2008 AEC-NRC Bilateral Technical Meeting

AEC's Regulatory Action after Earthquake on Japanese Kashiwazaki-Kariwa NPP

May 13, 2008

Wen-Chun Teng
Section Chief
Department of Nuclear Regulation
AEC

Kashiwazaki-Kariwa Nuclear Power Station

View of Kashiwazaki-Kariwa Nuclear Power Station

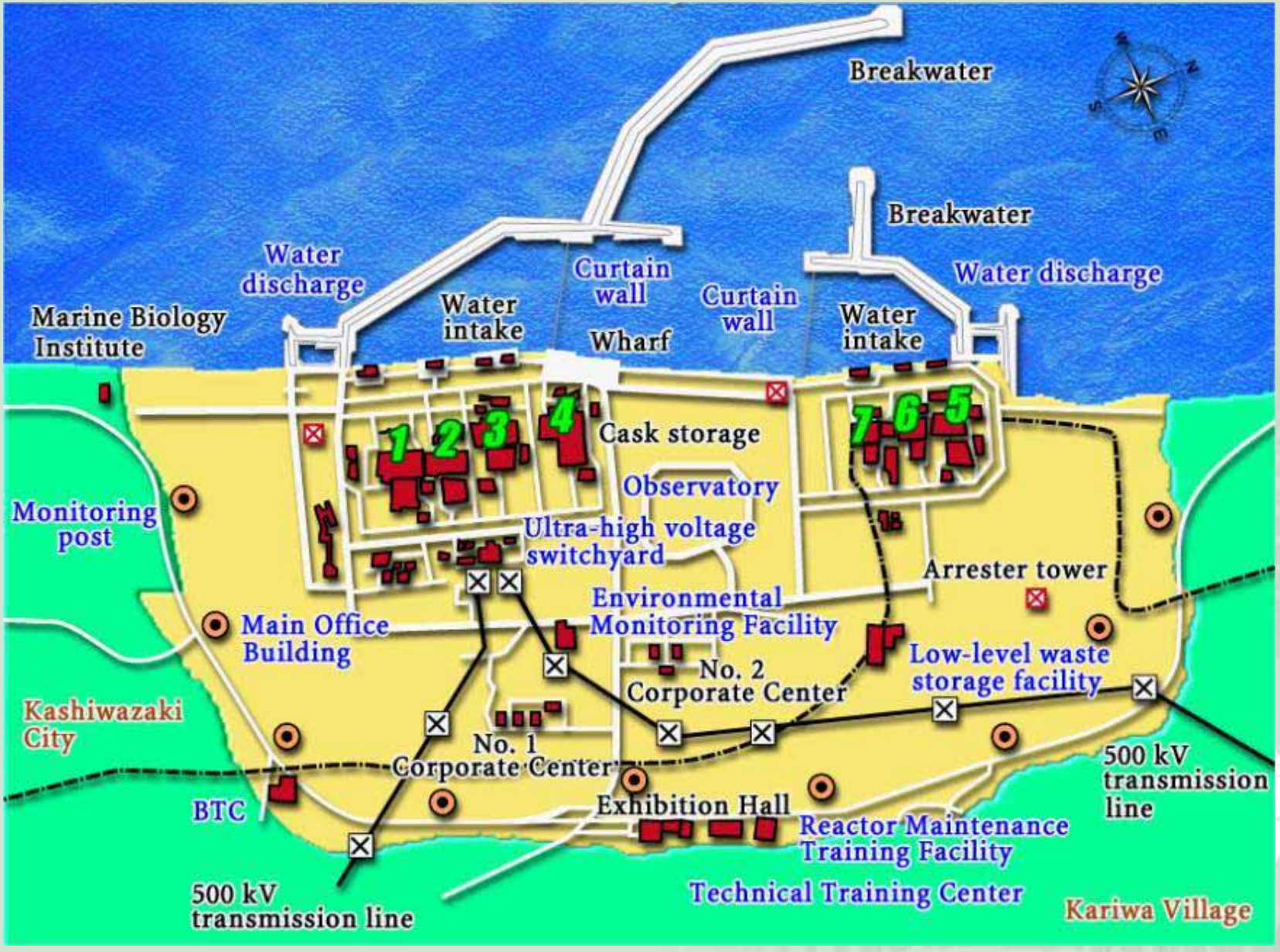
- 7 units, 8,212 MWe
- Reactor type

  Units 1-5: BWR

  Units 6, 7: ABWR

Service Area and Electric Power System of TEPCO

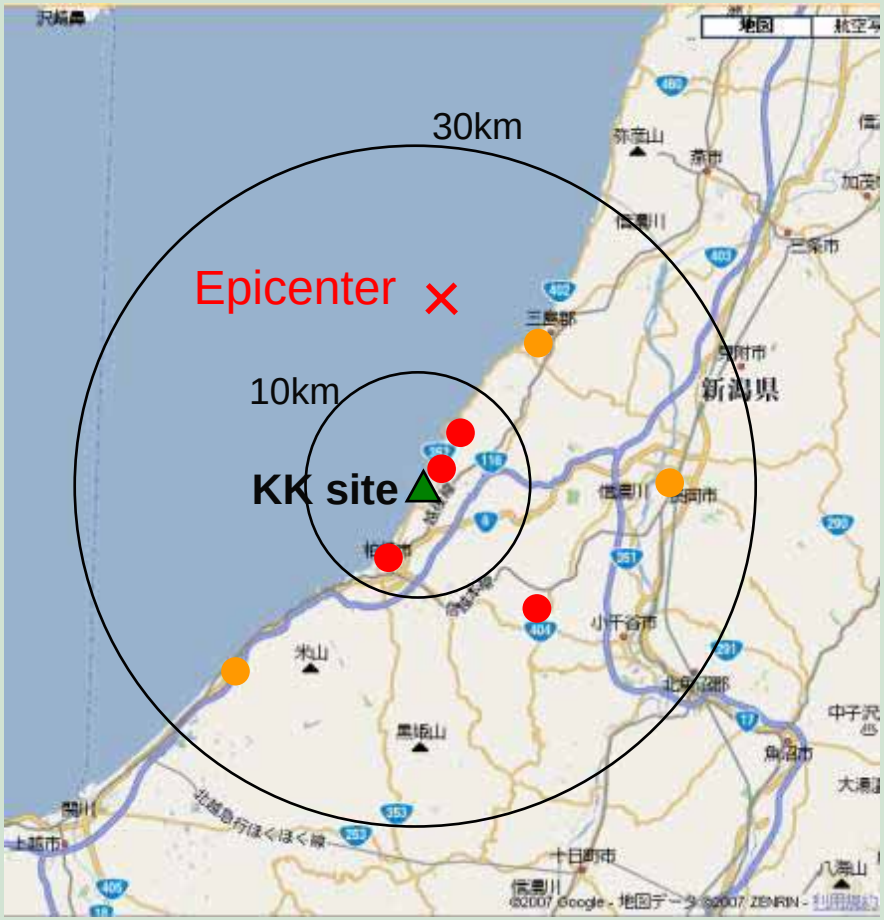
Site Layout

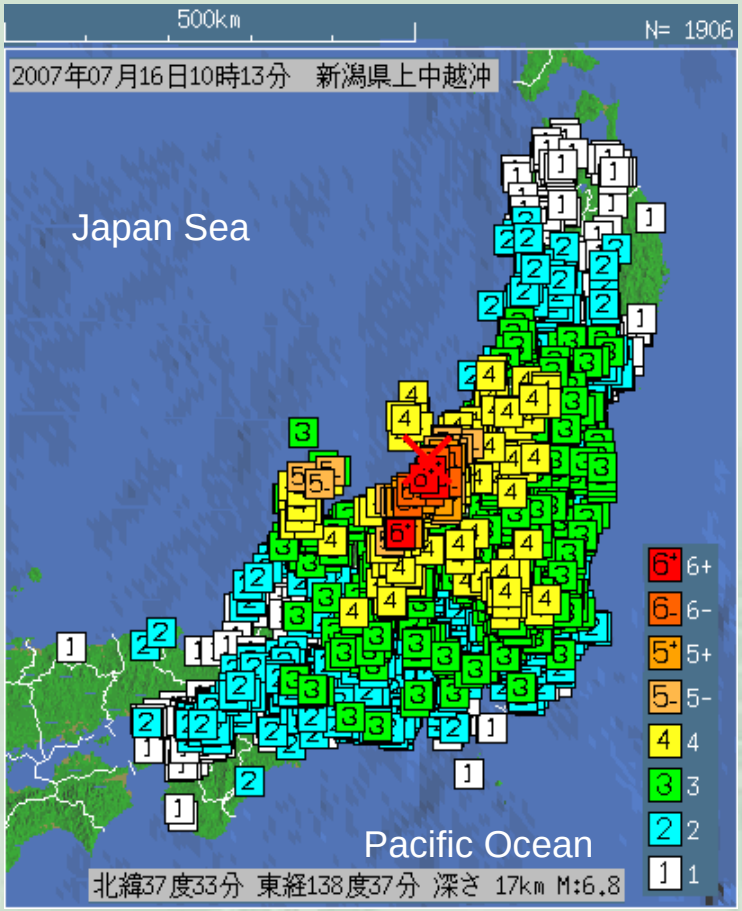

Breakwater
Breakwater
Water discharge
Water discharge
Curtain wall
Curtain wall
Water intake
Water intake
Wharf
Marine Biology Institute
1
2
3
4
Cask storage
7
6
5
Observatory
Monitoring post
Ultra-high voltage switchyard
Arrester tower
Environmental Monitoring Facility
Main Office Building
No. 2 Corporate Center
Low-level waste storage facility
Kashiwazaki City
No. 1 Corporate Center
500 kV transmission line
BTC
Exhibition Hall
Reactor Maintenance Training Facility
500 kV transmission line
Technical Training Center
Kariwa Village

Plant Profile

Unit	Date of Commercial Operation	Reactor Type	Generator Output (MWe)	Thermal Power (MWt)	Main Contractor	Status at the quake
No.1	1985/9/18	BWR-5	1,100	3,293	Toshiba	Outage
No.2	1990/9/2	BWR-5	1,100	3,293	Toshiba	Start-up
No.3	1993/8/11	BWR-5	1,100	3,293	Toshiba	Operation
No.4	1994/8/11	BWR-5	1,100	3,293	Hitachi	Operation
No.5	1990/4/10	BWR-5	1,100	3,293	Hitachi	Outage
No.6	1996/11/7	ABWR	1,356	3,926	T/H/GE	Outage
No.7	1997/7/2	ABWR	1,356	3,926	T/H/GE	Operation
Total	-	-	8,212	-	-	

The Chuetsu-oki Earthquake





Distribution of seismic intensity (JMA)

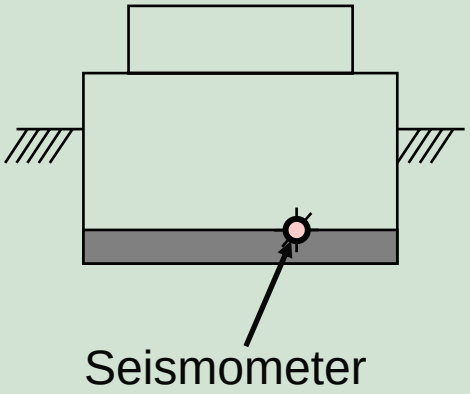
- **Date & Time of the quake: July 16, 2007 10:13 AM (National Holiday)**
- **Magnitude on the Richter scale: 6.8**
- **Depth: 17 km**
- **Distance from NPS: Epicenter → 16 km, Hypocenter →23 km**

Observed Acceleration at R/B Base Mat

Unit:Gal (cm/s/s)

	Horizontal-NS	Horizontal-EW	Vertical
Unit 1	311(274)	680(273)	408(235)
Unit 2	304(167)	606(167)	282(235)
Unit 3	308(192)	384(193)	311(235)
Unit 4	310(193)	492(194)	337(235)
Unit 5	277(249)	442(254)	205(235)
Unit 6	271(263)	322(263)	488(235)
Unit 7	267(263)	356(263)	355(235)

Design Value is in ( )



◆Set point for SCRAM (Automatic Shutdown)

Horizontal : 120 Gal

Vertical: 100Gal

Shutdown

Occurrence of the earthquake

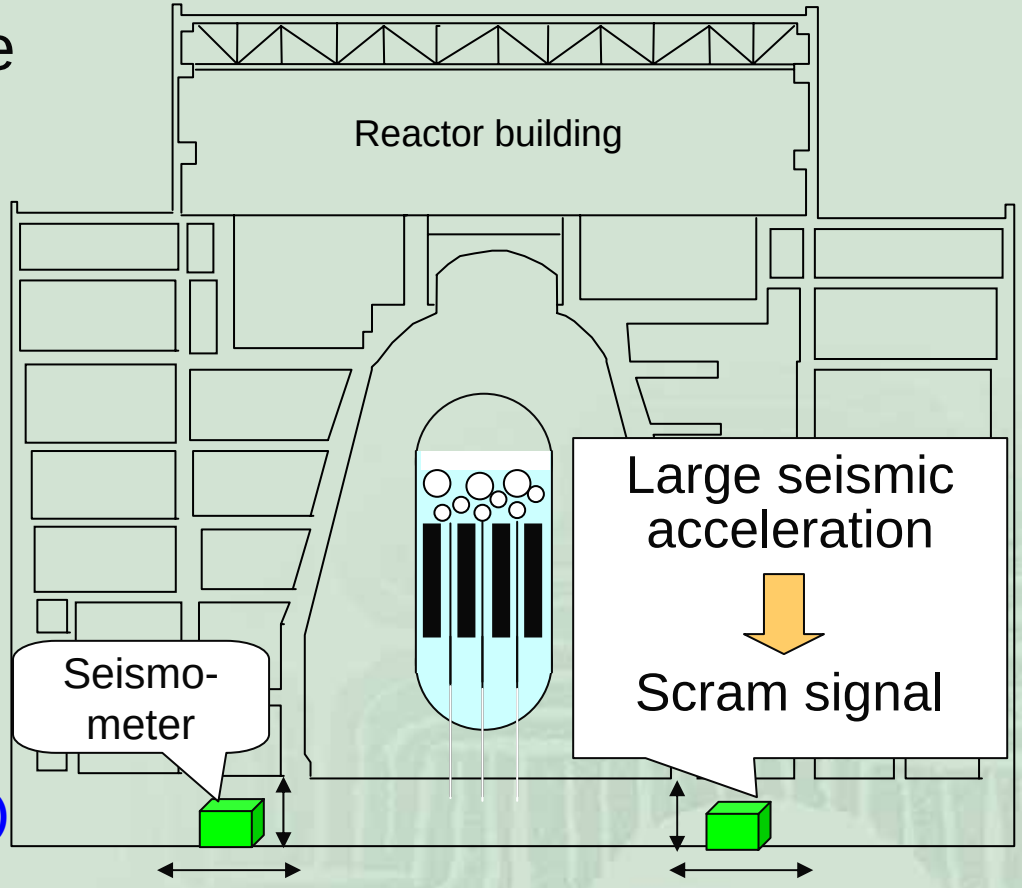
↓

Large seismic acceleration

↓

Automatic scram of the reactor

- Full insertion of all control rods



[SCRAM speed]

- **Unit 2**

  0.905~0.955s at 75% < 1.62s (design value)

- **Unit 7**

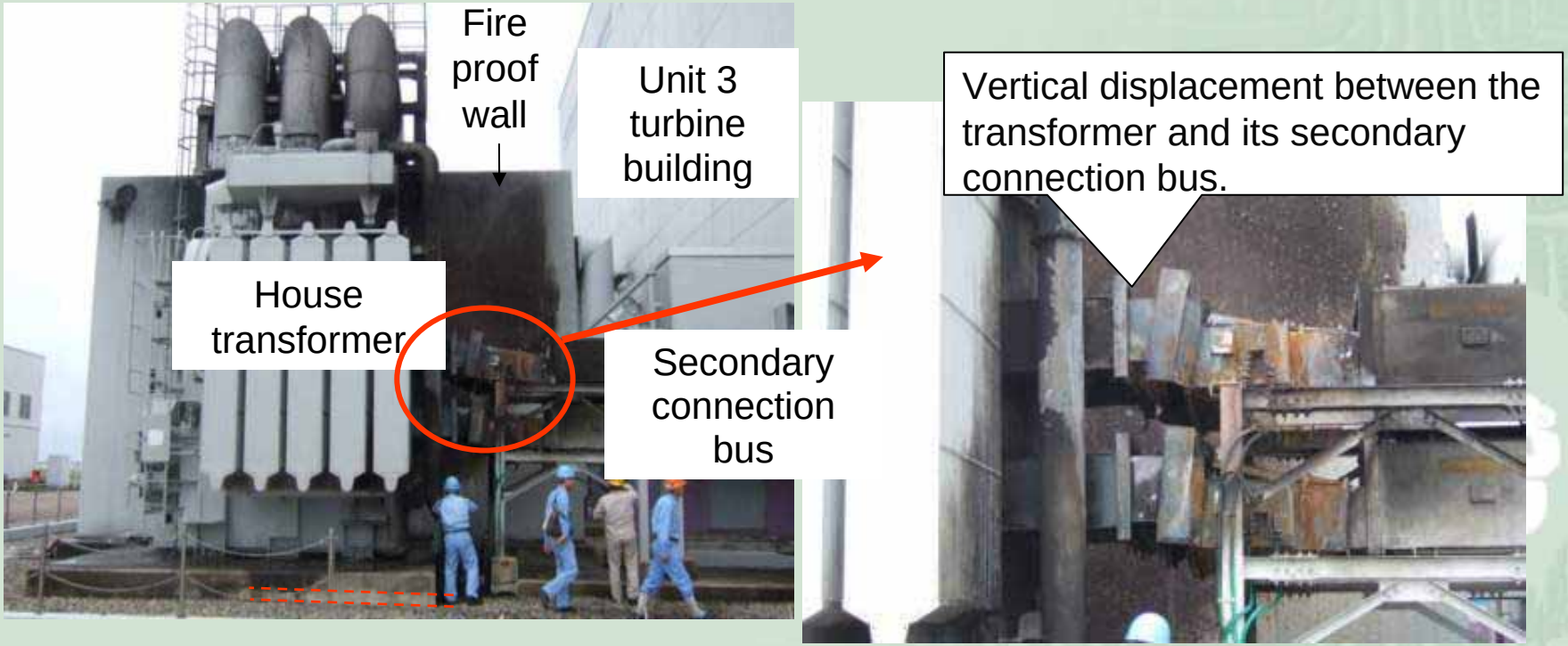
  0.714~0.807s at 60% < 1.44s (design value)

- **Unit 3, 4**

SCRAM timing recorder was not available but SCRAM was confirmed by All CR full insertion signal.

Quake-induced Event #1: Unit 3 House Transformer Fire

- The house transformer was on sound base but the base of secondary connection bus was not and vertically sank, which caused a short circuit.
- Sparks from the short circuit ignited insulating oil that leaked from the transformer.
- The fireproof wall prevented the fire from spreading to other important facilities.
- This transformer is for house power demand while generator is running, which means it does not have any safety functions after the reactor trip.



Improvements for resolving the issue (Transformer fire)

- Reinforcement of the in-house fire fighting corps.
  - Forming a fire-fighting corps on round-the-clock standby.
  - Deployment of chemical fire engine and fire engine with a water tank.
  - Setting up a hotline with the Main Control Room.

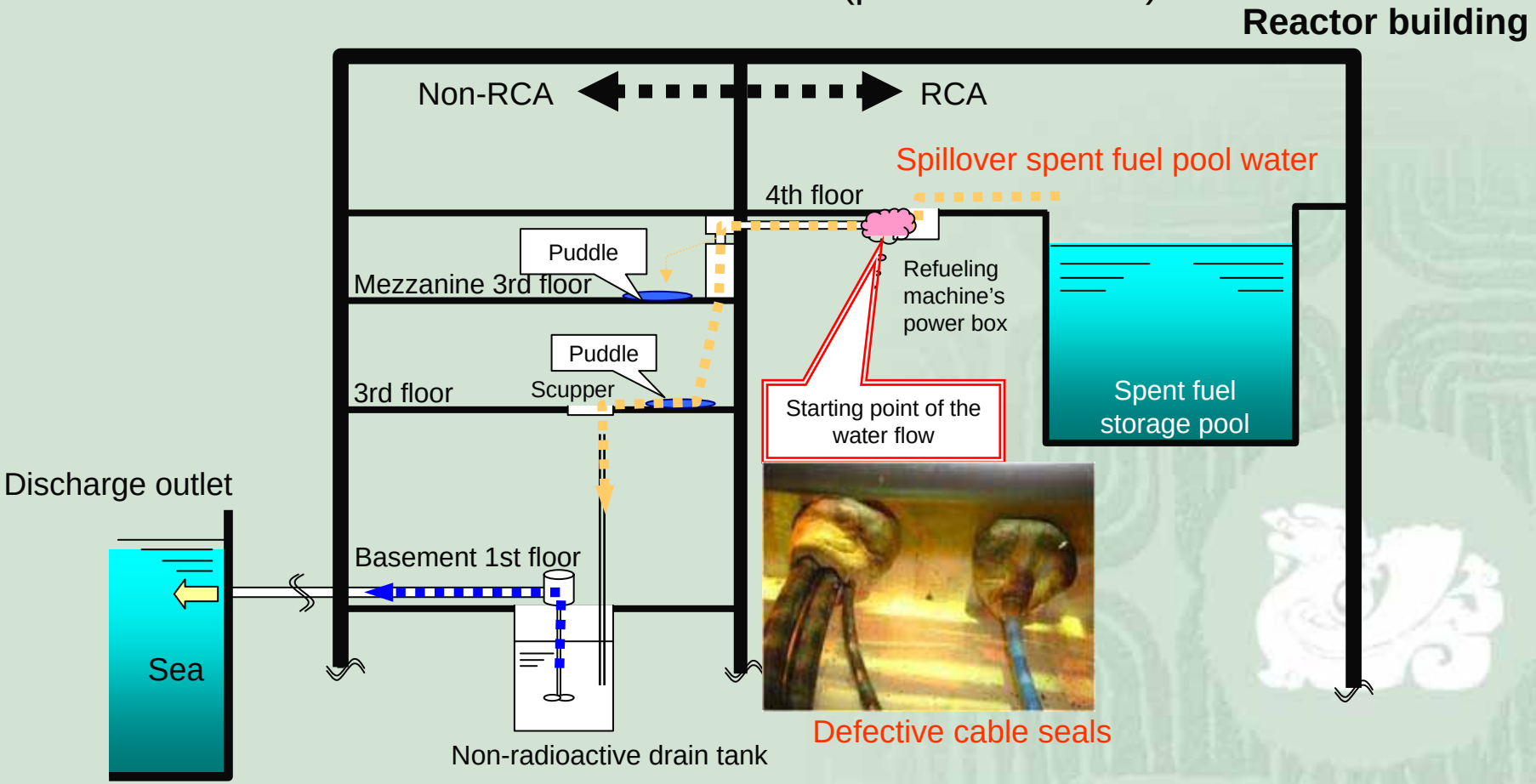
Exterior view of the chemical fire engine 1.

Exterior view of the chemical fire engine 2.

The fire engines and personnel have been on round-the-clock standby on the station premises since the evening of July 19.

Quake-induced Event #2: Minuscule Amount of Radioactivity Leaked into the Sea from Unit 6

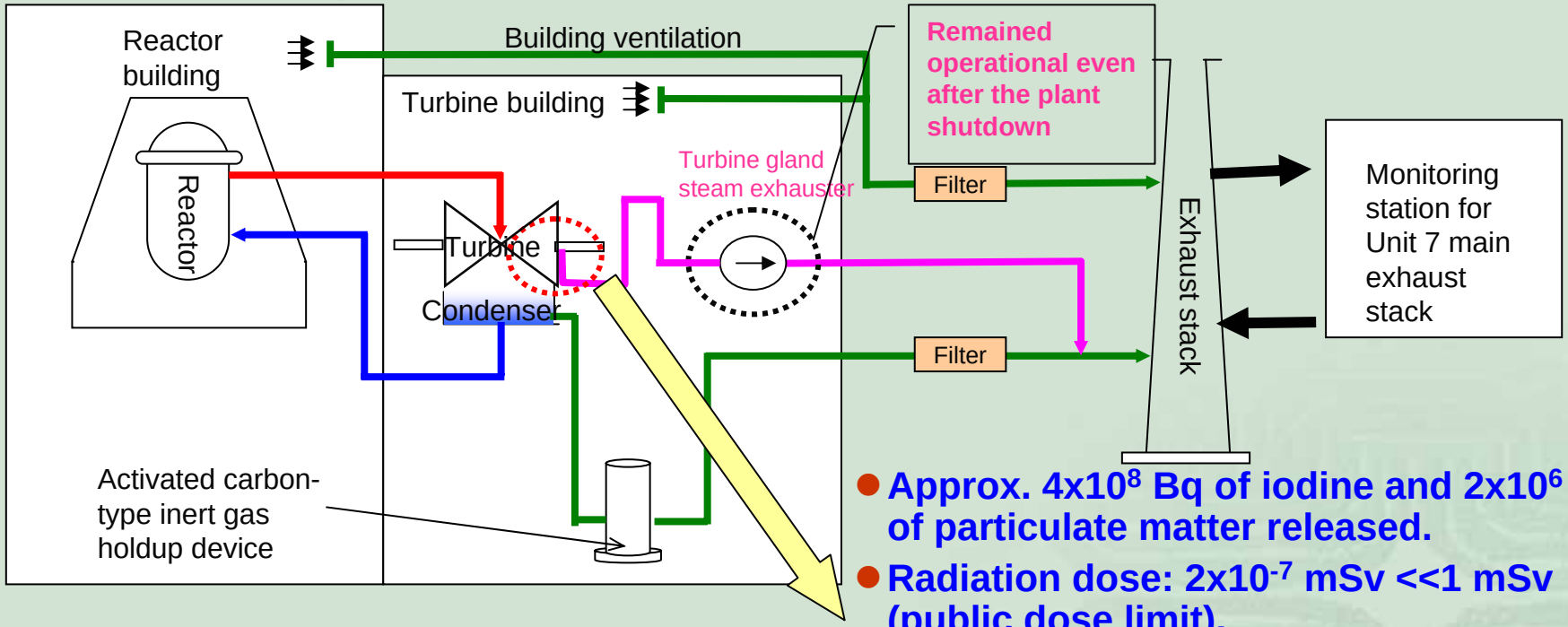
- Water leakage and subsequent release of radioactive substances into the sea.
  - Amount of water discharged: 1.2 m3.
  - Radiation dose: 2×10^{-9} mSv << 1 mSv (public dose limit).



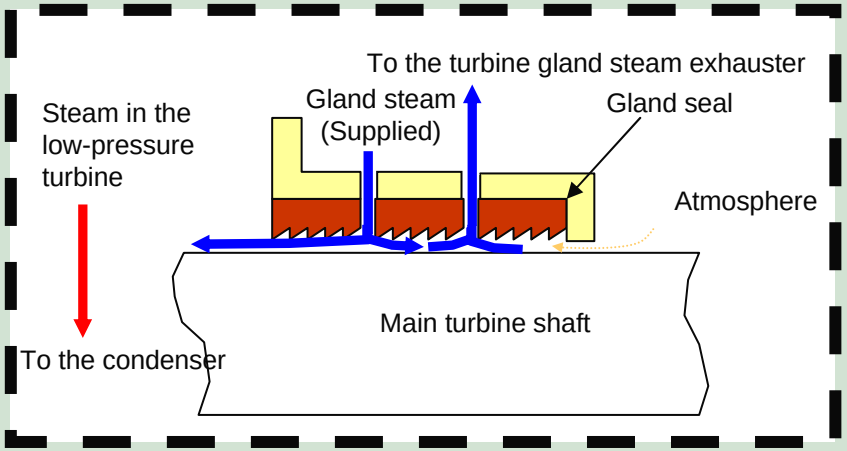
Improvements for resolving the issue (Radioactive leakage)

- Development of a swift and strict reporting process.
  - TEPCO's management was blamed for delayed radioactive sampling and slow reporting
  - Developing a round-the-clock process that enables accurate and swift sample collection and radiation measurement in the event of leakage of radioactive substances. Radiation technicians on round-the-clock stanby has been introduced at all stations
  - Ensuring the isolation of leakage routes and circulation of information upon the discovery of leakage in non-RCA areas and possibility of contamination with radioactive substances.

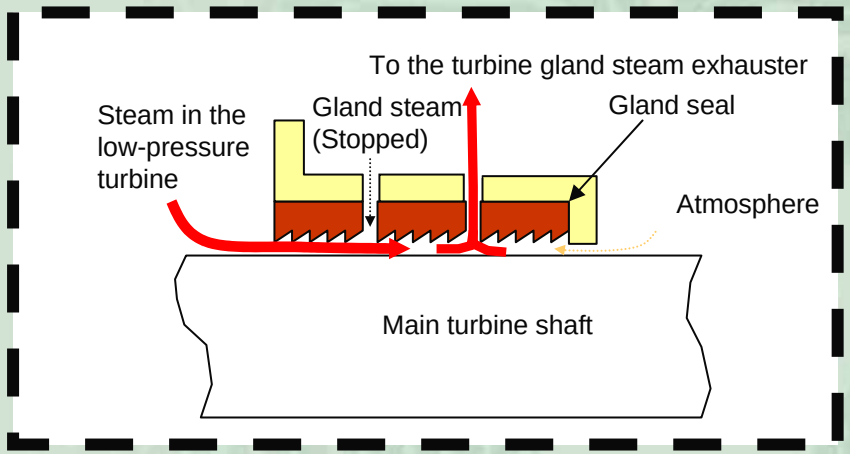
Quake-induced Event #3: Minuscule Amount of Airborne Radioactivity Released into the Air from Unit 7



- **Approx. 4×10^{8} Bq of iodine and 2×10^{6} Bq of particulate matter released.**
- **Radiation dose: 2×10^{-7} mSv <<1 mSv (public dose limit).**



Normal condition

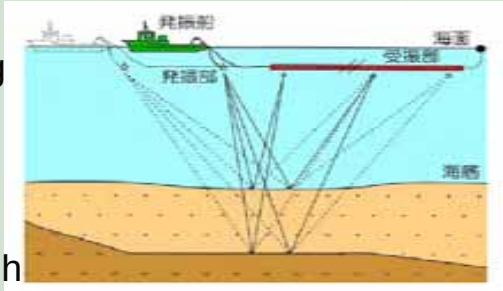


Condition after the earthquake

Geological Survey Plan

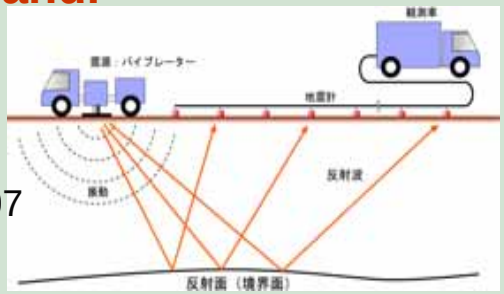
Survey in the sea.

- Seismic sonic prospecting covering additional area including where aftershock occurred.
- From August through October, 2007.



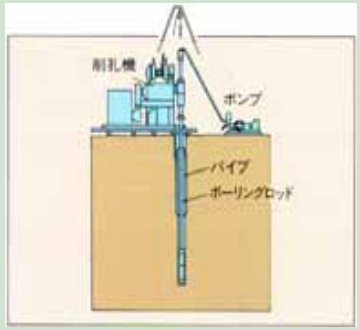
Survey in the land.

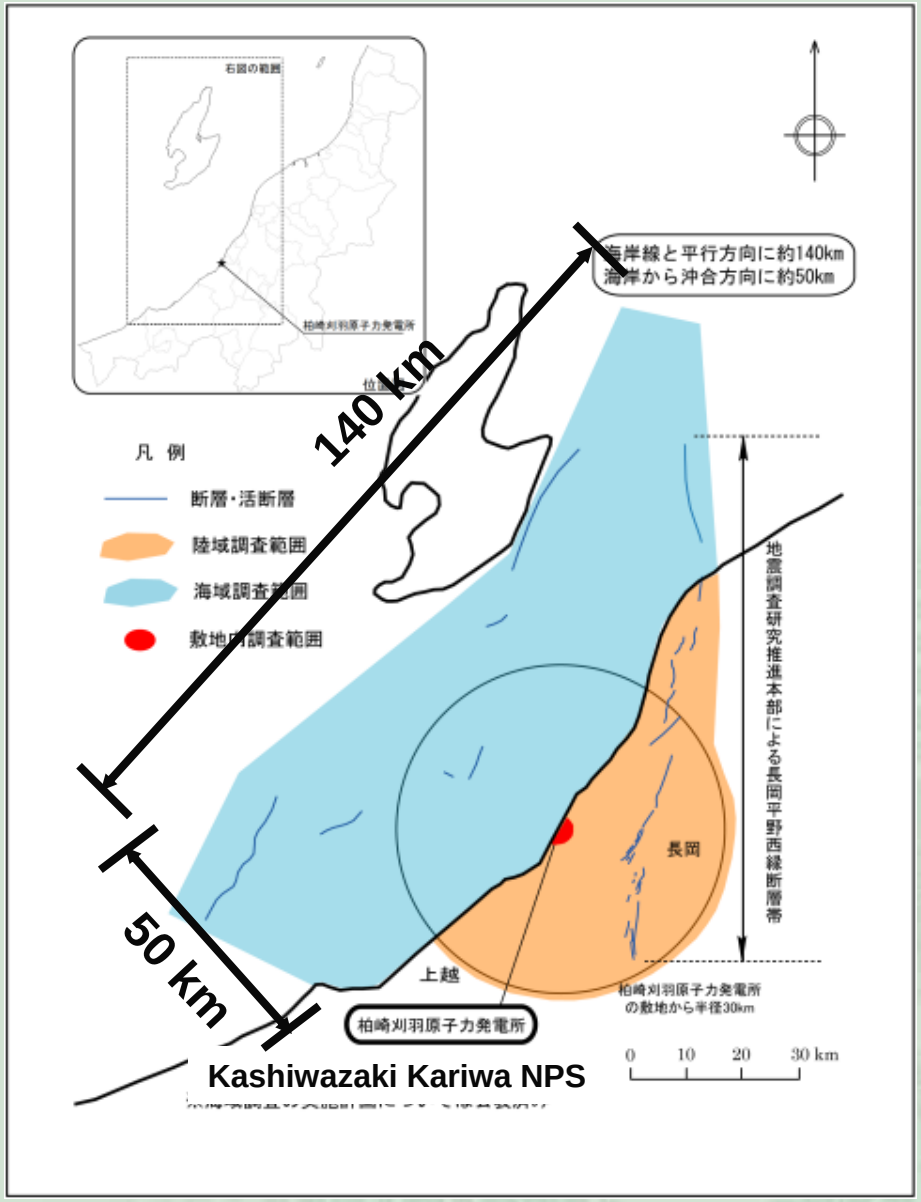
- Seismic reflection method covering additional area.
- From September, 2007 to March, 2008.



Survey on the site.

- Additional boring deep underground. Evaluating ground settling and liquefaction.
- From September, 2007 to March, 2008.





Strengthening Emergency Preparedness

- Rupture of fire-protection piping.
  - securing multiple sources of water for fire fighting operation.
  - designing piping anticipating ground settling.
  - introducing flexible joints.
  - installing above ground fire-protection piping.

- Transformer fire.
  - Installing additional fire-protection piping for station transformers.
  - deploying chemical fire engine.
  - adopting a structure that inhibits short-circuiting at the interface.

- Emergency control room & administration building.
  - setting up an emergency control room in a quake-resistant building.
  - reinforcing the existing administration building.
  - providing power from an emergency sourced.

Strengthening Emergency Preparedness (continued)

- Communication systems.
  - Exploring ways of improving the reliability of external communications systems. A direct phone line to a local fire station from the main control room has been set up.
- Portal monitors.
  - Exploring ways of improving the reliability of RCA (Radiation Controlled Area) portal monitors. There may be better ways for contamination monitoring in emergency situations.
- Falling objects.
  - Securely fastening items such as lighting fixtures and cabinets in important office spaces such as the main control room, to prevent falling objects from interfering with plant opeartion or injuring people.

AEC'S Regulatory Measures

- Re-evaluation of seismic design of the Fire Protection System*
- Firefighting personnel--- 24 hour in-house fire brigade
- Firefighting equipment---fire engines with both water and chemicals
- Hot line telephone between Plants and the Firefighting Department of local Administration established, and tested every week*
- Reporting to AEC within 1 hour and once per hour hereafter

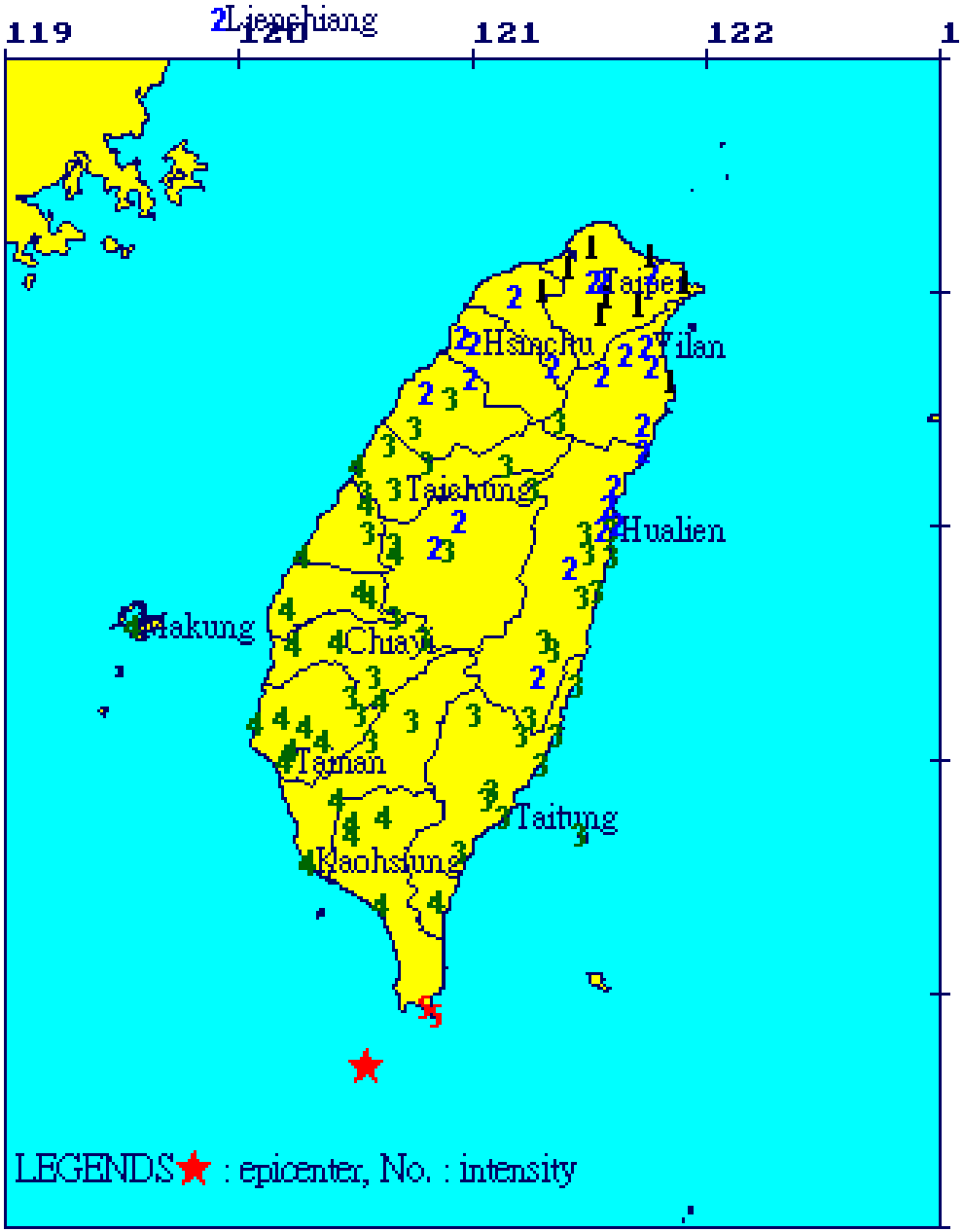
AEC'S Regulatory Measures (cont'd)

- Evaluation of possible leak-out path for the SFP water sloshed out*
  - Inspection of penetration seals of cables、conduits and pipes between fuel building
  - Drainage system on the floor adjacent to SFP
- Auto Scram when large scale earthquake（OBE-5%） hit installed in the RPS
- Expanded memory capacities of the seismic data logging system*

***Req'd by AEC after KK seismic event**

2006.12.26 Hengchun Earthquakes

- At 20:26, December 26, 2006, an earthquake with magnitute 7.0 on the Richter scale occurred 40 km SSW of Hengchun.
- 8 minutes later, at 20:34, another earthquake with magnitute 7.0 occurred 33.1 km W of Hengchun.



CWB EARTHQUAKE REPORT

Earthquake No.: 95106

Origin time (Taiwan Standard Time: GMT+08:00):
12/26/2006 20:26:21.0

Location: 21.69N, 120.56E

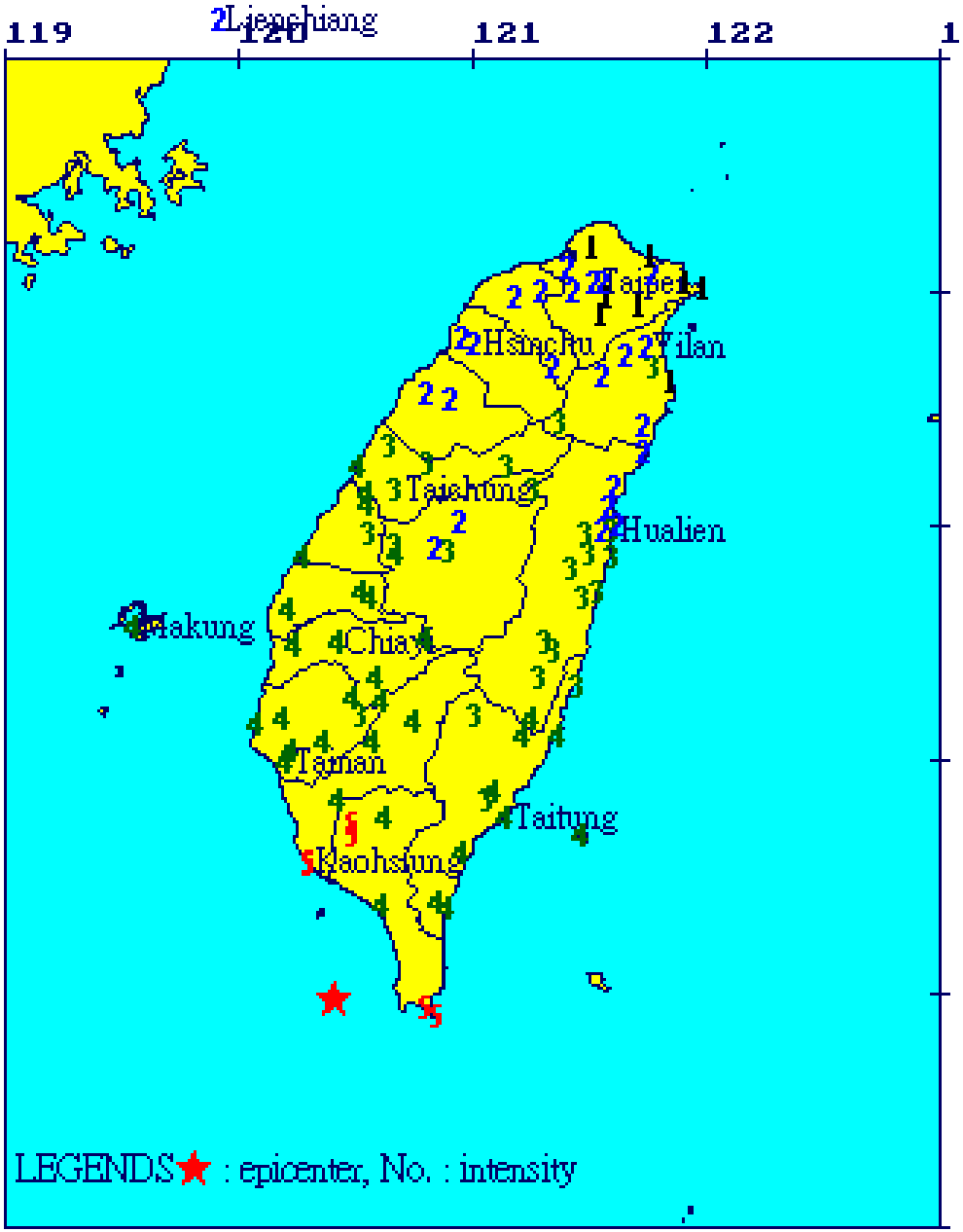
i.e. 40.0 km SSW of Hengchun, Pingtung

Depth : 44.1 km

Magnitude(ML): 7.0

Local Largest Intensity :

Pingtung County	5	Hualien County	3
Taitung County	4	Nantou City	3
Kaohsiung County	4	Taichung City	3
Kaohsiung City	4	Hualien City	3
Pingtung City	4	Miaoli County	3
Tainan City	4	Yilan County	3
Tainan County	4	Miaoli City	2
Chiayi County	4	Taoyuan County	2
Chiayi City	4	Hsinchu City	2
Yunlin County	4	Hsinchu County	2
Douliou City	4	Yilan City	2
Penghu County	4	Taipei City	2
Changhua County	4	Taipei City	2
Nantou County	4	Lienchiang County	2
Changhua City	4	Taoyuan City	1
Taichung County	4	Kinmen County	1
Taitung City	3	Keelung City	1



CWB EARTHQUAKE REPORT

Earthquake No.: 95107

Origin time (Taiwan Standard Time: GMT+08:00):
12/26/2006 20:34:15.1

Location: 21.97N, 120.42E

i.e. 33.1 km W of Hengchun, Pingtung

Depth : 50.2 km

Magnitude(ML): 7.0

Local Largest Intensity :

Pingtung County	5	Taichung County	4
Kaohsiung County	5	Nantou City	3
Kaohsiung City	5	Taichung City	3
Pingtung City	5	Hualien City	3
Taitung County	4	Yilan County	3
Tainan City	4	Miaoli County	2
Taitung City	4	Miaoli City	2
Tainan County	4	Taoyuan County	2
Chiayi County	4	Hsinchu City	2
Hualien County	4	Hsinchu County	2
Chiayi City	4	Yilan City	2
Yunlin County	4	Kinmen County	2
Douliou City	4	Taoyuan City	2
Penghu County	4	Taipei County	2
Changhua County	4	Taipei City	2
Nantou County	4	Lienchiang County	2
Changhua City	4	Keelung City	1

Plant Status

- Max. local Intensity is Level V
- Max. acceleration at site is 0.17g (Maanshan's Safe Shutdown Earthquake SSE is 0.4g, and Operating Basis Earthquake OBE is 0.2g.)
- Maanshan Unit 2 was manually scram when the first quake struck on operator's conservative decision.
- Unit 1 continued in steady operation.

Plant Status (continued)

- Small amounts of spent fuel pool water was spilled out, but was confined in the building.
- Small amounts of diesel fuel was also spilled out from diesel oil storage tanks.
- No major damage to the station. Only some dormitory houses had foundation damages, but did not affect the structure integrity of the buildings.

Regulatory Measures of AEC

- Review of safety systems actuation after reactor trip
- Currently discuss the appropriateness of Maanshan NPP's seismic design with the Licensee
- Plans to ask the Licensee to reconfirm the plant's geological and seismological survey