Impact of Fukushima Accident on Spent Fuel Management in Japan

Koji Shirai and Toshiari Saegusa
CRIEPI

Tuesday, January 31, 2012
INMM Spent Fuel Management Seminar XXVII

Contents

1. SF at Fukushima
2. Dry Metal Casks at Fukushima
3. Plan of SF Removal from Reactor Pools at Fukushima
4. Plan of SF Debris Removal from Reactors at Fukushima
5. Status of SFM Facilities in Japan
6. Revising Nuclear Energy Policy of Japan

1. SF at Fukushima NPS(1/2)

-(1) In the reactor buildings-

Ref.1

Unit		1	2	3	4	5	6
FA in Core (No.)		400	548	548 (MOX 32)	0	548	764
SF in Pool (No.)		292	587	514	1331	946	876
FF in Pool (No.)		100	28	52	204	48	64
Decay Heat in Pool (MW)	March 11,2010	0.18	0.62	0.54	2.26	1.00	0.87
	June 11 2010	0.16	0.52	0.46	1.58	0.76	0.73

Condition of Unit 4‘s spent fuel pool

1. SF at Fukushima NPS(2/2)

-(2) Outside the Reactor Buildings- Ref. 2

a. Dry Metal Cask Storage Facility, 9 casks with 408 BWR assemblies

b. Common Pool Storing 6,375 BWR assemblies

2. Dry Metal Casks at Fukushima

- As of March 11, the Fukushima PPT has stored 9 metal casks (408 BWR SF) in a building.
- Large amounts of sea water, sand and rubble gushed in the building by the tsunami.
- The cask cooling function was not lost as the casks were cooled by natural air convection.
- So far, no issues on their integrity have been identified from the external appearance.

Ref.3

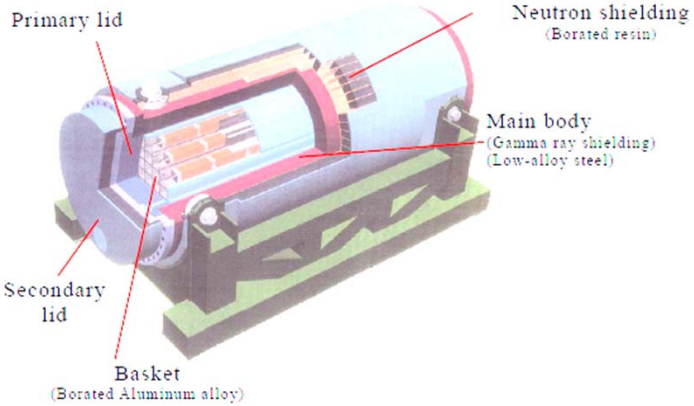
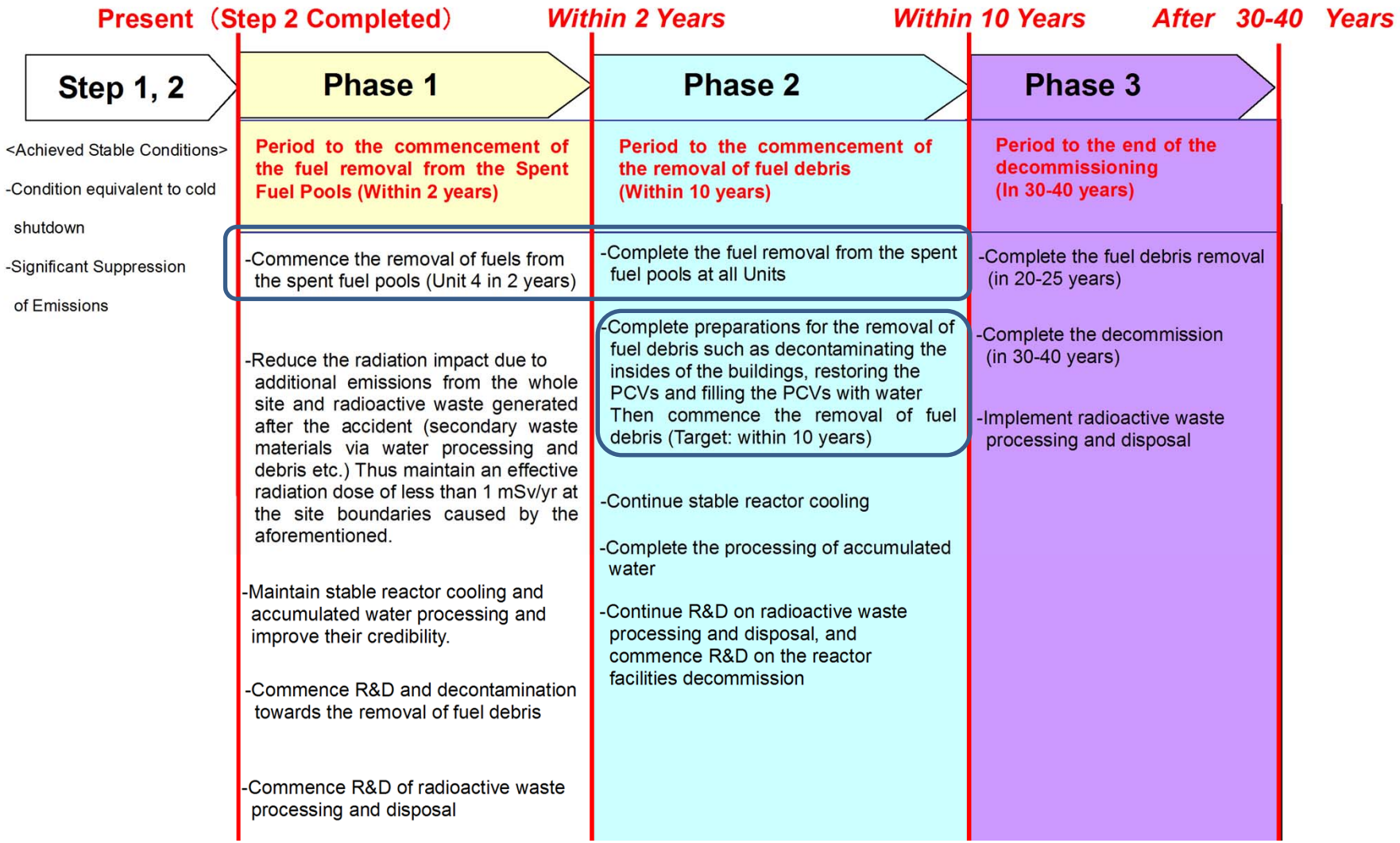


Figure II-2-55 Structure of Dry Storage Cask

Figure II-2-56 Situation in Dry Storage Cask Facility

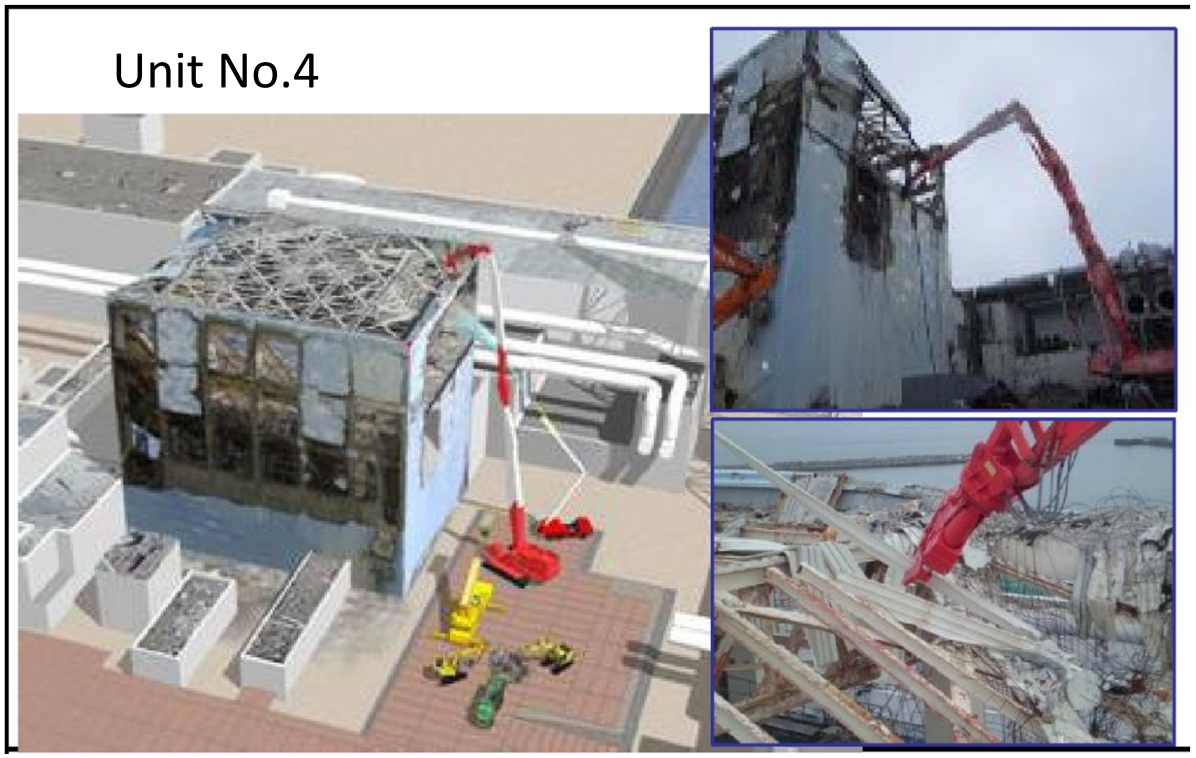
3.1 Roadmap of Decommissioning of F1 NPP Ref.4



3.2 Plan to Remove SF from SF Pools(1/4)

(1) Removal of Rubble from Upper Parts of Reactor Blgs

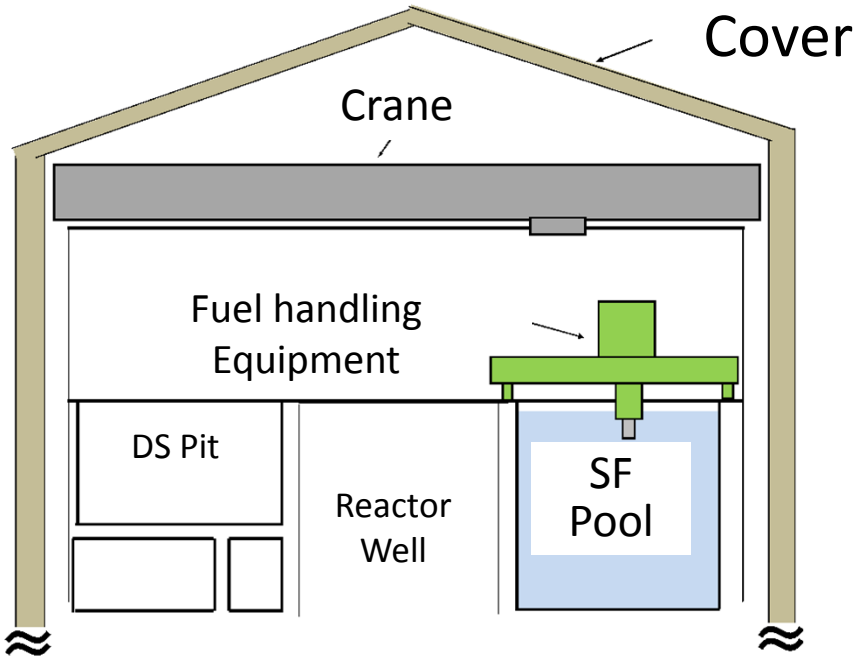
Ref.4



The upper parts of the reactor buildings for Units 1,3 and 4 were damaged and rubble was scattered over the refueling deck and into the SF pools. The rubble must be removed at first.

3.2 Plan to Remove SF from SF Pools(2/4)

Ref.4



(2) Covers will be Installed to maintain a working environment for fuel removal by blocking wind and rain. New fuel handling equipment may be installed, or the existing equipment may be repaired if possible.

Example of SF Shipping Cask

Photo from Vender

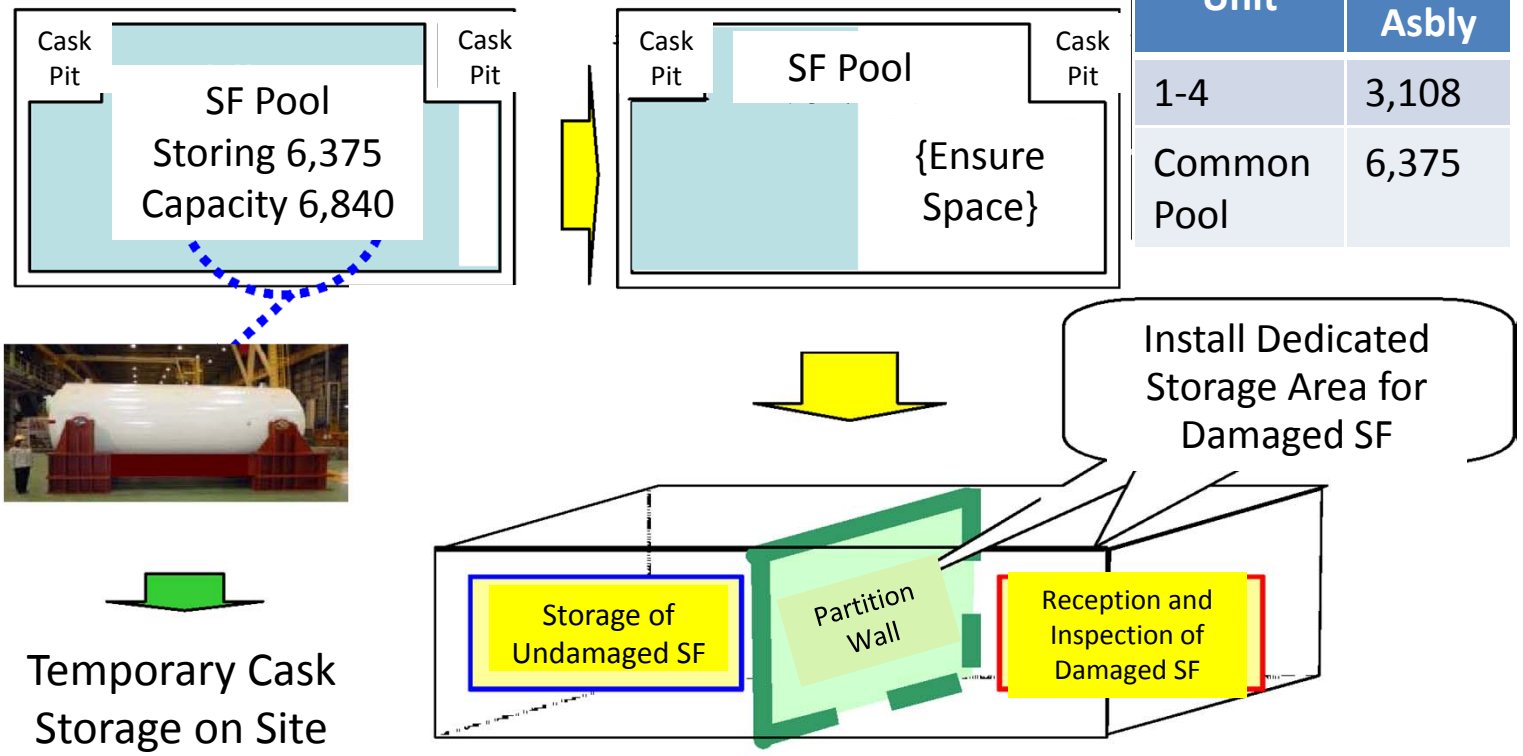
(3) Design and Manufacture of Shipping Cask:

If SF had been damaged, it will be placed in storage canisters and placed in casks.

3.2 Plan to Remove SF from SF Pools(3/4)

(4) Ensure/Remodel Space within the Common Pool

Ref.4



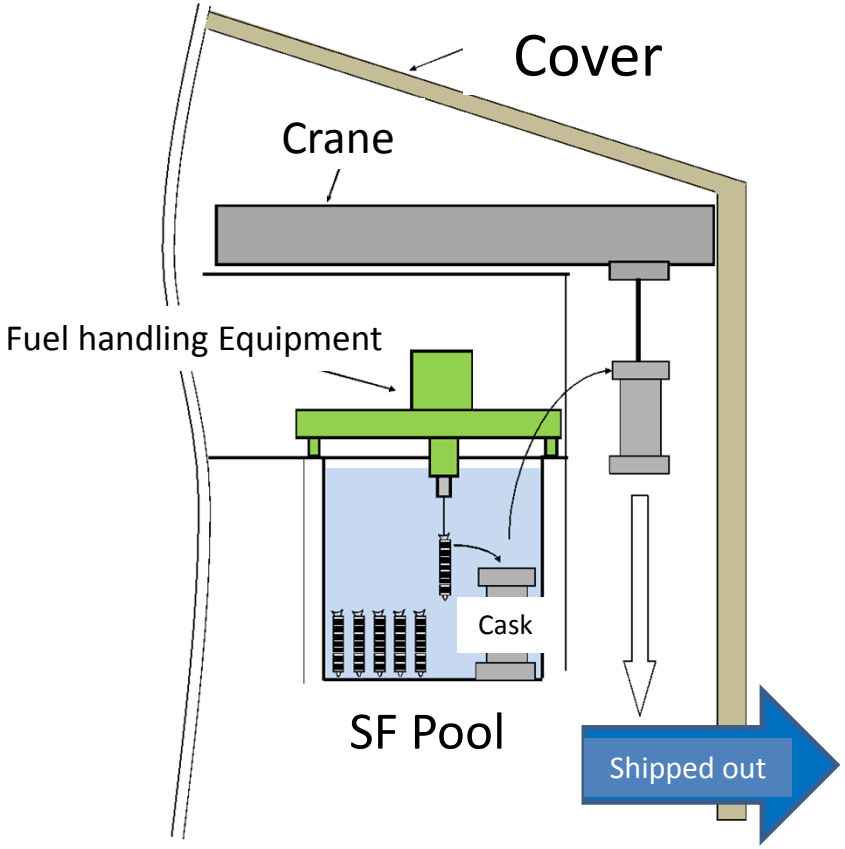
Unit	SF Asbly
1-4	3,108
Common Pool	6,375

To ensure an area to receive and store SF removed from the SF pools, the undamaged SF currently stored in the common pool will be stored in dry casks and moved out of the common pool. New dry cask temporary storage equipment will be installed on site.

3.2 Plan to Remove SF from SF Pools(4/4)

(5) Fuel Removal from SF Pools

Ref.4



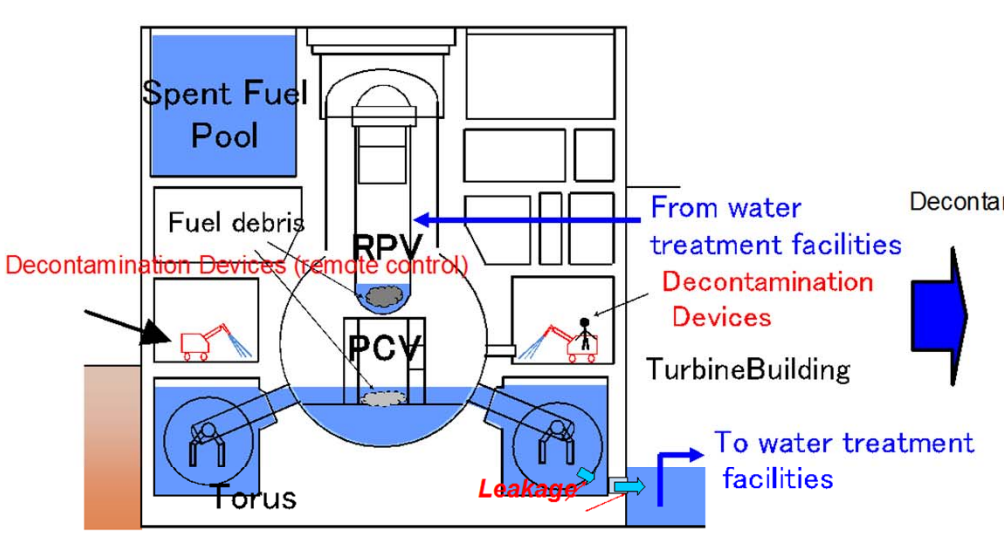
(6) Storage and Management of Removed SF in the Common Pool

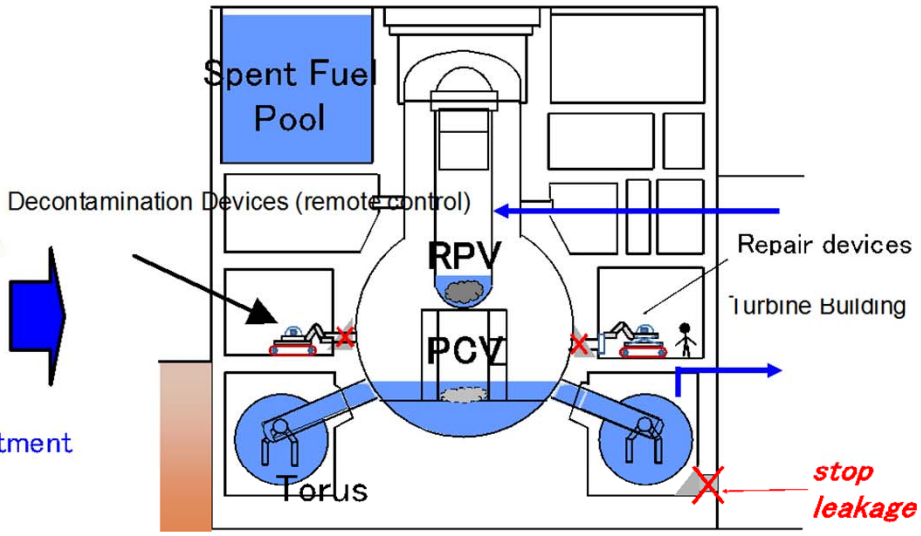
In the common pool, cooling and purification system will improve and maintain the purity and transparency of the water.

The integrity of SF will be checked before placed in casks. Damaged SF will be placed in canisters. The SF in the reactor pool may be contaminated with sea water.

4.1 Removal of SF Debris from Reactors(1/3)

Ref.4





a) Reactor Building Decontamination

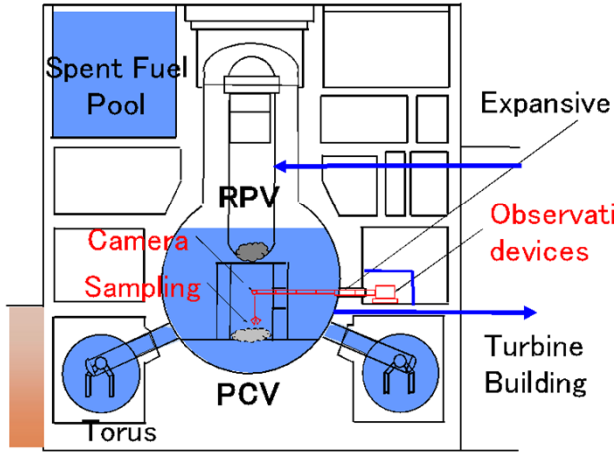
Past inspections have identified rubble scattered about and areas of high dosage (~ 1,000mSv/h) inside reactor buildings. Decontamination should be first.

b) Repairs to stop inter-building and PCV leakage

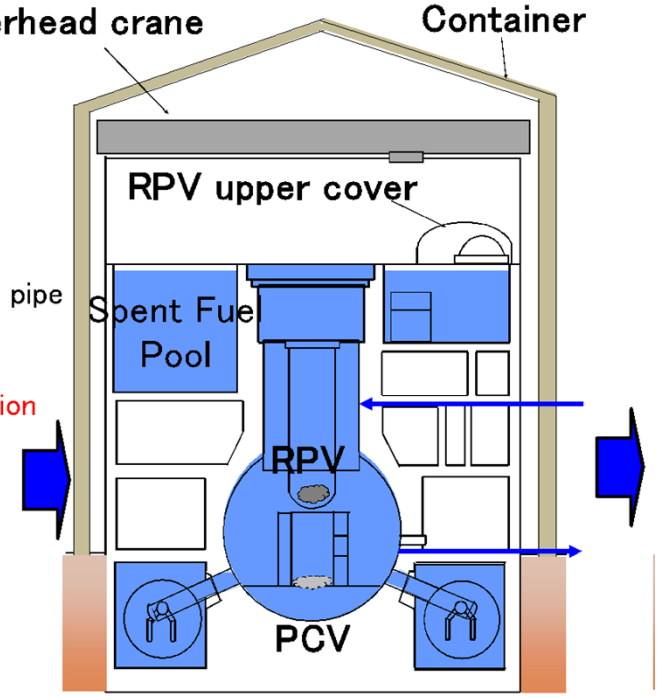
Performing the underwater fuel debris removal will require repairing leaks in PCVs and filling them up with water.

4.2 Removal of SF Debris from Reactors(2/3)

Ref.4



c) Investigation and Sampling of inside of PCV



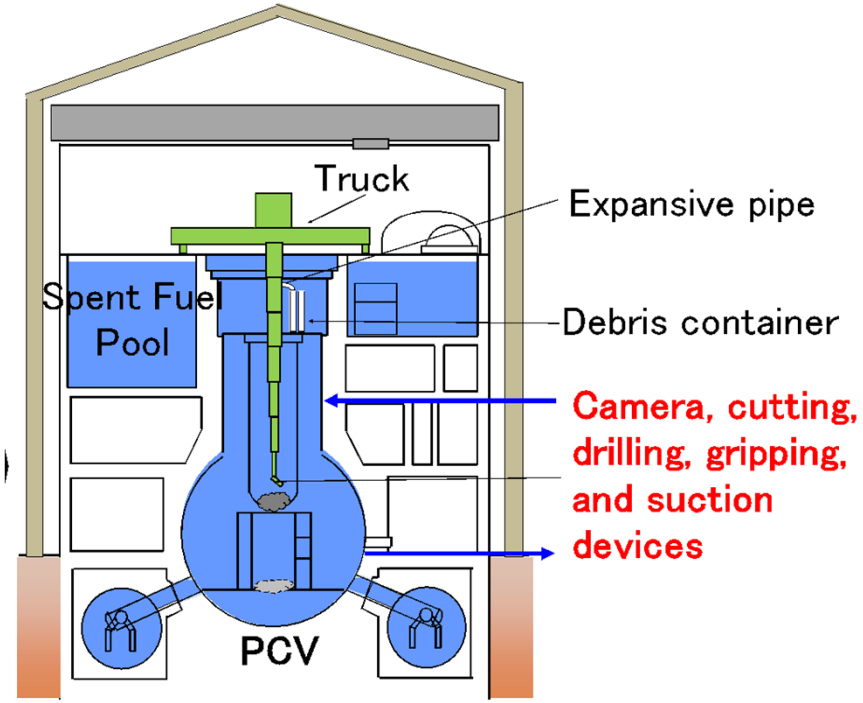
d) Filling with water and removing RPV upper cover

After partially filling up the PCVs, workers will remotely access the inside of PCVs and by performing through inspections and samplings, ascertain fuel debris distributions and characteristics.

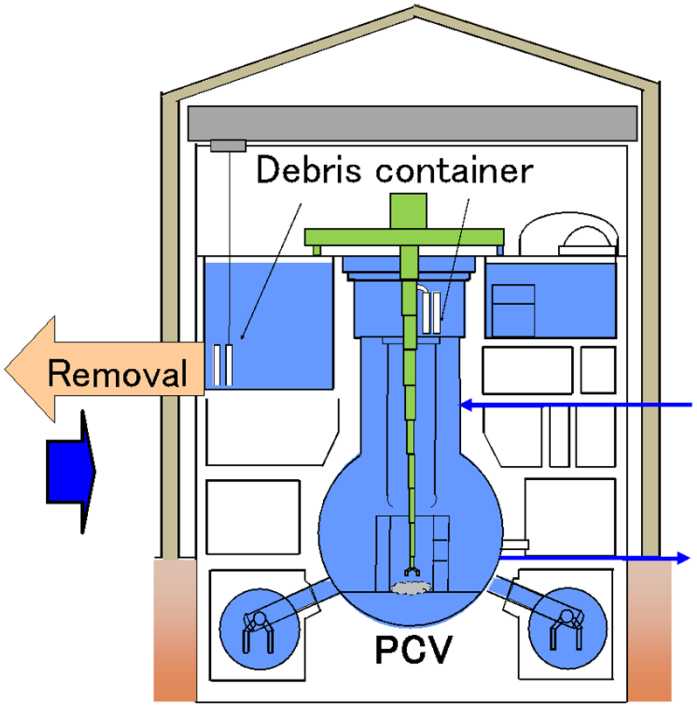
Workers will fill up reactor pressure vessels and PCVs with consideration for criticality prevention measures. Workers will then open the upper lids on PCVs.

4.3 Removal of SF Debris from Reactors(3/3)

Ref.4



e) RPV inside investigation and sampling



f) Removal of fuel debris

Because the insides of PCVs are highly radioactive and the contaminated water inside will be murky, remote inspection technologies and jigs will need to be developed.

A variety of technologies including crashing the fuel debris , holding, vacuuming, etc. should be developed. The fuel debris will be highly saline, which should be stored in canisters resisting corrosion by salt.

5.1 Status of SFM Facilities in Japan(1/2)

Ref.5

- Reprocessing Facility
  - With lessons from the Fukushima incident, safety measures were strengthened.
  - Although the active tests of the vitrification have been interrupted since 3.11, re-start of the active test is being prepared since January 2012.
- Nuclear Power Generation with MOX Fuel
  - Although four NPPs (including Fukushima No.1 NPP) had started their power generation with MOX fuel, the Unit No.3 of the Fukushima NPP is now planned for decommissioning.

5.2 Status of SFM Facilities in Japan(2/2)

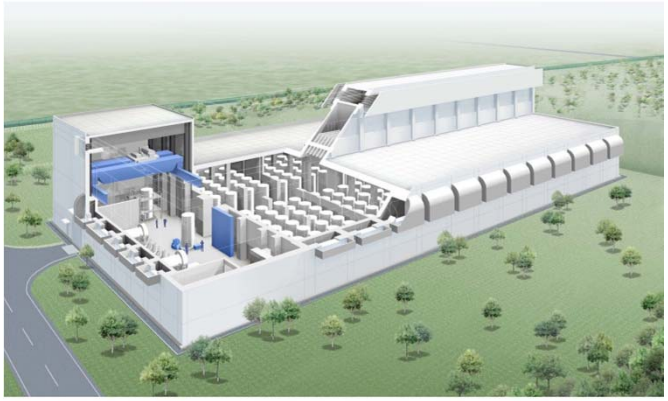
Ref.5

– MOX Fuel Fabrication

Although the construction of a new fabrication plant of fresh MOX fuel started from October 2010 at Rokkasho village, it is being interrupted after 3.11. From around this spring, the construction will restart.

— Interim Storage of SF

Although the construction of a new interim storage facility started from August 2010 at Mutsu city, it is being interrupted after 3.11.



RFS

6.1 Revising Nuclear Energy Policy of Japan(1/2)

Ref.6

- The current "Framework for Nuclear Energy Policy" was decided by The Atomic Energy Commission in 2005.
- The Japanese government respects "Framework for Nuclear Energy Policy" as a fundamental principle for research, development and utilization of nuclear science and engineering.
- The Policy is being discussed for revision, now.

6.2 Revising Nuclear Energy Policy of Japan(2/2)

Ref.6

- The policy shall be thoroughly revised with the experience of Fukushima Accident.
- A new policy shall indicates important issues for Japan to pursue and fundamental guideline to tackle with them in the next 10 years as a temporary target period.

6.3 Revising Nuclear Energy Policy of Japan(1/5)
-Major Opinions for Utilization of Nuclear Energy(1)-

Ref.6

- The Japanese government has indicated "Reducing Dependency on Nuclear Power Generation". The followings are major opinions.

  ①Promotion of return of the residents of Fukushima area shall be essential for recovery of confidence in nuclear energy.

  ②-1 For stable power supply, the role of nuclear energy is important based on total point of views such as stability, cost, effect of reducing CO_2, energy

  ②-2 Recent poor operating rate shows the role of nuclear power generation may not expand in the future.

6.4 Revising Nuclear Energy Policy of Japan(2/5)

-Major Opinions for Utilization of Nuclear Energy(2)-

Ref.6

③-1 For mid-and-long-term energy, the nuclear power generation should be reduced based on the development of renewable energy and energy saving technology.

③-2 Nuclear energy has enormous risk. The disaster might not be prevented even if safety measures were improved.

④-1 The renewable energy cannot be introduced without enough substantiation.

④-2 With the experience of last year's energy savings, the energy demand could be fulfilled without operating the nuclear power plants that are currently being stopped.

6.5 Revising Nuclear Energy Policy of Japan(3/5)

-Major Opinions for Utilization of Nuclear Energy(3)-

Ref.6

⑤-1 It is Japan's responsibility to deliver information on the accident, and to contribute to improve safety of the nuclear power plants in the world.

⑤-2 If Japan might stop nuclear power generation, it might lead a direction of reducing the dependency on nuclear power in the world.

6.6 Revising Nuclear Energy Policy of Japan(4/5)

-Major Opinions for Utilization of Nuclear Energy(4)-

Ref.6

⑥Conditions to continue the utilization of nuclear energy are to secure safety, reestablish confidence of local people, and remove feelings of uneasiness and suspicion by the Japanese public.

⑦It would be difficult to recover the public confidence, if we could not solve the issues of opening information, risk communication, consistency of the governmental judgment on whether nuclear power plants can be re-operated, etc.

6.7 Revising Nuclear Energy Policy of Japan(5/5)

-Options for Spent Fuel management-

Ref.7

- Sub-Committee of AEC is discussing following options in terms of safety, economy, effective use of energy resources, non-proliferation, security, wastes.
  - Once-through fuel cycle of LWR
  - LWR with reprocessing and MOX with disposal
  - LWR with MOX
  - LWR and FR (as actinide burner)
  - FBR
- Other than these, interim storage is also being discussed.

Reference

1. Report of Japanese Government to the IAEA Ministerial Conference on Nuclear Safety (June 2011) http://www.meti.go.jp/english/earthquake/nuclear/
2. Brochure of TEPCO Fukushima Dai-ichi NPP (Nov 2010)
3. Additional Report of the Japanese Government to the IAEA (Sept 2011) http://www.meti.go.jp/english/earthquake/nuclear/iaea/iaea_110911.html
4. Government-TEPCO Mid-and-long Term Response Council, “Mid-and-long-Term Roadmap towards the Decommissioning of Fukushima Daiichi Nuclear Power Station Units 1-4, TEPCO “ (Dec.21 2011) http://www.tepco.co.jp/en/press/corp-com/release/betu11_e/images/111221e14.pdf
5. Sub-Committee of AEC on Nuclear Power and Fuel Cycle Technology, “Trend of Nuclear Fuel Cycle after Fukushima Accident” (Jan. 11, 2012)

   http://www.aec.go.jp/jicst/NC/tyoki/hatukaku/siryo/siryo5/siryo1.pdf
6. New Nuclear Policy-planning Council, “Issues of Important Policy in the Future” (Jan.18, 2012)

   http://www.aec.go.jp/jicst/NC/tyoki/sakutei/siryo/sakutei11/siryo4.pdf
7. Ibid (Jan. 24, 2012)

   http://www.aec.go.jp/jicst/NC/tyoki/hatukaku/siryo/siryo6/siryo1-2.pdf

" To Our Friends Around the World, Thank You for Your Support"