Potential health effects from radioactive emissions from the Fukushima Daiichi nuclear reactors

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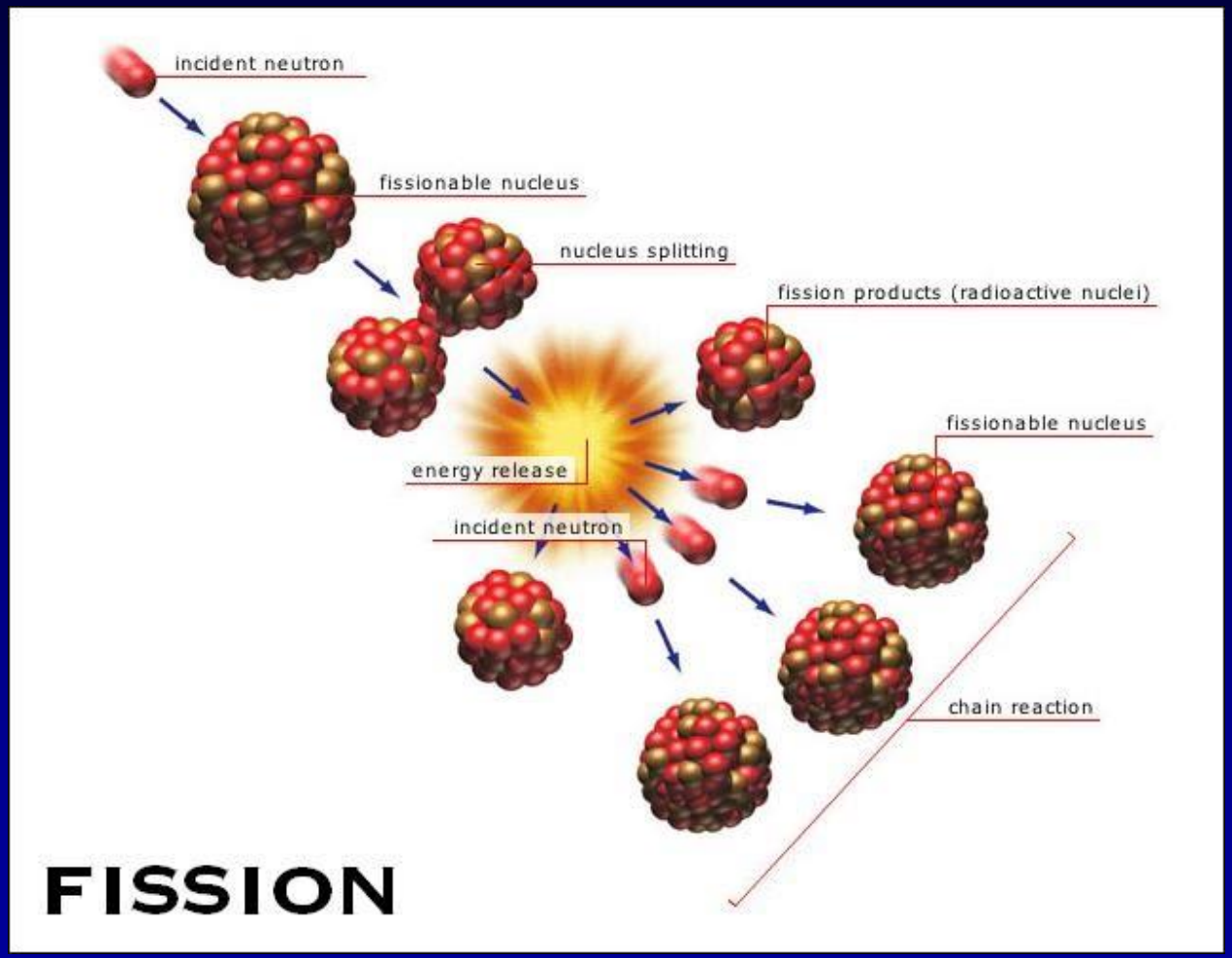
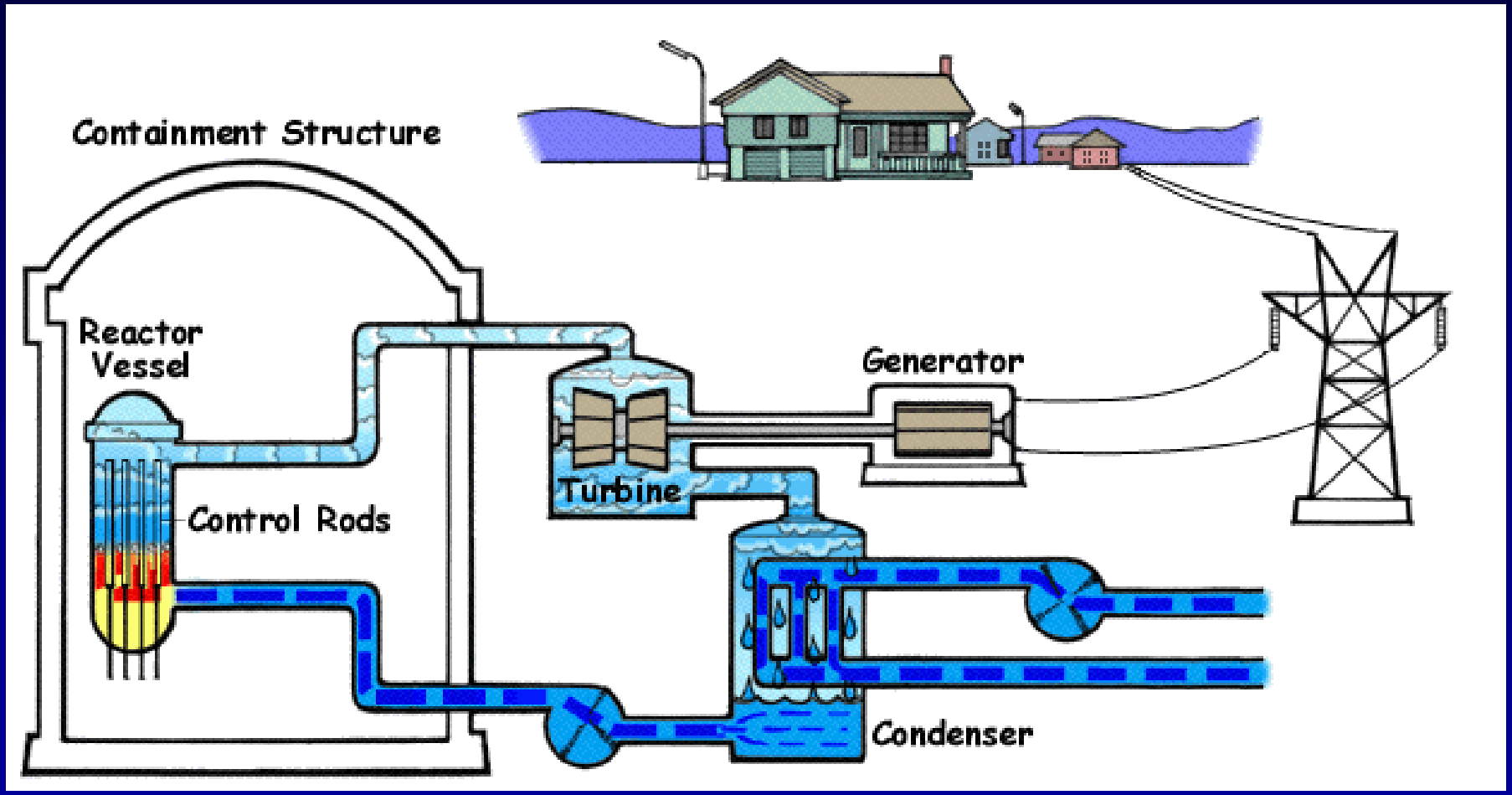
What is nuclear fission?

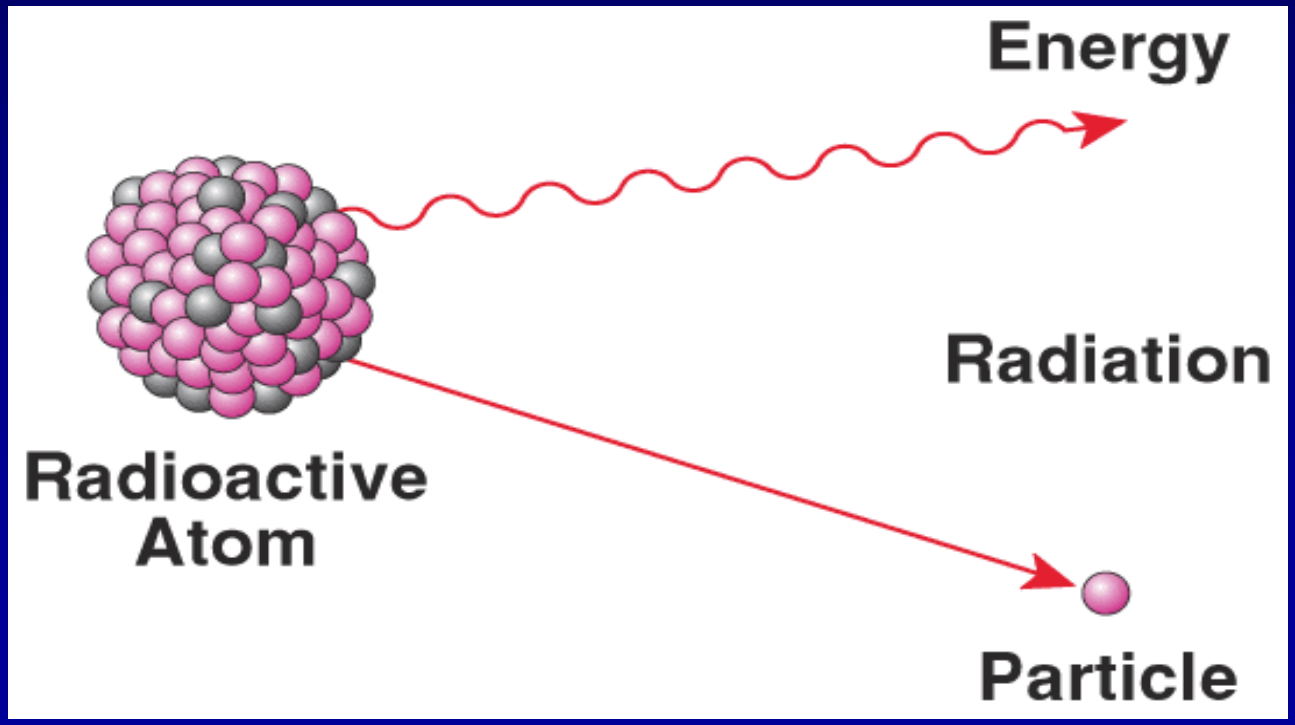


How does a nuclear reactor work?



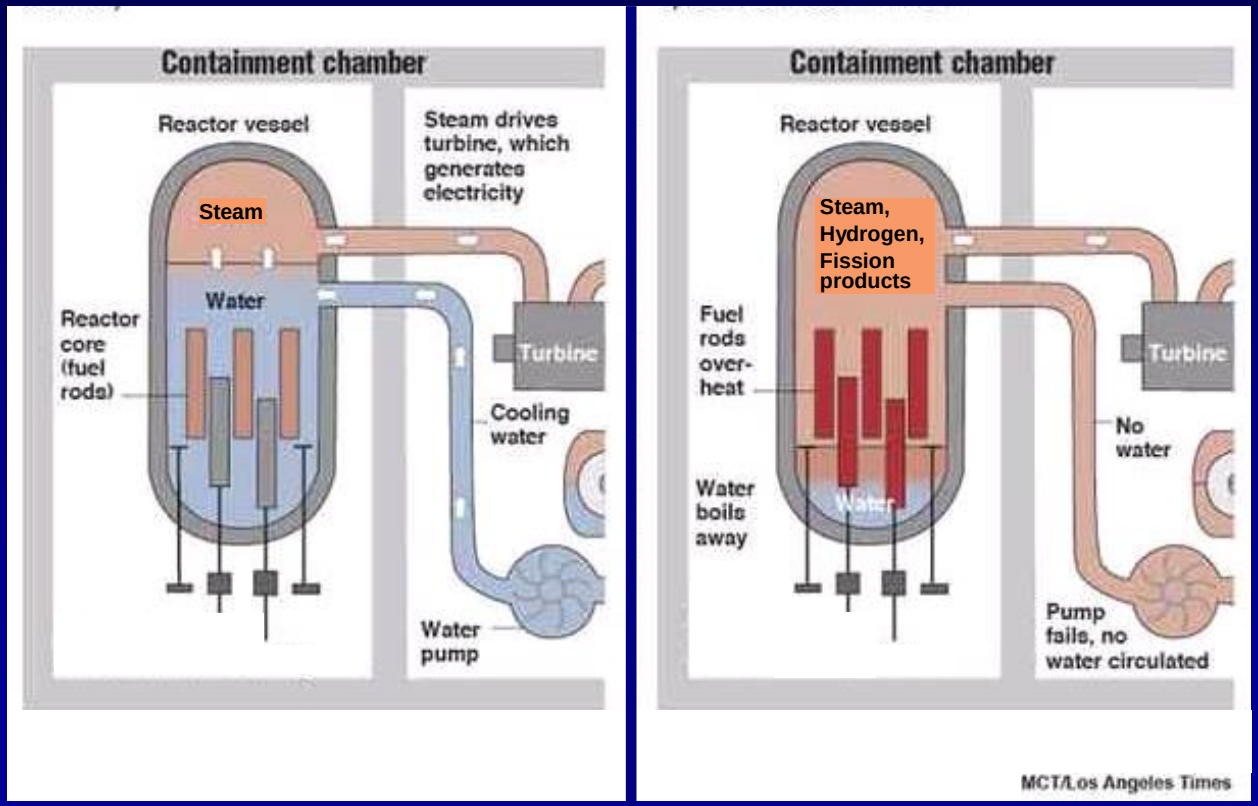
What is Radioactivity?

The spontaneous "decay" of a radioactive nucleus, resulting in the emission of energy…. *radiation*



What can go wrong in a water-cooled reactor?

- Loss of water which covers and cools the fuel rods



Which are the important isotopes / pathways that lead to human radiation exposure?

- Drinking milk (I-131) 55%
- Ingestion of other foodstuffs (Cs-137) 15%
- Inhalation (I-131, Cs-137,…) 15%
- External exposure (Cs-137) 15%

Radioactive iodine and cesium emissions at other reactor incidents

	I-131 (TBq)	**Cs-137** (TBq)
Three Mile Island, 1979	**1**	**0.000001**
Windscale, 1957	**750**	**20**
Chornobyl, 1986	**260,000**	**38,000**

How long will the exposures last? Physical and Biological half lives

	Physical half life	*Biological half life*
I-131	**8 days**	**3 months**
Cs-137	**30 years**	**70 days**

What is the primary health risk after exposure to low doses of ionizing radiation?

A small increase in long term cancer risks

- Our “normal” lifetime risks of developing cancer is about 44%
- The radiation-related cancer risk among A-bomb survivors who were ~1 mile from the explosion was 0.3%

What is the primary health risk after exposure to high doses of ionizing radiation?

Damage to stem cells, particularly of the blood-forming organs and the gut

- **Functional cells can typically still function**
- **The ability to replace functional cells when required is compromised**

Radiation Hematopoietic Syndrome

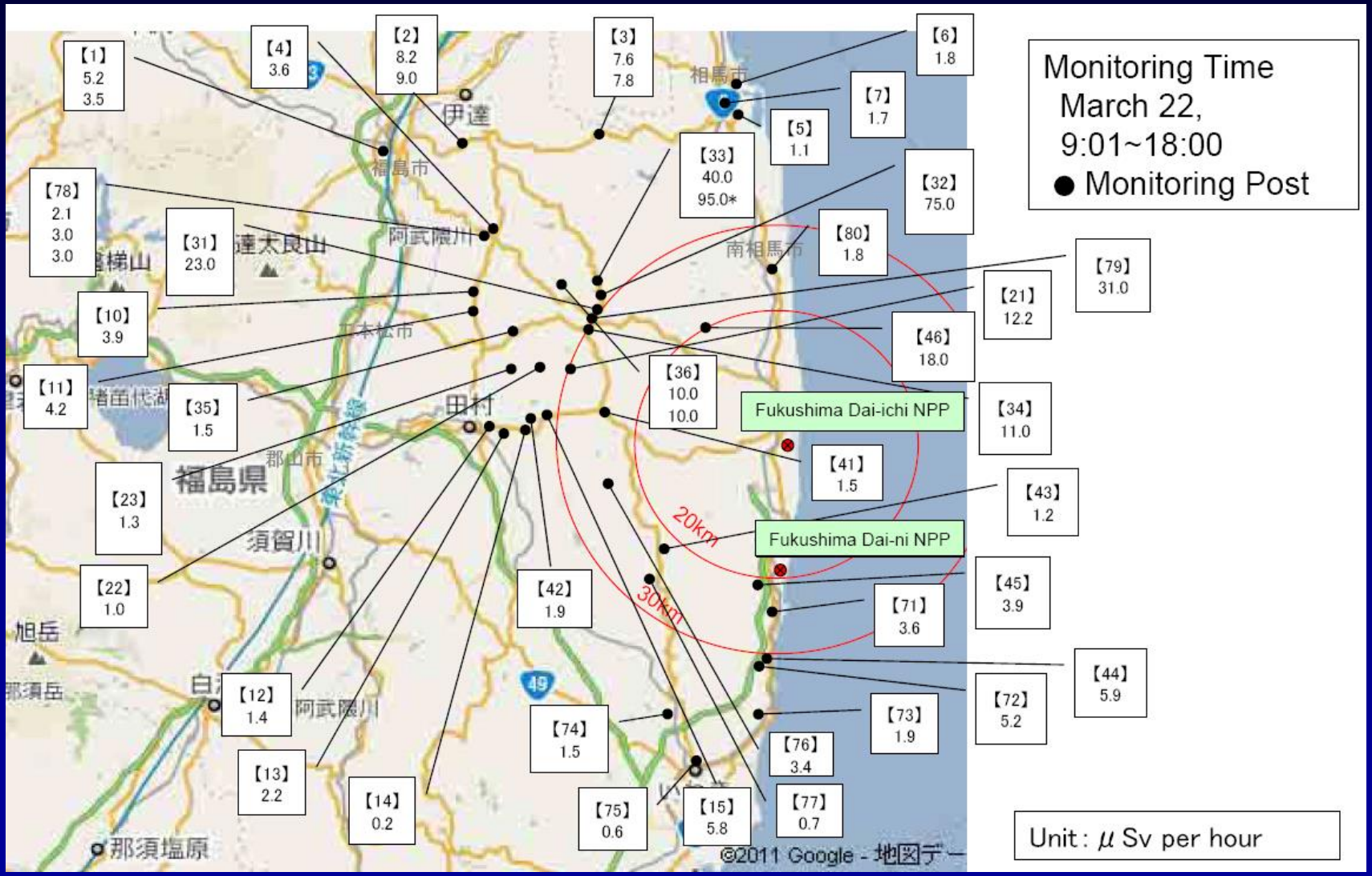
- Early symptoms: nausea, vomiting, diarrhea
- Typically a latency period where patient improves
- ~ 3 weeks after exposure, chills, fatigue, skin hemorrhages, mouth ulceration, anemia, epilation
- Death within ~60 days due to infections and fever
- Treatment is good nursing, antibiotics, stem cell growth factors, possibly bone marrow transplant

Psycho-social responses to a radiation incident: e.g. Goiânia 1987

- 130,000 people (10% of population) came to ER / temporary screening locations
- 250 were contaminated, 4 died
- Of the first 60,000 screened, 5,000 showed symptoms consistent with radiation sickness

What do we know about the situation in Japan?

Dose readings at monitoring posts in Fukushima Prefecture, March 22



Radioactivity in local food

- **Milk:** Some reports of milk from Fukushima prefecture containing 1,500 Bq/kg of I-131
  - FDA intervention level is 150 Bq/kg
- Solution: Don't sell or drink local milk
- Short-term issue

- Some reports of local **vegetables** with 500 Bq/kg of Cs-137.
  - FDA intervention level is 1,200 Bq/kg
- Solution: Wash it off
- Longer-term issue is Cs-137 in the food chain


Questions and Answers

What are the likely health consequences of the accident… best case / worst case?

Workers:

Acute radiation syndrome from high radiation doses: Fatalities very possible among the 50 – 200 workers

General population: No early radiation sickness

1. ***If plant releases do not increase significantly from current levels, and soon start to decrease:***

   Very small increase in cancer risks (<0.01%) in ~100,000 population. Unlikely to be detectable in epidemiological studies

2. ***If plant releases increase sharply, and the wind blows consistently onshore:***

   Small increases in cancer risks (<0.05%) in ~500,000 population. Epidemiological studies possible

Will there be any health consequences for people in the US?

- No, it is inconceivable that the plume could cross the Pacific Ocean without being drastically dispersed

Should anyone who was in Japan for a few days after the accident be concerned?

- No, the radiation doses that one would currently receive in a few days exposure, even close to the evacuation zone, are very small

Should anyone planning to travel to Japan cancel ? Should anyone in Japan leave?

- *From the radiation perspective*, if the situation doesn't significantly deteriorate, then no
- A reasonable approach would be to delay a decision for a couple of weeks

Should we be concerned about Japanese food?

- Not at this time….

Could this happen in the US?

- **Less likely:**
  - **Detailed station blackout plans**
  - **However there are 23 reactors (e.g. Oyster Creek, NJ) in the US of similar age and design to the older Fukushima Daiichi reactors**
  - **Modern reactor designs have passive emergency cooling systems operated by gravity, requiring "no electric power or human intervention"**

Are we prepared if something similar were to happen in the US?

- Much planning ongoing in the US for response to a terrorist improvised nuclear device (IND) or “dirty bomb”
- Equally applicable to a the scenario after a large-scale reactor accident
- One key is individualized biodosimetry – provide a rapid radiation dose estimate for every exposed individual
  - Both for high-dose triage and to reassure the “worried well”

The Columbia RABiT: Rapid Automated Biodosimetry Tool

- Fully automated ultra high-speed robotic biodosimetry workstation.
- Automates well-established manual assays
- One fingerstick (20μl) of blood
- No subsequent human intervention

- **Phase I (2008): 6,000 samples/day**
- **Phase II (2010): 30,000 samples/day**