Nuclear safety, radiation, waste management and Fukushima

H. Douglas Lightfoot
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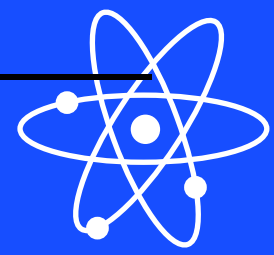
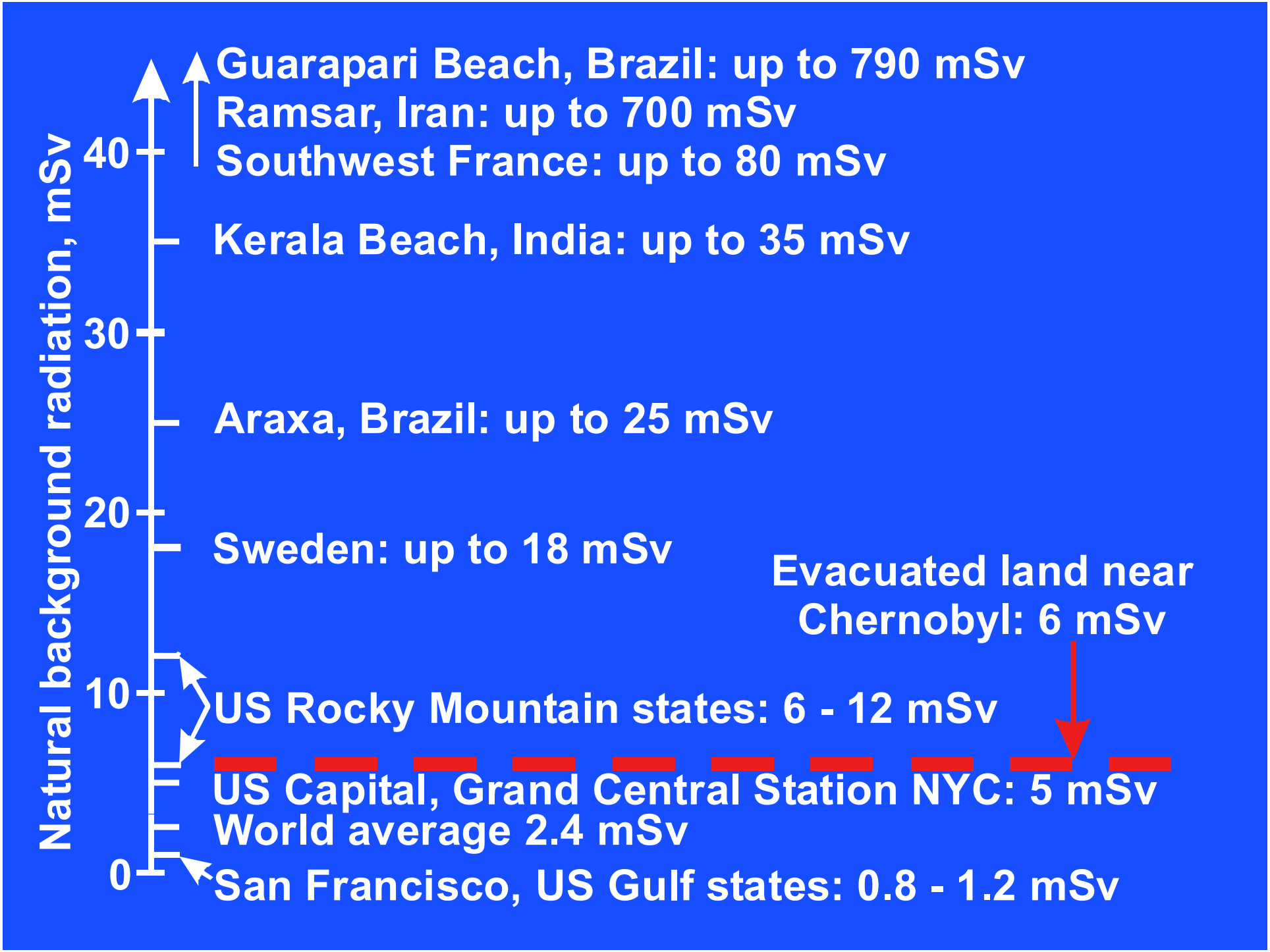
- **Member:**
  Global Environmental and Climate Change Centre (GEC3)
- **Web sites:**
  http://geog.mcgill.ca/gec3/
  http://www.nobodysfuel.com
  http://www.thelightfootinstitute.ca

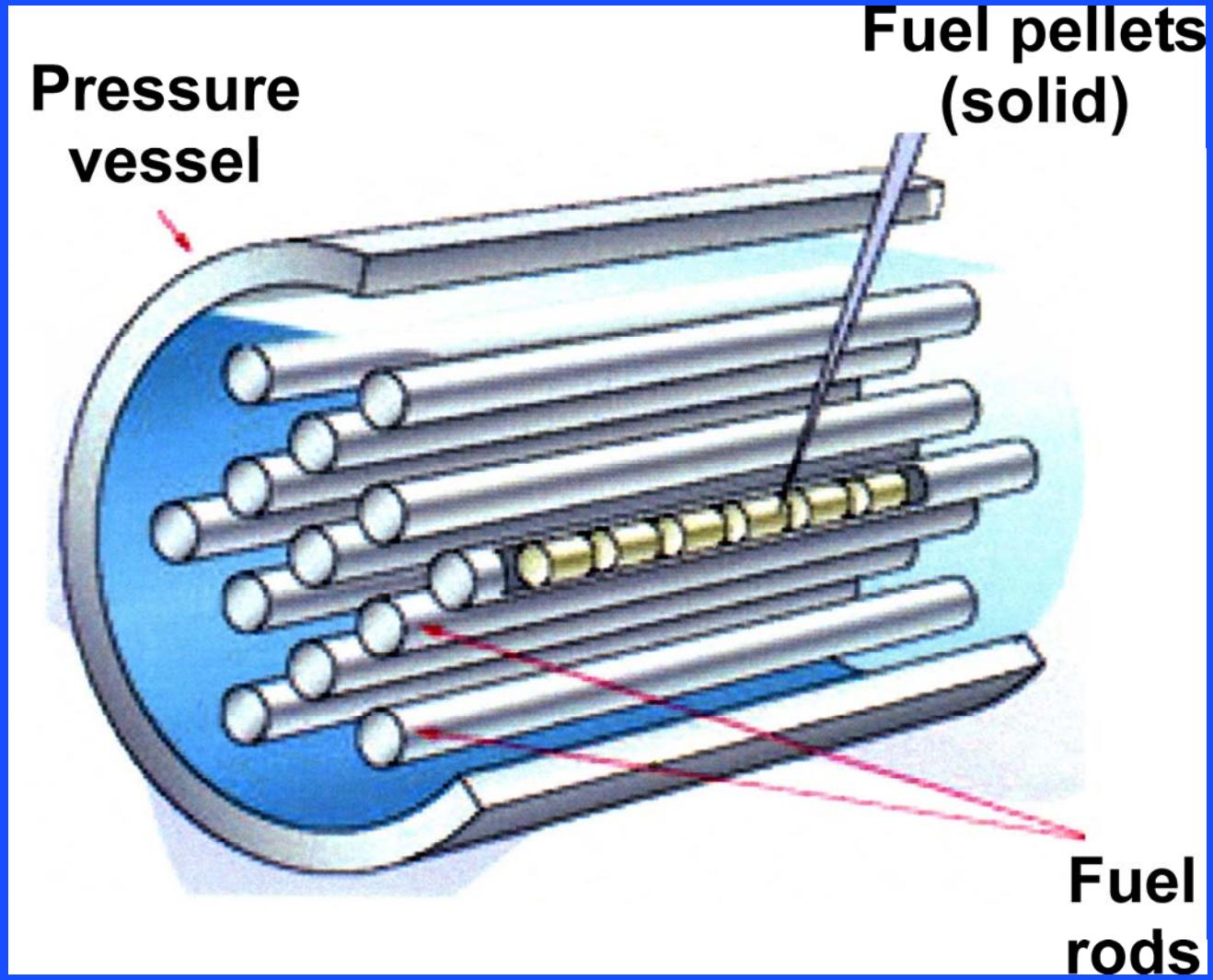
Accidents generating electricity, per unit of energy, 1966 to 1996 [1]

	Immediate Fatalities	Injured	Evacuated
L P Gas	3.1	15	500
Oil	0.42	0.45	7.2
Coal	0.35	0.07	0
Hydro	0.9	0.20	32
Natural gas	0.09	0.21	6
Nuclear	0.009	0.11	80




Natural background radiation, mSv
40
30
20
10
0
Guarapari Beach, Brazil: up to 790 mSv
Ramsar, Iran: up to 700 mSv
Southwest France: up to 80 mSv
Kerala Beach, India: up to 35 mSv
Araxa, Brazil: up to 25 mSv
Sweden: up to 18 mSv
Evacuated land near
Chernobyl: 6 mSv
US Rocky Mountain states: 6 - 12 mSv
US Capital, Grand Central Station NYC: 5 mSv
World average 2.4 mSv
San Francisco, US Gulf states: 0.8 - 1.2 mSv

Nuclear fuel bundle



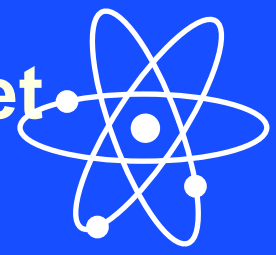
From: http://www.mei.gov.on.ca/images/content/en/nuclear-gen-fuel-bundle-dia.jpg

Nuclear waste and spent fuel

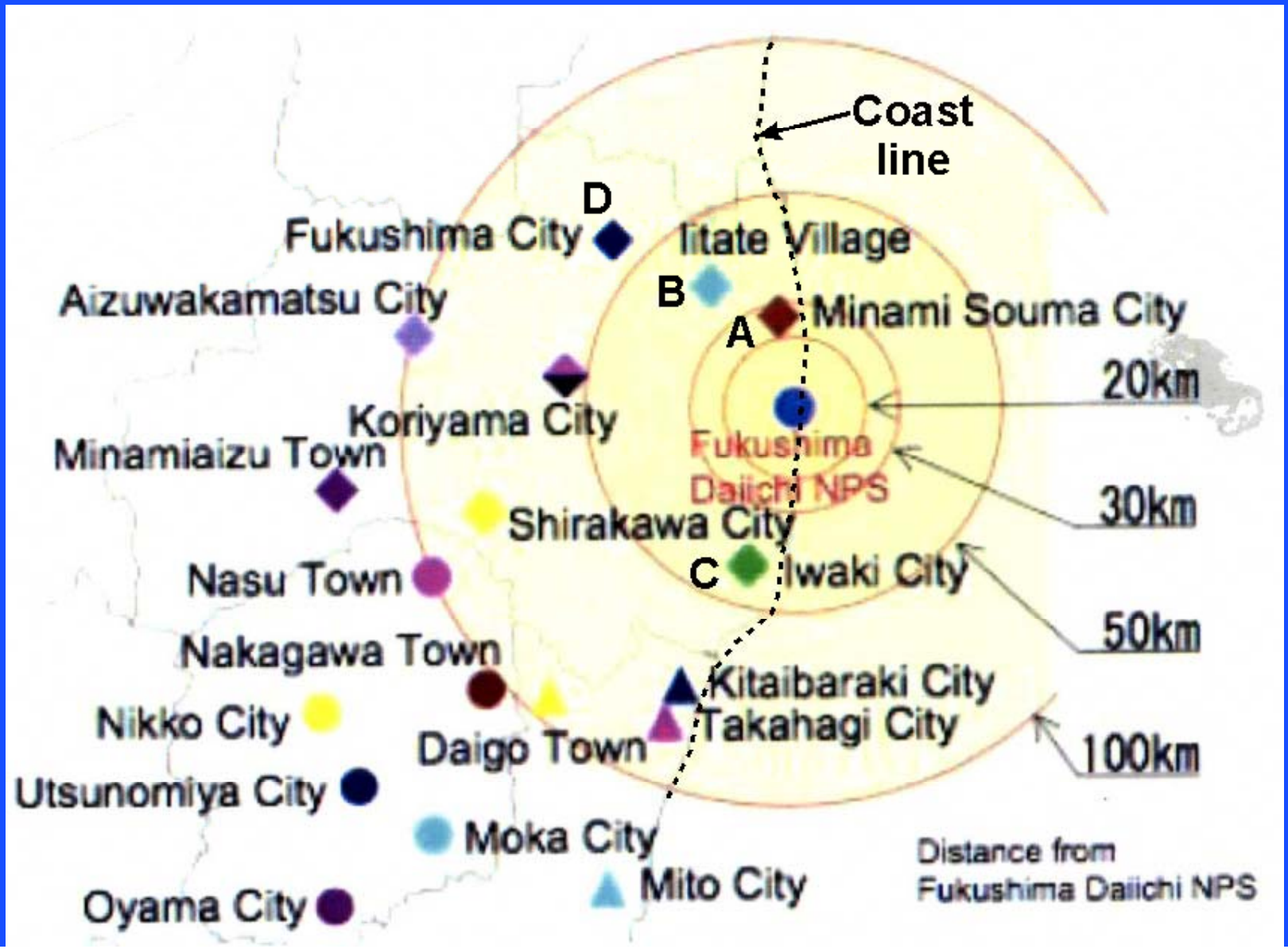
- Short term storage of spent fuel:
  - Swimming pool
- Long term storage of spent fuel:
  - Dry cask storage
- Central long term storage:
  - Reprocessing to recover U 238
  - Isolate long-lived isotopes
- Low level waste: stored in concrete boxes

Fukushima

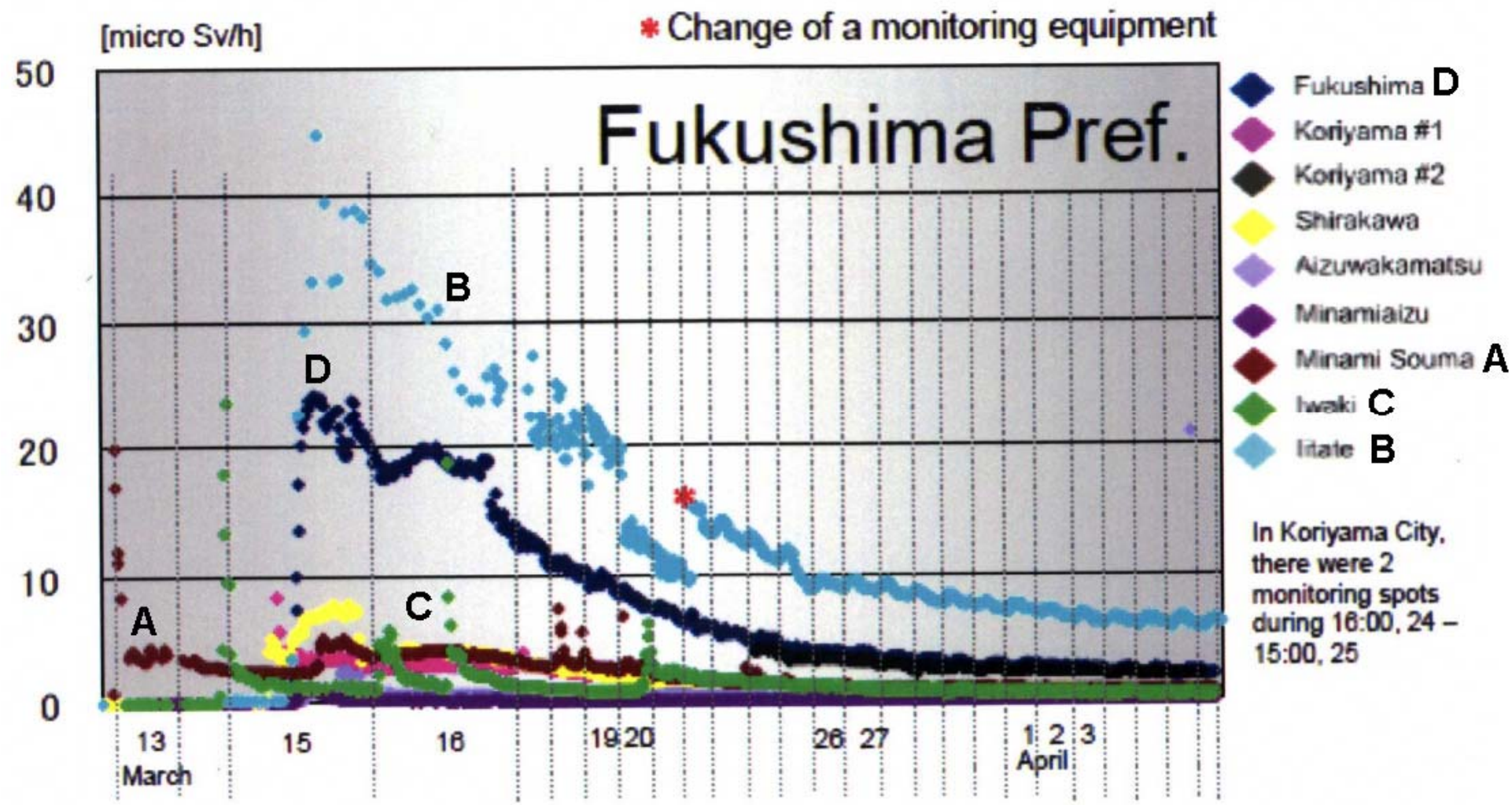
- Earthquake: design 8.2, received 8.9
- All reactors shutting down as designed
- Tsunami one hour later: diesels out
- Serious incident: partially melted cores
- Hydrogen explosion: overheated spent fuel
- Water leak to ocean: under repair
- 6 workers killed by earthquake and tsunami
- Radiation: no deaths or serious injuries
  - Three workers had minor burns to feet
- Earthquake + tsunami: ≈27,000 deaths



Fukushima [3]


Coast line
D
Fukushima City
Iitate Village
B
Aizuwakamatsu City
A
Minami Souma City
20km
Koriyama City
Minamiaizu Town
Fukushima Daiichi NPS
30km
Shirakawa City
C
Iwaki City
Nasu Town
50km
Nakagawa Town
Kitaibaraki City
Takahagi City
Nikko City
Daigo Town
100km
Utsunomiya City
Moka City
Mito City
Oyama City
Distance from Fukushima Daiichi NPS

Fukushima [3]



1 microSv/hr = 8.8 milliSv/yr

Fukushima

- Major problem: economic disruption
- Initially out: 4 nuclear, 6 coal, 11 oil
- 20% of electricity capacity out of service
- Rolling blackouts: ≈1 year
- Major reconstruction

- ≈30% of electricity, 54 reactors, 49 GW
- B kWh 2009: US 799, France 390, Japan 260

We are surrounded by radiation [4]

- Eating 1 banana = 0.1 μSv
- Extra from 1 day on Colorado plateau = 1 .2 μSv
- Dental X-ray = 5 μSv
- Average person background 1 day = 10 μSv
- Airplane flight NYC to LA = 40 μSv
- Radiation worker one year dose = 50,000 μSv
- = 50 mSv
- Symptoms if received in a short time = 400 mSv

Nuclear safety

- People who work in nuclear plants know they are safe
- They are familiar with the plant and the safety procedures
- France: school children visit
- We need to do that in Canada
- Nuclear industry: one of the safest in which to work

- **References:**

- [1] Paul Scherrer Institute, Severe accidents in the energy sector, November 1998. Available at: http://manhaz.cyf.gov.pl/manhaz/szkola/materials/S3/psi_materials/ENSAD98.pdf

- [2] Cuttler J M, Pollycove M, Nuclear energy and health, Dose-Response, Vol. 7, Issue 1, 2009. Available at: http://www.nwmo.ca/uploads_managed/MediaFiles/1184_dr.jerrym.cuttler-december1320.pdf

- [3] Current monitoring spots around Fukushima Daiichi Nuclear Power Station (April 7, 2011) Available at: http://www.jaif.or.jp/english/news_images/pdf/ENGNEWS01_1302486267P.pdf

- [4] Radiation Dose Chart. Available at: http://xkcd.com/radiation/

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