

# ***The Accident at Fukushima : What Happened?***

February 27, 2012

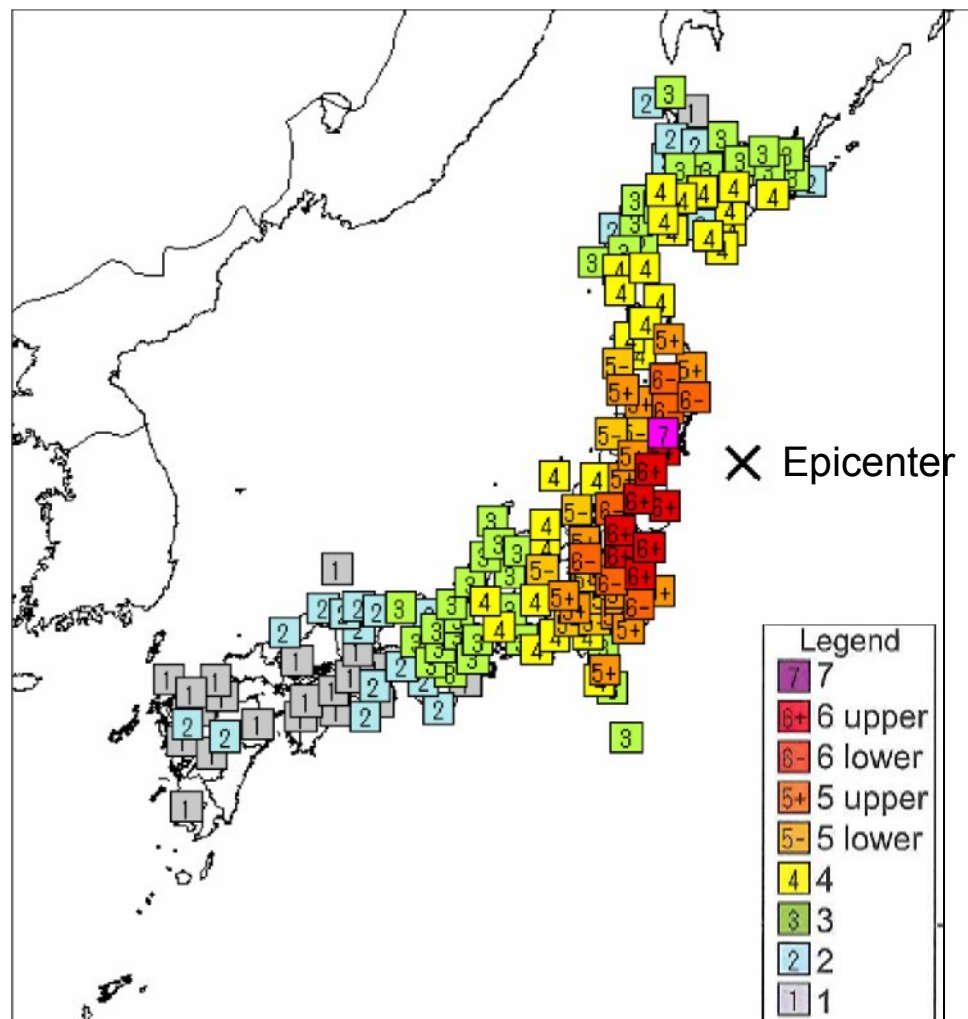
**Takao Fujie**

**President and Chief Executive Officer  
Japan Nuclear Technology Institute (JANTI)**



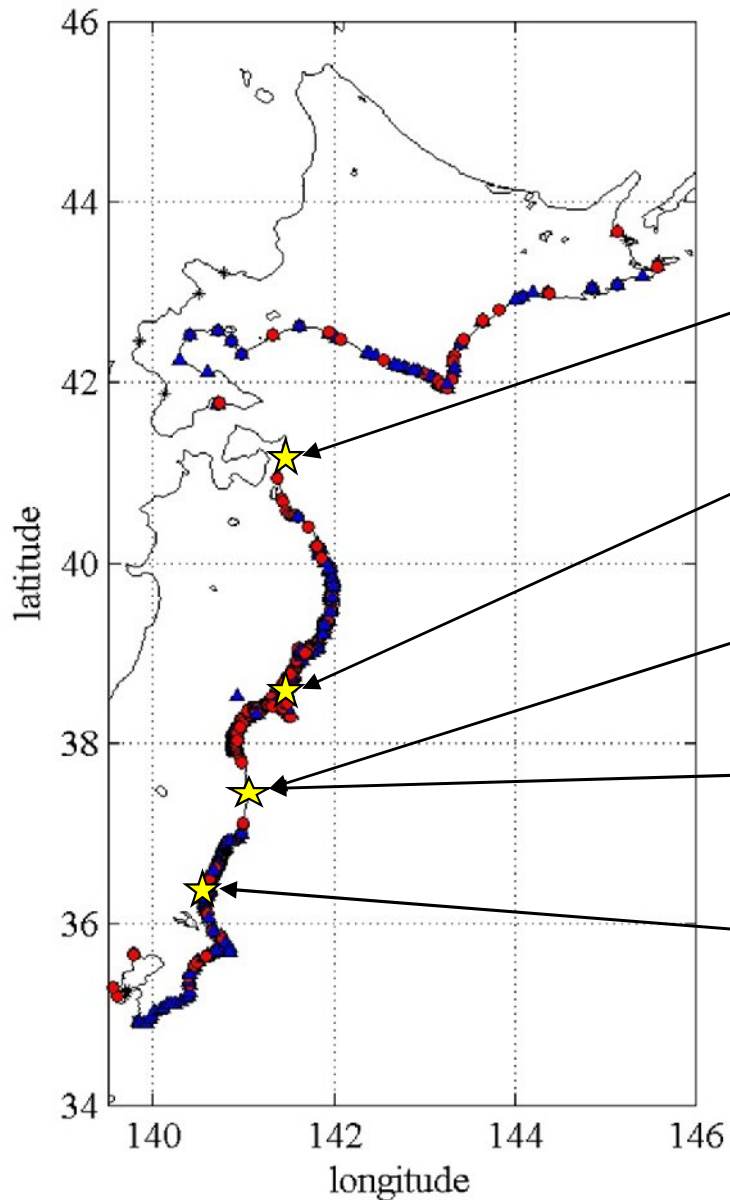
# The 2011 Earthquake off the Pacific Coast of Tohoku

1. Date : March 11, 2011
2. Epicenter : ~130 km offshore
3. Depth : ~ 24 km
4. Magnitude : **Mw 9.0**
5. Seismic Intensity : 7 (Miyagi Pref.)  
6 upper (Fukushima Pref.)



Source: Website of Japan Meteorological Agency

# Tsunami Height Observed at Nuclear Power Stations on Pacific Coast of Japan

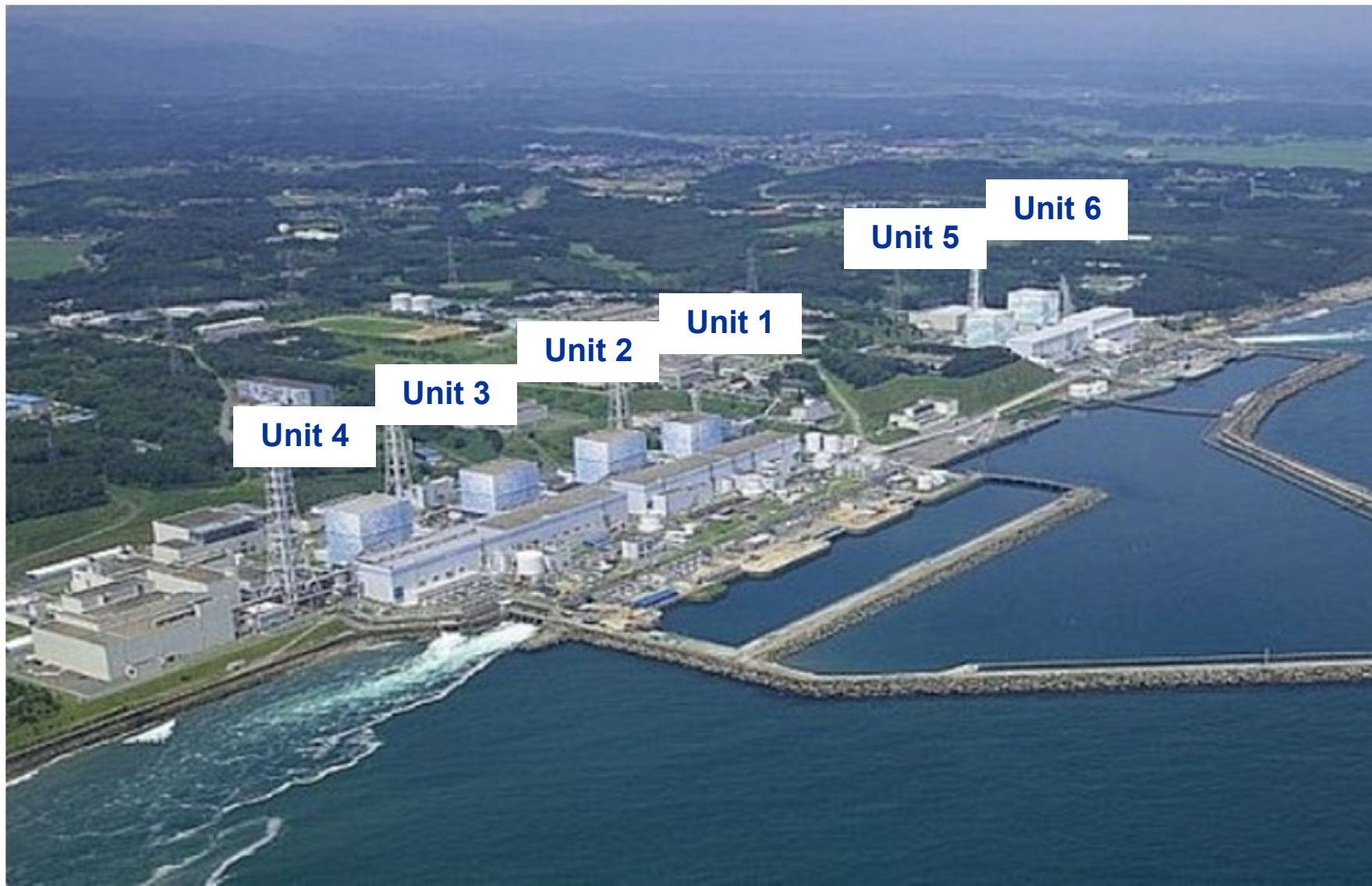


Name of NPS	Operating	Outage
Higashidori < 4m	—	1
Onagawa 13m	3	—
Fukushima Daiichi 14~15m	3	3
Fukushima Daini 6.5~7m, Locally >14m	4	—
Tokai Daini 5.4m	1	—

● :Tsunami Observation Points



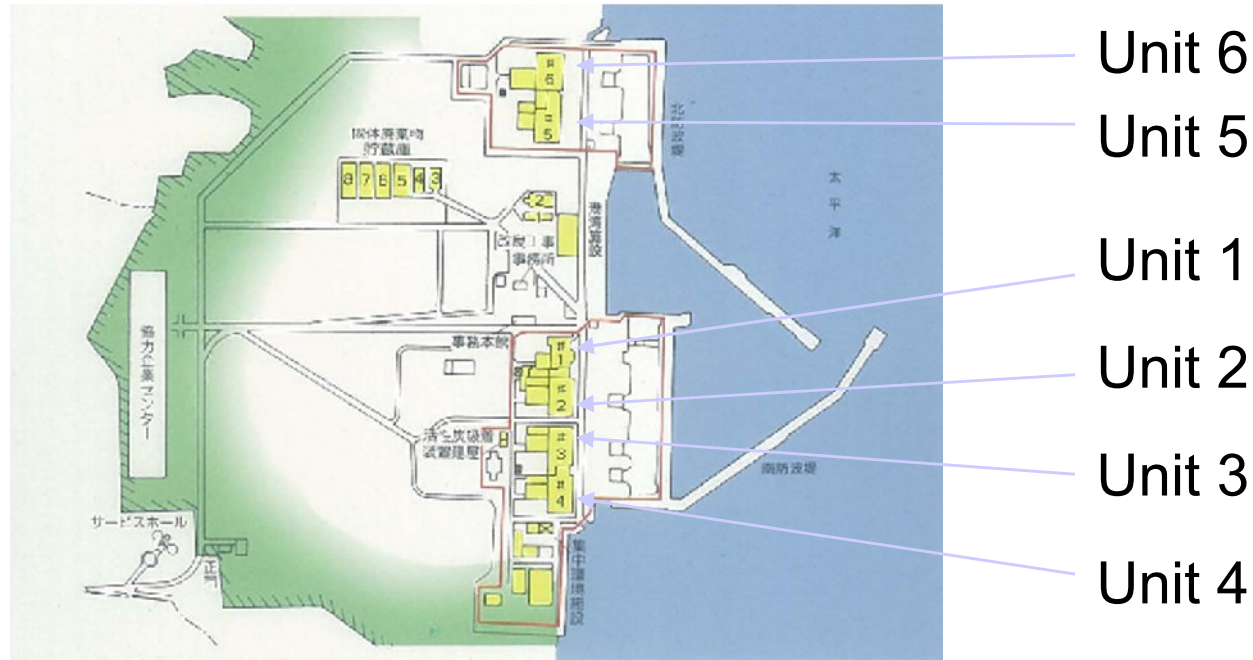
# Fukushima Daiichi Nuclear Power Station (Before Accident)



Source: Website of Tokyo Electric Power Company



# Major Specifications of Fukushima Daiichi NPS



Location	Unit	In operation since	Plant type	Power Output (MW)	Main Contractor	Pre-earthquake status
Ohkuma	1	1971.3	BWR-3	460	GE	Operating
	2	1974.7	BWR-4	784	GE/Toshiba	Operating
	3	1976.3	BWR-4	784	Toshiba	Operating
	4	1978.10	BWR-4	784	Hitachi	Shutdown for maintenance
Futaba	5	1978.4	BWR-4	784	Toshiba	Shutdown for maintenance
	6	1979.10	BWR-5	1100	GE/Toshiba	Shutdown for maintenance

# Damage by Earthquake at Shin-Fukushima Substation



Source: Website of Tokyo Electric Power Company

## 275kV Circuit Breaker

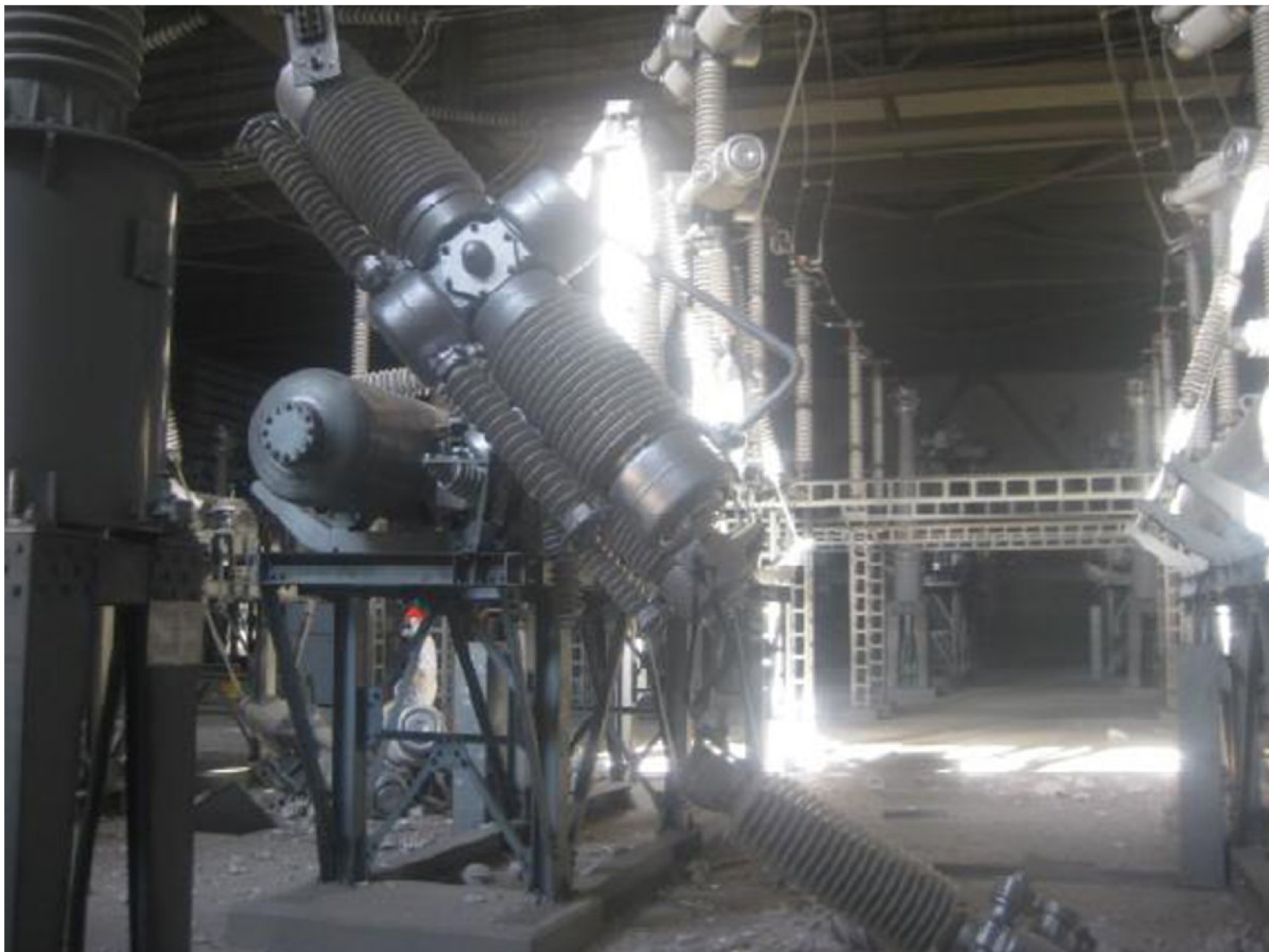
~ Toward the further Nuclear Safety ~

Japan Nuclear Technology Institute





# Damage by Earthquake at Fukushima Daiichi NPS



Circuit Breaker

Source: Website of Tokyo Electric Power Company

# Tsunami Strikes Fukushima Daiichi NPS



Source: Website of Tokyo Electric Power Company



# Tsunami Striking North Breakwater

1-1



Source: Website of Tokyo Electric Power Company

# Tsunami Striking North Breakwater

1-2



Height of Breakwater: about 10m

Source: Website of Tokyo Electric Power Company

# Tsunami Striking North Breakwater

1-3



Source: Website of Tokyo Electric Power Company



# Tsunami Striking North Breakwater

1-4



Source: Website of Tokyo Electric Power Company

# Flooding by Tsunami around R/W Treatment Facility

## 2-1



Source: Website of Tokyo Electric Power Company



# Flooding by Tsunami around R/W Treatment Facility

## 2-2



Source: Website of Tokyo Electric Power Company



# Flooding by Tsunami around R/W Treatment Facility

## 2-3



Source: Website of Tokyo Electric Power Company

# Flooding by Tsunami around R/W Treatment Facility

## 2-4





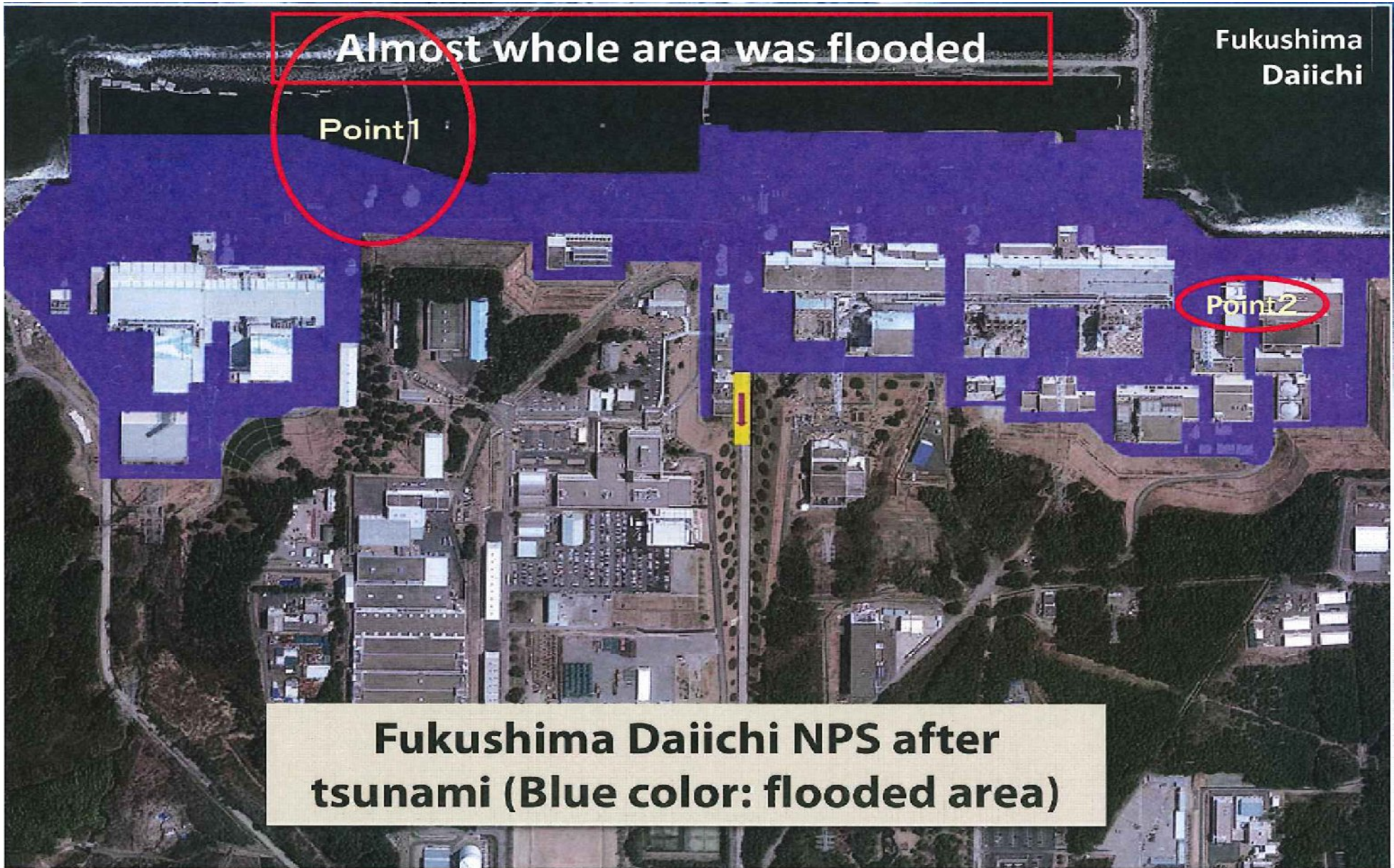
# Flooding by Tsunami around R/W Treatment Facility

## 2-5



Source: Website of Tokyo Electric Power Company





Source: Website of Tokyo Electric Power Company

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# Example of Damage by Tsunami - Oil Tank



Source: Website of Tokyo Electric Power Company

# Example of Damage by Tsunami - Seawater Facility



Source: Website of Tokyo Electric Power Company

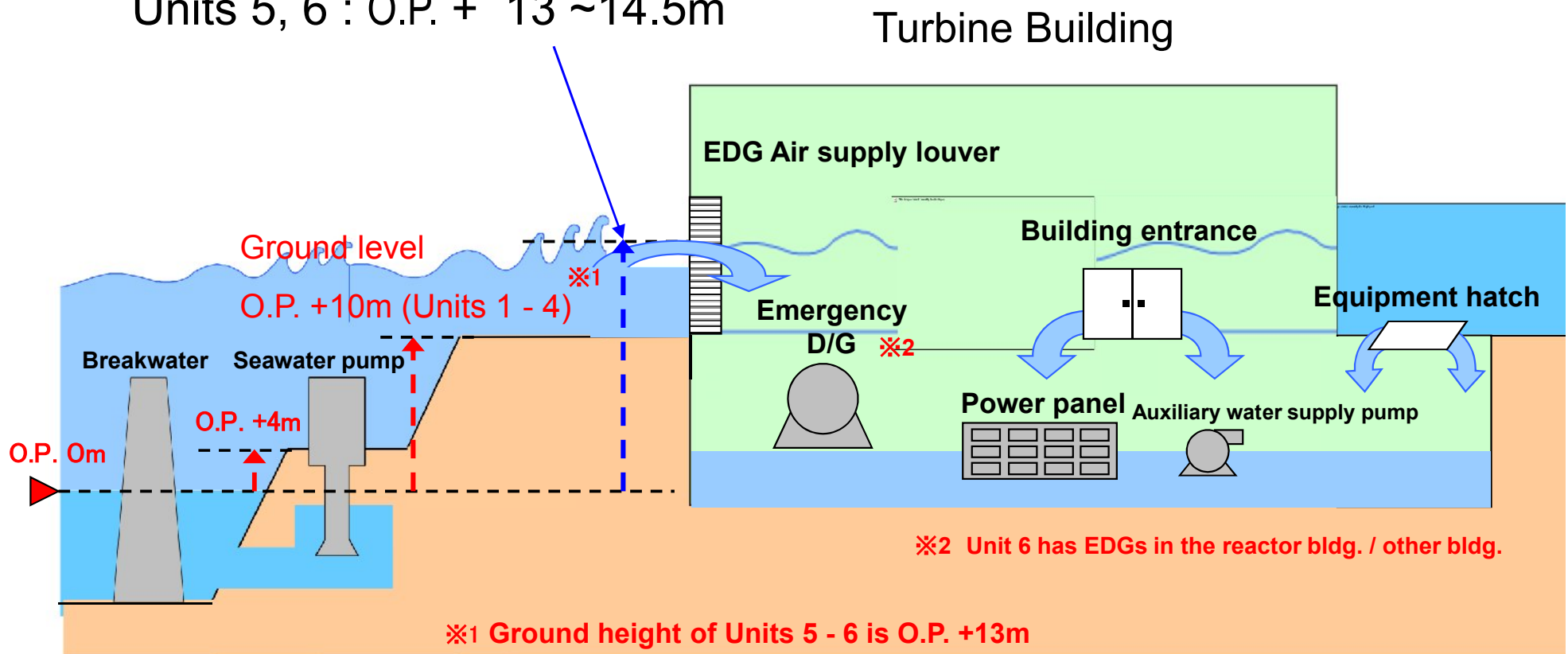


# Flood Pathways into Turbine Building

## Flood Height

Units 1- 4 : O.P. +11.5~15.5m

Units 5, 6 : O.P. + 13 ~14.5m



Source: Website of Tokyo Electric Power Company

# Chronology of Accident at Unit 1

**March 11 14:46** Great East Japan Earthquake occurred  
**Reactor automatically scrammed**  
**【SHUTDOWN】**

↓

**15:37** Station black-out due to Tsunami strike  
 (Sea water systems also lost)

↓

**Water injection**  
**【COOLING】**

↓

**Venting**  
**【CONTAINMENT】**

**March 12 15:36** **Hydrogen Explosion Occurred**

**March 12 19:04** **Injection of sea water started**

# Major Activities at Unit 1 - Temporary Batteries



Source: Website of Tokyo Electric Power Company



# Major Activities at Unit 1 - Operator



Source: Website of Tokyo Electric Power Company

# Major Activities at Unit 1 - Deputy Shift Supervisor



Source: Website of Tokyo Electric Power Company

# Major Activities at Unit 1 - PCV Venting



Before PCV Venting



After PCV Venting

Source: Website of Tokyo Electric Power Company



# Hydrogen Explosion at Unit 1

March 12 15:36 Hydrogen Explosion Occurred at R/B.



Source: Website of Tokyo Electric Power Company

# Damage by Hydrogen Explosion - Main Control Room



Source: Website of Tokyo Electric Power Company

# Damage by Hydrogen Explosion - Adjoining Building



Source: Website of Tokyo Electric Power Company

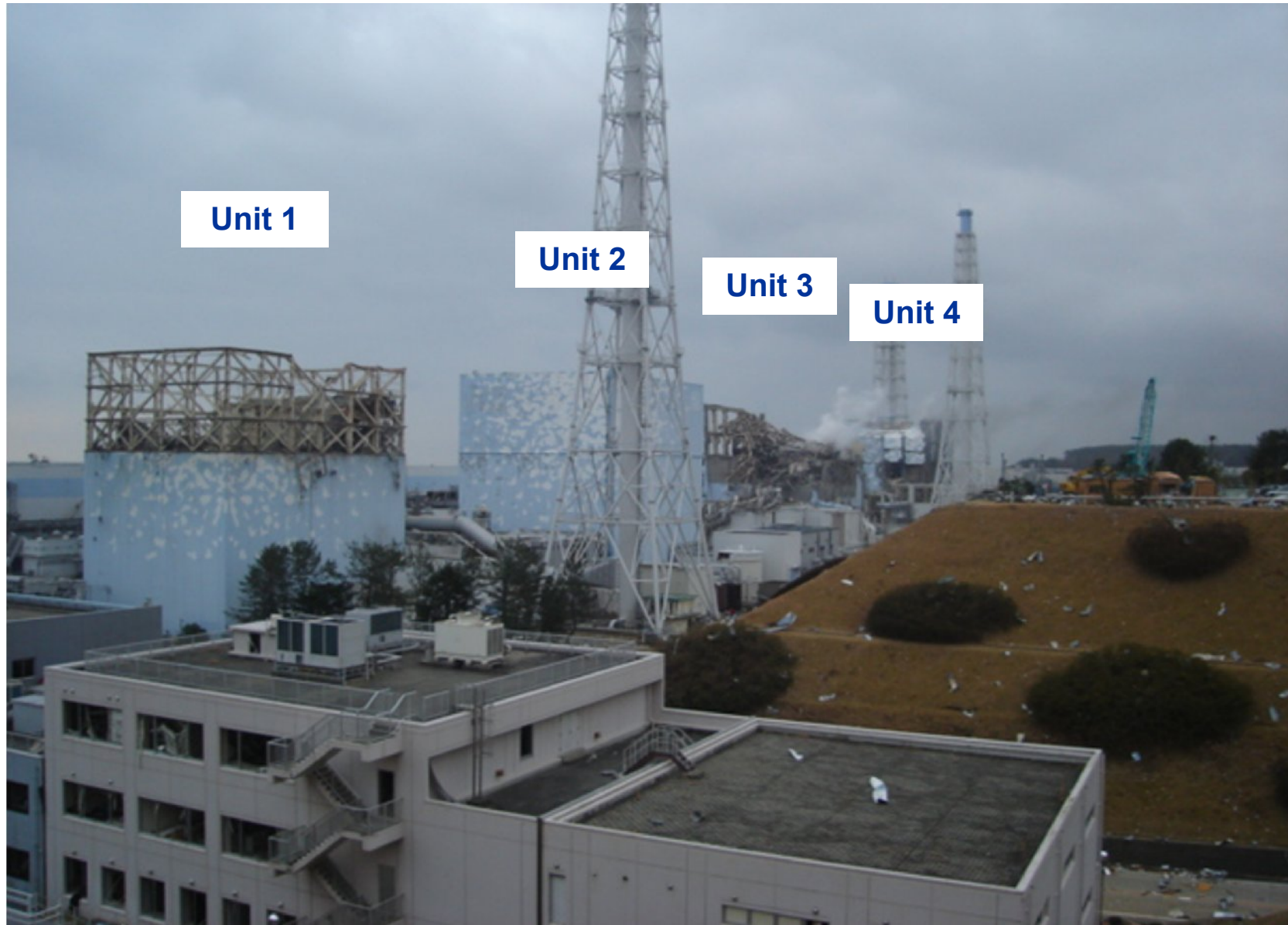


# Major Activities at Unit 1 - Seawater Injection



Source: Website of Tokyo Electric Power Company

# Units 1 - 4 after Hydrogen Explosions



Source: Website of Tokyo Electric Power Company



# Unit 1 Reactor Building



Source: Website of 2011 Secretariat of the Investigation Committee on the accidents at the Fukushima Nuclear Power Station



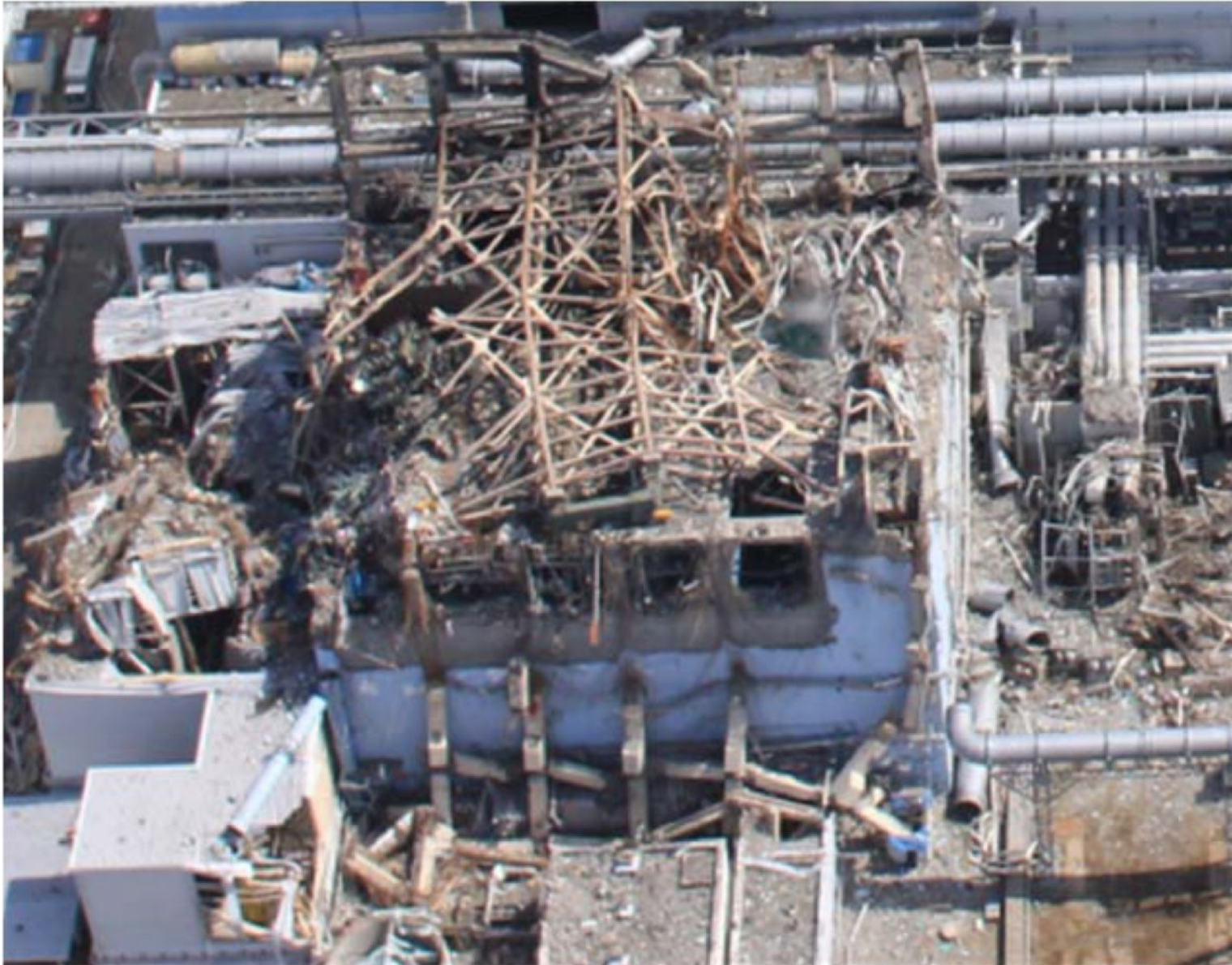
# Unit 2 Reactor Building



Source: Website of Tokyo Electric Power Company



# Unit 3 Reactor Building



Source: Website of 2011 Secretariat of the Investigation Committee on the accidents at the Fukushima Nuclear Power Station

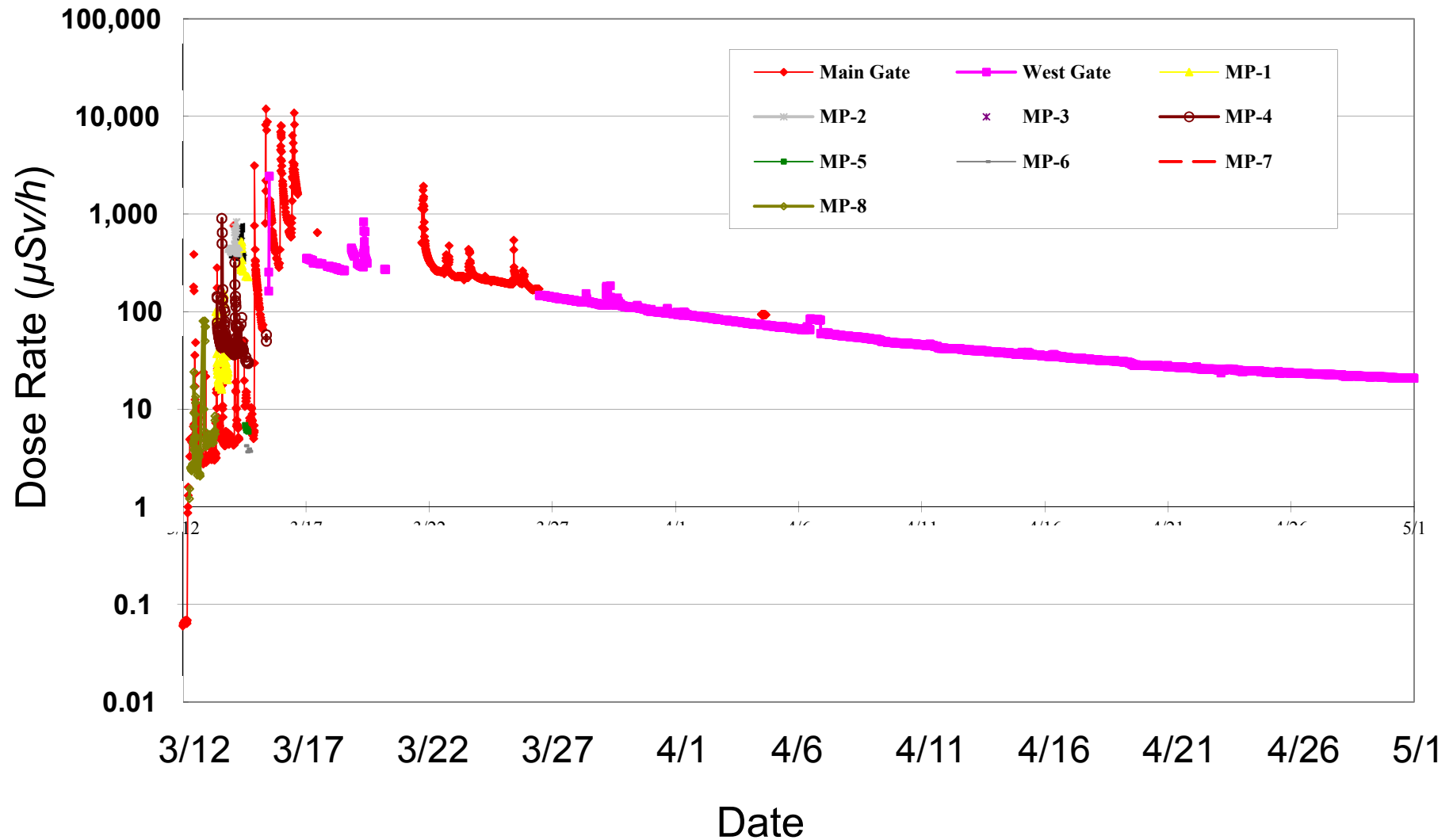


# Unit 4 Reactor Building



Source: Website of 2011 Secretariat of the Investigation Committee on the accidents at the Fukushima Nuclear Power Station

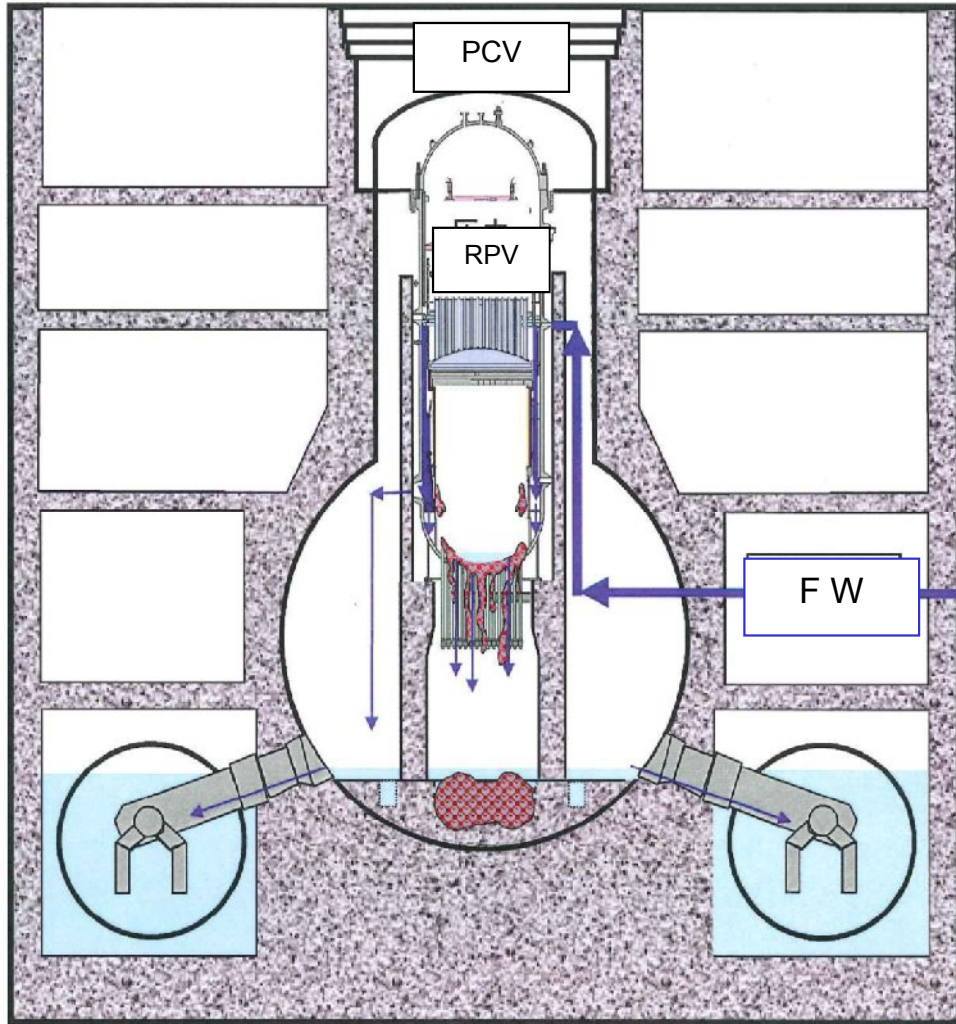
# Dose Rate Trend at Site Boundary



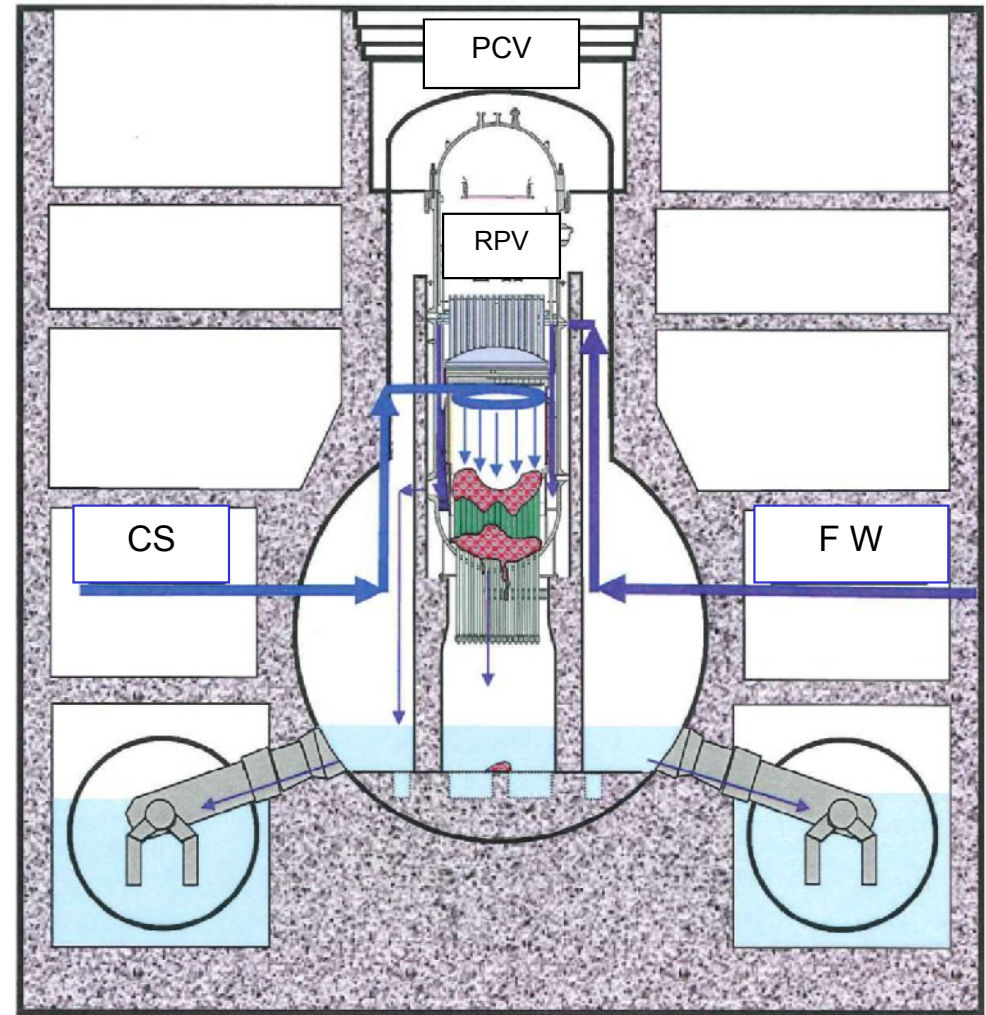
Source: Website of Tokyo Electric Power Company



# Estimated Damage of Reactor Core



Unit 1



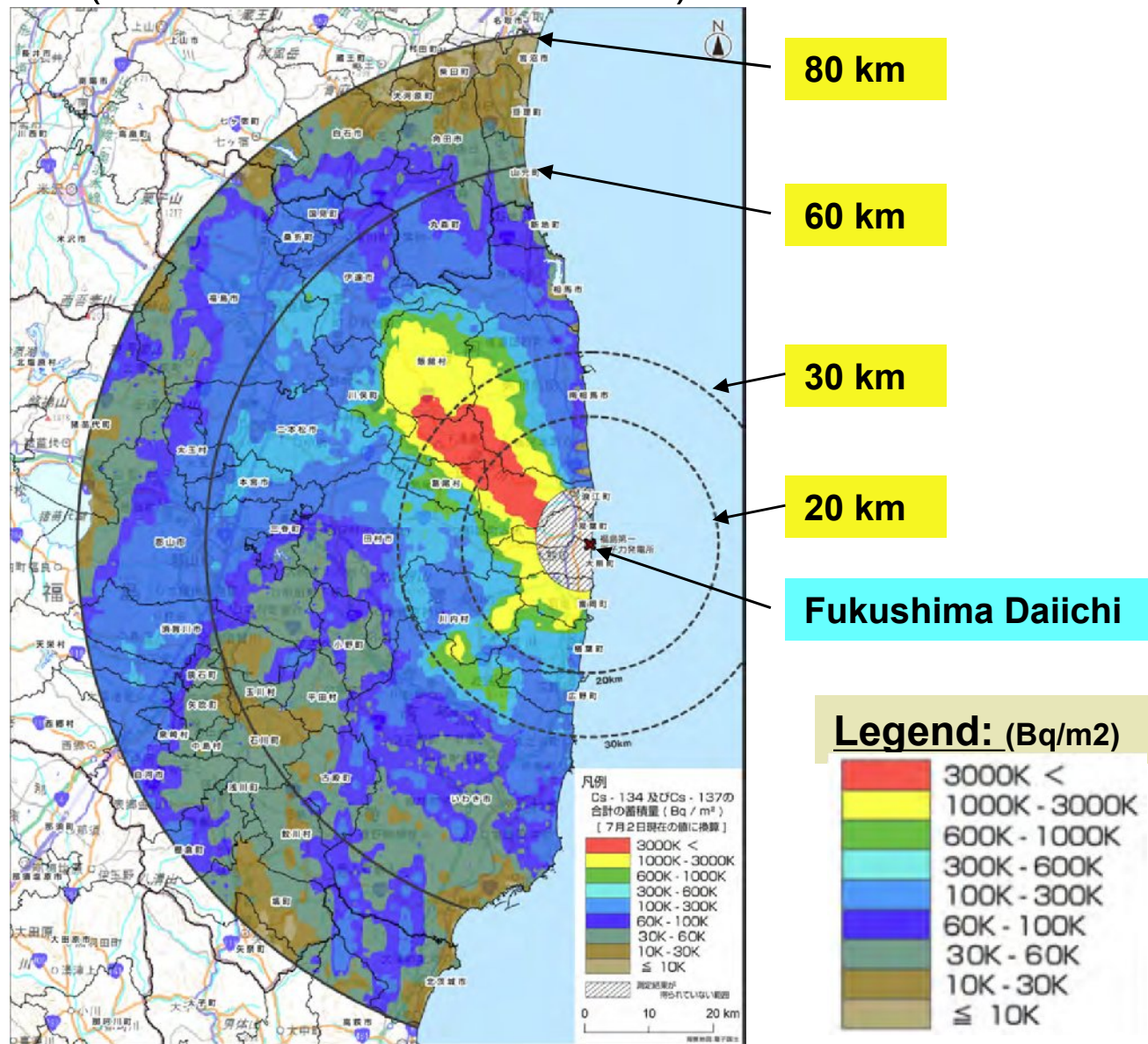
Units 2, 3

Source: Website of Tokyo Electric Power Company



# Land Contamination around Site

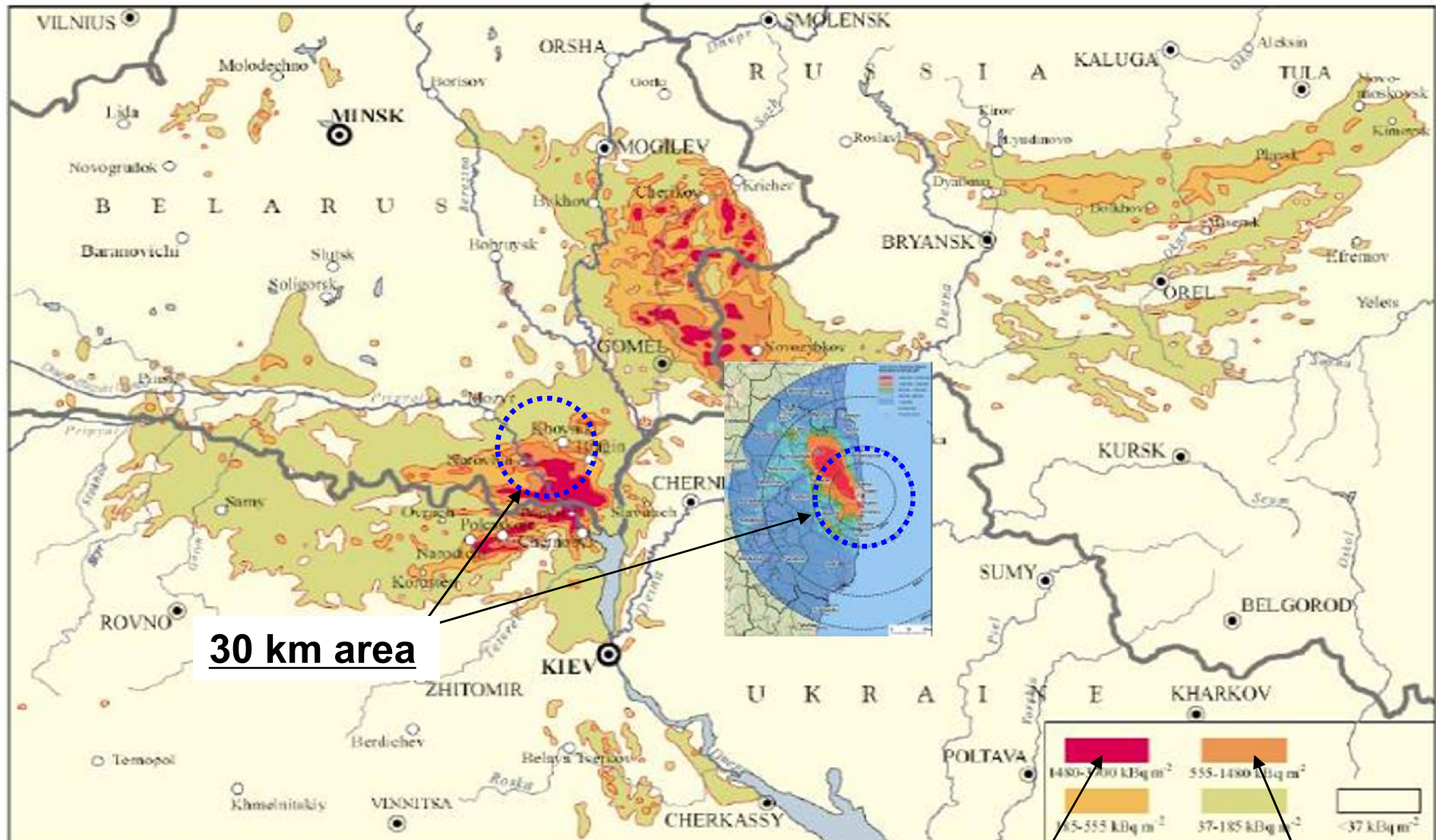
(Cesium134 and Cesium137)



Source: Website of Ministry of Education, Culture, Sports, Science & Technology in Japan



# Comparison with Spread of Contamination from Chernobyl Accident



Source :IAEA Pub-1239 "Environmental Consequences of the Chernobyl Accident and their Remediation :Twenty Years of Experience " (April 2006)

Confiscated/Closed Zone:  
Cs-137:1480-3700kBq/m<sup>2</sup>

Permanent Control Zone:  
Cs-137: 555-1480kBq/m<sup>2</sup>



# Roadmap towards Stabilization

April '11                      July '11                      Dec. '11



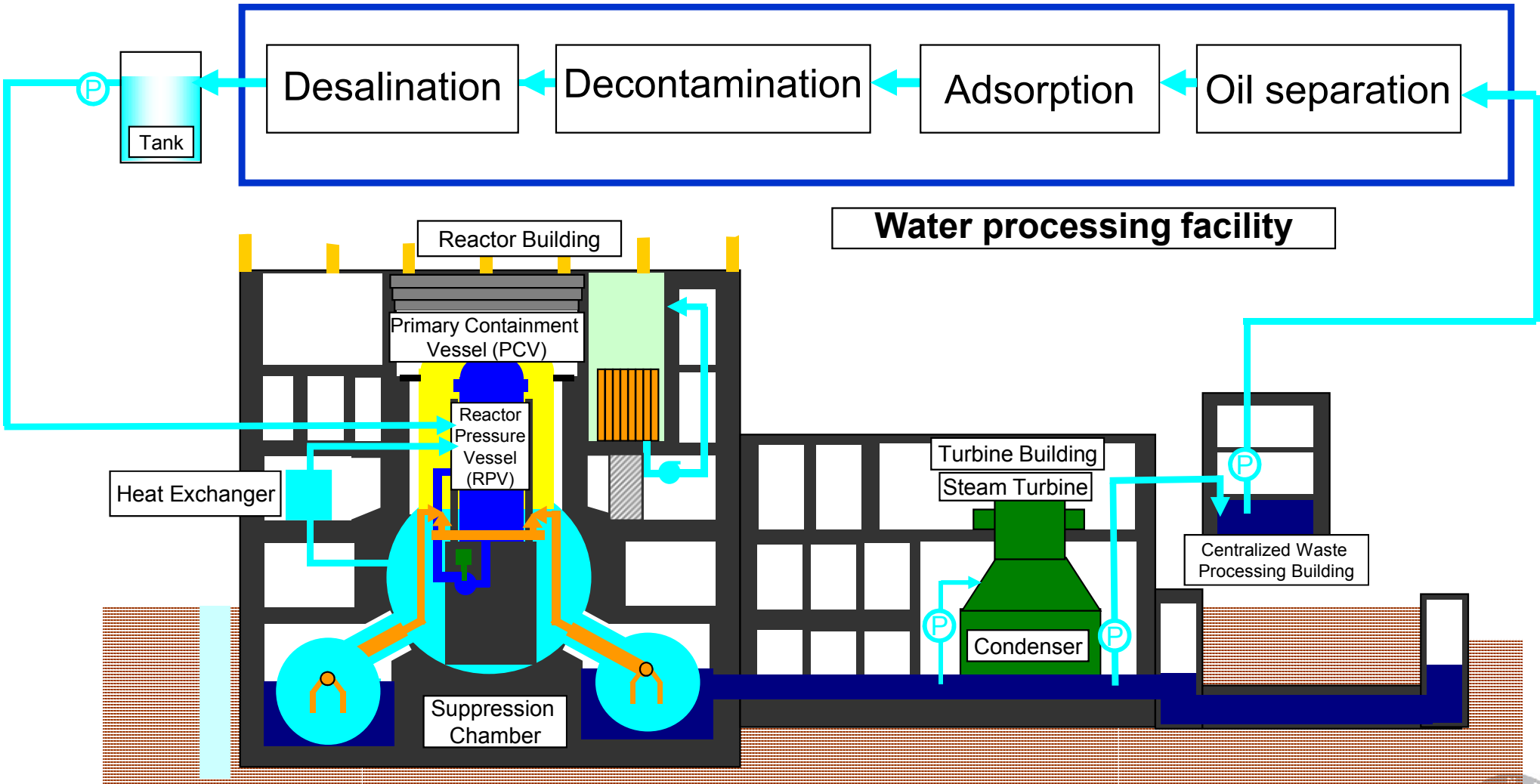
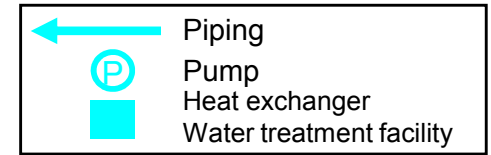
	Step 1 April '11 - July '11	Step 2 July '11 - Dec. '11	Mid-term issues Dec. '11 onwards
<b>Reactors</b>	<b>Stable cooling</b>  <b>Injection of water</b>	<b>Cold shutdown condition</b>  <b>Circulating injection cooling</b>	<b>Protection against corrosion cracking of structural materials</b>
<b>Spent Fuel Pools</b>	<b>Stable cooling</b>	<b>More stable cooling</b>	<b>Start of fuel removal work</b>
<b>Accumulated Contaminated Water</b>	<b>Secure storage location</b>	<b>Reduction of total amount of contaminated water</b>	<b>Installation of full-fledged water processing facilities</b>

Source: Website of Tokyo Electric Power Company





# Circulating Water Cooling System



Source: Website of Tokyo Electric Power Company



# Storage of Highly Contaminated Water and Processed Water

Receiving processed water



Concentrated sea water



Receiving highly contaminated accumulated water (Installation work)



Concentrated liquid waste



Source: Website of Tokyo Electric Power Company

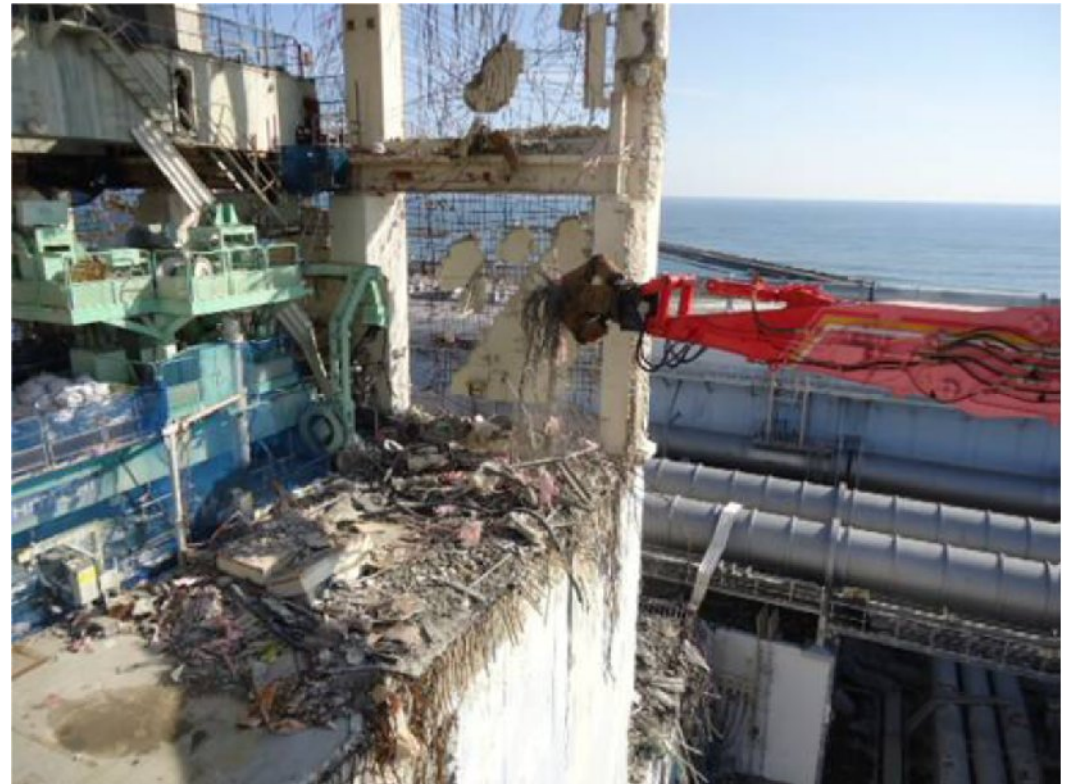
# Reactor Building Cover - Unit 1



Source: Website of Tokyo Electric Power Company



# Removal of Debris from Reactor Building

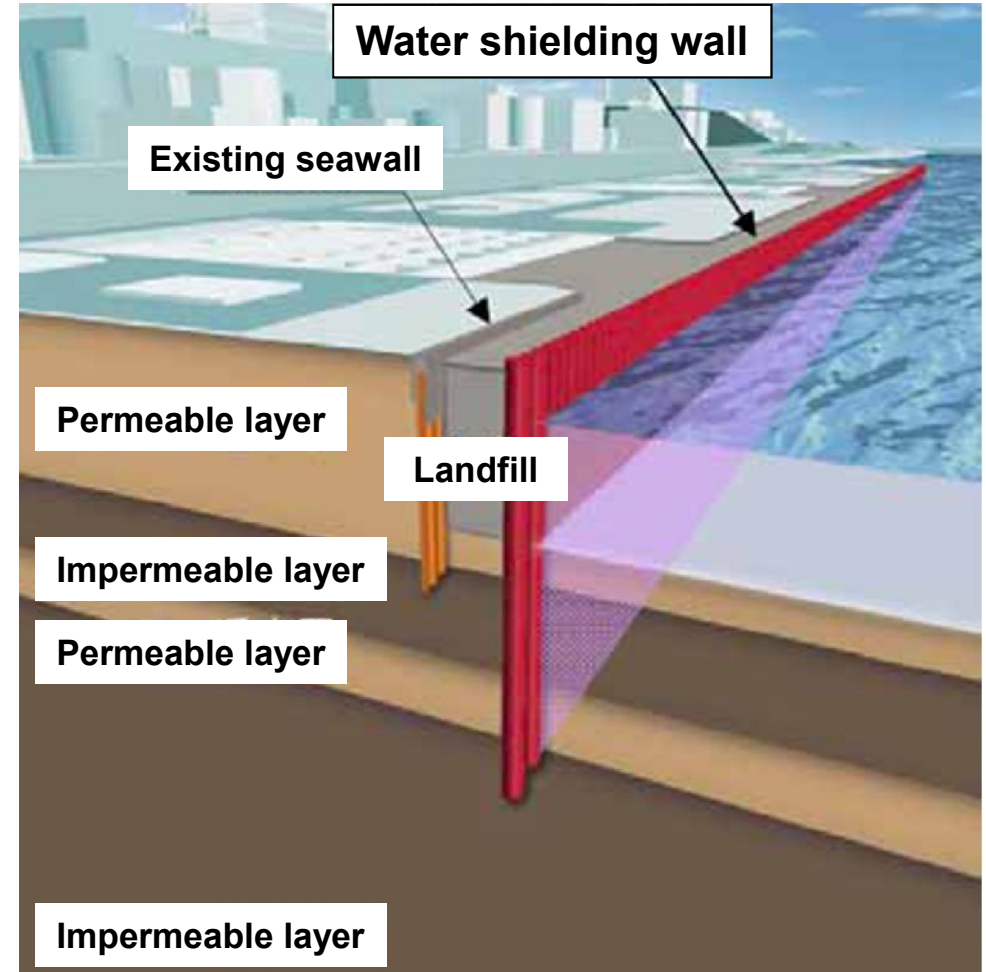


Source: Website of Tokyo Electric Power Company

# Water Shielding Wall



**Overview**

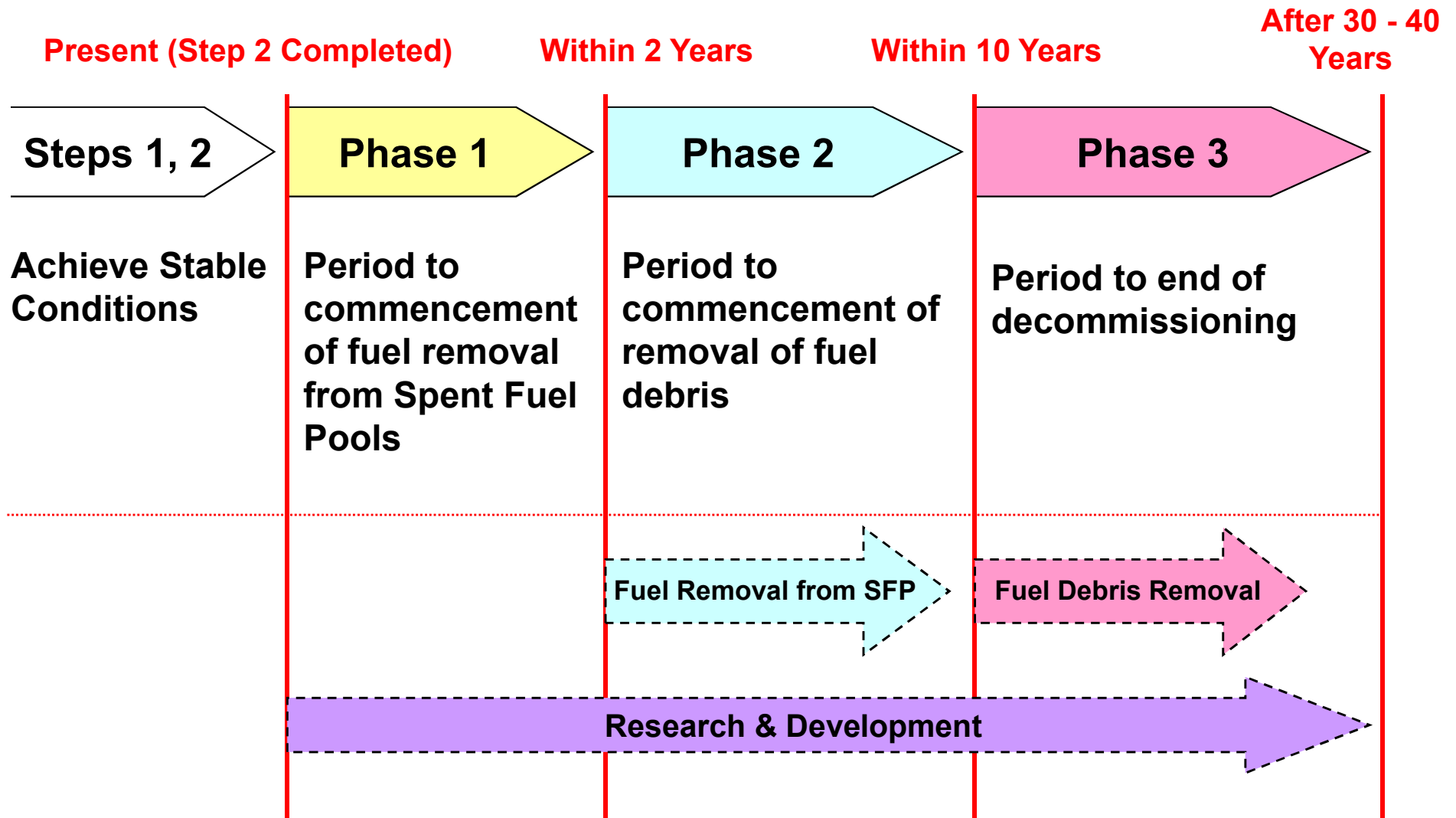


**Cross-section**

Source: Website of Tokyo Electric Power Company



# Mid- and Long-Term Roadmap



Source: Website of Tokyo Electric Power Company



# WWMR Symposia 2012