WHAT HAPPENED, WHAT IS GOING ON IN FUKUSHIMA NO.1 NUCLEAR POWER STATION?

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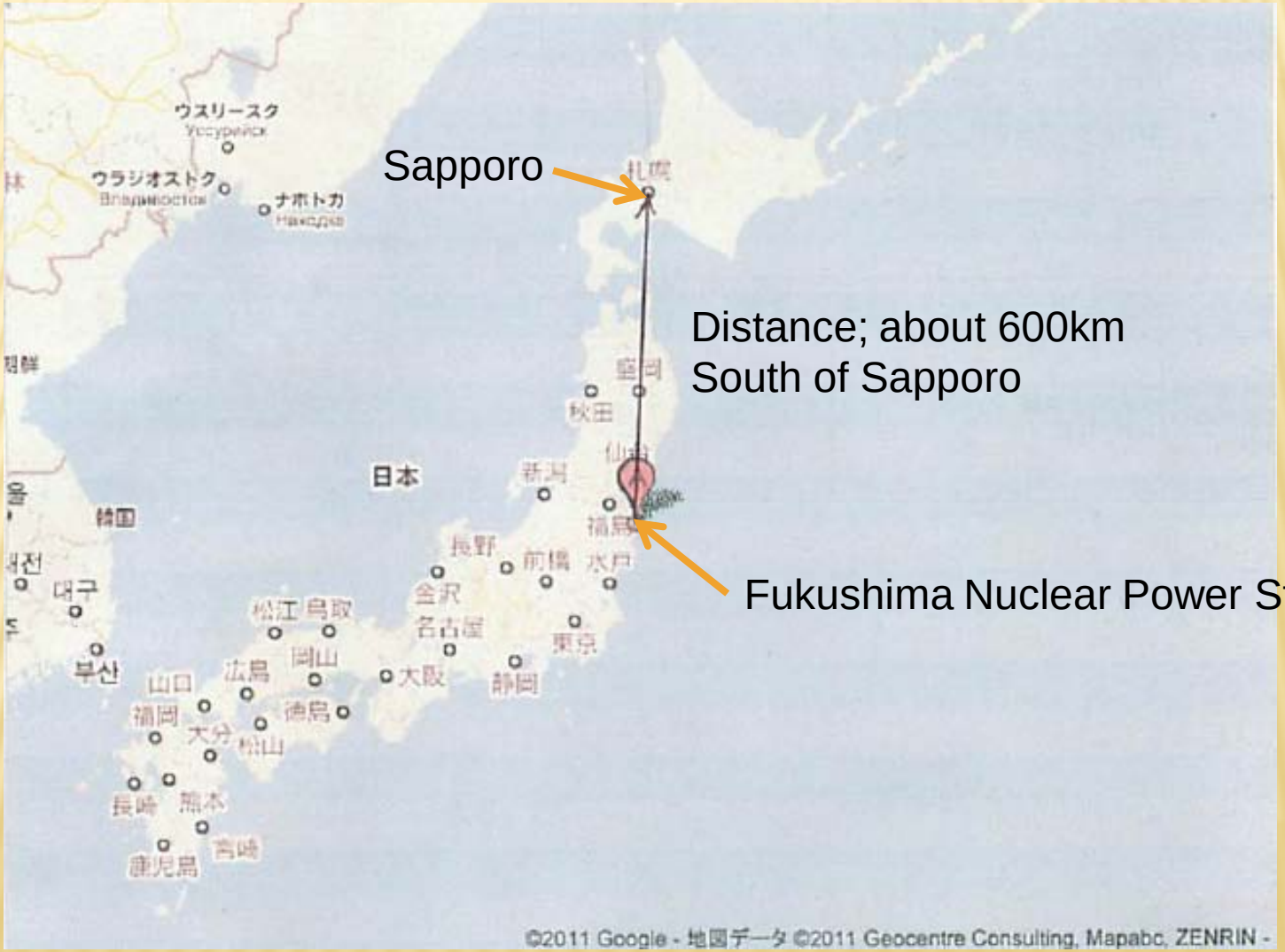
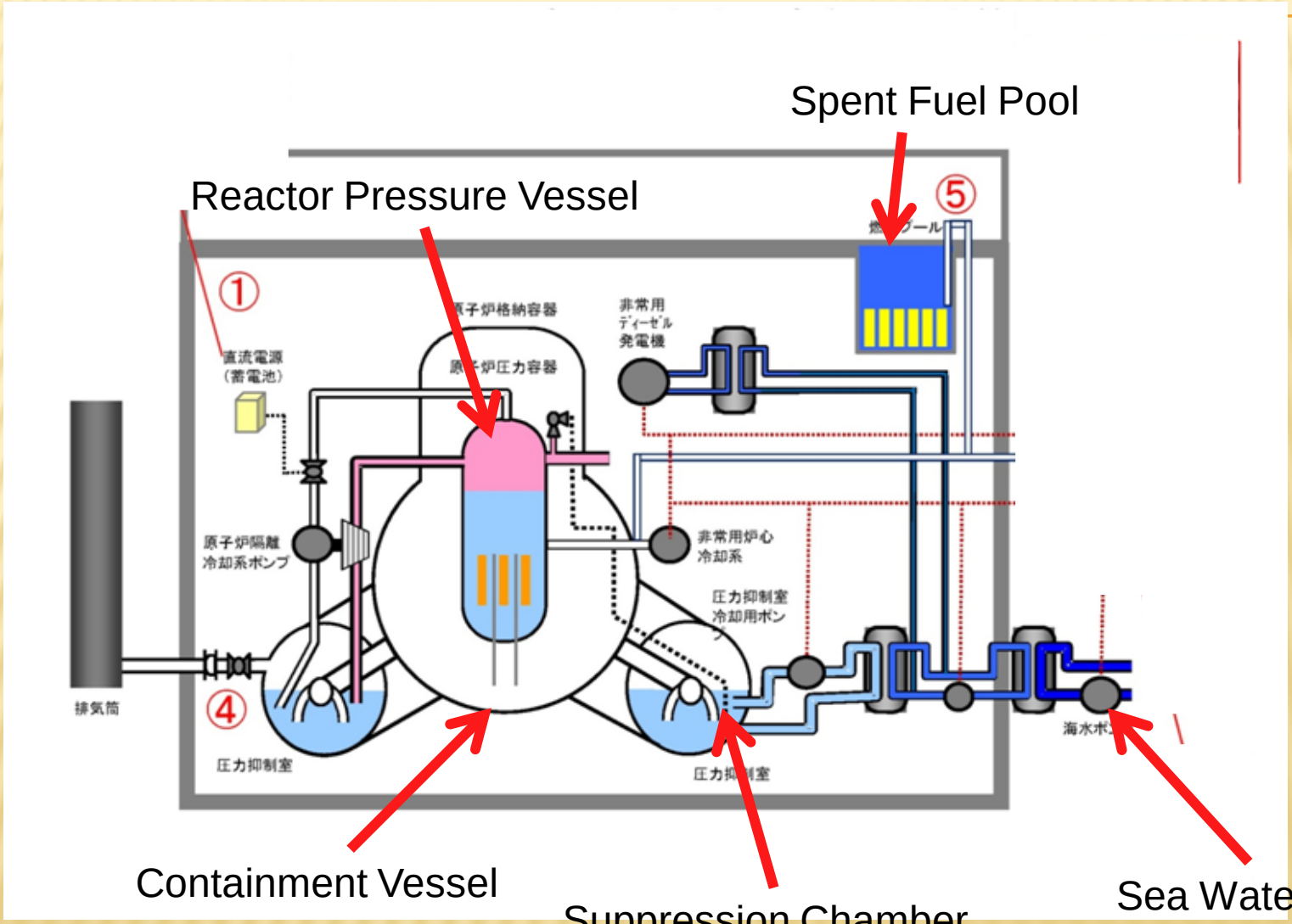
WHERE IS FUKUSHIMA NUCLEAR POWER STATION?



WHAT HAPPENED?

- The largest earthquake in history hit North-East Japan at 14:46 on 11, March, 2011; Magnitude of 9.0
- The largest Tsunami caused by the earthquake hit the coastline of Pacific Ocean; the height of the wave thought to reach over 15 meters at the maximum at the site, although the design value was about 5.7 meters. Almost of the plants systems were covered with sea water of 4m in depth.
- In Fukushima-1 site, operating units (Unit No. 1 to 3) succeeded to shutdown as designed. (Unit No.4 to 6 were during inspection.)
- The electrical power from external grid was lost due to the earth-quake.
- Back-up diesel driven generators started but, they all failed in one hour or so due to the loss of cooling.
- The final heat sink was completely lost because all of the sea water pumps were damaged by the tsunami.

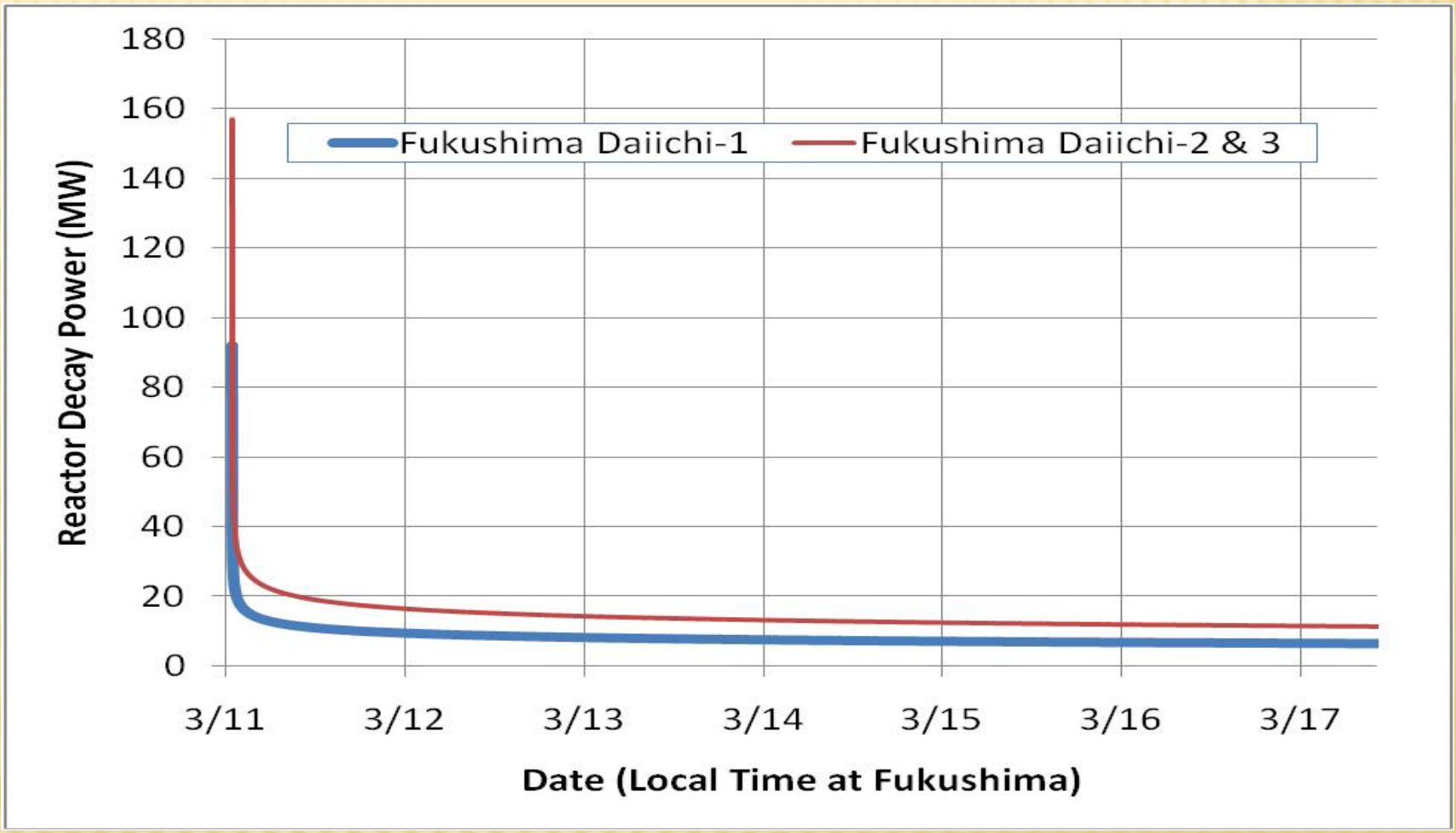
SYSTEM CONFIGURATION of BWR (Mark-1)



WHY IS THE HEAT SINK REQUIRED?

- Nuclear fission reactions produce fission products (FP) in nuclear fuel.
- Some of the nuclides of FP are unstable, thus they emit energy in the form of radiation in order to be stabilized, which result in heat called as “Decay Heat.”
- This distinguishes the nuclear fuel from the fossil fuel. (The latter generates heat only when it burns.)

HOW LARGE THE DECAY HEAT?



MIT NSE Unclear Information Hub
http://web.mit.edu/nse/

DECAY HEAT (NUMERICAL DATA)

Date/Time (Fukushima Time)	Fukushima Daiichi-1 Decay Heat (MW)	Fukushima Daiichi-2 & 3 Decay Heat (MW)	Percent of Full Reactor Power
3/11/11 2:46 PM	92.0	156.8	6.60%
3/11/11 2:47 PM	44.7	76.2	3.21%
3/11/11 2:48 PM	36.9	62.8	2.64%
3/11/11 2:50 PM	31.4	53.5	2.25%
3/11/11 3:00 PM	24.1	41.0	1.73%
3/11/11 3:30 PM	19.1	32.5	1.37%
3/11/11 8:00 PM	12.8	21.9	0.92%
3/12/11 8:00 AM	10.1	17.3	0.73%
3/12/11 8:00 PM	9.1	15.5	0.65%
3/13/11	8.5	14.5	0.61%
3/14/11	7.8	13.2	0.56%
3/16/11	6.9	11.8	0.50%
3/20/11	6.1	10.5	0.44%
4/1/11	5.2	8.8	0.37%
7/1/11	3.7	6.3	0.26%
10/1/11	3.3	5.6	0.23%
3/11/12	2.9	5.0	0.21%

Decay heat needs to be cooled for a long time

WHAT HAPPENED WITH NUCLEAR FUELS?

- When cooling capability was lost, the water temperature rising in the core and also in spent fuel pool, some of the water began to vaporize and eventually uncovered some of the fuel rods.
- The fuel rods have a layer of cladding material made of a zirconium alloy. If zirconium is hot enough and is in the presence of oxygen (The steam provides the oxygen) then it can undergo a reaction that produces hydrogen gas. ($Zr+2H_2O \rightarrow ZrO_2+2H_2$)
- Hydrogen at concentrations above 4% is highly flammable when mixed with oxygen; however, not when it is also in the presence of excessive steam

This hydrogen caused the explosions in Unit 1through 4.

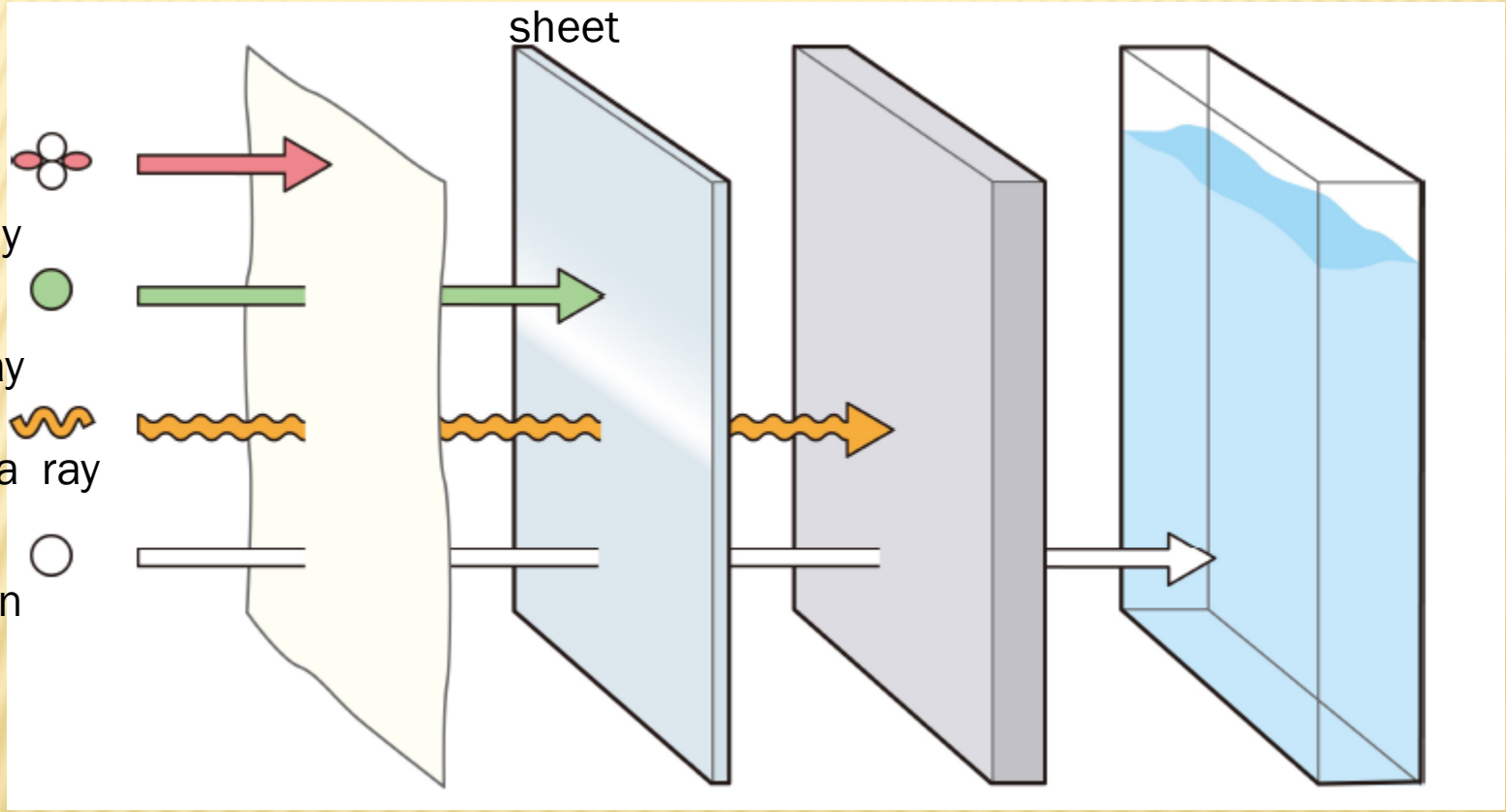
RELEASE OF RADIOACTIVITY

- Increasing temperature results in vaporization of coolant, thus increasing pressure of reactor vessel
- In order to protect reactor vessel integrity, pressure must be lowered by venting the steam
- Radioactive fission products came out with steam to environment through containment vessel and broken reactor building

RELEVANT RADIOACTIVE NUCLIDES

	I-131	Cs-137
Melting Temp.	113.6C	28.4C
Boiling Temp.	182.8C	671 C
Half life	8 days	30 years (Effectively 70days)
Radiation	Beta	Beta & gamma
Energy(Mev)	0.606	0.514 & 0.66
Radio Toxicity	Thyroid cancer	Leukemia

RADIATION AND SHIELDING



RADIATION UNITS

- Becquerel: Bq

  Number of decays per second

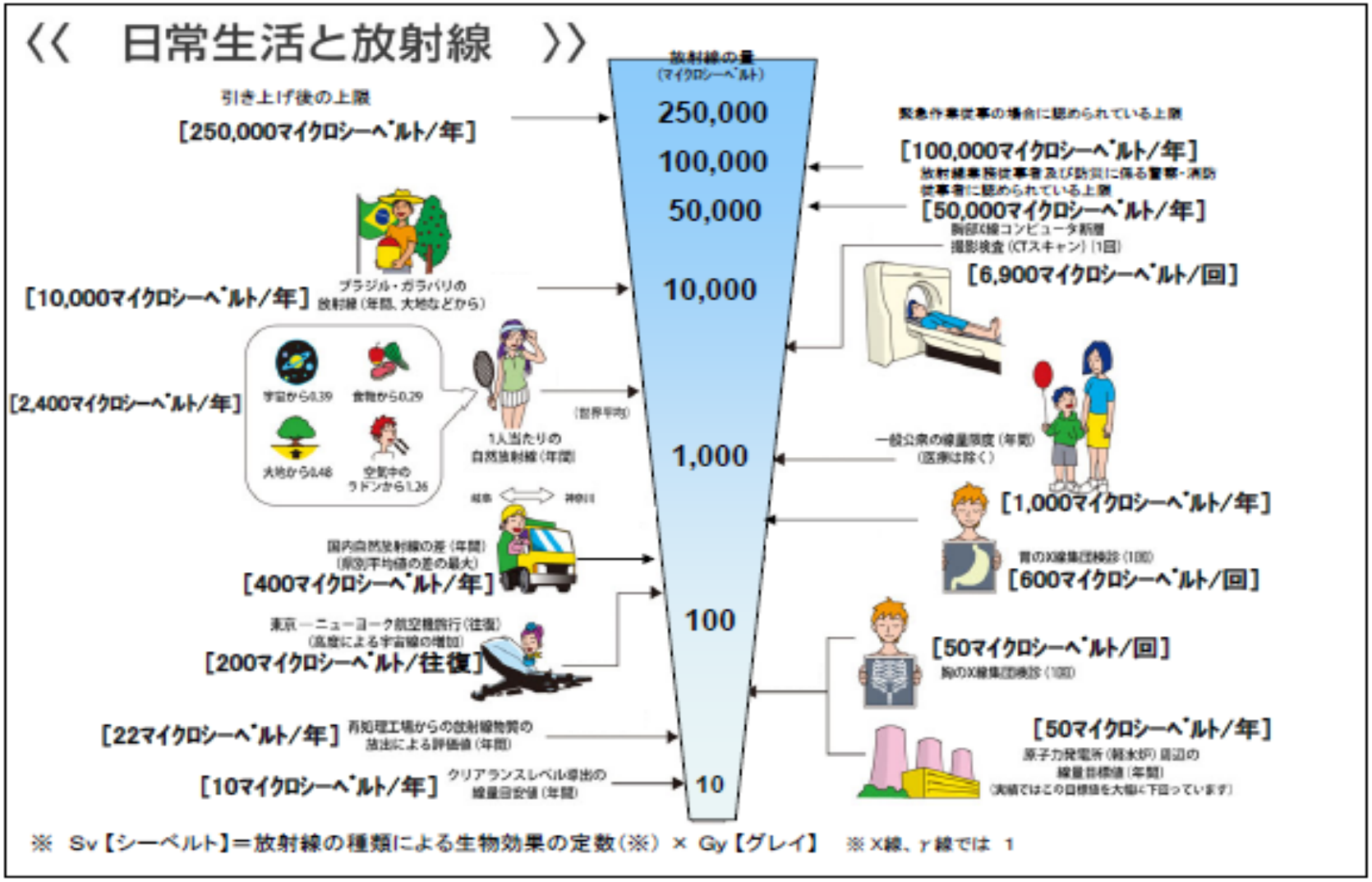
  Ex. Average human has about 7000 Bq
- Sievert: Sv ; 1mSv=1000μSv

  Measure to evaluate effect on human body

  Ex. 100mSv is assumed to causes no health problems

Do not confuse numbers and units reported by media.

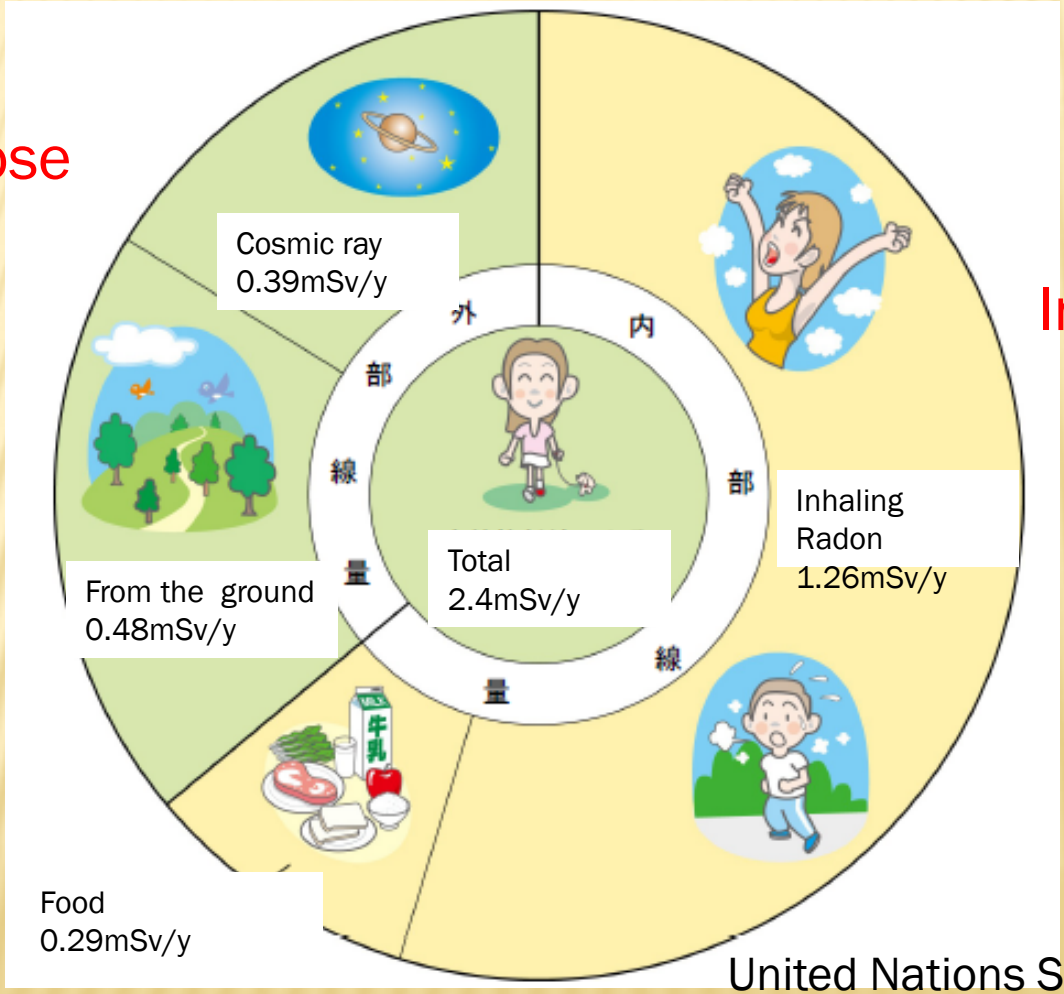
RADIATION DOSE IN DAILY LIFE



資源エネルギー庁「原子力2002」をもとに文部科学省において作成

EXTERNAL AND INTERNAL DOSES FROM NATURAL SOURCES (WORLD AVERAGE)

External dose



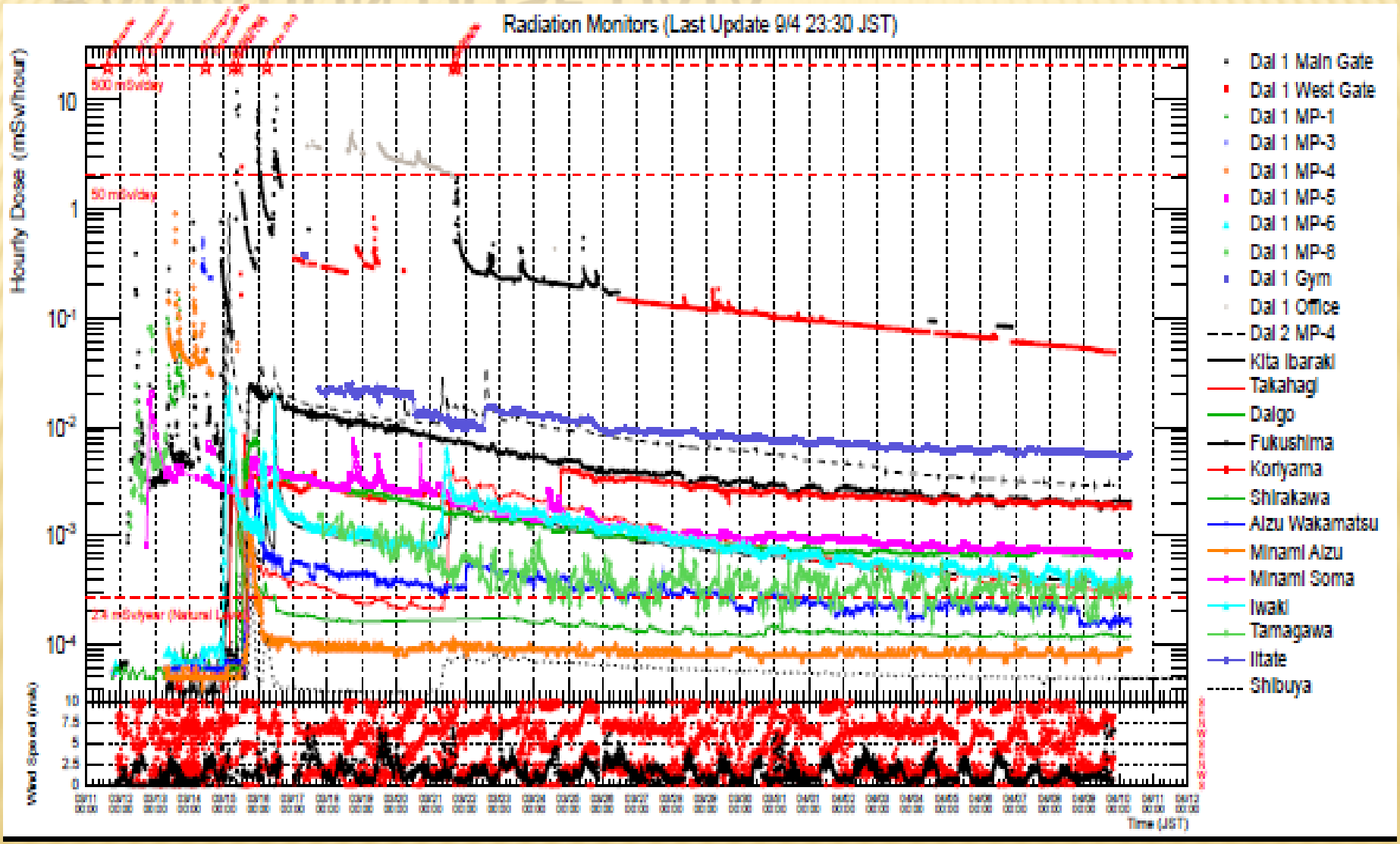
Internal dose

United Nations Scientific Committee on the Effect of Atomic Radiation(1993)

CURRENT SITUATION

- Cooling by poring water into the reactors and spent fuel pool is going on with temporary pumps, thus the plants condition holds a stability.
- The recovery of the cooling capability is still underway.
- High level of radiation from the water inside the reactor and turbine buildings prevents the progress of the operation.
- Cooling still needs to be provided from external sources, using fresh water and pump trucks, while work continues to establish a stable heat removal path to external heat sinks.

RADIATION DOSE DATA



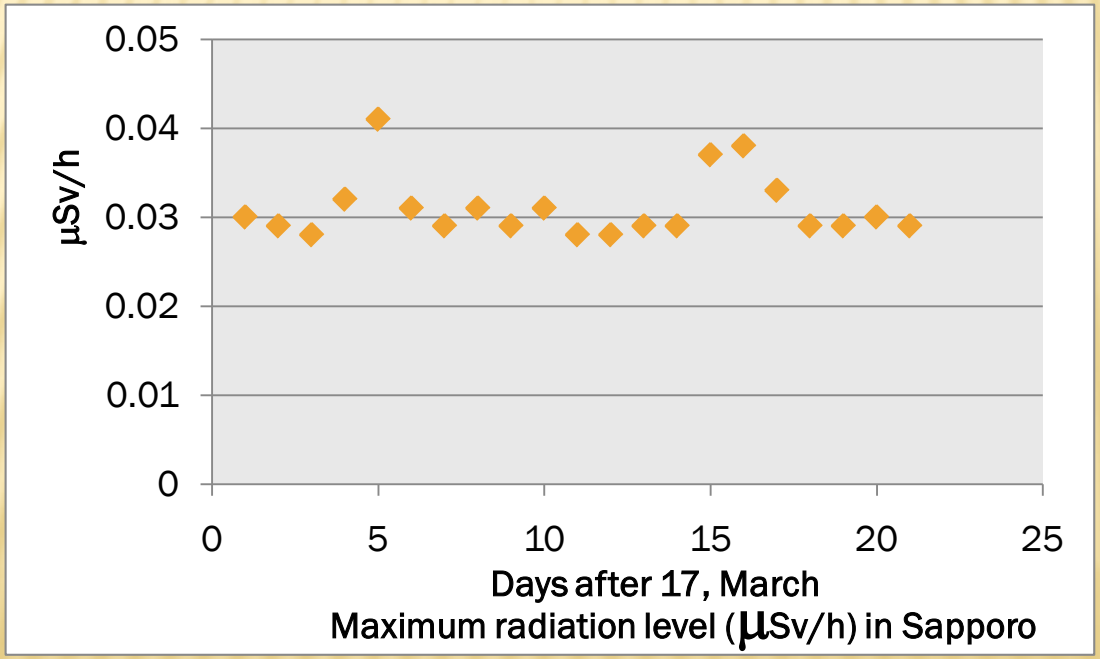
http://d.hatana.ne.jp/oxon/20110318/1300381733

ANNUAL DOSE IN SAPPORO

- External radiation

  0.03*24*365=263 μSv/y

Less than the world average of 870 μSv/y



http://atmc.jp/

PROTECTION FROM RADIATION

- Studies on Hiroshima and Nagasaki atomic bomb, accidents in Three Mile Island, Chernobyl and Japan Nuclear Fuel Conversion Company , dose limits for health have become well understood.
- Based on the facts learned from the above, procedures for health protection have been well controlled
- The regulations are set based on the ICRP international guide lines with large margin and openly measured data
- Thus, nothings to worry about right now in Sapporo