Fukushima 2011 Disaster

This detailed information supplements the 2011 Disaster topic stated in the CMBG Survival Guide.

The 2011 Disaster

On March 11, 2011, a magnitude 9.0 earthquake struck Japan, triggering a massive tsunami that damaged the Fukushima Daiichi Nuclear Power Plant. The tsunami caused Beyond Design Basis (BDB) flooding caused the emergency power supplies and electrical distribution systems to be inoperable, resulting in an ELAP in several of the six units on the site. The ELAP led to (1) the loss of core cooling, (2) loss of spent fuel pool cooling capabilities, and (3) a significant challenge to maintaining containment integrity. All DC power was lost early in the event on Units 1 and 2 and after some period of time at the other units. Core damage occurred in three of the units along with a loss of containment integrity resulting in the release of radioactive material to the surrounding environment.

Approximately 160,000 people were evacuated from the surrounding towns, and a 20-kilometer exclusion zone was established around the plant. While no deaths were directly caused by radiation, the disaster indirectly contributed to over 2,000 disaster-related deaths due to stress, evacuation, and medical interruptions.

This event created several industry responses including:

Immediate US Nuclear Industry Actions - Shortly after the events at Fukushima, INPO issued three event reports (IER) with recommendations for actions by the US nuclear industry as follows:

- IER L1-11-1: recommended actions (e.g., walkdowns and inspections) to ensure the functionality of existing strategies and associated equipment for mitigating extreme

- events at US nuclear sites. A supplement to IER L1-11-1 recommended actions to address apparent causes and organizational contributors to the performance issues identified in responses to IER L1-11-1.

- IER L1-11-2: recommended actions to provide assurance that each station increases the sensitivity to spent fuel storage event response and that a high state of readiness is maintained to respond to events that challenge spent fuel pool integrity. These actions focused on ensuring that the knowledge of spent fuel pool conditions would be maintained throughout an accident scenario.

- IER L1-11-4: recommended actions to develop methods to maintain (or restore) core cooling, containment integrity, and spent fuel pool integrity during an ELAP, including associated support functions such as required instrumentation, providing fuel to emergency equipment, and communications.

Regulatory Actions - Near Term Task Force (NTTF)

The NRC assembled an NTTF to advise the Commission on actions the US nuclear industry should take to preclude core damage and the release of radioactive material after a natural disaster such as that seen at Fukushima. The NTTF report contained many recommendations to fulfill this charter, including assessing extreme external event hazards and strengthening station capabilities for responding to beyond-design-basis external events (BDBEE).

- **NRC Order -** Based on NTTF Recommendation 4.2, the NRC issued Order EA-12-049 on March 12, 2012 to implement mitigation strategies for BDBEE. The order provided the following requirements for strategies to mitigate a BDBEE:

- Licensees shall develop, implement, and maintain guidance and strategies to maintain or restore core cooling, containment, and SFP cooling capabilities following a BDBEE. These strategies must be capable of mitigating a simultaneous loss of all AC power and loss of normal access to the ultimate heat sink and have adequate capacity to address challenges to core cooling, containment and SFP cooling capabilities at all units on a site subject to the Order.

- Licensees must provide reasonable protection for the associated equipment from external events. Such protection must demonstrate that there is adequate capacity to address challenges to core cooling, containment, and SFP cooling capabilities at all units on a site subject to the Order.

- Licensees must be capable of implementing the strategies in all modes. Full compliance shall include procedures, guidance, training, and acquisition, staging or installing of equipment needed for the strategies.

- The Order specifies a three-phase approach for strategies to mitigate a BDBEE. NRC Order EA-12-049 required licensees of operating reactors to submit an overall integrated plan, including a description of how compliance with these requirements would be achieved by February 28, 2013. The Order also required licensees to complete implementation of the requirements no later than two refueling cycles after submittal of the overall integrated plan or December 31, 2016, whichever comes first.

The Industry's Response to the NRC Order

- The Nuclear Energy Institute (NEI) developed NEI 12-06, *Diverse and Flexible Coping Strategies (FLEX) Implementation Guide* which provides guidelines for nuclear stations to assess extreme external hazards and implement the mitigation strategies specified in NRC Order EA-12-049.

- The NRC issued Japan Lessons- Learned Project Directorate (JLD) Interim Staff Guidance (ISG) JLD-ISG-2012-01, *Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events*, dated August 29, 2012, which endorsed Revision 0 of NEI 12-06 with clarifications on determining baseline coping capability and equipment quality.

- In December 2015, NEI issued Revision 2 of NEI 12-06. On January 22, 2016, the NRC issued Revision1 to JLD-ISG-2012-01. The revised ISG endorses, with exceptions, additions, and clarifications, the methodologies described in the industry guidance document, NEI 12-06, Revision 2.

The following NEI guidance documents are necessary to meet and implement the FLEX strategies.

- NEI 12-01, Guideline for Assessing Beyond Design Basis Accident Response Staffing and Communications Capabilities.

- NEI 13-02, Industry Guidance for Compliance with Order EA-13-109: BWR Mark I & II Reliable Hardened Containment Vents Capable of Operation under Severe Accident Conditions.

- NEI 12-02, Industry Guidance for Compliance with Nuclear Regulatory Commission (NRC) Order EA-12-051, “To Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation”.

Strategic Alliance for FLEX Emergency Response (SAFER) Centers

The nuclear industry has two National Response Centers, one in Memphis, TN, and one in Phoenix, AZ. These response centers help U.S. nuclear power plants meet the requirements of the NRC's Mitigation Strategies Order. The centers contain extra equipment to duplicate plants' emergency diesel generators, pumps, hoses, etc. This equipment would maintain plant safety functions for an indefinite period if an event disabled a plant's installed safety systems. An industry group, called the Strategic Alliance for FLEX Emergency Response (SAFER), is managing the response centers.

Current Status as of April, 2026

Fifteen years later, recovery and decommissioning efforts continue. The reactors remain highly radioactive, and the exact location of melted fuel is still uncertain. Spent fuel removal from Units 3 and 4 has been completed, and preparations are ongoing for Units 1 and 2. Contaminated water is treated using the ALPS system, with controlled releases into the ocean under monitoring, and radiation levels in the marine environment are reported as low and stable. Soil decontamination is ongoing, with a goal to remove radioactive soil by 2045.

Life in Fukushima Today as of April, 2026

Some towns, like Okuma, have been partially resettled, with new residents and infrastructure projects, but large areas remain unsafe to enter, particularly forests and abandoned zones. Radiation monitoring continues along highways and in public spaces, and food safety is strictly regulated. The government offers incentives for resettlement, but many former residents remain hesitant due to lingering radiation concerns and social stigma.

Energy and Decommissioning

The Fukushima disaster led to a shutdown of Japan’s nuclear reactors, with only a fraction now operational. Decommissioning of the Daiichi plant is planned in phases, with final closure expected between 2041 and 2051. Research and innovation centers, such as F-REI, have been established to study robotics, renewable energy, and radiation management in the region.