20120518 Presentation for IRPA13, PPT slides

FUKUSHIMA LESSONS AND CHALLENGES IN JAPAN

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Main Issues of Presentation

1. Japan in Pan-Pacific Seismic Zone
2. 2011 Off the Pacific Coast of Tohoku Earthquake
3. Fukushima Daiichi Accident and Lessons Learnt
4. The Future of Nuclear Energy in Japan
5. International Influence

1. Japan in Pan-Pacific Seismic Zone

- Japan is a nice and beautiful country with rich natural scenery and at the same time has to receive big natural disasters such as seismic, volcanic explosion and typhoon.
- Japanese people had always have to prepare for such natural disasters in their long history.
- They have not to forget their historical bitter experience in any time.
- Unfortunately, people is forgetful in sometime.

2. 2011 Off the Pacific Coast of Tohoku Earthquake

- Scale : from north to south about 400km
  from east to west about 200km
- Offshore :200km in Pacific Ocean
- Sliding length of Plate: 25m-30m,
- Magnitude:9 (Biggest in Japanese history)
- Energy stored for 700 years was released
- Caused huge Tsunami

3.11 Earthquake

Design basis earthquake and observed acceleration (Basement of Reactor/B)

Nr.	MWe	3.11 Observed (max. gal)			Design (Ss) (max. gal)		
		N-S	E-W	Vertical	N-S	E-W	Vertical
1Fuku1	460	460	447	258	487	489	412
1Fuku2	784	346	550	302	441	438	420
1Fuku3	784	322	507	231	449	441	429
1Fuku4	784	281	319	200	447	445	422
1Fuku5	784	311	548	256	452	452	427
1Fuku6	1100	298	444	244	445	448	415

Note 1: **Damage by the earthquake**: Not fully inspected but maybe not significant considering the KK earthquake (2007) where no damage to safety functions even though the observed acceleration exceeded design basis by factor 2-3 (Acceleration will not necessarily be damages indicators)

Note 2: **Scram set points** by acceleration (Basement of Reactor Building) Horizontal=135-150 gal, Vertical=100 gal

14 NPPs along the coastal line affected by Tsunami

Onagawa
- Unit1: 524 MW, 1984-
- Unit2: 825 MW, 1995-
- Unit3: 825 MW, 2002-

Fukushima Ⅰ
- Unit1: 460 MW, 1971-
- Unit2: 784 MW, 1974-
- Unit3: 784 MW, 1976-
- Unit4: 784 MW, 1978-
- Unit5: 784 MW, 1978-
- Unit6: 1,100 MW, 1979-

Fukushima Ⅱ
- Unit1: 1,100 MW, 1982-
- Unit2: 1,100 MW, 1984-
- Unit3: 1,100 MW, 1985-
- Unit4: 1,100 MW, 1987-

Tokai Ⅱ (1,100 MW, 1978-)

3.11 Tsunami

Unit	Ground Level		Tsunami height [m]			Location of Electric Equipment Room (M/C, P/C, Battery)	Type & location of Emergency Diesel Generator SC: Seawater-cooled AC: Air-cooler
	R/B, Tb/B [m]	Intake str. [m]	DB	Mod (2002)	3.11		
1Fuku1,2,3, & 4	10.2	4	3.1	5.7	14-15		1F1.3: 2 SC-EDGs 1F2,4: 1 SC-EDG + 1 AC-EDG
1Fuku5	13.2	4	3.1				2 SC- EDGs
1Fuku6							2 SC-EDGs 1 AC-EDG
2Fuku1,2,3 & 4	12	7	3.7	5.2			3 SC-EDGs
Ogagawa1,2 & 3	14.8		9.1	-	13		3 SC-EDGs

Location information not listed here

1. *One of the offsite power lines for 2F stayed alive during & after the Earthquake/Tsunami*
2. *What mattered was the elevation of air intake/exhaust of EDG room & location of Electric Equipment rooms*

3. Fukushima Daiichi Accident /Lessons Learnt

- At the time of the Earthquake,

  No.1,2,3 NPP: in rated power operation,

  No.4,5,6 NPP: in shutdown for refueling.

- All operating NPP scrammed, all external power lines unavailable, EG started as usual.
- About one hour later, huge tsunami attacked.

  (highest estimation 5.7m: tsunami 15m)
- All EGs of No,1-4 were out of order: Blackout

3. (continued)

- Since station blackout, emergency passive cooling system worked for a while;

  No.1 plant: several hours (designed 8x2 hours)

  No.2 plant : about 71 hours,

  No. 3 plant: about 36 hours.
- Starting fuel melt down 2-3 hours later

  and hydrogen generation,
- Hydrogen explosion and radioactive material were released.

3. (continued)/ Lessons Learnt (on-site)

- Practical planning and exercise for emergency preparedness ; knowledge and practice,
- Importance of continuous cooling system; possibility of robust passive cooling system, redundancy and diversity of cooling system, long standing final sink of residual heat, redundancy and diversity of power system.
- Containment of radio-active materials within reactor site ; robust filtered ventilation system.

3. (continued) Lessons Learnt (off-site)

- Preparation for practical off-site center,
- Enhancement of governance on emergency,
- Enhancement of regulatory system
(dependency, competence, transparency, reliability, man-power, international mind)
- Enhancement of safety culture,
- Stakeholder involvement and reconstruction of social reliability,
- Return home of evacuated people.

4.The future of Nuclear Energy in Japan

- The AEC of Japan is deliberating a new policy for future utilization of nuclear energy in Japan. The commission is expecting a new strategy by the early next Summer.
- The majority of Japanese people(about 60 %) seems to escape from dependence on nuclear energy.
- On the contrary, the 30 % of people supports to use and to depend on nuclear utilization.

4. (continued)

- JPN media is divided into three color; con-, pro- and middle,
- No strong pro- nuclear politician.
- Business community are inclined to pro-nuclear, except small fraction of con-nuke group.
- Most of nuclear experts are strong pro-nuke.
- Most of young mothers seems to be con-nuke.
- Irrational nuclear phobia is expanding in Japanese society.

4. (continued)

- Japan can not have wide range of option for choosing energy resource.
- Regarding to key factors for energy option, such as quality, quantity, stability, reliability, environmental influence, economy, safety, and geo-political circumstance, Japan’s choice is severely limited.
- Nuclear option seems to be very prominent except SAFETY.
- Safety could be assured by head and mind.

4.(continued)

- Japanese government lays a set of bills before the Diet in order to establish a new regulatory system ;independency, transparency, competence, emergency preparedness.
- 30 Countermeasures for enhancing safety assurance; External and On-site Power Supply, Cooling, Containment, Communication, I & C, Emergency Response Arrangement.
- On the way toward safe decommissioning.

4. (continued)

- All nuclear power reactors are in shut down since 5^{th} of this month.
- All utilities are challenging to Stress-Test of NPPs for assessing the robustness against extreme operational conditions.
- Acceptance of public people on NPP operation is in very difficult situation.
- Many people are very much concerned for electricity shortage in coming Summer.

5. International Influence

- After Fukushima Daiichi Accident, only a few countries changed their nuclear policy; Germany, Swiss, and Italy.
- Most of countries of using nuclear and emerging in nuclear arena do not change their nuclear policy.
- The main reason is a concern and speculation of shortage of energy resource in future.

5. (continued)

- Quite a few experts conclude that,

  the main reason of the Fukushima Daiichi Accident doesn't exist in present nuclear technology. It was caused by insufficiency and inconsistency of Japanese method and system of regulation and management.
- I have to accept partly the above comment.
- It is not so easy to improve the Japanese management style but Japan has to change and has started for improvement.