission Lessons

- **Lesson 16: Nuclear regulatory systems should ensure that regulatory independence and clarity of roles are preserved in all circumstances in line with IAEA Safety Standards.**

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Summary

Many learning opportunities – most severe circumstances

Concentrate on Securing the 3 Cs

- Containment, cooling, control

Robust Design for external hazards

- Postulate events
- Robust methods

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Summary

Prepare for severe accidents

- Multiple, independent barriers
- Simple, effective contingency measures
- Trained and capable response

Develop robust emergency arrangements for such circumstances

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Summary

- World must grasp this opportunity
- To Seek to learn and improve
- Foundation Stone of Sustained High Standards of Nuclear Safety

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