Fukushima accident underscores need for US to seek out new information about nuclear plant hazards

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A new congressionally mandated report from the National Academy of Sciences concludes that the overarching lesson learned from the 2011 Fukushima Daiichi nuclear accident is that nuclear plant licensees and their regulators must actively seek out and act on new information about hazards with the potential to affect the safety of nuclear plants. The committee that wrote the report examined the causes of the Japan accident and identified findings and recommendations for improving nuclear plant safety and offsite emergency responses to nuclear plant accidents in the U.S.

The accident at the Fukushima Daiichi plant was initiated by the Great East Japan Earthquake and tsunami on March 11, 2011. The earthquake knocked out offsite AC power to the plant, and the tsunami inundated portions of the plant site. Flooding of critical equipment resulted in the extended loss of onsite power with the consequent loss of reactor monitoring, control, and cooling functions in multiple units. Three reactors—Units 1, 2, and 3—sustained severe core damage, and three reactor buildings—Units 1, 3, and 4—were damaged by hydrogen explosions. Offsite releases of radioactive materials contaminated land in Fukushima and several neighboring prefectures, prompting widespread evacuations, distress among the population, large economic losses, and the eventual shutdown of all nuclear power plants in Japan.

Personnel at the Fukushima Daiichi plant responded to the accident with

courage and resilience, and their actions likely reduced its severity and the magnitude of offsite radioactive material releases, the committee said. However, several factors relating to the management, design, and operation of the plant prevented plant personnel from achieving greater success and contributed to the overall severity of the accident.

Nuclear plant operators and regulators in the U.S. and other countries are taking useful actions to upgrade nuclear plant systems, operating procedures, and operator training in response to the Fukushima Daiichi accident. As the U.S. nuclear industry and its regulator, the U.S. Nuclear Regulatory Commission (USNRC), implement these actions, the report recommends particular attention to improving the availability, reliability, redundancy, and diversity of specific nuclear plant systems:

- DC power for instrumentation and safety system control
- Tools for estimating real-time plant status during loss of power
- Reactor heat removal, reactor depressurization, and containment venting systems and protocols
- Instrumentation for monitoring critical thermodynamic parameters—for example temperature and pressure—in reactors, containments, and spent-fuel pools
- Hydrogen monitoring, including monitoring in reactor buildings, and mitigation
- Instrumentation for both onsite and offsite radiation and security monitoring
- Communications and real-time information systems

To further improve the resilience of U.S. nuclear plants, the report also recommends:

- The U.S. nuclear industry and the USNRC should give specific attention to improving resource availability and operator training,

including training for developing and implementing ad hoc responses to deal with unanticipated complexities.

- The U.S. nuclear industry and USNRC should strengthen their capabilities for assessing risks from events that could challenge the design of nuclear plant structures and components and lead to a loss of critical safety functions. Part of this effort should focus on events that have the potential to affect large geographic regions and multiple nuclear plants, including earthquakes, tsunamis and other geographically extensive floods, and geomagnetic disturbances. USNRC should support these efforts by providing guidance on approaches and overseeing rigorous peer review.
- USNRC should further incorporate modern risk concepts into its nuclear safety regulations using these strengthened capabilities.
- USNRC and the U.S. nuclear industry must continuously monitor and maintain a strong safety culture and should examine opportunities to increase the transparency of and communication about their efforts to assess and improve nuclear safety.

Until now, U.S. safety regulations have been based on ensuring plants are designed to withstand certain specified failures or abnormal events, or "design-basis-events"— such as equipment failures, loss of power, and inability to cool the reactor core—that could impair critical safety functions. However, four decades of analysis and experience have demonstrated that reactor core-damage risks are dominated by "beyond-design-basis events," the report says. The Fukushima Daiichi, Three Mile Island, and Chernobyl accidents were all initiated by beyond-design-basis events. The committee found that current approaches for regulating nuclear plant safety, which have been based traditionally on deterministic concepts such as the design-basis accident, are clearly inadequate for preventing core-melt accidents and mitigating their consequences. A more complete application of modern risk-assessment principles in licensing and regulation could help address this inadequacy

and enhance the overall safety of all nuclear plants, present and future.

The Fukushima Daiichi accident raised the question of whether offsite emergency preparedness in the U.S. would be challenged if a similar-scale event—involving several concurrent disasters—occurred here. The committee lacked time and resources to perform an in-depth examination of U.S. preparedness for severe nuclear accidents. The report recommends that the nuclear industry and organizations with emergency management responsibilities assess their preparedness for severe nuclear accidents associated with offsite regional-scale disasters. Emergency response plans, including plans for communicating with affected populations, should be revised or supplemented to ensure that there are scalable and effective strategies, well-trained personnel, and adequate resources for responding to long-duration accident/disaster scenarios. In addition, industry and emergency management organizations should assess the balance of protective actions—such as evacuation, sheltering-in-place, and potassium iodide distribution—for affected offsite populations and revise the guidelines as appropriate. Particular attention should be given to protective actions for children, those who are ill, and the elderly and their caregivers; long-term social, psychological, and economic impacts of sheltering-in-place, evacuation, and/or relocation; and decision making for resettlement of evacuated populations in areas that were contaminated by radioactive material.

More information: www.nap.edu/catalog.php?record_id=18294

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