Frequently asked questions related to the March 11, 2011 Japanese earthquake and tsunami as applied to the U.S. Department of Energy's Idaho site

1. **What level of earthquake hazard would the Idaho National Laboratory (INL) reactors survive?** (Adapted from US Nuclear Regulatory Commission frequently asked questions related to the March 11, 2011 Japanese Earthquake and Tsunami)

   An earthquake's magnitude is a measure of the strength of the earthquake as determined from seismographic observations. Magnitude is essentially an objective, quantitative measure of the size of an earthquake. The magnitude can be expressed in various ways based on seismographic records (e.g., Richter Local Magnitude, Surface Wave Magnitude, Body Wave Magnitude, and Moment Magnitude). Currently, the most commonly used magnitude measurement is the Moment Magnitude, Mw, which is based on the strength of the rock that ruptured, the area of the fault that ruptured, and the average amount of slip. Moment magnitude is, therefore, a direct measure of the energy released during an earthquake.

   Because of the logarithmic basis of the scale, each whole number increase in magnitude represents a tenfold increase in measured amplitude; as an estimate of energy, each whole number step in the magnitude scale corresponds to the release of about 31 times more energy than the amount associated with the preceding whole number value.

   The Richter magnitude scale was developed in 1935 by Charles F. Richter of the California Institute of Technology and was based on the behavior of a specific seismograph that was manufactured at that time. The instruments are no longer in use and the magnitude scale is, therefore, no longer used in the technical community. However, the Richter Scale is a term that is so commonly used by the public that scientists generally just answer questions about "Richter" magnitude by substituting moment magnitude without correcting the misunderstanding.

   Nuclear plants, and in fact all engineered structures, are actually designed based on ground motion levels, not earthquake magnitudes. Ground motion is a function of the magnitude of an earthquake, the distance from the fault to the site, and other elements such as the geologic materials through which the waves pass. The ATR was originally designed on a "deterministic" or "scenario earthquake" basis that accounted for the largest earthquakes expected in the area around the plant, without consideration of the likelihood of the earthquakes considered. New seismic evaluations of the ATR use probabilistic techniques that characterize both the ground motion levels and uncertainty at the ATR site. These probabilistic techniques account for the ground motions that may result from all potential seismic sources in the region around the site. Technically speaking, this is the ground motion with an annual frequency of occurrence of 1x10-4/year, but this can be thought of as the ground motion that occurs every 10,000 years on average. The ground motion at the ATR foundation anticipated from this severe earthquake has a peak acceleration of 0.19g. The ATR is designed to survive this force with no significant damage. Moreover, unlike Japan the DOE's Idaho site is not a location with high seismic activity.

2. What types of nuclear facilities exist at the DOE's Idaho site?

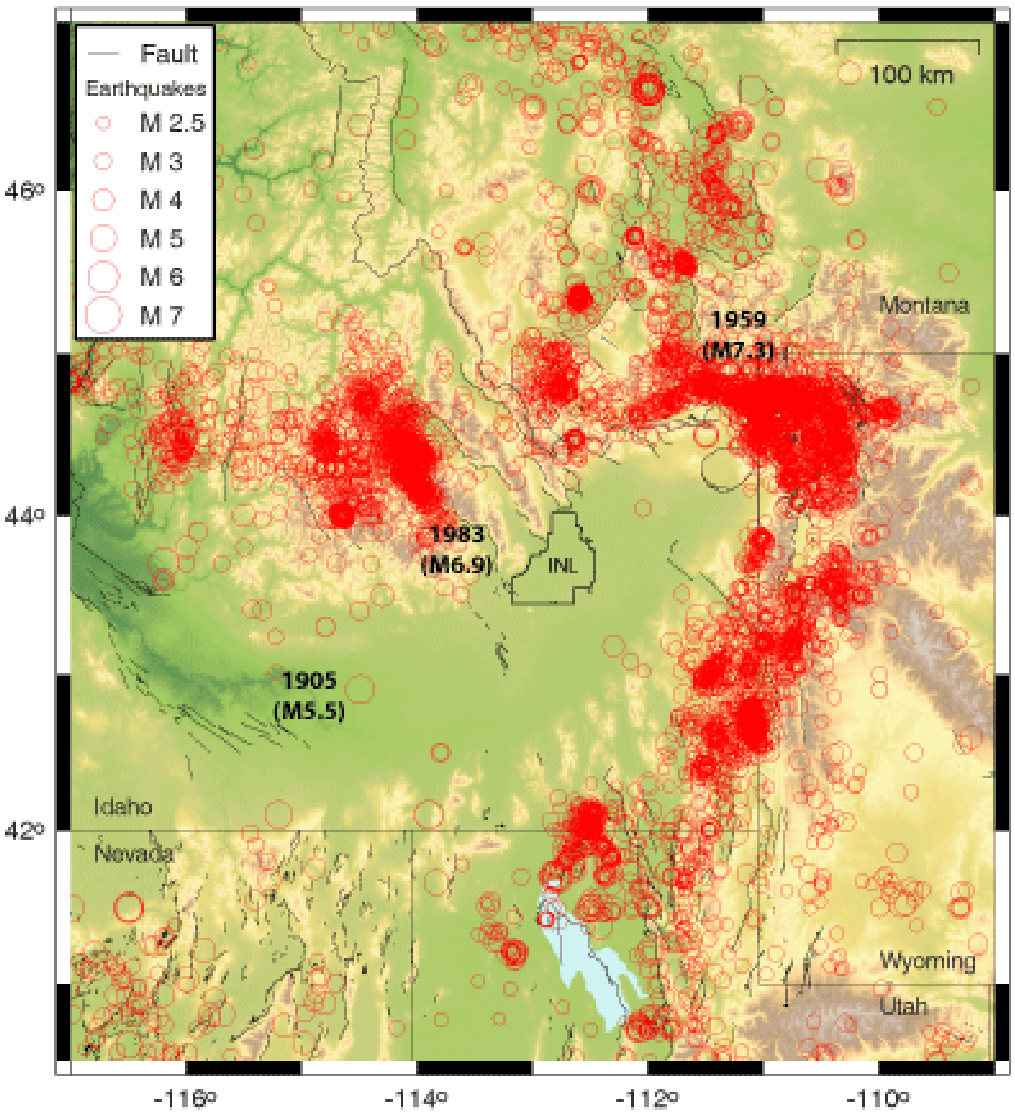
The major operating nuclear facilities managed by the DOE Idaho Operations Office at the DOE's Idaho site include operating reactors and non-reactor nuclear facilities. There are three operating reactors. The Advanced Test Reactor (ATR) is a small 250 mega-watt (MW) research reactor. During routine operation, the ATR is less than one-tenth the size of each Japanese reactor in terms of thermal power produced. The ATR Critical (ATRC) is a smaller replica of ATR used to test experiments before beginning irradiation in ATR with a maximum power level of 5 kilo-watt (kW). The ATR and ATRC facilities are located at the Advanced Test Reactor Complex on the south west portion of the DOE Idaho Site. The Neutron Radiography reactor (NRAD) is a much smaller 250 kW pool type TRIGA (Training Research & Isotopes by General Atomics) that is used for neutron radiography, allowing researchers to examine the insides of nuclear fuel and other material similar to the way X-rays are used. The NRAD reactor is located at the Materials and Fuels Complex (MFC). In addition to the described facilities, the Naval Nuclear Propulsion Program operates several facilities at the Idaho site.

Other non-reactor nuclear facilities at the DOE Idaho site include wet and dry spent fuel storage facilities (at the ATR complex, MFC and the Idaho Nuclear Technology and Engineering Center [INTEC]), large shielded cells where research is done on irradiated materials at MFC, new fuel and nuclear material storage facilities at the ATR Complex and MFC and a variety of facilities for managing and retrieving stored and buried radiological waste (at MFC and the Radioactive Waste Management Complex) for eventual, compliant disposal. Two waste treatment facilities exist on site: The Advanced Mixed Waste Treatment Project (AMWTP), and the Sodium Bearing Waste Treatment Project (SBWTP). AMWTP is operational and primarily conducts size reduction of retrieved waste, sending treated waste to compliant disposal. The SBWTP will be operational at the end of calendar year 2011, with a mission length of ten to twelve months.

3. What is the seismic activity like at the DOE's Idaho site?

The DOE's 890-square-mile Idaho site is located on the Eastern Snake River Plain, which is seismically quiet compared to the surrounding mountains. The map below shows seismic events from 1850-2007 with magnitudes greater than 2.5. As shown in the map (below), many significant seismic events have been recorded in the mountains around the DOE's Idaho site, but the site, itself, is well isolated from these events. In 1983, the DOE's Idaho site felt the Mt. Borah earthquake which was a magnitude 6.9 (elsewhere described as a 7.3 magnitude on a different scale). The earthquake was centered about 55 miles away from the ATR site. Ground accelerations from the earthquake were felt at the DOE's Idaho site and the ATR site. The peak horizontal acceleration (0.023 g) recorded at the ATR Complex was well below the severe earthquake for ATR.

A severe earthquake, called a "safe shutdown earthquake" for ATR, is considered to be an earthquake likely to occur only once in a 10,000 year interval. For ATR, this earthquake has peak horizontal acceleration of 0.19g.



Historic Regional Seismic Activity 1850-2007 at DOE's Idaho Site

4. Are the reactors at the DOE's Idaho site able to survive a severe earthquake?

Yes. The DOE;s Idaho site has three operating reactors; two very small pool reactors and a relatively small test reactor called the Advanced Test Reactor (ATR). The two pool reactors are very low power and generate very little heat. Consequently they do not have the same heat removal concerns as commercial power reactors. The ATR also has a much lower heat load than commercial reactors (including the Japanese reactors) due to a much lower design power, much lower operating temperature, and much shorter operating cycle. The ATR is a 250 MW reactor, about 1/10 the power of the commercial Japanese reactors. It is designed to automatically shut itself down before ground motions become large enough to do any damage to the reactor. This automatic shutdown occurs at 0.01g. While there may be widespread damage to non-essential structures at the ATR reactor site, the ATR reactor substructure (basements), reactor vessel, primary coolant system, shutdown system, and long term cooling will continue to function sufficient to assure the safety of the public.

5. Is the ATR prepared to supply cooling water to the reactor after a severe earthquake?

Yes. The ATR is built to survive a severe earthquake. Even though there may be widespread damage to nonessential equipment, the substructure, reactor vessel, primary coolant system (PCS), shutdown system, and long term cooling would continue to function sufficient to assure the safety of the public.

The emergency coolant system is comprised of numerous redundant and diverse systems that will survive a severe earthquake. Millions of gallons of stored on site water can provide enough pressure from gravity to supply water to the ATR reactor core in the event that all pumps are lost. There are numerous other on site water and sources (i.e. wells) that could be used in case of an emergency.

6. Are the ATR and the Materials and Fuels Complex prepared for a long term loss of electrical power similar to what occurred at the Fukushima Daiichi Nuclear Station?

The DOE’s Idaho site implements processes which examine potential hazards to nuclear facilities and how those could be prevented and/or minimized. All accident consequences are of concern to the DOE. The DOE’s Idaho site has systematic processes which look at hazards both man-made and natural and determine the extent to which the hazard could damage and cause undesirable effects to facility workers, members of the public and the environment. Of greatest concern are facilities which have accident consequences which could impact members of the public.

The ATR has numerous backup diesel water pumps and electrical generators that can supply both electrical power and water to the ATR in a long term loss of electrical power. In 2005, the ATR installed long-term remote emergency power to a deep well pump when a routine review of a related Nuclear Regulatory Commission notice revealed that this was a weakness.

MFC has two facilities (Fuel Manufacturing Facility [FMF] and Fuel Conditioning Facility [FCF]) which have the potential for consequences which could impact members of the public. In one case, FMF, the facility structure is the safety system which is fortified to withstand the effects of a severe earthquake. The FCF safety system has a ventilation system that is specialty designed to withstand a severe earthquake. To ensure this ventilation system remains operational after a severe earthquake, backup power systems are designed to remain running up to three and one-half days after the event. This system has redundancy with its backup power equipment to ensure a backup safety system is always available.

7. **At the Fukushima Daiichi Nuclear Station batteries for the control power to the steam driven cooling system depleted after their eight hour capacity. What has been done to ensure that your emergency batteries will last long enough to protect the ATR?**

In part due to a very large water coolant inventory to fuel mass ratio, the ATR requires forced water flow for less than one hour. To ensure the water flow, batteries are maintained to power ATR emergency coolant pump operation. After the short period of battery operation, no other power supplies are required to keep the reactor in a safe condition as long as the fuel remains covered with water. The batteries are tested and monitored regularly for proper function and have been determined to last several times longer than is required for their safety function. This is different than the Japanese plants that require power to supply multiple systems to safely cool the plant down and are needed for many days.

Additionally, after a periodic review of the ATR emergency coolant pump battery room, additional seismic strengthening was determined to be prudent and added to ensure the battery room would survive a severe earthquake.

If needed, long term emergency cooling water can be supplied by numerous backup diesel generators that can supply both electrical power and water to the ATR in a long term loss of electrical power.

8. **Could ATR experience a hydrogen explosion like those at the Japanese reactors?**

No. Explosions in the secondary containment buildings at two Japanese reactors were reported to be caused by a build-up of hydrogen, which is extremely flammable. Fuel at the Japanese reactors is clad with zirconium, which rapidly reacts with water at high temperatures to produce hydrogen. ATR fuel is clad with aluminum. Hydrogen production due to steam oxidation of aluminum is minimal. Large, damaging hydrogen explosions such as occurred at the Japanese reactors are not credible for ATR.

9. **What assurance is there that redundant safety systems will function after a severe earthquake?**

The DOE Idaho Site has performed analyses which identify those safety systems which are crucial to safety of the facility, worker, and public. Part of that identification, puts the equipment into categories which ensure it is constructed or procured to function after severe natural phenomenon events (earthquake, flood, etc,). Periodic equipment reviews are conducted to ensure safety systems are operated and maintained as recommended by the vendor and appropriate for the safety function. Contractor and DOE personnel routinely review these crucial safety systems. The purpose of these reviews is to ensure the safety systems will operate as designed and are maintained for design basis accidents including natural phenomenon events.

10. What improvements have been made in the ATR and MFC nuclear facilities to increase their safety?

At the Advanced Test Reactor there have been several major modifications to improve seismic safety margin and improve capability to survive a long term loss of electrical power. The improvements are based on DOE reviews and seismic updates at the DOE's Idaho site. These modifications included upgrades to the ATR emergency cooling water system (also called the Emergency Firewater Injection System), and other components. In addition, the ATR installed remotely located long term backup power as a redundant supply of power for emergency cooling water when a routine review of related Nuclear Regulatory Commission notices about long term electrical power loss revealed that this was a weakness. Lessons learned from industry and periodic hazard reviews are evaluated to improve the design of safety systems on a continuing basis.

The Materials and Fuels Complex is in the process of upgrading its nuclear safety documentation. As part of that effort, the analysis for natural phenomena-related hazards to facilities is re-examined to ensure it is accurate and representative of what could be postulated to occur at the MFC area. The improvements include updated seismic analysis to ensure existing structures are adequate and/or recommendations for physical improvements if natural phenomena vulnerabilities are noted. Examples of improvements include: seismic bracing for portions of the structure in the Fuel Manufacturing Facility (FMF), seismically qualified nuclear material storage racks in FMF, and additional seismic bracing for ancillary equipment in the Fuel Conditioning Facility.

11. Can spent nuclear fuel in the ATR and INTEC fuel pools be cooled in a long term loss of electrical power?

Yes. The fuel storage canal at ATR is stainless steel lined and built into the concrete structure of the ATR building. The canal has been found to be seismically qualified and will withstand a severe earthquake with a large safety factor precluding structural damage. A severe earthquake at ATR would not result in the uncovering of fuel in the spent fuel canal. If for any reason there is a leak in the spent fuel pool, bulkheads with dual seals isolate the spent nuclear fuel and additional water can be supplied to protect against the uncovering of irradiated fuel that requires continued immersion.

The ATR canal contains hundreds of thousands of gallons of water that provides the capacity to allow the stored ATR fuel to be cooled with natural circulation, without the need for a canal cooling system. If for any reason there is a leak in the canal, bulkheads with dual seals and emergency firewater protect against the uncovering of irradiated fuel that requires continued immersion. If additional water is needed in the ATR canal and normal make-up water is not available, the emergency firewater system can be used to provide make-up to the canal. The emergency firewater system will survive a severe earthquake. Emergency water can be provided from numerous large storage tanks which can provide millions of gallons. This additional inventory exceeds the ATR water volume by ten times. All of the aforementioned equipment is designed to survive a severe earthquake. Also, the large storage tanks will provide enough pressure from gravity to temporarily supply water to the spent fuel pool in the event that all pumps are lost.

The Fluorinel Dissolution Process and Fuel Storage (FAST), CPP-666, at the Idaho Nuclear Technology and Engineering Center (INTEC) fuel storage pool area is built into the concrete structure of the FAST building. The original seismic design criteria used for the storage pools is about fifty percent higher than is required by DOE standards today. A seismic event should not result in damage to the spent nuclear fuel. Fuel placed into the FAST pool produces very low amounts of heat. Water is not necessary for cooling the fuel, but is used for shielding workers from radioactivity. The FAST pool has a leak detection system and the pool can be sectioned off to limit the amount of any possible leakage following an earthquake. In a worst-case scenario, make-up water for the FAST storage pools could be provided by various means using gravity flow. A loss of water from the FAST pool would pose no danger to the public from radiation.

12. What will occur at the DOE’s Idaho site if there is a major flood?

The DOE’s Idaho site has examined the potential for floods of varied intensity and their impact to nuclear facilities. The DOE Idaho Site has developed measures to divert rising water away from facilities, and to drain it naturally in low lying areas. The strategy is to be able the handle the largest postulated flood for our geographic area and meteorology.

A flood from the Mackay dam which is about 50 miles from the DOE Idaho Site is the source of the worst case analyzed flood for the ATR, and the DOE Idaho Site. This flood will take several hours to reach the ATR, by which time the ATR will have been shut down for several hours and spent nuclear fuel (SNF) able to be cooled by ambient heat losses. Further, it is unlikely that the worst case Mackay dam flood will reach the ATR building.

13. How does the DOE's Idaho site handle emergencies?

The DOE's Idaho site has an active Emergency Response Organization. Regular drills are conducted to ensure the readiness and proficiency of emergency responders. A unified command structure is used to direct emergency response actions in the event of facility abnormal conditions and natural disasters. The emergency response actions cover the spectrum of minor personal injury to full scale damage to site areas and include response to natural phenomena affecting multiple facilities. Original planning for what is now the INL located the national laboratory in an area away from the population. The area is a geologically and meteorologically favorable area. This tends to minimize the effects from natural phenomena events.

14. What actions are currently in progress to assure ATR and MFC facilities are prepared for a Beyond Design Basis Safety Event?

DOE immediately directed the operating contractor at INL to assess any vulnerabilities at our nuclear facilities using the US commercial nuclear industry's Institute of Nuclear Power Operations (INPO) guidance and recommendations related to the damage caused by the earthquake and tsunami at the Fukushima Nuclear Station (Fukushima Daiichi Nuclear Station Fuel Damage Caused by Earthquake and Tsunami, INPO Event Report 11-1, March 15, 2011). This guidance seeks to verify and assess the capability to mitigate conditions from beyond design basis events. Some of the actions include reviewing emergency equipment readiness, ensuring procedures for beyond design accidents are executable, reviewing the training and qualifications of operations and support personnel needed to implement the emergency procedures, and looking at the equipment and procedures for mitigation of internal and external flooding required by facility design. We will take appropriate actions to address any vulnerabilities that are identified.

As facts from the Japanese reactor accident become known, DOE will use the lessons learned from the accident, along with evaluations and actions the NRC and the commercial nuclear power industry are taking in the United States, to ensure that applicable evaluations and actions are completed with respect to ATR and other nuclear facilities at the DOE's Idaho site.