Two problems:

1) Accumulation of weapon-usable plutonium

2) Spent fuel pool safety

One solution:

Dry cask storage

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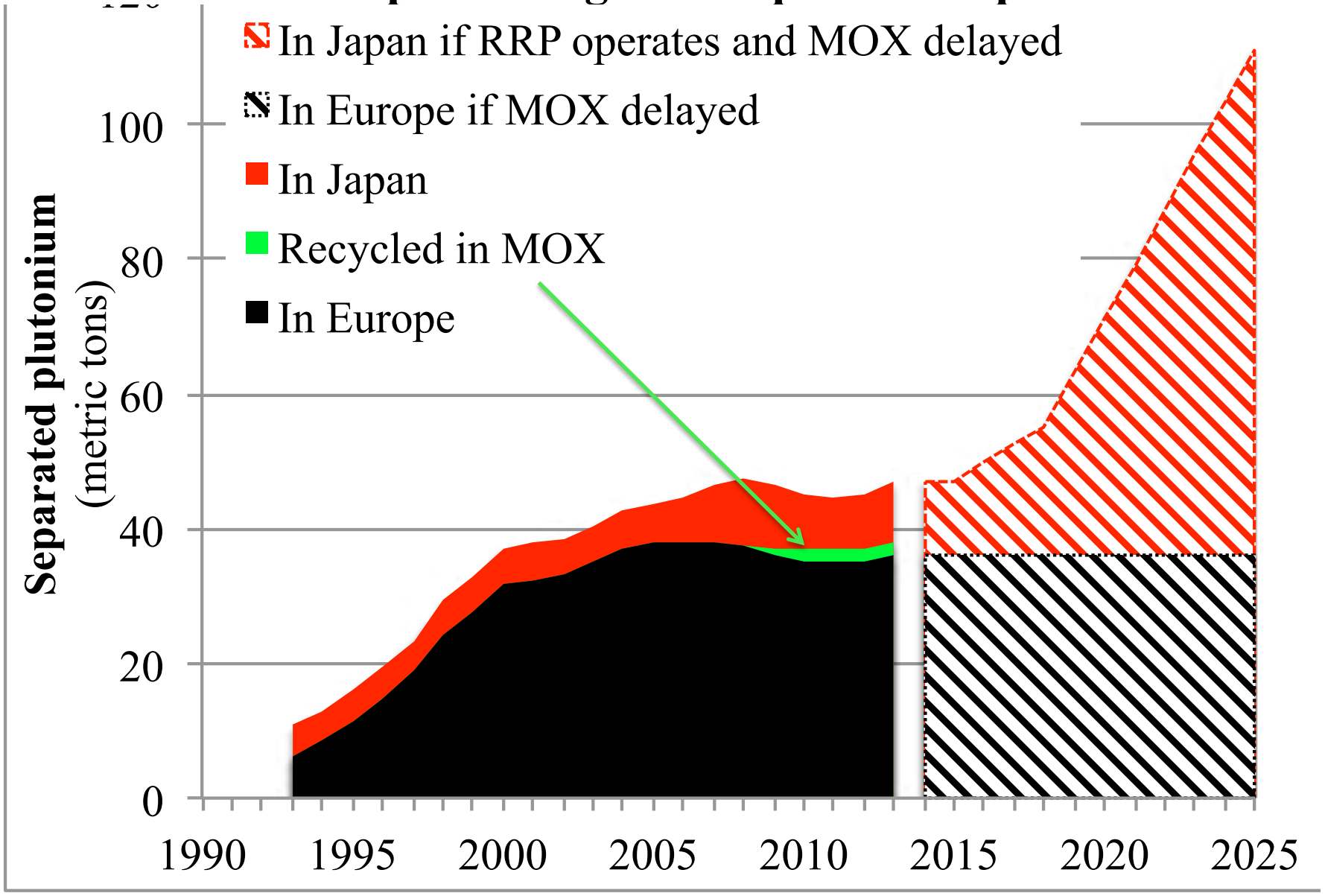
Princeton University and

International Panel on Fissile Materials

Diet Energy Research Committee

Tokyo, 18 June 2015

Japan's MOX program has failed so far. Would have to become *very* successful to prevent explosive growth of Japan's stockpile if Rokkasho Reprocessing Plant operates as planned.



Argument is that Japan must continue reprocessing because its spent fuel pools are filling up

But only three of Japan's 15 nuclear power plants have less than 10 years pool storage.

- ***Kashiwazaki-Kariwa***. TEPCO only has requested restart of two newest reactors. Then 12 years storage.
- ***Tokai Daini***. On-site dry-cask storage and local community willing to accept more.
- **Genkai.** Kyushu applied for re-racking and shared use of pools among reactors Planning dry cask storage.

Plant	Years till full
Tomari 1-3	23
Onagawa 1-3	11
Higashidori 1	21
Kashiwazaki-Kariwa 1-7	4
Hamaoka 3-5	11
Shika 1,2	19
Mihama 1-3	11
Takahama 1-4	10
Ohi 1-4 PWR	10
Shimane 1,2	10
Ikata 1-3	12
Genkai 1-4	4
Sendai 1, 2	15
Tsuruga 1, 2	13
Tokai Daini 2	4
44 reactors	**10 (average)**

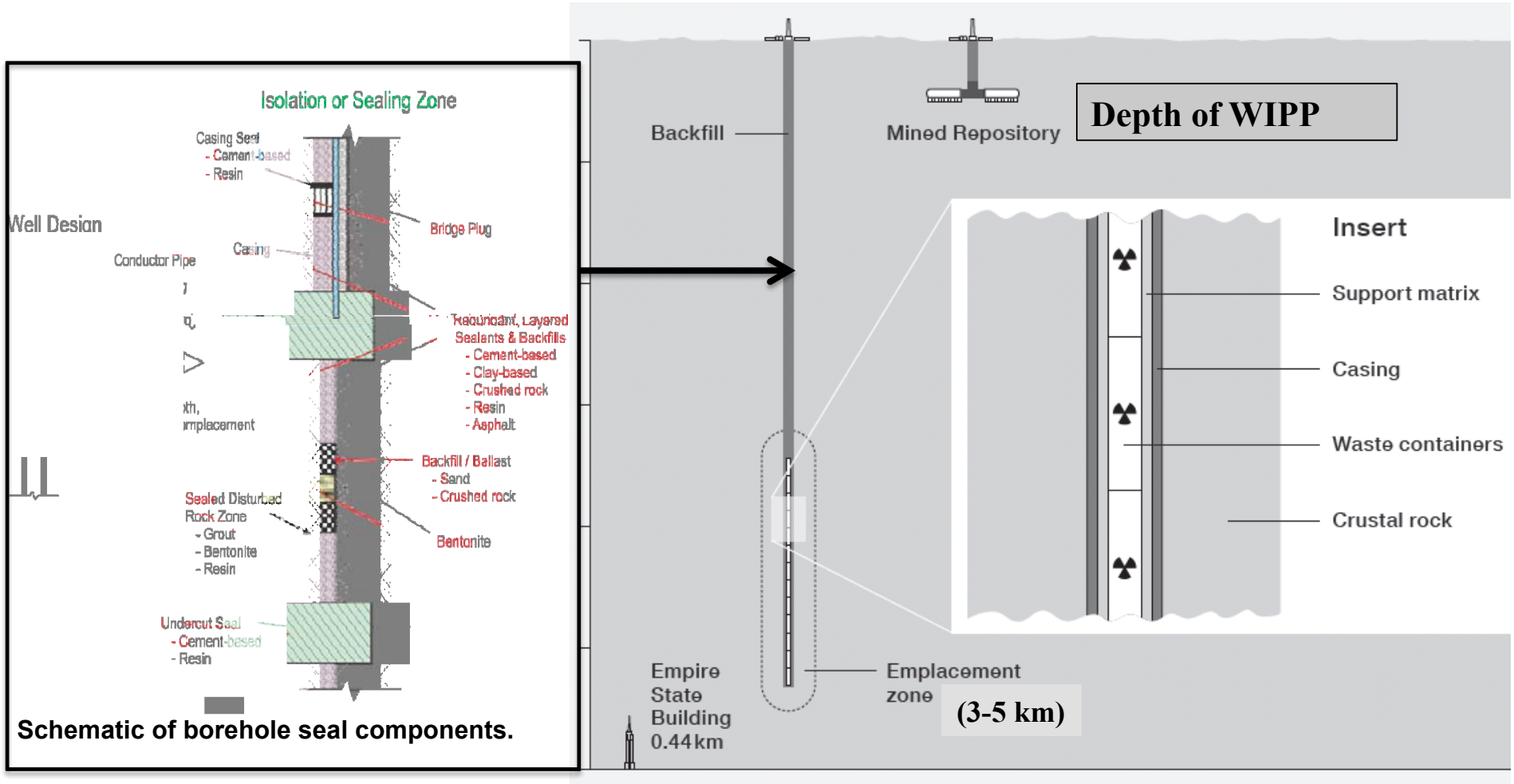
U.S. MOX Plant being built by AREVA, to dispose of half of U.S. Cold War weapons plutonium

Disposal cost estimate has increased from $3 to $23 billion.
Obama Administration has declared project "unaffordable."

The U.S. therefore is considering less costly plutonium disposal alternatives

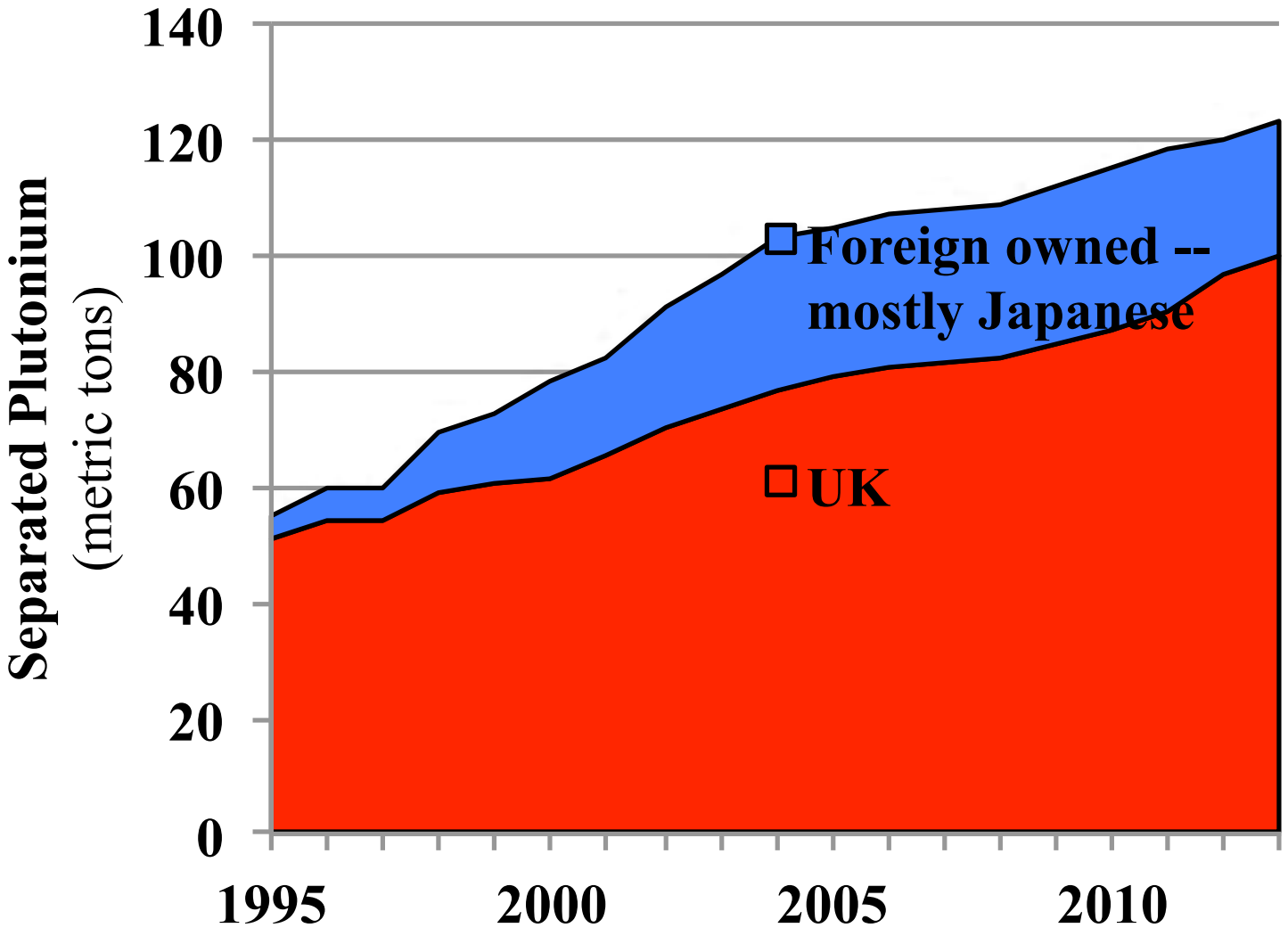
1. Direct disposal at the Waste Isolation Pilot Plant (WIPP) in a salt deposit 655 meters under New Mexico.
2. Embedding in reprocessing waste from which the plutonium was originally separated as it is glassified for eventual disposal in a deep final repository.
3. In a 5,000-meter deep borehole.

Deep boreholes have been developed for drilling oil and geothermal wells. U.S. Department of Energy plans demonstration project for other types of radioactive waste.



Deep Borehole Disposal of Nuclear Waste: Final Report (Sandia National Laboratories, SAND2012-7789, 2012)

Other countries have problems with MOX too. UK spent $4 billion on a MOX plant for its foreign customers (mostly Japan). Abandoned in 2011 as a technical failure.

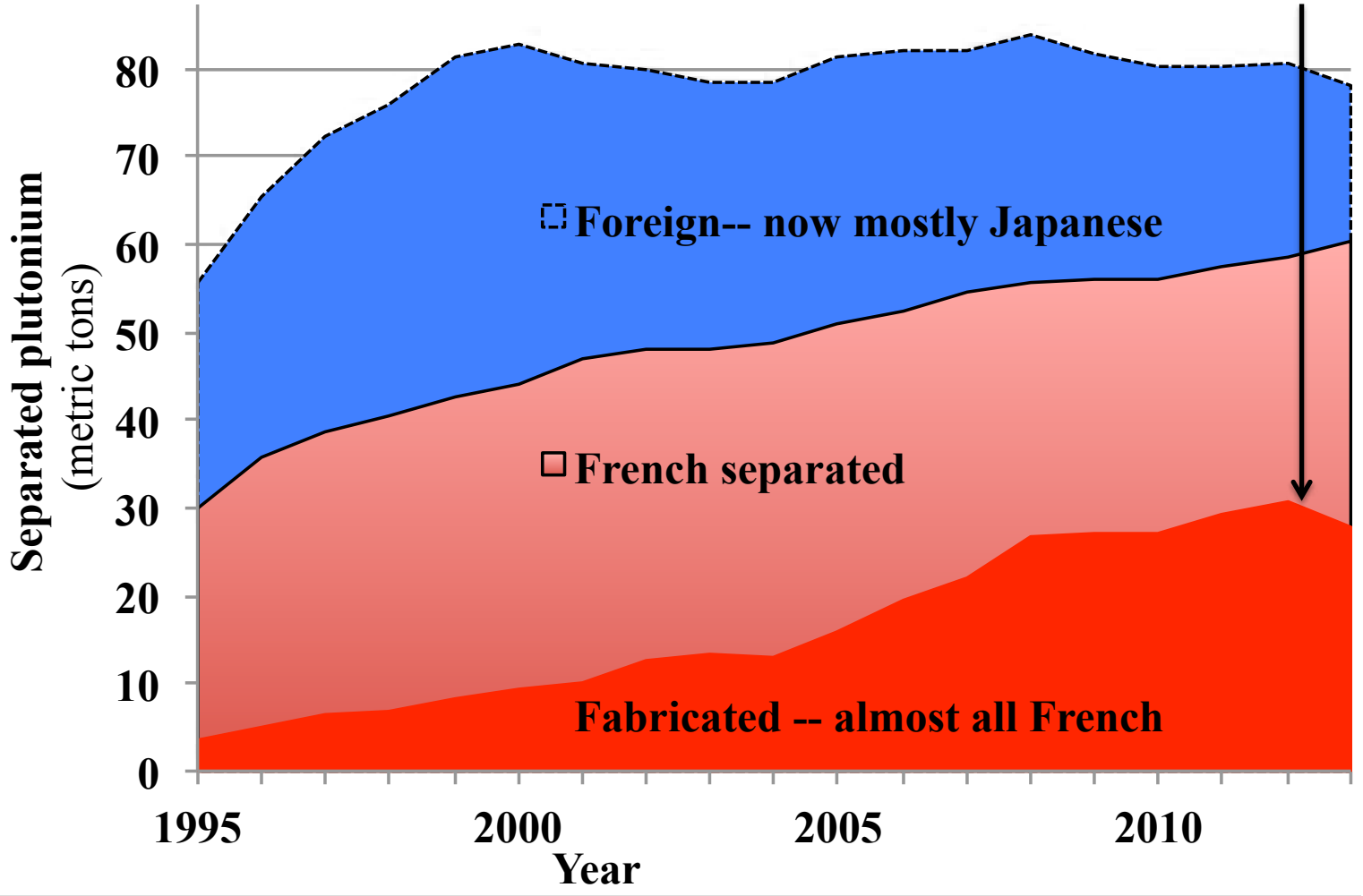


France's approach: Keep separating the plutonium and use it in MOX fuel for light water reactors

France has been more successful technically but has failed economically.

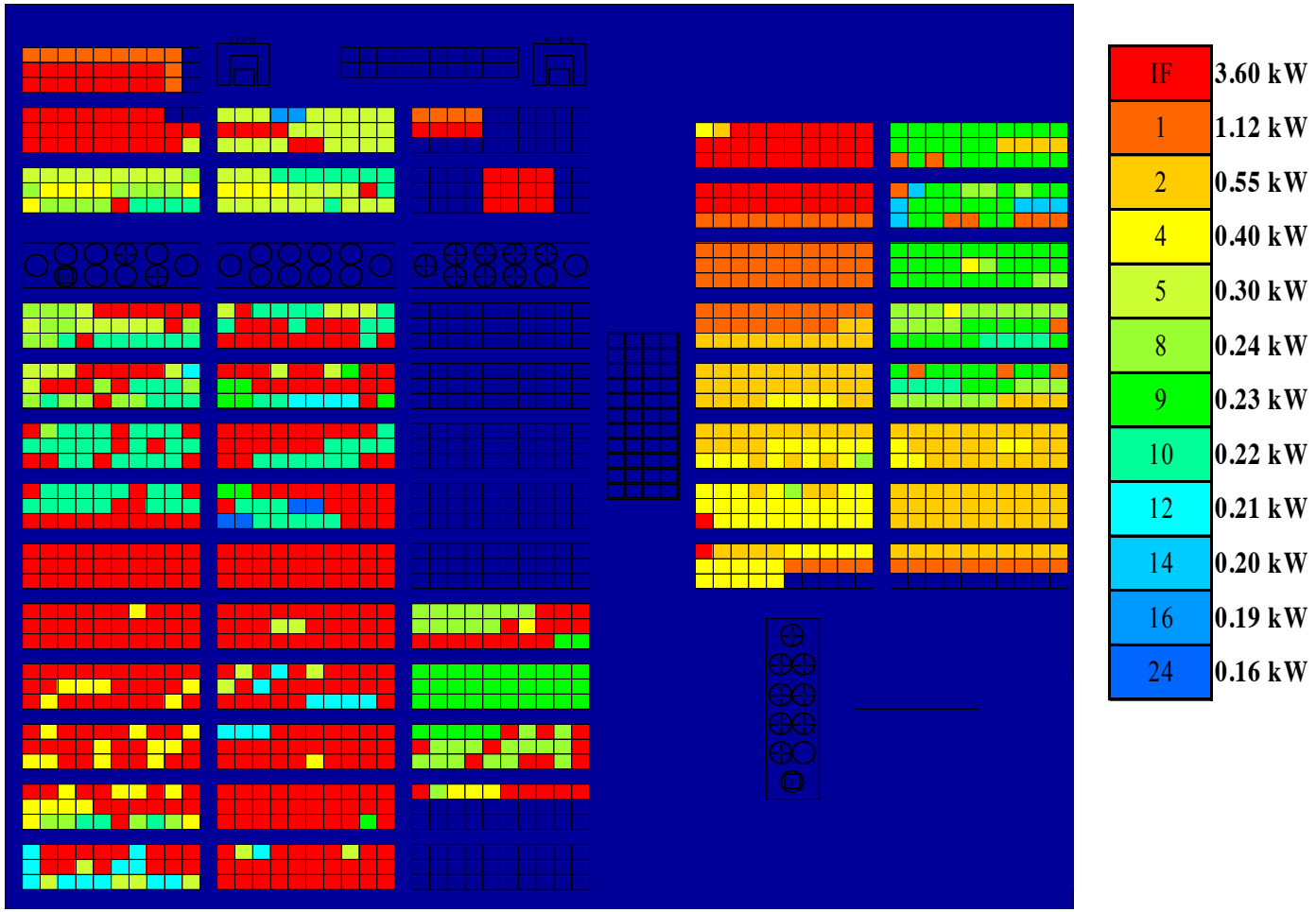
MOX 12 times cost of low-enriched uranium fuel (JAEC, 2011)

France's stockpile growing because some of its MOX is unusable.

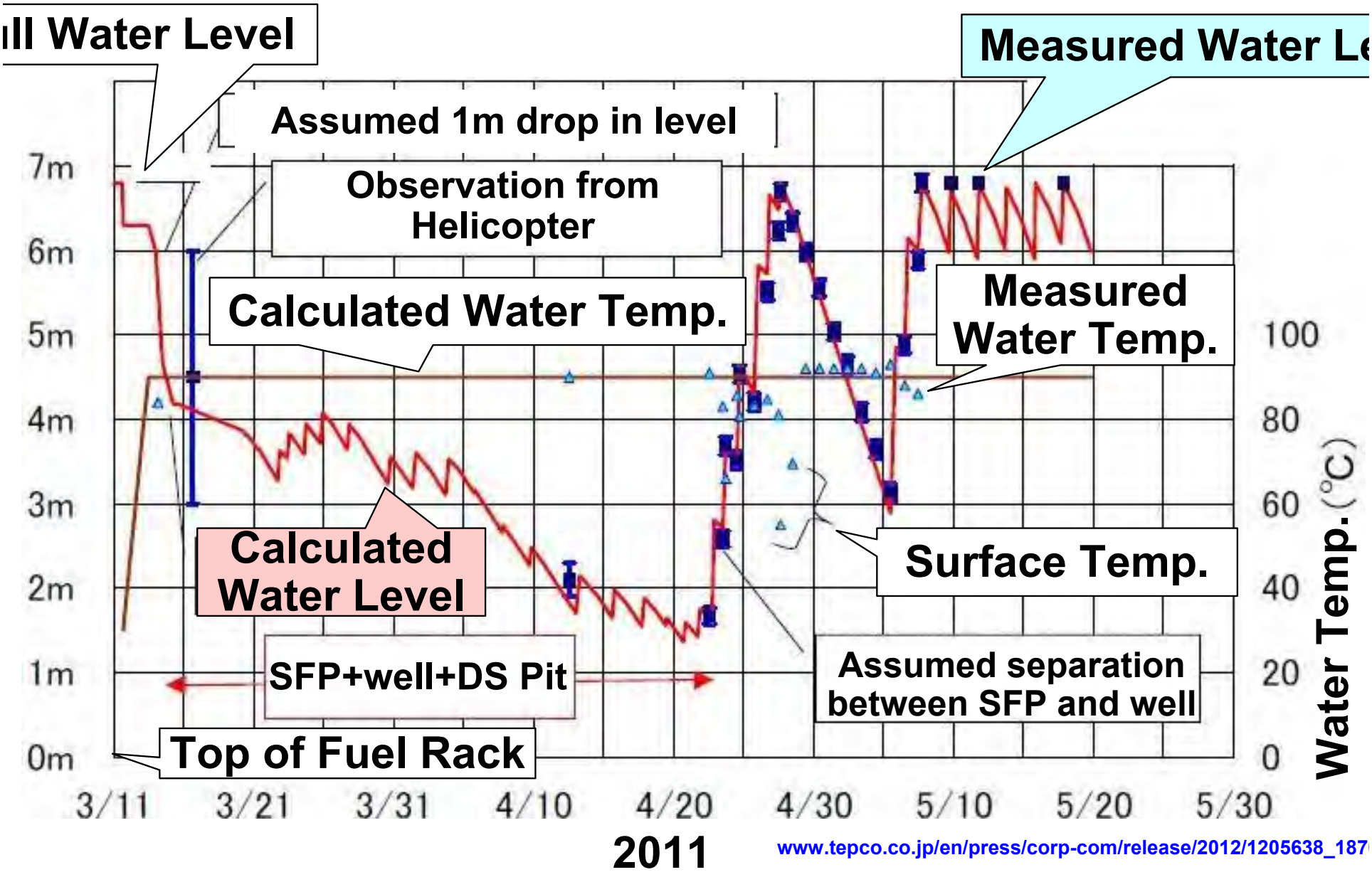


Spent fuel pool safety

Currently, most pools in the United States are dense packed – even more than spent fuel pool #4 at Fukushima Daiichi



Fukushima Spent Fuel Pool #4: Fear of a spent fuel fire



www.tepco.jp/en/press/corp-com/release/2012/1205638_187

Lowest water level at top of fuel rack +1.5 m

Spent fuel pool safety

During Fukushima crisis, JAEC Chairman Kondo told Prime Minister Kan that the worst case would be a spent fuel fire.

Chairman Kondo told Prime Minister Kan that, if the contents of spent fuel pool #4 burned and the wind below toward Tokyo, the area that would have to be evacuated indefinitely – like the forbidden zone around Chernobyl – would stretch almost to Tokyo.

Following the Fukushima Accident, the US Nuclear Regulatory Commission did studies of potential safety benefits of moving spent fuel from pools into dry cask storage after 5 years

3055 → 850 fuel assemblies in pool (Unit #4 had 1331)

(US Nuclear Regulatory Commission, *Consequence Study of a Beyond-Design-Basis Earthquake Affecting the Spent Fuel Pool for a U.S. Mark I Boiling Water Reactor*, NUREG-2161, 2013; *Regulatory Analysis for Japan Lessons-learned Tier 3 Issue on Expedited Transfer of Spent Fuel*, COMSECY-13-0030, 2013)

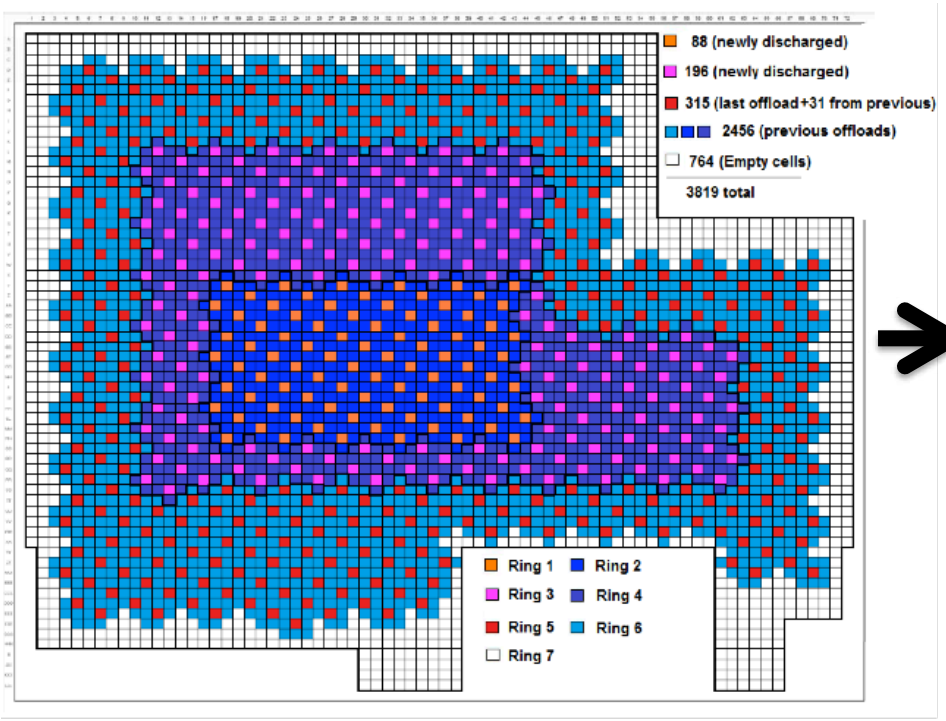


Figure 46 Layout of assemblies for OCP2 high-density (1x4) model

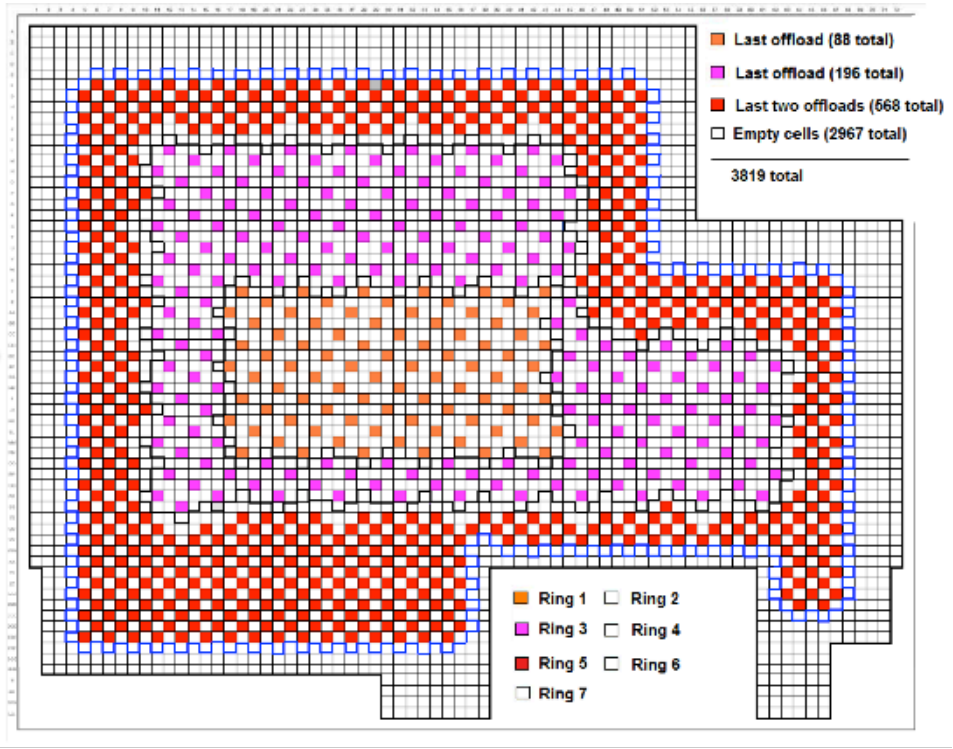


Figure 48 Layout of assemblies for OCP2 low-density model

Consequences of a fire in a low-density pool are on the same order as Fukushima.

Fire in a high-density pool 100 times worse.

	High Density	**Low Density**	**Fukushima Daiichi**
Release (PBq)	925	4	6-20
Cancer deaths	43,100	1,100	~1000
Area (km^2)	46,600	221	~650
Displaced	10.9 million	72,000	~100,000

Primary reason for difference is that NRC found there would be enough hydrogen generated for an explosion that would destroy the reactor building for the high-density but not low-density pool.

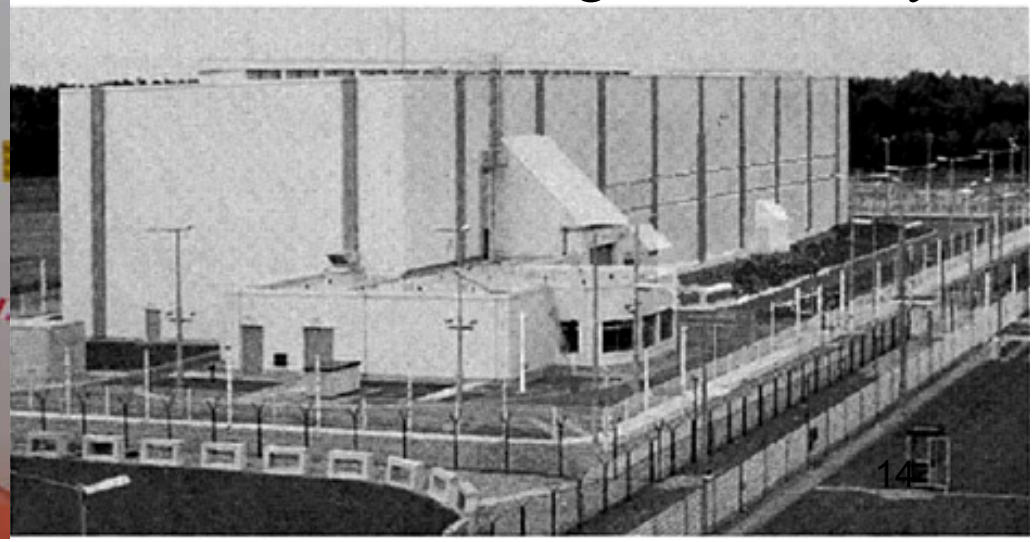
Source. http://pbadupws.nrc.gov/docs/ML1328/ML13282A564.pdf; http://pbadupws.nrc.gov/docs/ML1328/ML13282A563.pdf

The safer alternative to reprocesing and dense-packed pools: On-site, dry cask spent-fuel storage.

At Fukushima Daiichi
a*fter* tsunami

Tunnel under administrative building,
Neckarwestheim NPP, Germany

Emsland NPP, Lingen, Germany



Some of the Commissioners on Japan's Nuclear Regulation Authority (NRA) understand the danger

On 19 September 2012, in his first press conference,NRA Chairman, Shunichi Tanaka urged

"Spent fuel not requiring active cooling should be put into dry casks … for five years or so cooling by water is necessary…I would like to ask utilities to go along those lines…"

At an 29 October 2014 NRA meeting, Chairman Tanaka and Commissioner Toyoshi Fuketa urged Michiaki Uryu, president of Kyushu Electric Power Company, to introduce dry-cask storage.

Does the NRA not have the authority to order the utilities to do this or do the other Commissioners not agree?