U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Japan and Fukushima Dai-ichi

Presentation to
NSTC Subcommittee on Disaster Reduction

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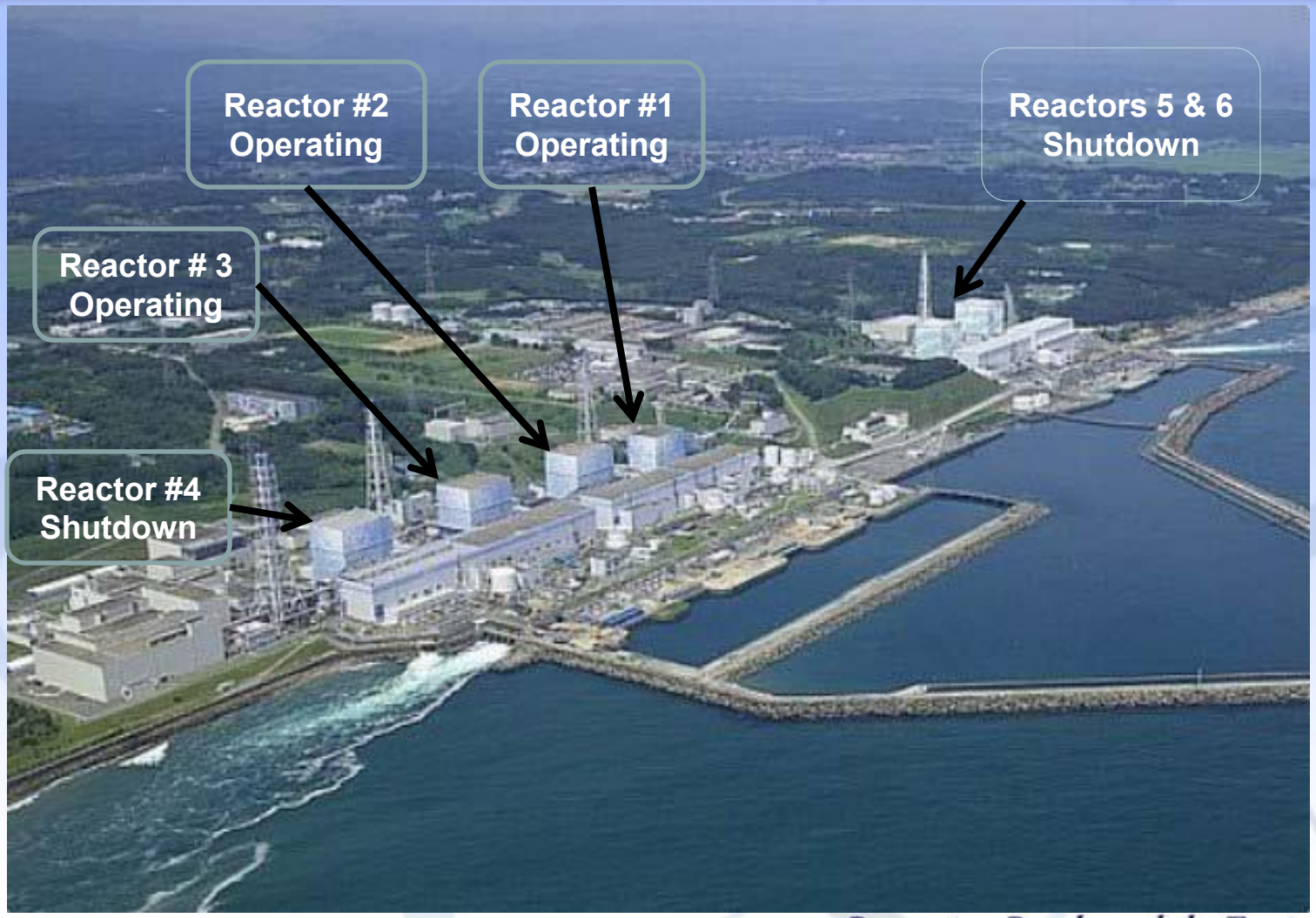
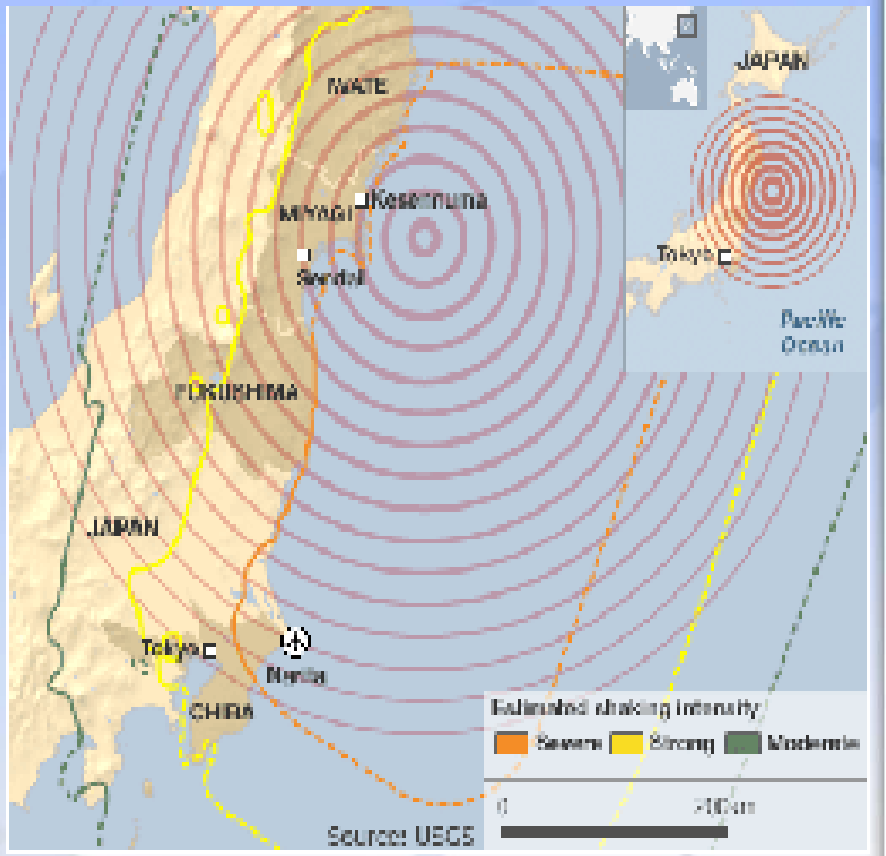
Fukushima Dai-ichi Before the Event



Earthquake

March 11, 2011
9.0 Earthquake

- 5th strongest ever recorded
- Epicenter 112 miles from site
- Shaking lasted over 3 minutes
- Moved Honshu island 8 feet east
- Shifted Earth on axis 4-10 inches
- Large aftershocks

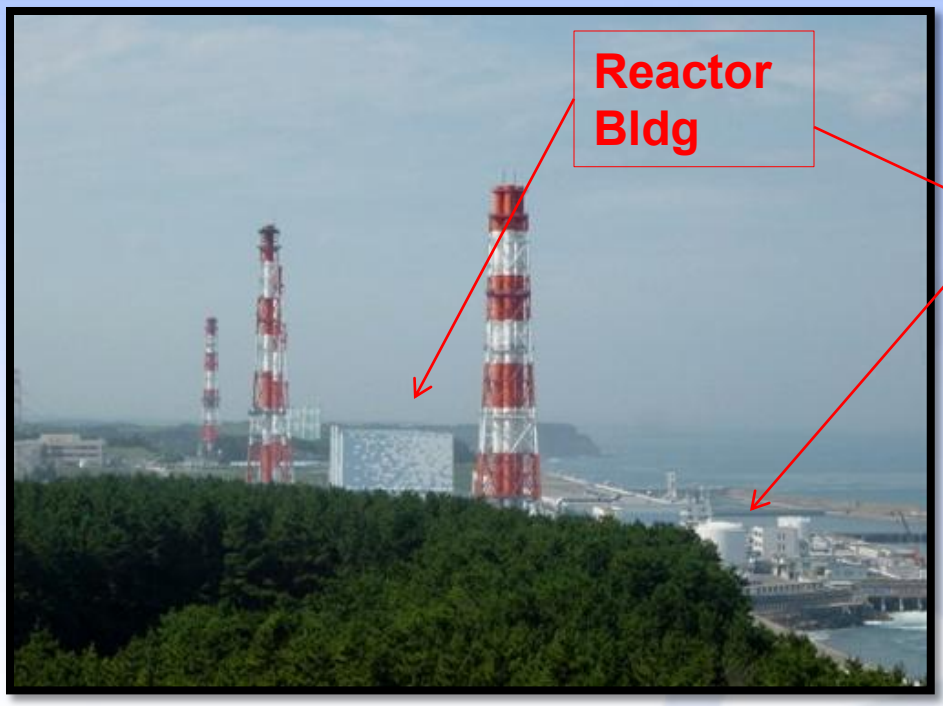


Initial Plant Response

- Reactors shut down as expected
- Emergency diesel generators supplied power as expected
- Plant conditions stable and controlled

Tsunami

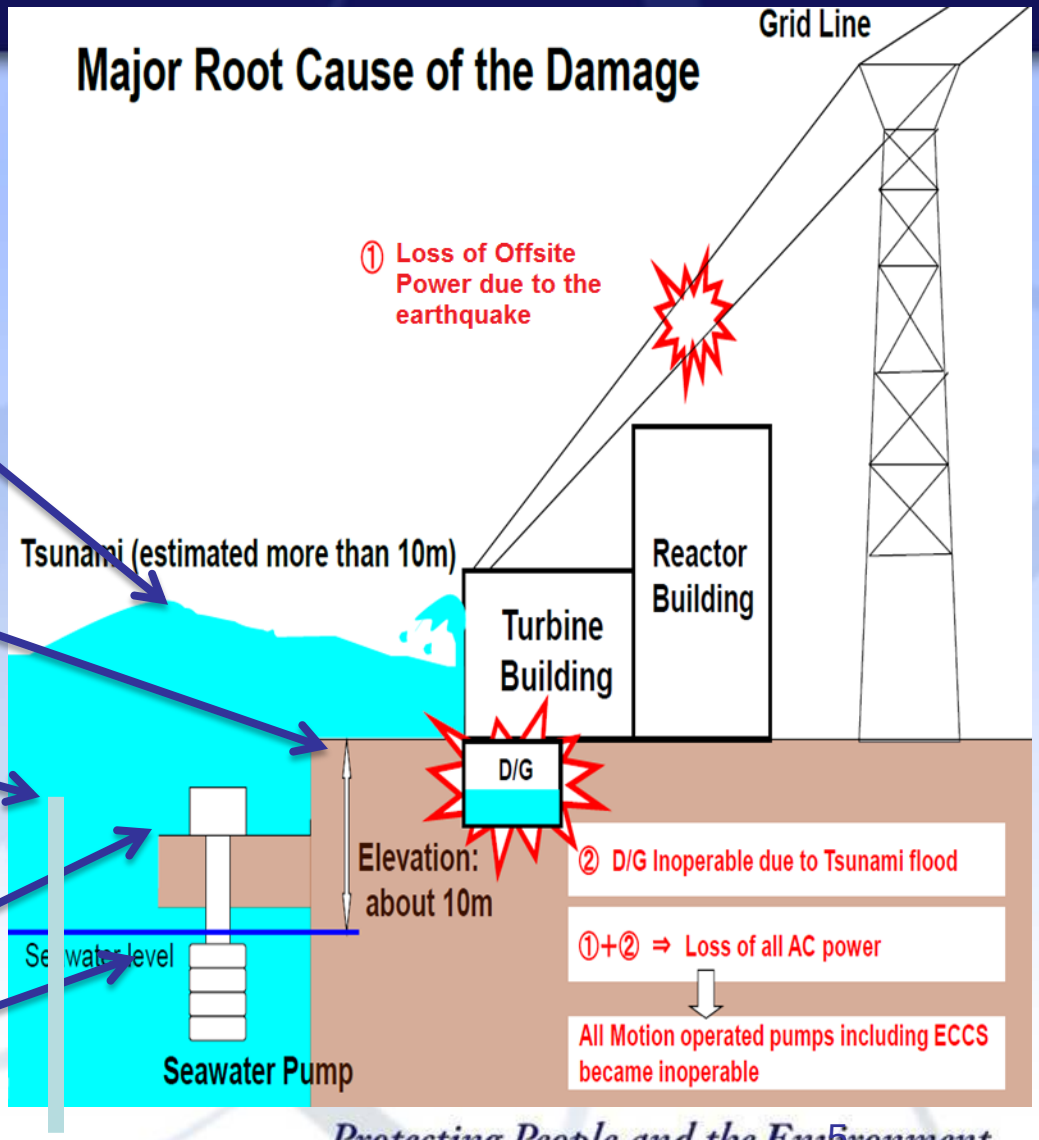
- Site designed to withstand 19 foot tsunami
- Hydrodynamic forces were not considered
- Actual height estimated 46 - 49 feet



Flood Damage

Reference Levels

- 46 feet. Tsunami Peak Elevation
- 42.5 feet Ground elevation of Units 5-6 TB/RB
- 33 feet Ground elevation of Units 1-4 TB/RB
- 17 feet Assumed highest tsunami and elevation of break wall
- 13 feet Ground elevation of intake structure
- 0 Feet Sea level



Site and Working Conditions

- High mental and physical stress, uncertainty and setbacks
- Many aftershocks and tsunami alerts
- Loss of ac and dc power impacted equipment, lighting, indications and communications
- Open manways and unsound terrain
- Debris, rubble and obstacles
- Respirators and protective equipment
- Elevated radiation fields
- Concern about family and loved ones

General Accident Progression

- Plant status unknown or questionable
- Heat removal capability lost
- Reactor temperature/pressure rise
- Core uncovery
- Fuel cladding T > 2200 F → hydrogen
- Hydrogen migration, accumulation and explosions
- Elevated radiation levels

Unit 1

- Most severe conditions
- Intermittent injection and venting
- Possible reactor pressure vessel (RPV) breach or stuck open safety relief valve
- Fuel melt (about 4.5 hours after earthquake) and core damage
- Hydrogen generation and explosion
- Elevated radiation levels and offsite release

Unit 2

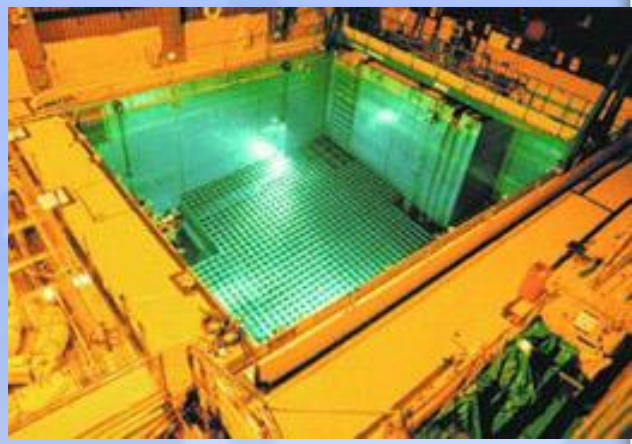
- Core injection for about 70 hours
- More time to prepare line-ups before doses increased
- Unit 1 explosion prevented core injection
- Unit 3 explosion damaged vent alignment and seawater injection staging
- Complications in depressurizing the RPV and venting containment led to core damage
- Elevated radiation levels
- Last core to melt – came close to saving

Unit 3

- Initial conditions not as severe as Unit 1
- Dc power available for about 30 hours
- Core injection available for about 35 hours
- Fire engine pump could not inject until the RPV pressure was reduced
- Safety relief valves could not be opened without ac and dc power and air
- After about 6 hours without injection → core melt (about 40 hours after the earthquake)
- Hydrogen explosion
- Elevated radiation levels

Unit 4 and Spent Fuel Safety

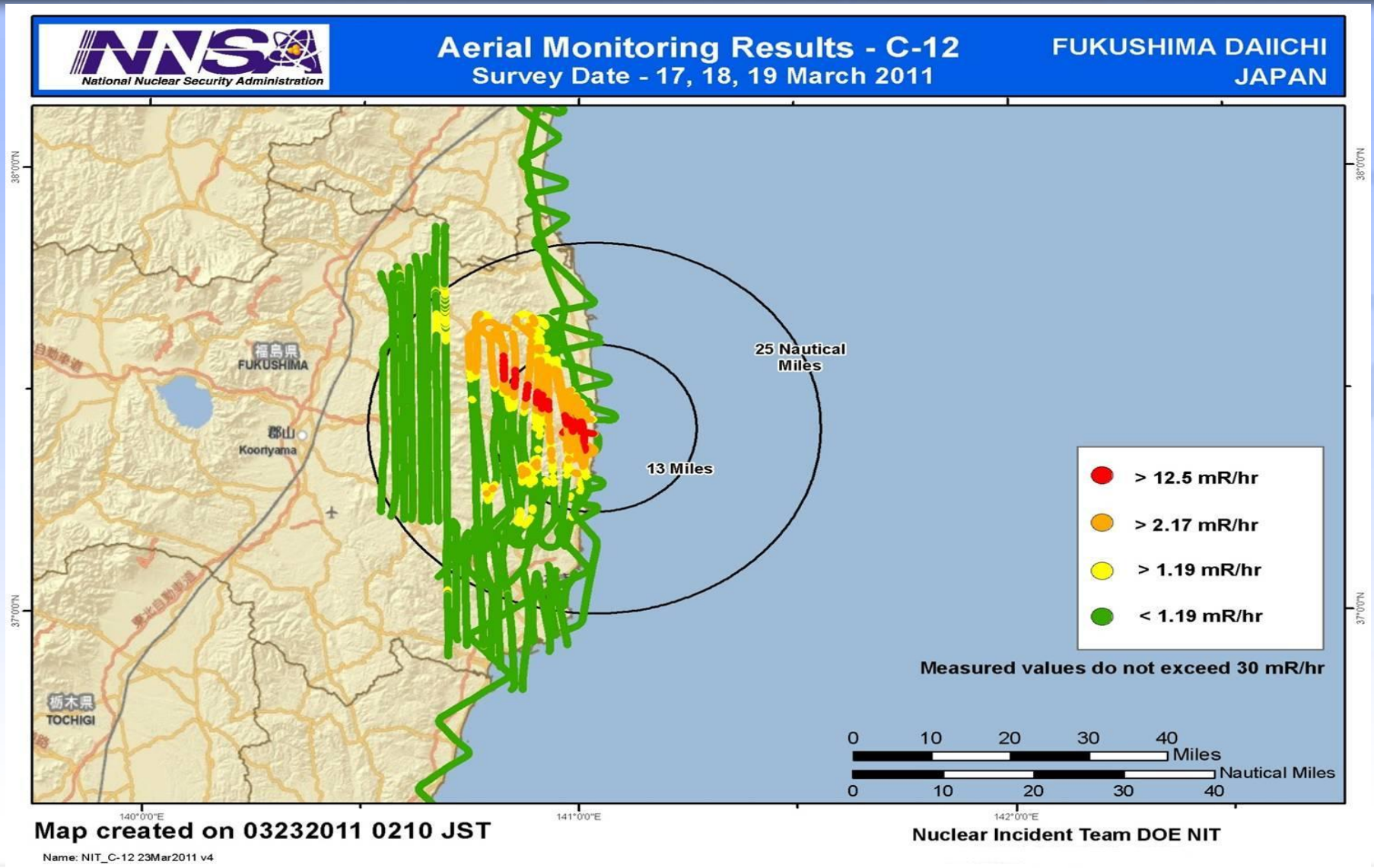
- Dry cask storage was flooded but fuel remained cool
- Spent fuel pools maintained structural integrity
- Unit 6 diesel generator provided heat removal to the Units 5 and 6 pools and the fuel in the cores
- Unit 4 spent fuel pool
  - Elevated temperatures was a concern
  - **Hydrogen explosion** due to backflow of hydrogen from Unit 3 gas treatment system
  - Concern diverted attention from the reactors



After Hydrogen Explosions

UNIT 4 UNIT 3 UNIT 2 UNIT 1

Radiological Release



Fukushima Dai-ichi Site Today

Removing Rubble from Unit 4
March 3, 2012

- All reactors are stable
- Fuel pool cooling is reliable
- Decontaminating water in 1000+ storage tanks and ground water control is a priority
- Releases do not pose a public health and safety concern
- Cleanup continues
- All six units being decommissioned (40 year project)
- 4,000 workers per day

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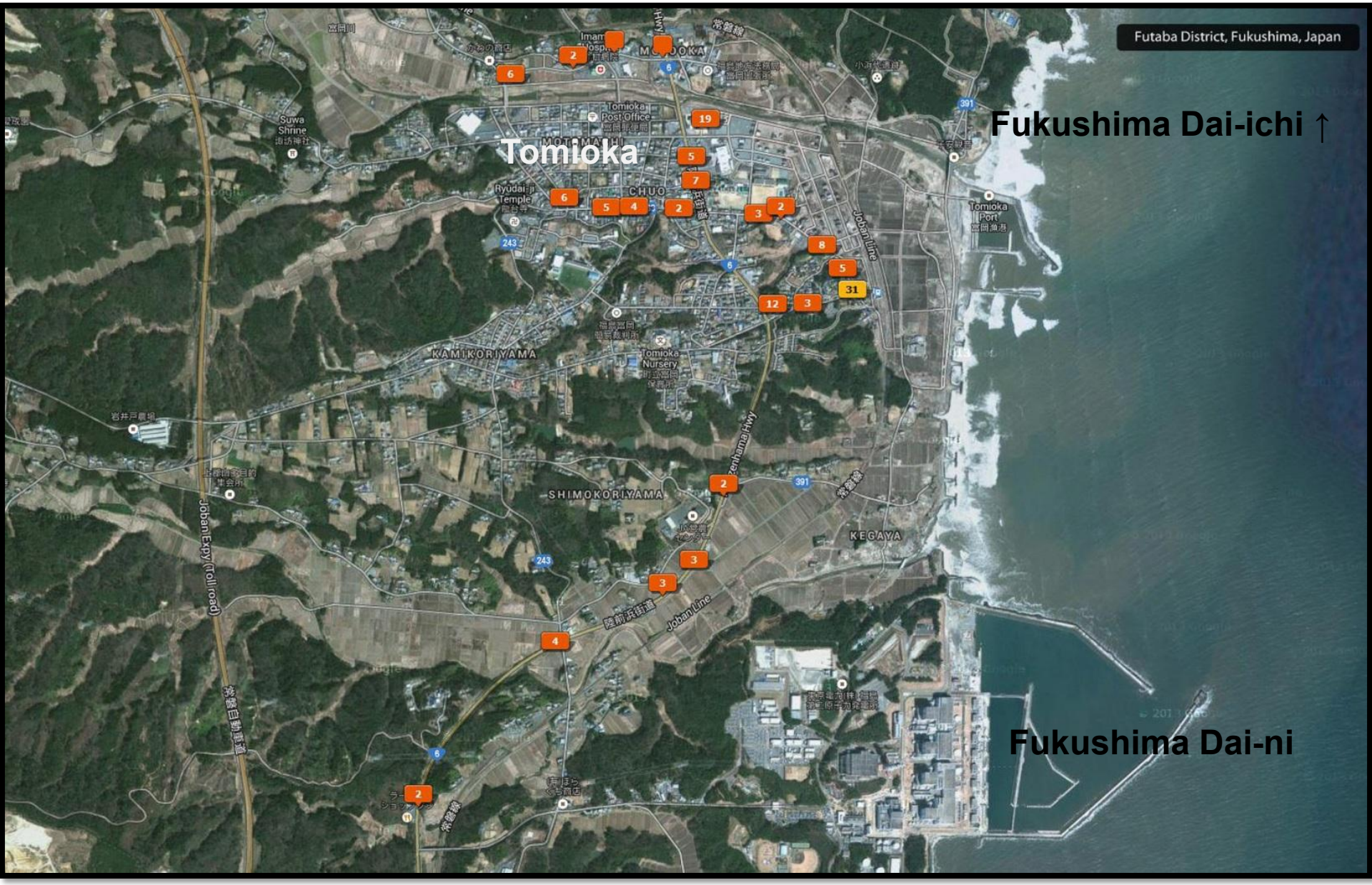
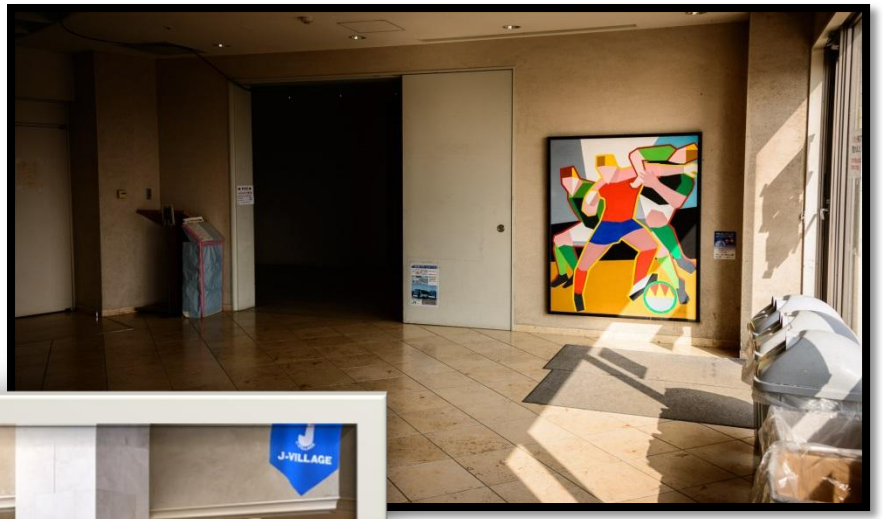
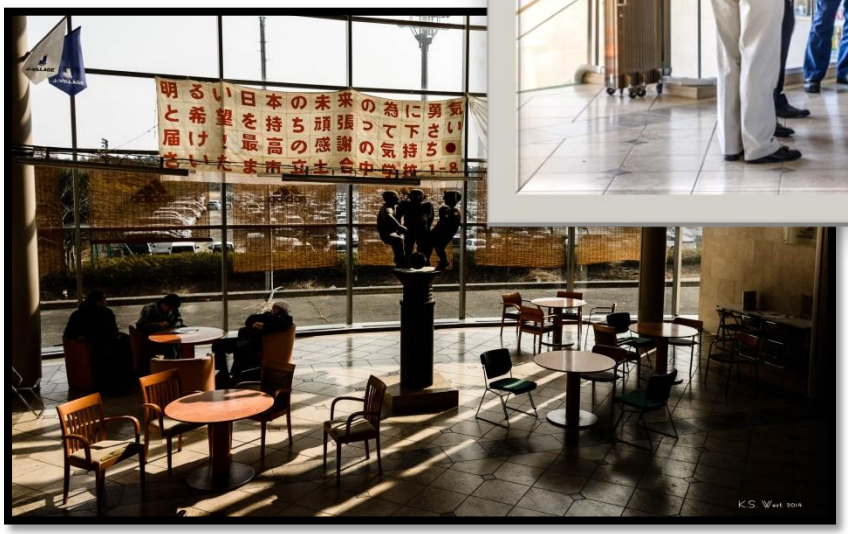
NRC Executive Team Visit to Japan



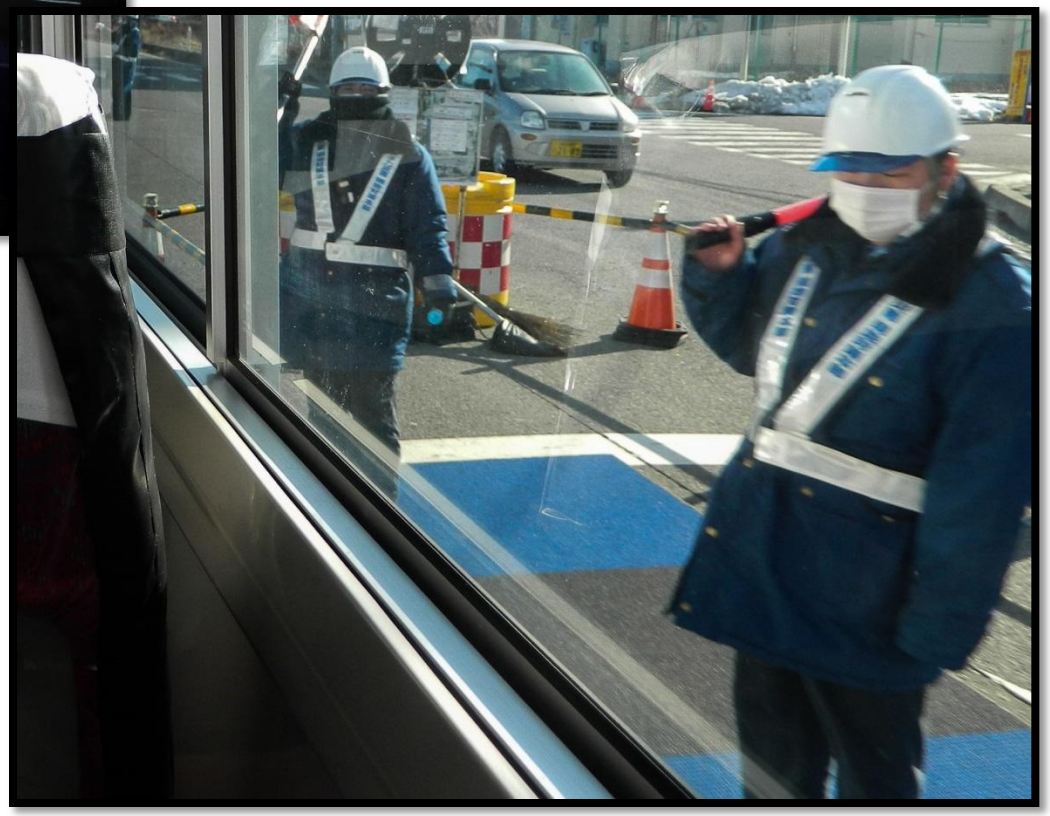
Tomioka Area, Japan, February 2014





J Village, February 2014

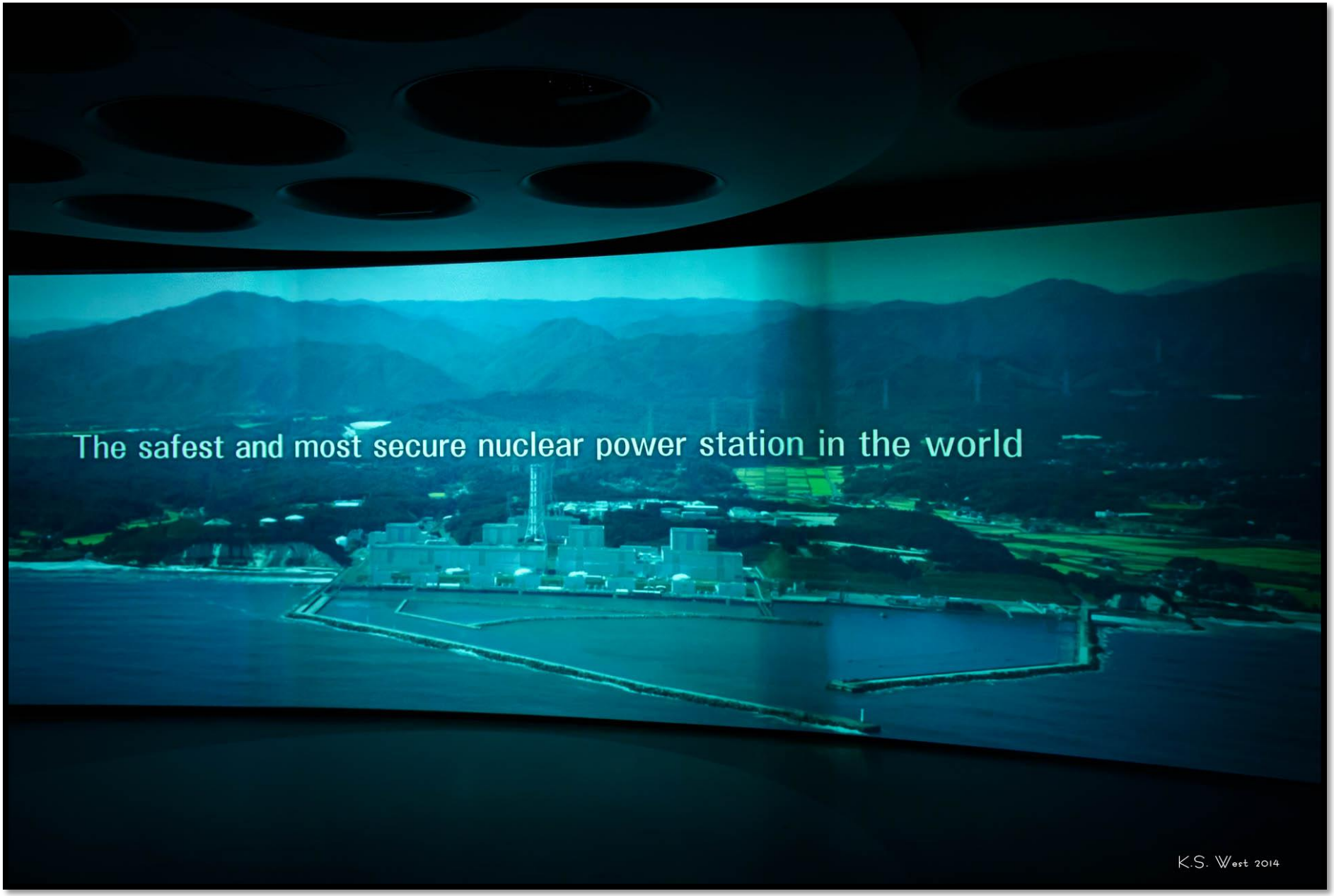
Between J Village and Fukushima Dai-ni, February 2014



Security and Traffic Control - Outskirts of Tomioka, Japan

Tomioka, Japan, February 2014

Tomioka, Japan, February 2014



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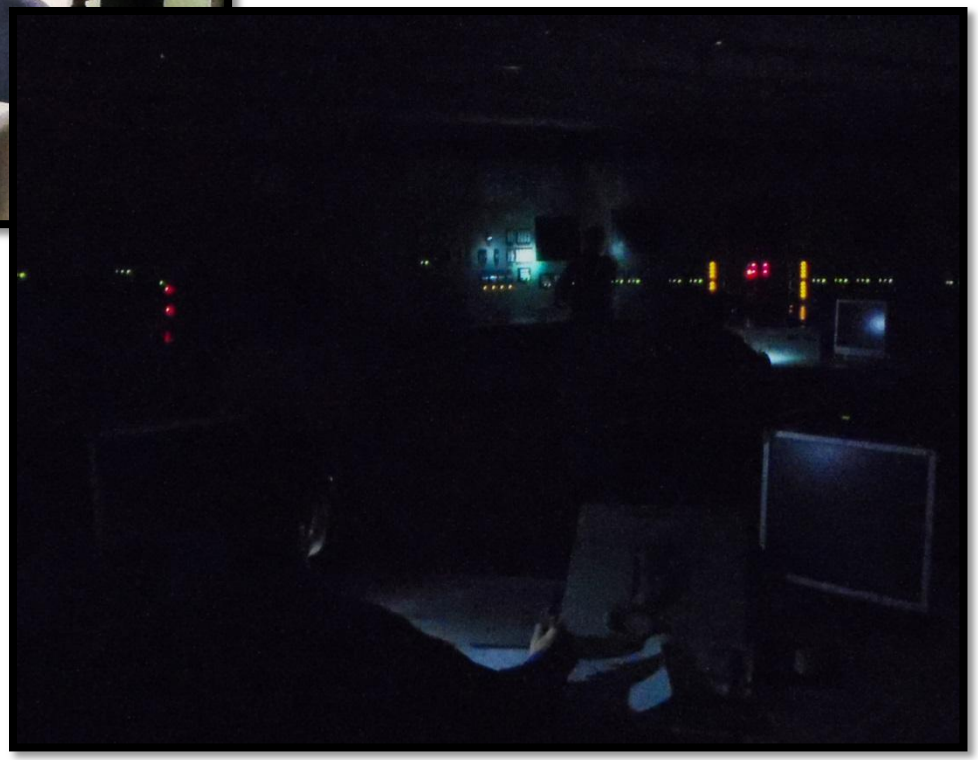
Outskirts of Tomioka, Japan, February 2014

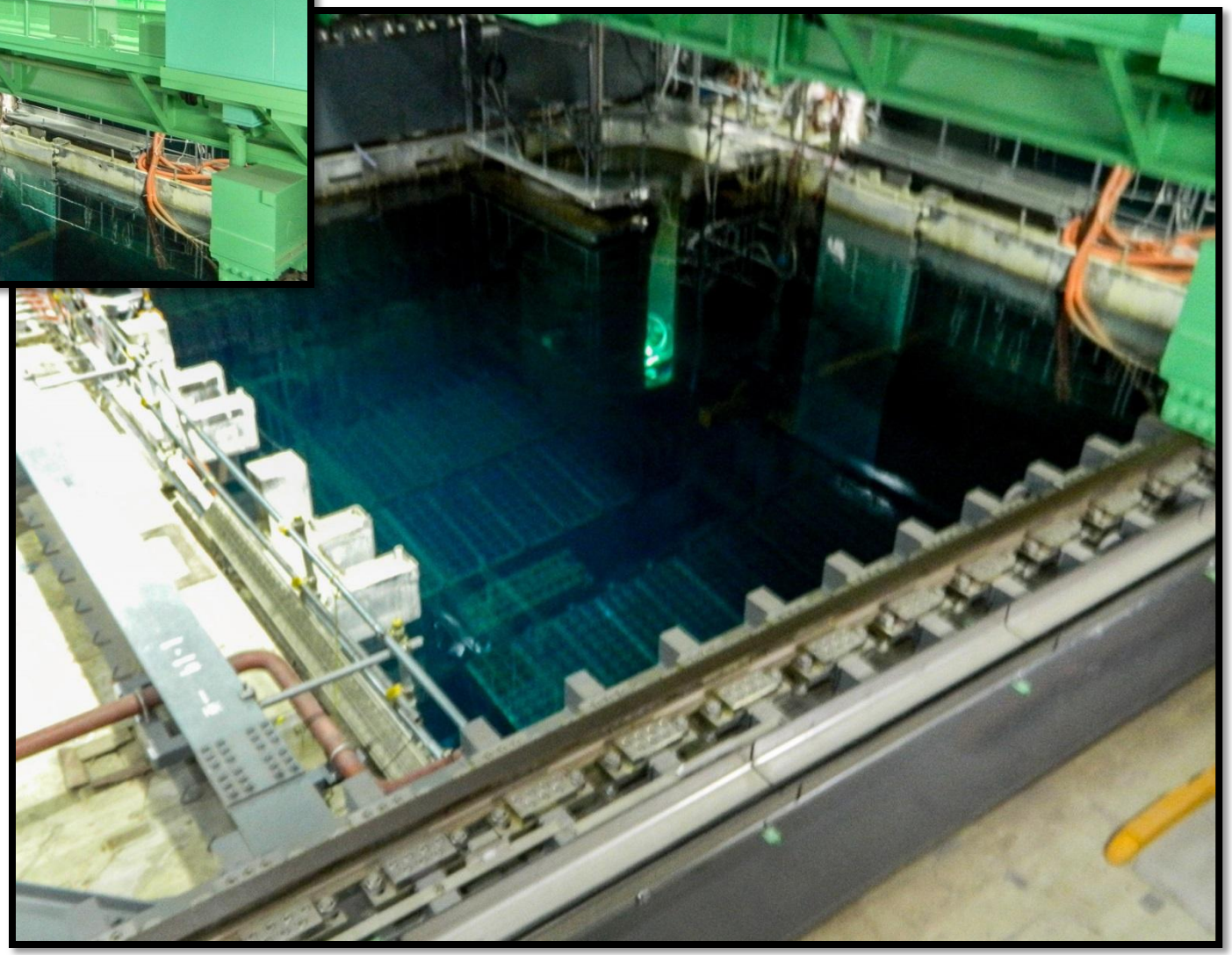
Cleanup and Decontamination, Outskirts of Tomioka, Japan, February 2014



Fukushima Dai-ni Control Room Simulation

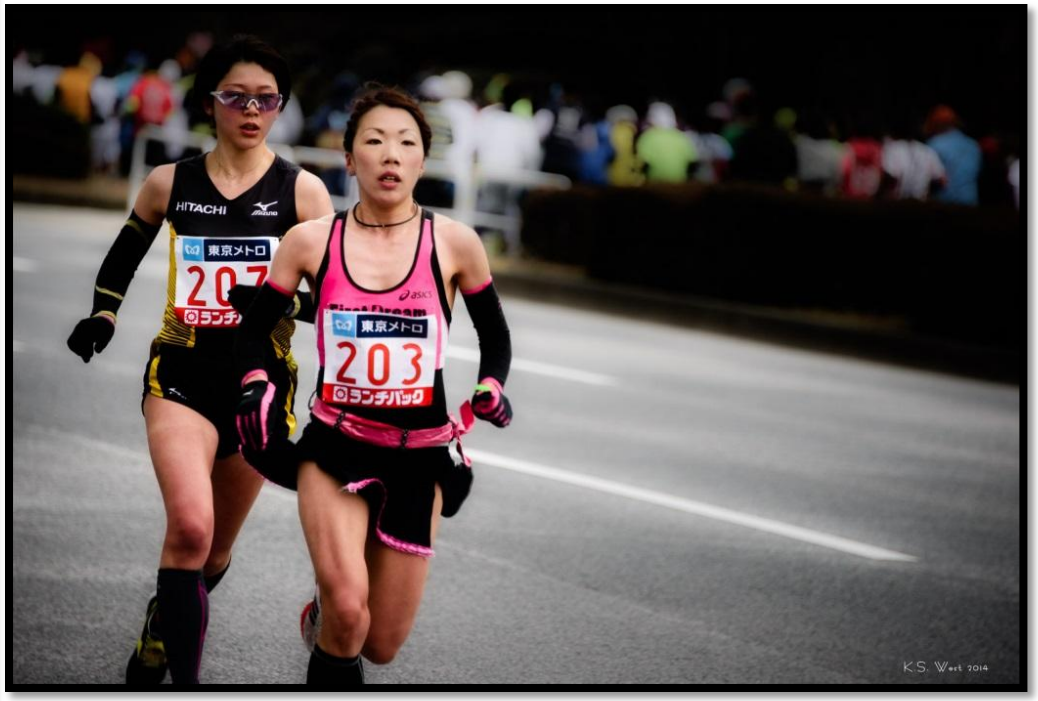
Fukushima Dai-ni "Tsunami Water" and Flood Damage

Fukushima Dai-ichi
Unit 4 Spent Fuel Pool



Fukushima Dai-ichi Contaminated Water Storage

Sensoji Temple



Tokyo Marathon 2014

Closing

- The tragedy in Japan is unprecedented
- The Japanese are dedicated to sharing their experiences worldwide to help improve nuclear safety
- No imminent risk from continued operation in the United States
- NRC is moving forward with identified enhancements for U.S. plants
- The changes will help prepare our licensees for the unexpected

For Additional Information

http://www.nrc.gov/reactors/operating/ops-experience/japan-dashboard.html