

International Recommendations on Safe Levels of Radiation and Radionuclides in Food

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Nuclear Emergency

Hydrogen explosion
Fukushima Nuclear Power
Plant

Fukushima Nuclear
Reactor No.4

Hydrogen explosion at the Fukushima Nuclear Power Plant
<http://awakeningnow2012.com/2011/03/191/>

Current Situation

- Current nuclear leakage in Japan
 - Leakage from a nuclear power plant in Fukushima, Japan after earthquake at 9.0 Richter scale
 - Various radionuclides released from the plant & contaminate agricultural produce, milk product & water sources in prefectures nearby

Contaminated Food Affect Health?

- Consumption of radioactively contaminated foodstuffs:
 - Dosage-dependent effect
 - Prolonged consumption → Long-term effects:
 - Increase cancer risk
 - Potential genetic disorders in offspring



Situation in Hong Kong

- Centre for Food Safety:
 - Step up surveillance on food from Japan
 - Fresh produce (e.g. milk, vegetables & fruits), aquatic products, meat & frozen confections
 - Excessive levels of radionuclides
 - Prohibit imports of food products



Table 1. Number of samples tested for radiation levels for food imported from Japan

表 1. 已進行輻射水平測試的日本進口食物樣本數目

Food type tested 已檢測食品類別	No. of samples examined (from 4 May 12 noon to 5 May 12 noon) 已檢測食品樣本數目 (從 5 月 4 日中午 12 時至 5 月 5 日中午 12 時)	Accumulative no. of samples examined (from 12 March to 5 May 12 noon) 已檢測食品積累樣本總數 (從 3 月 12 日至 5 月 5 日中午 12 時)
<i>Vegetables</i> 蔬菜	3	812
<i>Fruits</i> 水果	0	325
<i>Milk and milk beverage</i> 奶及奶類飲品	0	17
<i>Milk powder</i> 奶粉	0	65
<i>Frozen confections</i> 冰凍甜點	0	58
<i>Aquatic products</i> 水產及其製品	7	995
<i>Meat & products</i> 肉類及其製品	2	101
<i>Drinks</i> 飲品	18	544
<i>Others (eg. cereal products, snacks)</i> 其他(例如穀類產品、小吃)	275	2,226
Total no. of samples tested 已檢測食品樣本總數	305 (All satisfactory) (全部及格)	5,143 (Note 註 1) (3 unsatisfactory) (Note 2) (三個不合格) (註 2)

Situation in Hong Kong

- Unsatisfactory for I-131 (above CODEX standard of 100 Bq/kg): 3 samples imported from Chiba prefecture *spinach (1000 Bq/kg), white radish (260 Bq/kg) and turnip (800 Bq/kg)* on March 23

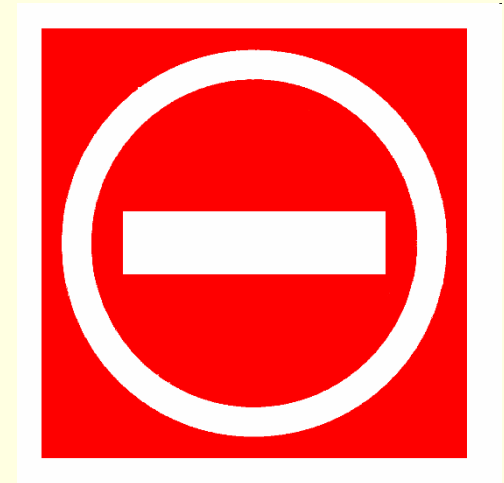


- Remaining samples have satisfactory results with two samples were found to have low radioactivity (below CODEX standard of 100 Bq/kg) *carrot (12 Bq/kg), celery (43 Bq/kg)*



Situation in Hong Kong -- Prohibition of Imports

- Prohibition order announced on 23 March and came into force at noon 24 March
- Food harvested, manufactured, processed or packed on or after March 11 from 5 prefectures in Japan:
 - Fukushima (福島縣)
 - Ibaraki (茨城縣)
 - Tochigi (栃木縣)
 - Gunma (群馬縣)
 - Chiba (千葉縣)



Situation in Hong Kong -- Prohibition of Imports



- Food items include:
 - All fruits and vegetables
 - All milk, milk beverages, dried milk
 - All chilled or frozen game, meat and poultry, poultry eggs, and live, chilled or frozen aquatic products
 - Unless accompanied by a certificate issued by the competent authority of Japan certifying that radiation levels do not exceed CODEX standards

Food Contamination After Nuclear Incident



**Nuclear fission products:
Mainly radioactive iodine-131 (I-131),
caesium-134 (Cs-134)
caesium-137 (Cs-137)
posing health risk**

Monitored by CFS

Significant radionuclides

IODINE \Rightarrow **THYROID GLAND**

CAESIUM \Rightarrow **WHOLE BODY EXPOSURE, SOFT
TISSUES**

History for Codex Guideline

- Guideline levels for radionuclides in foods contaminated following a nuclear or radiological emergency
 - 1st version developed in 1989 after 1986 Chernobyl accident
 - Elaborated by **Codex Committee on Food Additives and Contaminants (CCFAC)**
 - Based on a text by
 - Food and Agriculture Organization (FAO),
 - World Health Organization (WHO) and
 - International Atomic Energy Agency (IAEA)

Standards of Radionuclides in Food

- International and national standards
- Types and levels of radionuclides regulated vary from country to country, from agencies to agencies
- Different assumptions:
 - how long the product will be consumed
 - different thresholds of risk

Standards of Radionuclides in Food--Scope



- Codex Alimentarius Commission
 - Set out **Guideline Levels** for different radionuclides in foods contaminated following a **nuclear or radiological emergency**

Standards of Radionuclides in Food--Scope



- Codex Alimentarius Commission
- Guideline Levels
 - Foods for human consumption and traded internationally
 - Food after reconstitution or as prepared for consumption
 - Not for dried or concentrated foods
 - Based on an intervention exemption level of 1mSv in a year

Standards of Radionuclides in Food--Application



- Codex Alimentarius Commission
 - When radionuclide levels in food do not exceed corresponding guideline levels
 - food should be considered as safe for human consumption
 - Adopted by CFS

Codex Guideline Levels (Codex Standard 193-1995)

Representative Radionuclides	Level in Bq/kg	
	Infant food	Foods other than infant foods
Pu-238, Pu-239, Pu-240, Am-241	1	10
Sr-90, Ru-106, I-129, I-131 , U-235	100	100
S-35, Co-60, Sr-89, Ru-103, Cs-134 , Cs-137 , Ce-144, Ir-192	1000	1000
H-3, C-14, Tc-99	1000	10000

Assuming that a country continues to import foodstuffs from areas contaminated with radionuclides in the first year after major environmental radioactive contamination, the fraction of contaminated food is 0.1.

Multiple Radionuclides in Food

- Codex Guideline Levels:
 - Radionuclides in different groups:
 - No need to add (i.e. each group treated independently)
 - Radionuclides within same group:
 - Need to add
 - E.g. guideline level of 1000 Bq/kg refers to the summed activity of Cs-134 and Cs-137

Comparison of Codex and Japanese standards

- **Codex standards (Guideline Levels)**

- All Food**

- I-131 (100 Bq/kg); Cs-134,137 (1000 Bq/kg)**

- **Japan limit**

- Milk***

- I-131 (300 Bq/kg); Cs-134,137 (200 Bq/kg)**

- Vegetable**

- I-131 (2000 Bq/kg); Cs-134,137 (500 Bq/kg)**


- * Milk for baby formula or for direct drinking to baby:
I-131 (100 Bq/kg)


Summary of Japan Food tested for radioactivity in Japan

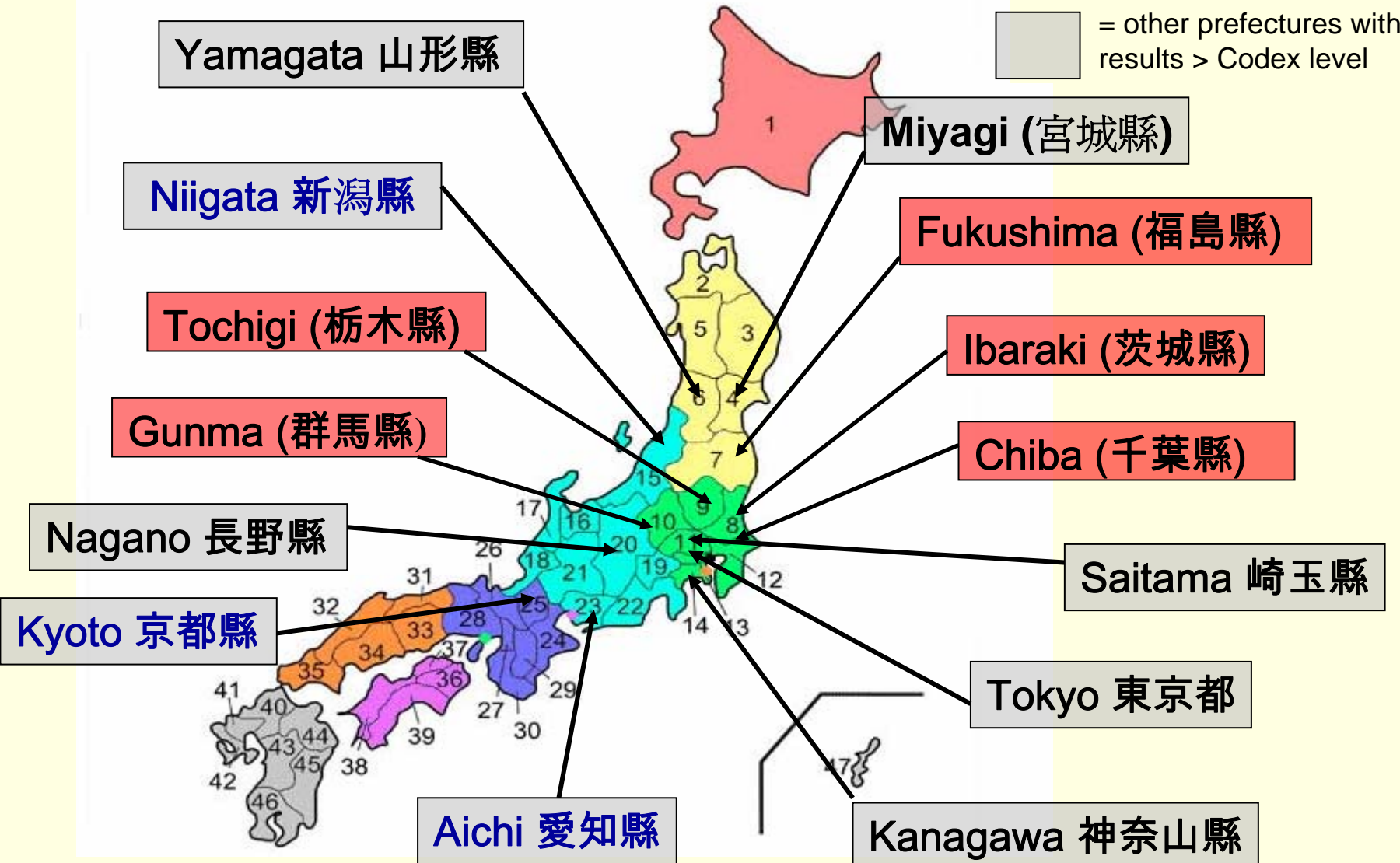
(as at 31 March 2011)

Food	Number of samples tested	<u>Exceeded both Codex & Japan Standard</u>	<u>Exceeded Codex standard but satisfy Japan Standard</u>	<u>Satisfy both Codex & Japan standard</u>
Vegetable	472	103	152	217
Milk	132	23	17	92
Fruits	38	0	1	37
Aquatic products	14	0	0	14
Meat	6	0	0	6
Egg	9	0	0	9
Total	671	126	170	375
%	100%	18.8%	25.3%	55.9%

Prefectures with samples exceeding Codex levels

 = prefectures prohibited by HK

 = other prefectures with results > Codex level



Actions Taken by Other Food Authorities

- A number of countries/ areas (Mainland including Macau, Singapore, South Korea, Taiwan, Australia, New Zealand, EU and USA) have taken action:
 - Increasing surveillance
 - Banning importation of products from some prefectures in Japan etc
- Action taken:
 - Depended on results of tests done locally and information from Japanese authorities
 - Based on their own interpretation of the results and standards that are being used
 - Some countries use standards that are different to those of CODEX

Codex Guideline Level Calculation

- Codex Guideline Levels (GL) were derived using the following formula:

$$GL = IED / (M \times IPF \times e_{ing})$$

Where:

- ***IED*** = Intervention Exemption Level of Dose
- ***M*** = food consumed per year
- ***IPF*** = import/production factor
- ***e_{ing}*** = ingestion dose coefficient (mSv/Bq)

Codex Guideline Level Calculation

- The following assumptions were made in calculating the levels:
 - ***IED*** = Intervention Exemption Level of Dose = 1 mSv/year
 - ***M*** = food consumed per year = 550 kg (adult)
 - ***M*** = food and milk consumed per year = 200 kg (infant)
 - ***IPF*** = import/production factor = 0.1
 - ***e_{ing}*** = ingestion dose coefficient (mSv/Bq)
–consult table

e.g. GL for I-131 in infant foods: ($e_{ing} = 0.00018 \text{ mSv/Bq}$)

$GL = 1 \text{ mSv} / (200 \text{ kg} \times 0.1 \times 0.00018 \text{ mSv/Bq}) = 278 \text{ Bq/kg}$

Rounded down to 100 Bq/kg for extra protection

Dosage Calculation

- Codex Alimentarius Commission:
 - Internal dose received by the PUBLIC
= radionuclide level in food
x annual food consumption
x ingestion dose coefficients
x ratio of import vs production

Radionuclide- & age-
dependent

Amount imported from
contaminated area

Amount produced +
Amount imported

Codex Effective Dosage Calculation

- The mean internal dose of the public, E (mSv), due to annual consumption of imported foods containing radionuclides can be estimated using the following formula:
- $E = GL(A) \cdot M(A) \cdot e_{ing}(A) \cdot IPF$
 - where:
 - $GL(A)$ is the Guideline Level (Bq/kg)
 - $M(A)$ is the age-dependent mass of food consumed per year (kg)
 - $e_{ing}(A)$ is the age-dependent ingestion dose coefficient (mSv/Bq)
 - IPF is the import/production factor (dimensionless)
- Assessment results both for infants and adults demonstrate that for all the twenty radionuclides doses from consumption of imported foods during the 1st year after major radioactive contamination do not exceed 1 mSv.
- E.g. dose assessment for Cs-137 in foods for adults:
 $E = 1000 \text{ Bq/kg} \cdot 550 \text{ kg} \cdot 1.3 \cdot 10^{-5} \text{ mSv/Bq} \cdot 0.1 = 0.7 \text{ mSv}$
(as shown in Table in next slide)

Codex Guideline and Effective Dose

Assessment of Effective Dose for Infants & Adults from Ingestion of Imported Foods/Year

Radionuclide	Guideline Level (Bq/kg)		Effective dose (mSv)	
	Infant foods	Other foods	1 st year after major contamination	
			Infants	Adults
²³⁸ Pu	1	10	0.08	0.1
²³⁹ Pu			0.08	0.1
²⁴⁰ Pu			0.08	0.1
²⁴¹ Am			0.07	0.1
⁹⁰ Sr	100	100	0.5	0.2
¹⁰⁶ Ru			0.2	0.04
¹²⁹ I			0.4	0.6
¹³¹ I			0.4	0.1
²³⁵ U			0.7	0.3
³⁵ S*	1000	1000	0.2	0.04
⁶⁰ Co			1	0.2
⁸⁹ Sr			0.7	0.1
¹⁰³ Ru			0.1	0.04
¹³⁴ Cs			0.5	1
¹³⁷ Cs			0.4	0.7
¹⁴⁴ Ce			1	0.3
¹⁹² Ir			0.3	0.08
³ H**	1000	10000	0.002	0.02
¹⁴ C			0.03	0.3
⁹⁹ Tc			0.2	0.4

Summary of international and national standards (1)

Country/region/organisation	Iodine, I-131 (Bq/kg)	Cesium, Cs-134 (Bq/kg)	Cesium, Cs-137 (Bq/kg)
Codex	100 (both infant & adult food)	1000 (both infant & adult food)	
Japan	Milk*: 300 Vegetable: 2000 * Milk for baby formula or for direct drinking to baby: I-131 is 100 Bq/kg	Milk: 200 Vegetable: 500	
<p>Japan's original limit was 370 (Bq/Kg) as set in 1986 based on the recommendation of International Commission on Radiological Protection (ICRP). Limit has been changed into 2,000 (Bq/Kg) from 17th March 2011</p>			
Mainland	Staple food(糧食): 190 Tubers(薯類): 89 Vegetable & fruit: 160 Meat & aquatic products(肉魚蝦類): 470 Milk: 33	NIL	Staple food(糧食): 260 Tubers(薯類): 90 Vegetables & fruits: 210 Meat & aquatic products(肉魚蝦類): 800 Milk: 330
Singapore	Apply Codex Guideline Levels to radionuclides		
Taiwan	Dairy Products and Infant Foods: 55 Other Foods: 300	Dairy Products and Infant Foods: 370 Other Foods: 370	

Summary of international and national standards (2)

Country/region/ organisation	Iodine, I-131 (Bq/kg)	Cesium, Cs-134 (Bq/kg)	Cesium, Cs-137 (Bq/kg)
EU	Baby foods: 150 Dairy produce: 500 Liquid foodstuffs: 500 Minor food stuffs (such as spice): 20,000 Other foodstuffs except minor foodstuffs: 2,000	All other nuclides of half-life greater than 10 days, notably Cs-134, Cs-137 Baby foods: 400 Dairy produce: 1,000 Other foodstuffs except minor foodstuffs: 1,250 Liquid foodstuffs: 1,000 Minor food stuffs: 12,500	
EU's new limit on 11 April 2011: requiring food imported from Japan to comply with the Japanese limits on radionuclides, more stringent than the limits imposed by EC			
USA	I-131 for food in domestic commerce and food offered for import: 170	Cs- 134 + Cs-137 for food in domestic commerce and food offered for import: 1200	
Canada	Fresh Liquid Milk: 100 Other Commercial Foods and Beverages: 1,000	Cs- 134 + Cs-137 Fresh Liquid Milk: 300 Other Commercial Foods and Beverages: 1,000	

Standards of Radionuclides in Food

- Types and levels of radionuclides covered vary from country to country
 - Specific standards set out for radionuclides
 - For example: Japan, Mainland China, EU, Taiwan, U.S.
 - Use Codex guideline levels as basis for assessment
 - For example: Australia, New Zealand
- Hong Kong
 - currently adopt the Codex standards

Standards of Radionuclides in Food

- National governments may adopt different values for internal use
 - Assumptions concerning food distribution used for Guideline Levels may not apply
 - E.g., in the case of wide-spread radioactive contamination
 - Just like in the Fukushima incidents, different countries have different standards

Radionuclides Tested by Other Food Authorities

- As of now the other national/regional food authorities are testing Japanese food for I-131, Cs-134 and Cs-137.
- Other food authorities include Mainland, EU, USA, Australia, New Zealand, South Korea, Singapore and Taiwan.

Acknowledgement:
Centre for Food Safety

The End
Thank you