National Institute of Radiological Sciences
as of April 22,2011
as of August 24,2011

Basic Facts- No.6

1. The Japanese Government designated the "deliberate evacuation area" on April 11. Will you explain what 20 mSv given as the reference level means?

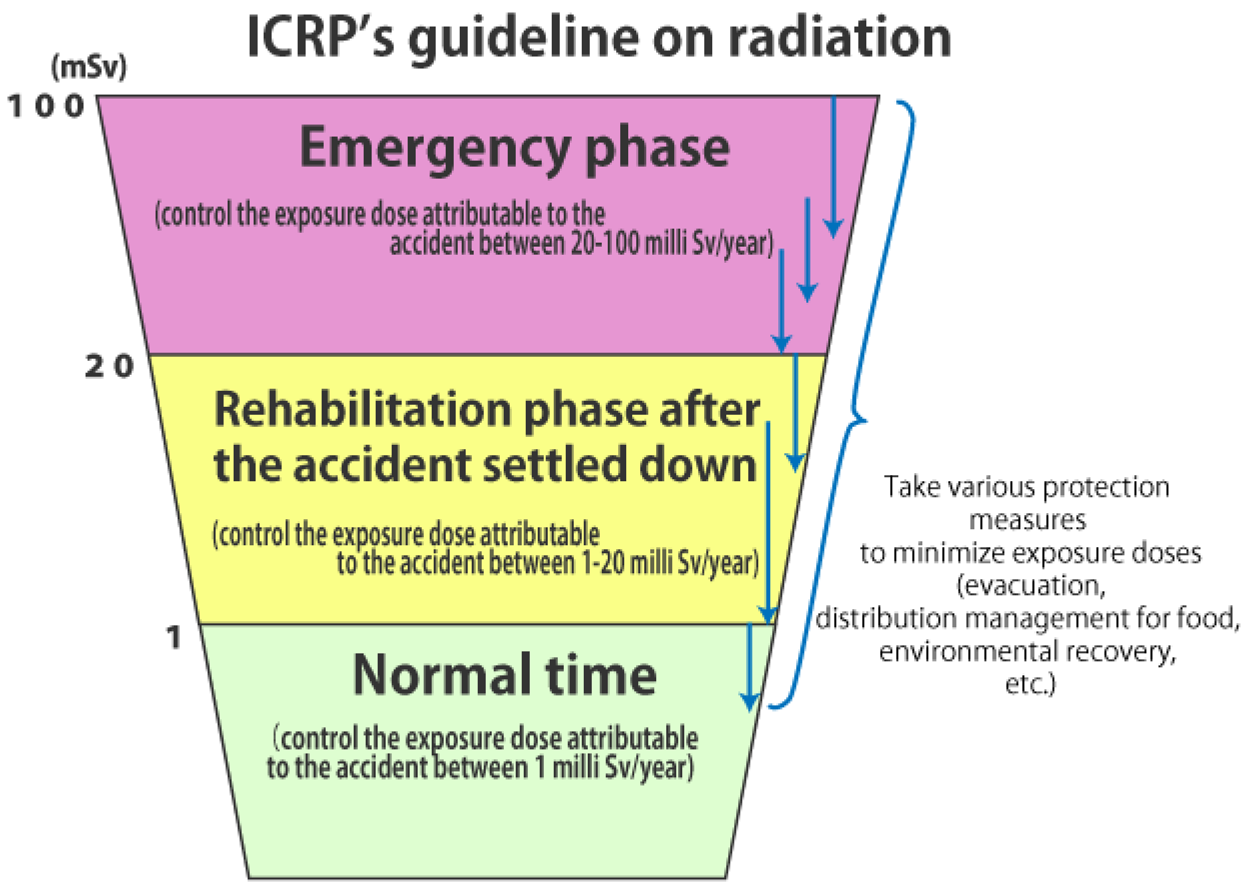
The International Commission on Radiation Protection (ICRP) is an international academic society of experts that makes recommendations about radiation protection. It has been reported that the reference level is set, based on the ICRP's recommendations and with advice from the Nuclear Safety Commission of Japan.

The ICRP's 2007 recommendations state that in emergencies radiation control standards different from the ones for normal times should be used. Moreover, it is suggested that emergency situations should be classified into two phases: an emergency phase and a rehabilitation phase, to take the following protection measures as a guideline.

1) Normal time: the dose should be limited to 1 mSv or less in a year.
2) Emergency phase: the exposure dose attributable to an accident should not exceed 20-100 mSv.
3) Rehabilitation phase after the accident settles down: the dose should not exceed 1-20 mSv in a year.

The current situation of the Fukushima Daiichi Nuclear Plant applies to the above-mentioned 2) Emergency Phase.

The Japanese government's decision has adopted the lower limit of the range between 20 to 100 mSv for the emergency phase. This means, while responding to the situation to control the total exposure dose of the residents in the plant's surrounding area under 100 mSv, it takes measures to lower the annual dose back to the level of 1 mSv per year in the future.



2. Some parts in the specified evacuation areas were observed to have a higher air dose than areas closer to the plant. Why did this happen?

As confirmed in the Chernobyl nuclear plant accident, it is not always the case that contamination levels decline in a gradual linear way as the geographical distance gets farther from the accident site, and the levels in some spots are found high.

If an emergency situation arises at a nuclear facility and radioactive materials leak in the form of gas or in particles, they could travel together with the air like clouds. This is called a radioactive plume. When a radioactive plume is passing high up in the sky, the air dose rate temporarily rises in this spot. Also, the plume may descend, being affected by geographical features such as a land depressions, direction of the wind, rainfall and snowfall. If radioactive substances deposit on the ground surface, the air dose will rise. It is believed that such phenomena cause some places far away from the plant to be observed as having a high dose rate.

3. The air dose rate in Tokyo is declining, but it is still continuing to be above normal. About how much milli Sv is the accumulated dose (for about a month from March 14 to April 11) of a resident in Tokyo?

This section explains both the external radiation exposure and internal exposure, i.e. ingestion of radioactive substances in the body. The following calculated values represent typical radiation doses, and the dose varies depending on individual’s behaviors and eating habits.

The dose of external radiation exposure from radioactive substances in the air is found to be about 16 micro Sv for a month (assuming that the person stays outdoors for 8 hours a day) since March 14, by adding up the data announced by the MEXT and then subtracting the average dose at normal times.

Radiation exposure doses should take into consideration water, food and breathing.

Suppose you drink 1.65 liter of tap water a day. The exposure from tap water will be an estimated 10 micro Sv or thereabouts using the data from the Tokyo Metropolitan Government (Please refer to Question 4).

Radiation exposure from food is far more difficult to estimate because it significantly varies from person to person affected by his or her eating habits and the actual amount of food intake. Suppose you drink milk containing 20Bq/kg iodine-131, 1 Bq/kg Cesium-137 and 1 Bq/kg Cesium-134, eat fish likewise containing 2 Bq/kg, 1 Bq/kg, 1 Bq/kg, respectively, and also eat vegetables containing 150, 10, 10 Bq/kg, respectively, every day for one month. Your exposure dose is estimated to be about 69 micro Sv.

The exposure from inhaling radioactive materials in the air is estimated to be about 21 micro Sv based on the Tokyo Metropolitan Government’s data about radioactive substances in the dust, in the case of breathing 22.2 cubic meter of air.

With all the above figures combined, the total is about 120 micro Sv for a month. This is lower than the upper level* of radiation exposure in a round trip by airplane between Tokyo and New York and not hazardous to your health. You, however, need to pay close attention to announcements by the governmental offices and follow instructions and guidance when they are issued.

*Concerning calculation of radiation exposure dose associated in case of travel by airplane, please refer to the JISCARD on the NIRS’s website.
JISCARD（Japanese Internet System for Aviation Rout Doses）

4. How can I find my accumulated dose in the area where I live?

You can calculate it to a certain degree, though it is slightly complex.

First, you can find an amount of radiation received from radioactive substances in the air by adding all the figures announced by the MEXT for a period from the day of the accident to the present. The following is the calculation of the radiation dose in Tokyo mentioned in Question 3.

Example: Calculation of radiation exposure in reference to the announced air doses

The air dose was 0.0927 micro Sv/h on average according to the MEXT's data (for 29 days from March 14 - April 11)

0.0927 x 24 hours x 29 days ＝ 64.5 micro Sv ----- ①

The average air dose in Tokyo in normal times is 0.028-0.079 micro Sv/h, so the median value 0.0535 is used as follows.

0.0535 × 24 hours × 29 days = 37.2 micro Sv ------ ②
①－② ＝ 27.3 ----- ③

If you go out for 8 hours and stay indoors for 16 hours, the reduction coefficient is:

1x 8/24＋0.4×16/24 ＝ 0.6---- ④

The dose of radiation received is:
③ x ④ = 27.3 x 0.6 = 16.38 ≒ 16 micro Sv.

Example: Calculation of exposure dose from radioactive substances occurring in food and water

The exposure dose from radioactive substances in water or food (including potential exposure from radioactive substances ingested into the body) can be estimated by the following formula.

Dose of radiation received (micro Sv) = Effective dose coefficient (the values given in the chart below) x radioactive concentration (Bq/kg) x food intake (kg)

Effective dose coefficients※（micro Sv/Bq）

	Iodine-131	Cesium-137	Cesium-134
New-born baby (3 months)	0.18	0.020	0.026
Infant(Age 1-2)	0.18	0.012	0.016
Child(Age 3-7)	0.10	0.0096	0.013
Adult	0.022	0.013	0.019

※(Oral ingestion; NIRS compiled the data based on "ICRP Database of Dose Coefficients: Workers and Members of the public, CD-ROM, 1998")

Suppose 1kg of water contains 8.59Bq iodine-131, 0.45Bq Cesium-137 and 0.28Bq Cesium-134※. If an adult drinks 1.65 liter of water a day for 29 days, the radiation exposure doses will be:

Iodine-131 : 0.022 x 8.59 x 1.65 x 29 = 9.0 micro Sv.---①
Cesium-137 : 0.013 x 0.45 x 1.65 x 29 = 0.28 micro Sv----②
Cesium-134 : 0.019 x 0.28 x 1.65 x 29 = 0.25 micro Sv----③

Exposure dose ＝ ① ＋ ② ＋ ③ ＝ 9.53＝about 10 micro Sv.
※ The average of the data announced by the Tokyo Metropolitan Government from March 18 to April 11.

The estimate given above in (3) uses values close to the average of the results of radiation tests on distributed foods (11 samples of milk, 241 samples of vegetables and 5 samples of fish) presented by the Ministry of Health from March 19 to April 11. When a total of Cesium isotopes 134 and 137 combined is given, the ratio of the two substances is assumed to be 1 to 1.

Example: Calculation of dose of radiation received from radioactive substances existing in the air

To estimate radiation dose from inhaling radioactive substances in the air, you need a concentration of radioactive substances in the air. Such data, however, are rarely announced. In question (3) mentioned above, the data presented by the Bureau of Labor and Industrial Affairs (http://www.sangyo-rodo.metro.tokyo.jp/) are used to calculate as follows.

Dose of radiation received (micro Sv) = Effective dose coefficient (the values in the chart below) x radioactive concentration (Bq/m^3) x respiratory coefficient (22.2m^3 a day here) x number of days

	Iodine-131	Iodine-132	Cesium-137	Cesium-134

New-born baby (3 months)	0.072	0.0011	0.11	0.070
Infant(Age 1-2)	0.072	0.00096	0.010	0.063
Child(Age 3-7)	0.037	0.00045	0.070	0.041
Adult	0.0074	0.000094	0.039	0.021

※(Oral ingestion of particles (Type F); NIRS compiled the data based on “ICRP Database of Dose Coefficients: Workers and Members of the public, CD-ROM, 1998”)

The highest levels of radioactive concentration in the dust in the air in Tokyo were recorded from 10:00 to 11:00 on March 15; the levels of Iodine-131, Iodine-132, Cesium-137 and Cesium-134 for this one hour were 241, 281, 60 and 64 Bq/m^3, respectively. It is said that the adult inhales an average of 22.2m^3 of air in a day. Thus, the amount of radiation you would potentially receive in the future from the radioactive substances taken in this one hour would be roughly estimated as follows.

Iodine-131: 0.0074 x 241 x 22.2 x 1/24 = 1.05 micro Sv. ---①
Iodine-132: 0.000094 x 281 x 22.2 x 1/24 = 0.0244 micro Sv. ----②
Cesium-137: 0.039 x 60 x 22.2 x 1/24 = 2.16 micro Sv. ----③
Cesium-134: 0.021 x 64 x 22.2 x 1/24 = 1.24 micro Sv. ---- ④

Radiation dose in this hour = ①+②+③+④
= 5.07 micro Sv.

Repeat this calculation for all the hours and add them up. The above question (3) refers to the total of all values recorded from March 14 to April 11. Iodine vapor is not included.

With respect to children’s respiratory coefficients per day, the ICRP suggests (in publication 71) 2.86 m^3/day for a new born baby (3 months), 5.16 m^3/day for an infant (age 1), 8.72 m^3/day for a child (age 5), 15.3 m^3/day for a child (age 10) and 20.1 m^3 for a child (age 15).

You can estimate your accumulated dose, to some extent, by combining the radiation dose by external exposure to your bodies as a result of the accident, the dose from breathing in air containing radioactive substances and the radiation dose from the intake of food or water containing radioactive substances.