INVESTIGATION OF SPENT FUEL INTEGRITY IN DRY STORAGE AT JAPANESE NUCLEAR POWER PLANTS

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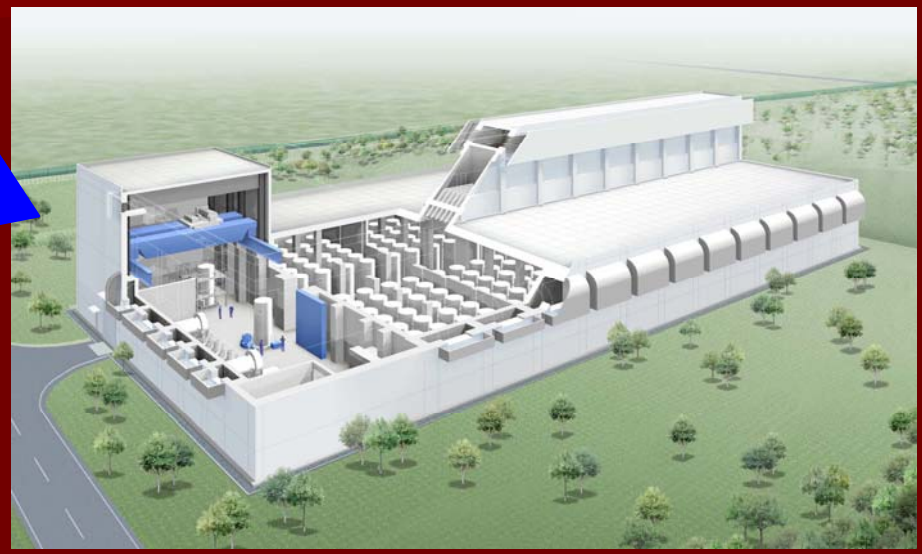
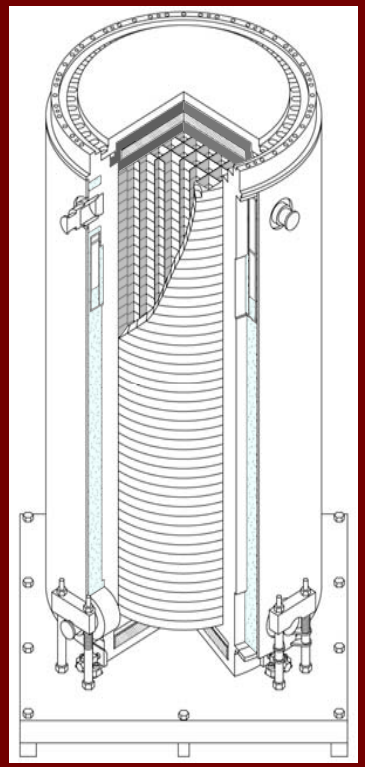
A Japanese first spent fuel interim storage facilities (1)



- The facility is owned by Recyclable-Fuel Storage Company (RFS)
- A joint company of Tokyo Electric Power Company (TEPCO) and the Japan Atomic Power Company (JAPC)

A Japanese first spent fuel interim storage facilities (2)



- Facility Name: Recyclable-Fuel Storage Center (RFSC)
- Beginning of Operation: July, 2012
- Storage system: Dual purpose (storage / transport) metallic dry cask
- Storage capacity: About 3,000 ton-U of LWR spent fuel (max. 288 casks)
- Storage period: Max. 50 years
- A hot-cell for opening the cask: None

The specification of spent fuel assemblies stored in RFSC

Fuel type		Cladding material of fuel rods	Burn-up (GWd/t)		Cooling period	
			Maximum for fuel assembly	Average for replacement fuel	TEPCO	JAPC
BWR	8 x 8	Zircaloy–2	40	27.5	18 years and over	
	New 8 x 8		40	28.5/29.5		
	New 8 x 8 Zr Liner	Zircaloy–2 (Zirconium liner)	40	33		8 years and over
	High Burn-up 8 x 8		50	39.5		
PWR	39GWd/t	Zircaloy–4	39	31		15 years and over
	48GWd/t		48	43		

Purpose of the investigation (1)

- RFSC is not equipped with a hot-cell for opening the primary lid of the cask.
- A visual inspection of spent fuel assemblies is usually carried out before spent fuel transportation in Japan.
- it is necessary to confirm spent fuel integrity by the same level of confirmation as visual inspection before transportation after the interim storage

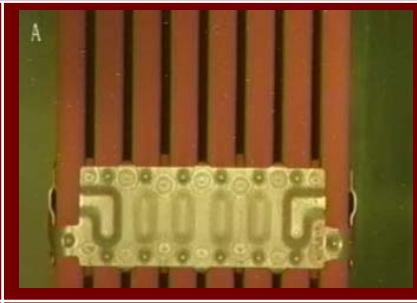
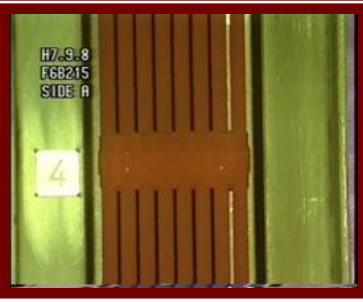
Purpose of the investigation (2)

- For this purpose, we will establish a quality control system of metallic dry casks from manufacturing to the end of storage.
- we are continuously **investigating spent fuel integrity on the actual spent fuel dry storage** at the nuclear power plants and the research facilities.

Investigations at the Japanese nuclear power plants (1)

Site	Fukushima-Daiichi		Tokai No.2
Fuel type	BWR 8 x 8	BWR New 8 x 8	BWR New 8 x 8 Zr Liner
Burn-up	28 GWd/t	32 GWd/t	33.5 GWd/t
Year of inspection	2005	2000	2009
Dry storage period	10 years	5 years	7 years
Rod Temperature	Approx. 90 ℃	Approx. 140 ℃	Approx. 165 ℃
Cover gas sampling	**Kr-85 was not detected.**		

Investigations at the Japanese nuclear power plants (2)

Site	Fukushima-Daiichi		Tokai No.2
Fuel type	BWR 8 x 8	BWR New 8 x 8	BWR New 8 x 8 Zr Liner
Visual inspection	The appearance of spent fuel remains the same as observed at the storage starting.		
Before storage			
At the inspection			

Investigation at Idaho National Laboratory (INL)

Site	INL
Fuel type	PWR 15 x 15
Burn-up	35.7 GWd/t
Year of inspection	2005
Dry storage period	20 yeas
Rod Temperature	344 ℃
Cover gas sampling	**Kr-85 was not detected**

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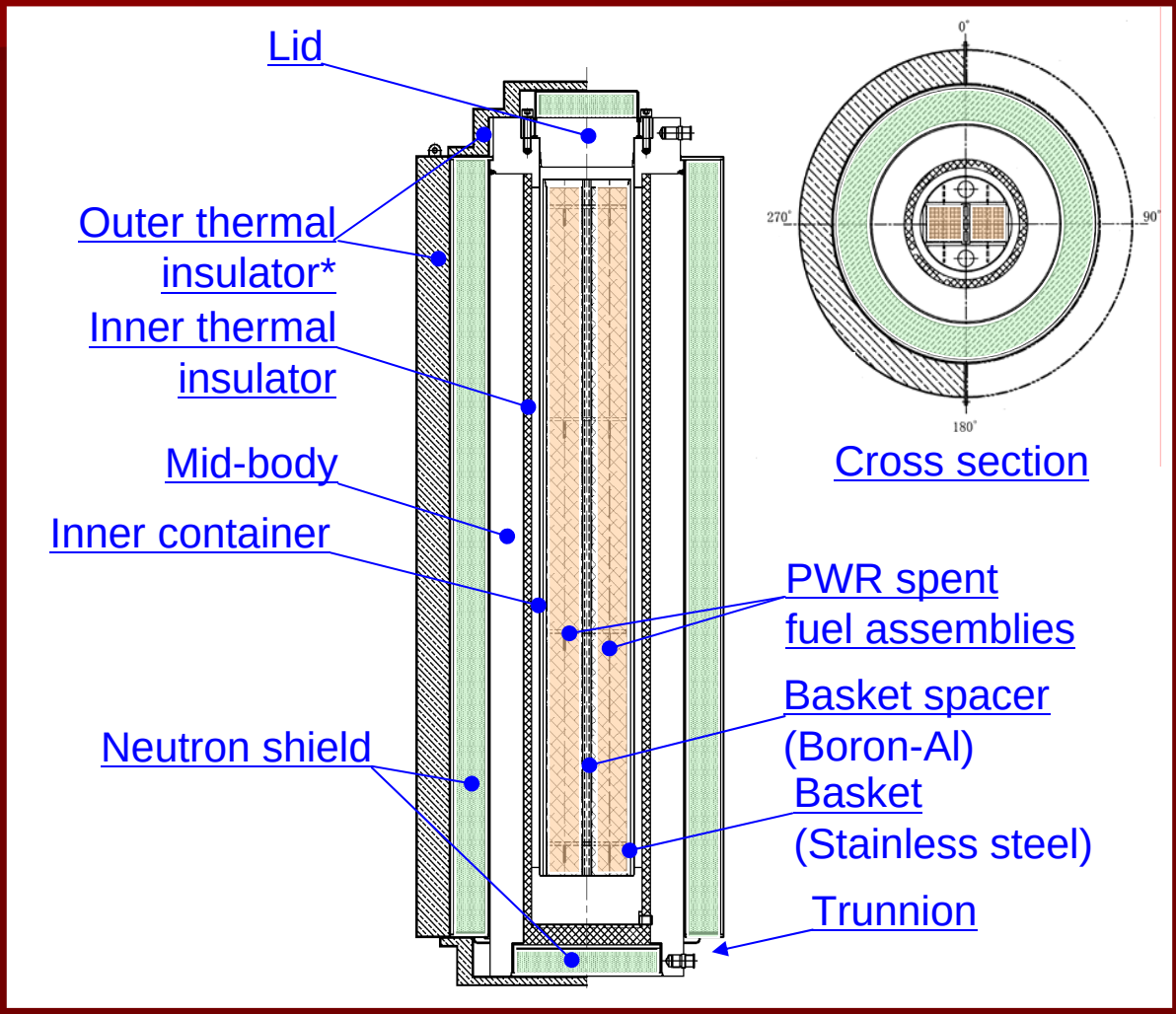
Continual investigations at Japanese NPPs and INL

Site	Fukushima-Daiichi	Tokai No.2	INL
Fuel type	BWR New 8 x 8	BWR High Burn-up 8 x 8	PWR 15 x 15
Burn-up	32 GWd/t	44 GWd/t	35.7 GWd/t
Rod Temperature	Approx. 140 ℃	Approx. 200℃	344 ℃
Investigation interval	5-15 years	5-15 years	5 years
Investigation method	**Cover gas sampling ***		

* If Kr-85 is detected on the cover gas sampling, a cause of the fuel failure will be investigated in detail.

PWR spent fuel dry storage test at NDC (Test container)

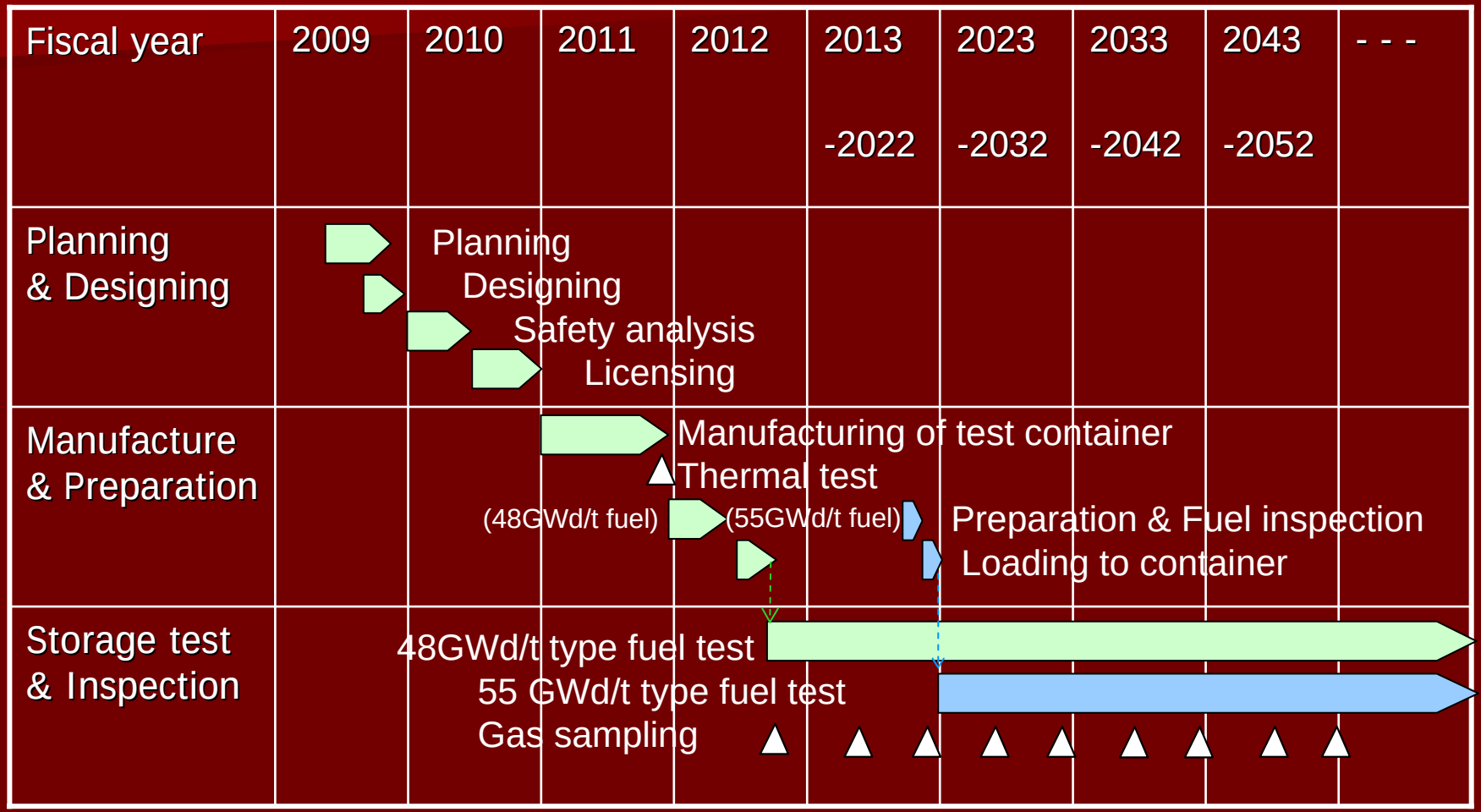


* Outer thermal insulator installed at loading only 48GWd/t F/A is removed when 55GWd/t fuel assembly is added.

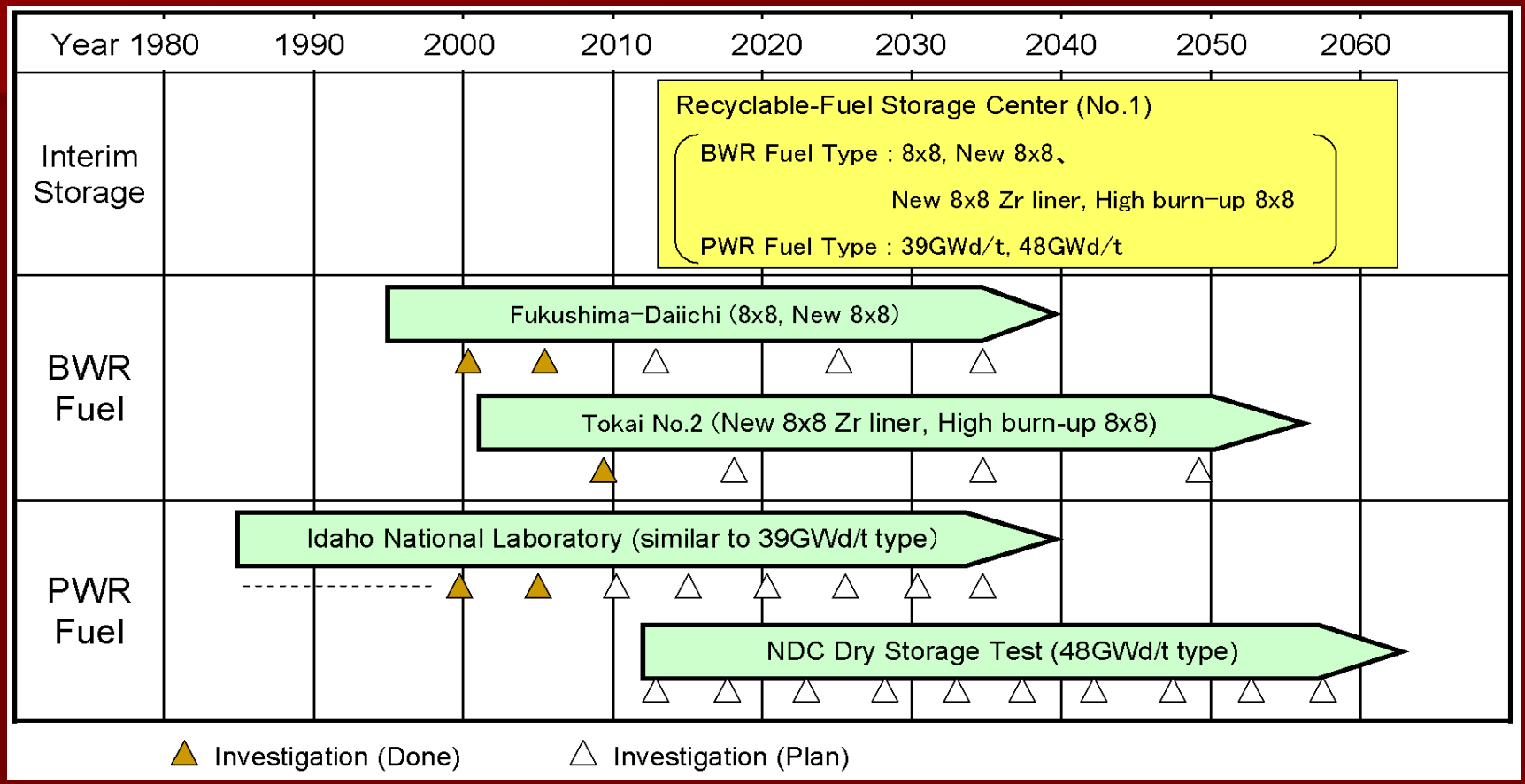
PWR spent fuel dry storage test at NDC (Fuel assemblies)

Fuel type	17×17 48GWd/t type	17×17 55GWd/t type
Beginning of storage	2012	2022
Burn-up	42.8 GWd/t	55 GWd/t or less
Cooling period	19 years	10 years or more
Rod temperature	Approx. 230 ℃	Approx. 230 ℃
Cladding material of fuel rods	Zircaloy–4	MDA or ZIRLO

PWR spent fuel dry storage test at NDC (Time schedule)



A Road map for the investigation



The road map will be checked in the licensing examination of packaging design approval as transport casks and each renewal examination of it (5-year intervals).

Conclusions (1)

- Spent fuel integrity in dry storage has been investigated at Fukushima-Daiichi, Tokai No.2 and INL.
- There was no problem on the spent fuel integrity for 10-20 years
- Cover gas sampling will be continued for decades at Japanese nuclear power plants and research facilities in order to confirm that unexpected events will not appear.

Conclusions (2)

- High burn-up fuel will be investigated at Tokai No.2 (BWR) and NDC (PWR).
- If Kr-85 is detected on the cover gas sampling, a cause of the fuel failure will be investigated in detail.
- The road map for the investigation will be checked in the licensing examination of packaging design approval and each renewal examination of it (5-year intervals).

Thank you very much.

Basic spent fuel integrity

- Metallic dry casks are just stored calmly.
- Spent fuel assemblies in the cask are kept in dry and inert-atmosphere.
- Thermal creep tests, hydride reorientation tests and irradiation hardening recovery tests were carried out.
- Spent fuel integrity will keep basically after the interim storage.

Cask handling process in the nuclear power plant

- Spent fuel assemblies are loaded to the cask in the spent fuel pool.
- The cask is moved to the decontamination pit and cavity water is drained.
- After vacuum drying, helium is filled in the cask cavity.
- Leak tightness of each lid is checked and space between the lids is filled with helium.
- Tertiary lid and shock absorbers are attached on the cask for the transportation to RFSC.