

Group 11

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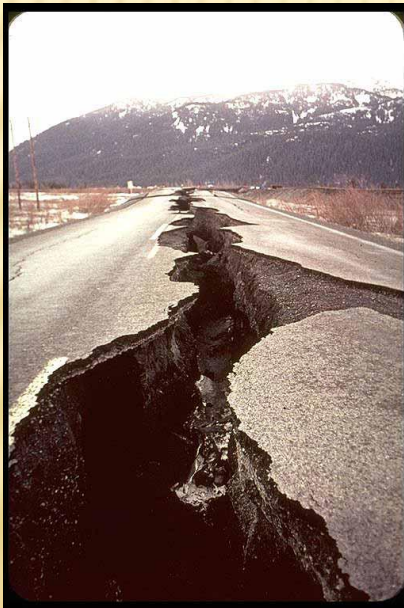
Ciao Withers



NUCLEAR DISASTER PREVENTION IN THE WAKE OF A NATURAL DISASTER

INTRODUCTION

- ✘ Natural disasters can disrupt a nuclear power plant's capability to safely shutdown.
- ✘ Our goal in such an event is to maintain sufficient backup power to prevent a subsequent nuclear disaster.



CORE NATURAL DISASTER RESPONSE

- ✘ Nuclear reactors are designed to shutdown at the occurrence of a natural disaster.
- ✘ After shutdown, the core still produces a large amount of decay heat which must be dissipated to prevent meltdown.
- ✘ Normal working fluid flow stops and emergency core cooling takes place. This process is generally powered by diesel generators and batteries. The Emergency Core Cooling System(ECCS) also includes high and low pressure coolant injection.

DAMAGE CAUSED BY NATURAL DISASTER

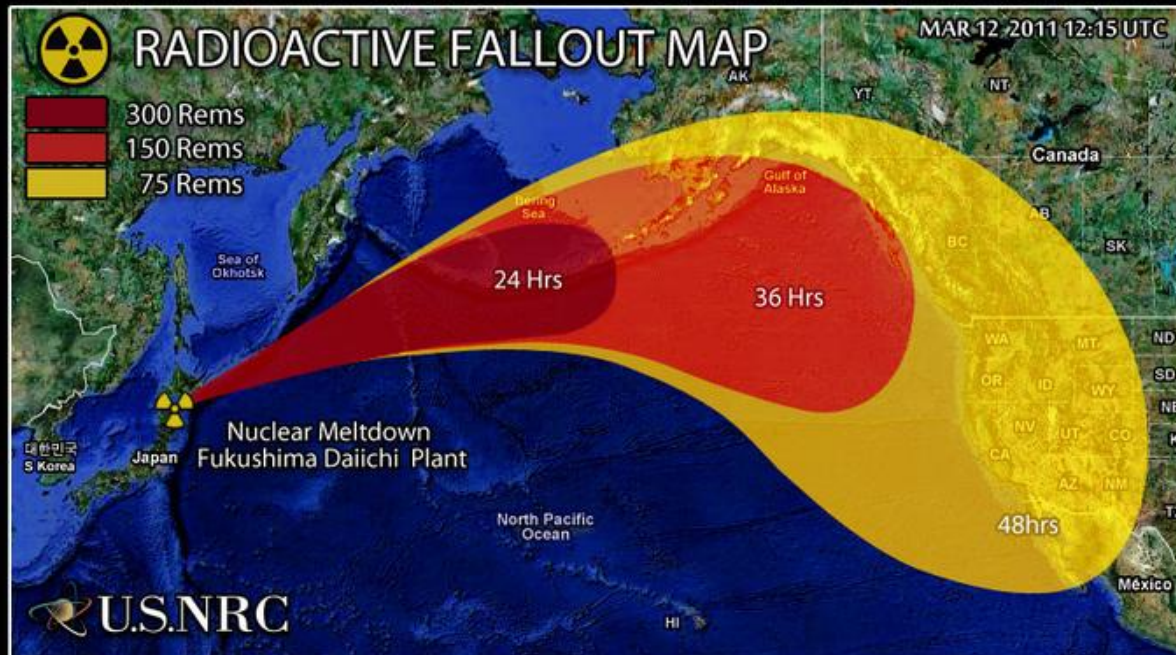
- ✘ Hurricane: High wind speed and flying debris, tidal storm surge and heavy rainfall cause flooding.
- ✘ Tsunami: Tidal surge causing massive flooding, hydrostatic and hydrodynamic forces, followed by receding water height. Substrate erosion and liquefaction.
- ✘ Earthquake: Massive structural damage above and below ground, substrate erosion and liquefaction.

LEARNING FROM THE PAST



✘ Fukushima Daiichi:

- + 9.0 Magnitude earthquake strikes off the coast of Japan and 14 m high tsunami waves travel toward. Plant only designed for 6 m waves. Vibrations trigger automatic core shutdown.
- + ECCS automatically activates but is manually shut off.
- + Tsunami reaches the coast and disables all 4 backup diesel generators and washes away fuel tanks.
- + Battery power lasts for 8 hours, but not long enough to get the backup generators back online.
- + Meltdowns release radioactive material into the atmosphere, soil and water.



BREACHED REACTORS

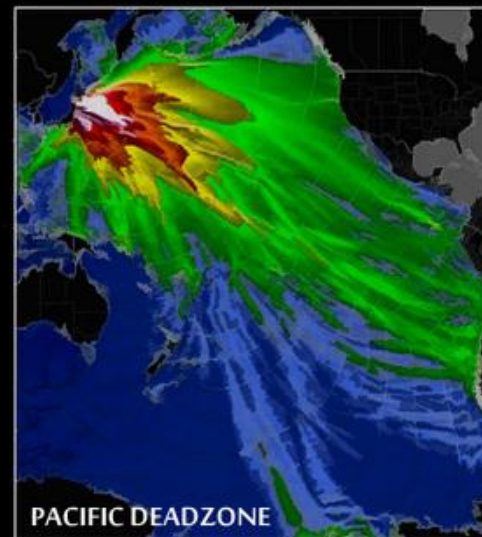


Latest updated time 2011/03/12

Radiation Maximum Data List

Prefecture	Maximum
Hokkaido	Under survey
Aomori	Under survey
Miyagi	Under survey
Fukushima	Under survey
Ibaraki	48nGy/h
Kanagawa	43nGy/h
Niigata	40nGy/h
Ishikawa	53nGy/h
Fukui/Kyoto	74nGy/h
Shizuoka	81nGy/h
Osaka	59nGy/h
Okayama/Tottori	34nGy/h
Shimane	42nGy/h
Ehime	24nGy/h
Saga/Nagasaki	33nGy/h
Kagoshima	45nGy/h

The above table is a list of the maximum values of the space dose rate distributions shown from local governments in the latest updated date and time.



LEARNING FROM THE PAST

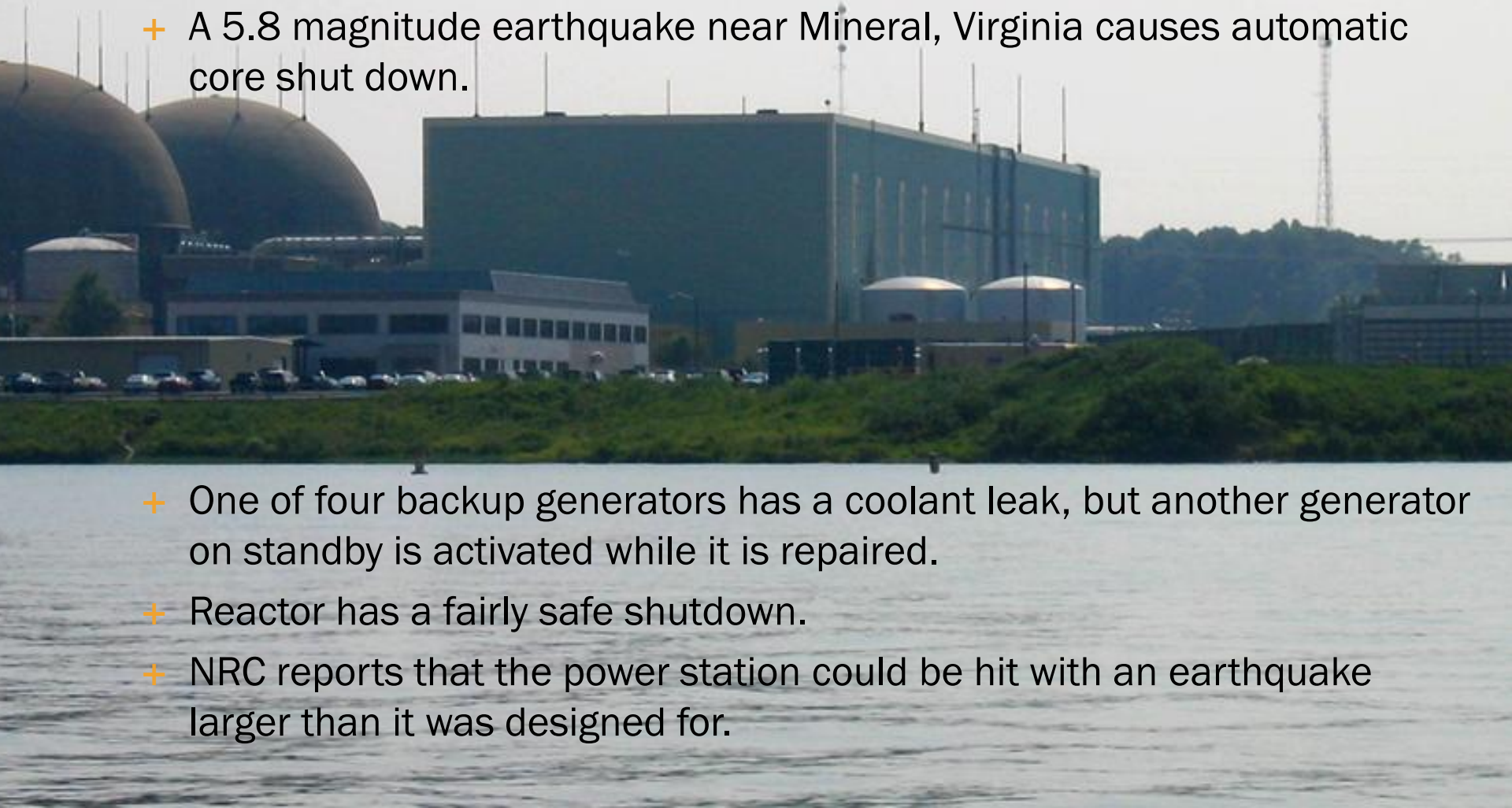
✘ North Anna

+ A 5.8 magnitude earthquake near Mineral, Virginia causes automatic core shut down.

+ One of four backup generators has a coolant leak, but another generator on standby is activated while it is repaired.

+ Reactor has a fairly safe shutdown.

+ NRC reports that the power station could be hit with an earthquake larger than it was designed for.



STRUCTURAL DAMAGE MITIGATION STRATEGY

- ✘ Vibration dampening structural foundations.
- ✘ Build to avoid soil erosion and liquefaction problems.
- ✘ Multiple backup generator locations, below ground and above reasonable wave and flood height.
- ✘ Design for at least 1 magnitude higher than probable seismic activity.
- ✘ Low drag structures and coatings would reduce forces from fast moving air or water.
- ✘ Natural wave barriers like rocks, mangrove or cypress to reduce wave power.

MAINTAINING SUFFICIENT BACKUP GENERATION

- ✘ Redundancy is key.
- ✘ Have enough backup diesel generators for at least twice your required cool down power.
- ✘ Have at least 24 hours of battery power stored at all times.
- ✘ Combination of diesel generators, batteries, and flywheels. The more diverse and decentralized your backup power supply is the better.
- ✘ Coolant water intake far below the local water level.

ALTERNATIVE BACKUP POWER

✘ Tidal generation

- + Could generate significant power from tsunami or hurricane tidal surge.
- + Not suitable for all areas.
- + Could fail in a massive tidal surge or post-tsunami low tide.

ALTERNATIVE BACKUP POWER

- ✘ Expanded Flywheel Storage Capacity
 - + Can provide a large amount of power nearly instantly.
 - + Very limited duration.
 - + Not cost-effective.

OUR SOLUTION

- ✘ System of modular, ready to use backup diesel generators stored off-site and ready for emergency delivery at a moment's notice.
- ✘ Fitted into ISO standard 20 and 40 foot storage containers.
- ✘ Power stations equipped to quickly accept these generators.
- ✘ Composed fully of existing technology.
- ✘ 1 or 2 containers could provide sufficient power for most plants.

DIESEL GENERATOR BUILT INTO 20' ISO SHIPPING CONTAINER



BY LAND

- ✘ 40-foot ISO standard containers can be shipped on tractor-trailer.
- ✘ Stored far enough inland to avoid tidal surge and flooding.



BY SEA

- ✘ Quickly delivered by small boat or aircraft.
- ✘ Offshore platforms outside the influence of tsunami waves store 20 and 40-foot backup generators.



BY AIR

- ✘ Sikorsky S-64 Skycrane can quickly deliver a 20-foot generator container to a power station within a few hours of initial shutdown.
- ✘ Quick response, but far enough away from major damage and able to fly over damaged roads and waterways

SIKORSKY S-64 SKYCRANE



RECAP

- ✘ Easy to implement on old or new power stations.
- ✘ Cost-effective for older stations, part of better safety regulation for newer ones.
- ✘ Could be ready for service fairly soon – all components are already in production.
- ✘ Multiple containers can be quickly deployed as small substations.
- ✘ Last line of defense after all on site options are exhausted.

CONTAINERIZED GENERATOR SUBSTATION

