Session M10, Paper #359, PSAM14

Risk Analysis of Taiwan Food Import from Japan after the Fukushima Nuclear Accident

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Outline

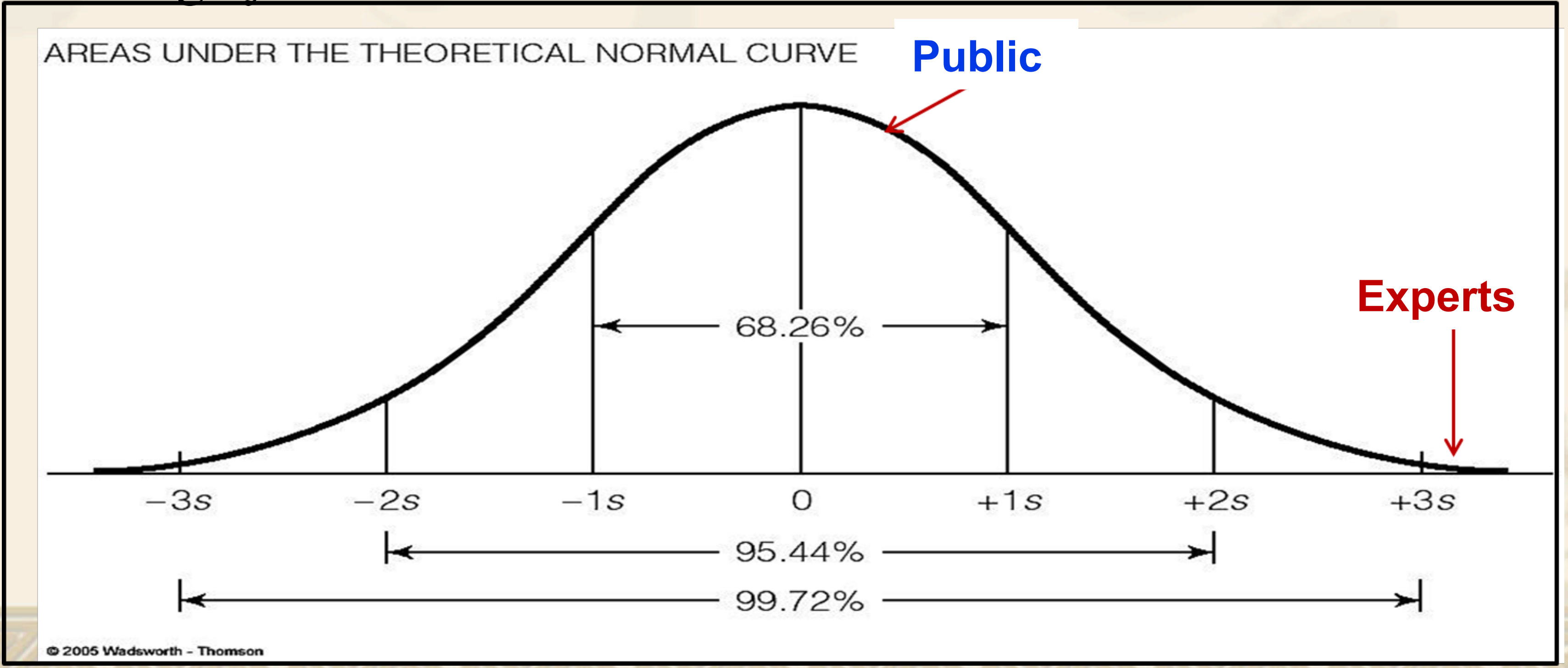
1. Introduction
2. Risk Analysis for Food Safety
3. Probabilistic Risk Assessment and Risk Management of Nuclear Power Plants in Taiwan
4. Risk Communication of Imported Food from Japan after the Fukushima Nuclear Accident
5. Conclusions

1. Introduction

- Globalization has resulted in the spread of infectious diseases, food safety and environmental issues, commodity hazmat and radiation proliferation and other public issues
- Risk Analysis, the fundamental methodology of food safety standards enables modern citizens to enjoy the benefits of technological developments while ensuring autonomy
  - **Risk Assessment: To find the sources of potential hazard, occurrence probability, and its consequence**
  - **Risk Management: The process of weighing policy alternatives according to the results of risk assessment**
  - **Risk Communication: An interactive process of exchange of information and opinion on risk among risk assessors, risk managers, and other stakeholders**
- Risk analysis uses strict scientific methods and procedures, excluding all other non-scientific factors (i.e., politics, ideology) to ensure the greatest credibility, presenting itself as the basis for decision-making in modern countries

1. Introduction (Cont.1)

- In US and Europe, professional questions are handled by experts, yet in Taiwan, everyone wants to participate
- Public opinion has roughly the same capacity as Normal Distribution, so naïve opinions take up the majority
- How can we change the basis of decision-making under the voting system which each vote as the same value?



1. Introduction (Cont.2)

- Since lack of trust is a major issue in Taiwan, effective communication is essential. Especially, informal pre-policy public interaction is key

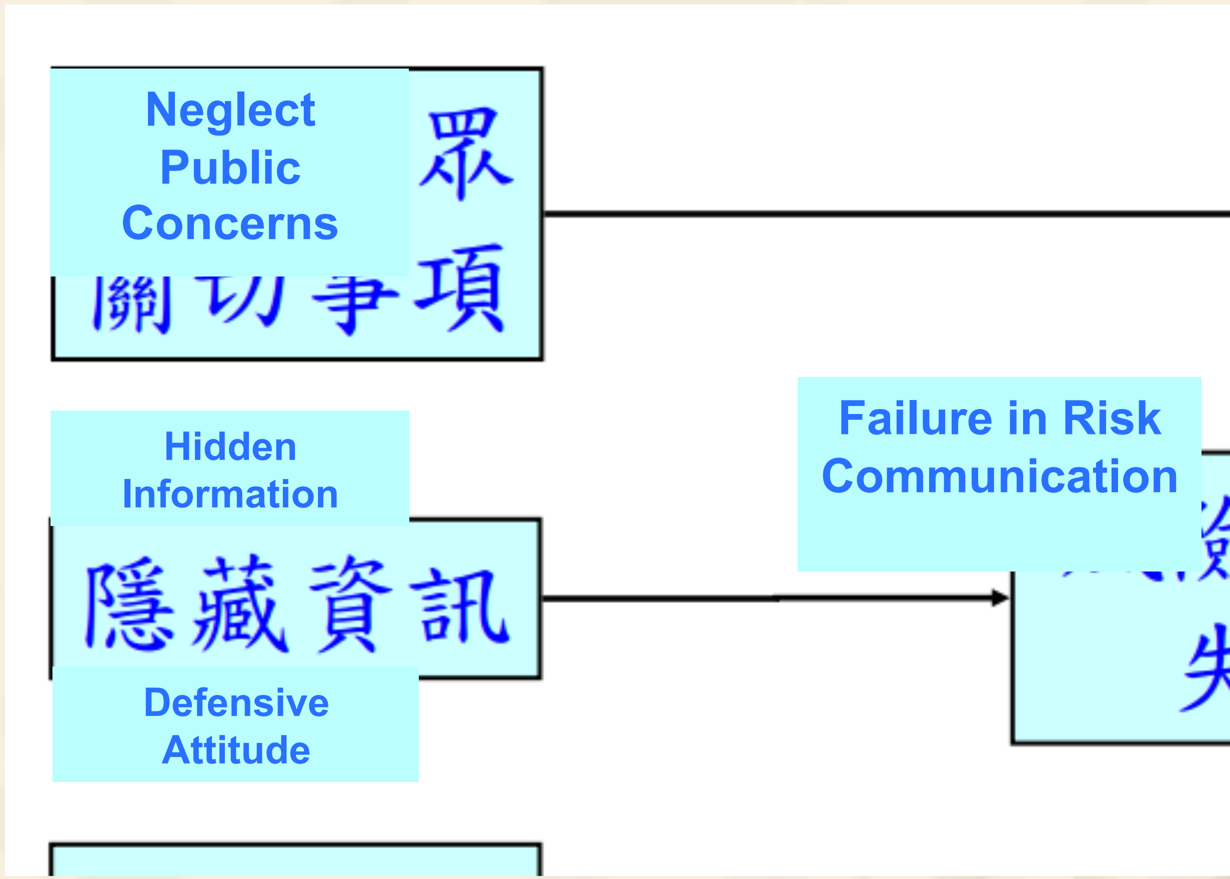
- How to enable the people with foresight and expert opinions to help the public make the right choices will be of great help to the quality of democratic decision-making

2. Risk Analysis

- **Objective expert assessment of the scientific risk**
  - –Technical rational measurement
  - – Based on statistical hard facts
  - – Risk = probability x consequence
- **Subjective public perception towards risk**
  - – Impact of risk on family and related communities
  - – Is it a risk of voluntary choice?
  - – The level of trust in government officials
  - – Emotional reaction towards the decision making process

2. Risk Communication with the Public

2. Effective Risk Communication



2. Public Understanding of Risk

- **Risk is not only probability** x **consequence**
- **Inseparable from cultural and psychological aspects**
- **Misinformed public opinion that high-tech equals high risk**
- **Fatality rate assessment is often more heartfelt than probability**
- **Lack of trust in government officials**
- **Prefer advice rather than being told what to do**

2. Relationship of Risk and Safety

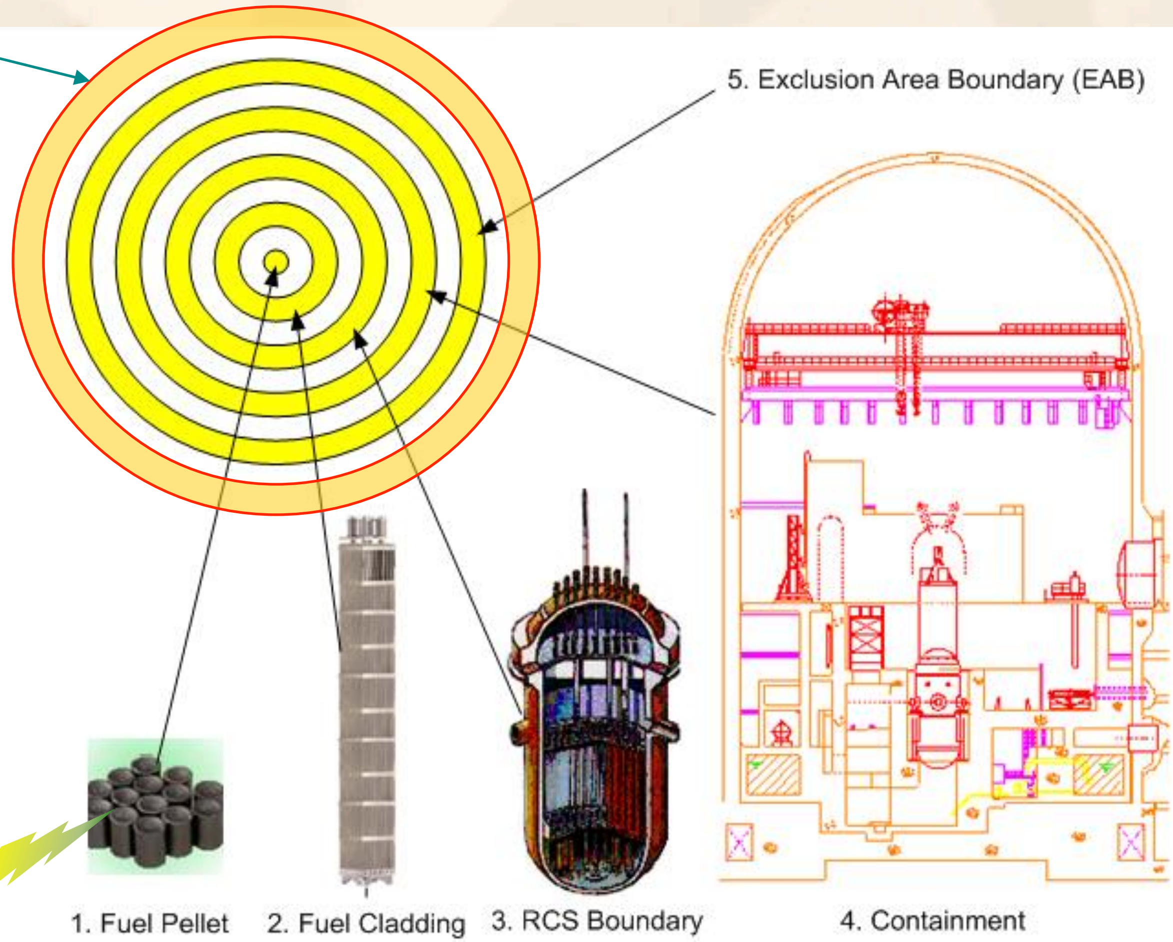
- German Philosopher Ulrich Beck introduced the "Risk Society" doctrine in 1986, pointing out that despite increased human welfare due to globalization and capitalism, the corresponding risk has also heightened. That is, mankind has entered a new era that requires co-existence with risk and potential disasters
- Risk and safety appear to be polar opposites, yet they are in fact interconnected and dependent. In reality, there is nothing that guarantees 100% safety, the best we do is reduce the risk
- "Safety" indicates comprehensive and effective pre-risk management, and the use of resources according to the risk proportions to decrease risk

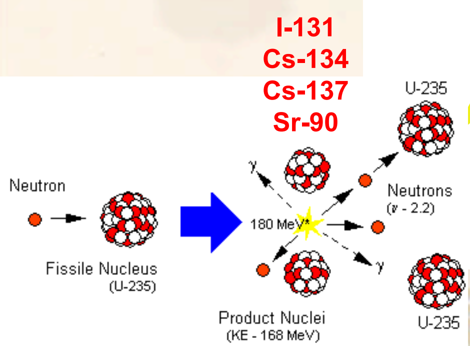
2. Relationship of Risk and Safety (Cont. 1)

- WHO indicates food safety is to prevent food from harming the health of consumers, including all chronic and acute hazards
- Consumers often demand "zero risk" for food safety. This is even more so due to improvement in food safety testing technology. As a result, more and more accurate testing equipment is constantly available, and laboratories can test relevant chemicals from food products. However, once consumers realize there is some amount of harm, regardless of the level, will feel uneasy
- The cost and practical feasibility of maintaining "zero risk" should be taken into account. How safe is safe enough?
- The myth of half-life and biological half-life (pharmacokinetic half-life) (Cesium 137 has a half-life in the environment of about 30 years, but in the human body it reduces radiation intensity as soon as 70 days)

3. Defense in Depth in Nuclear Power Plants Design

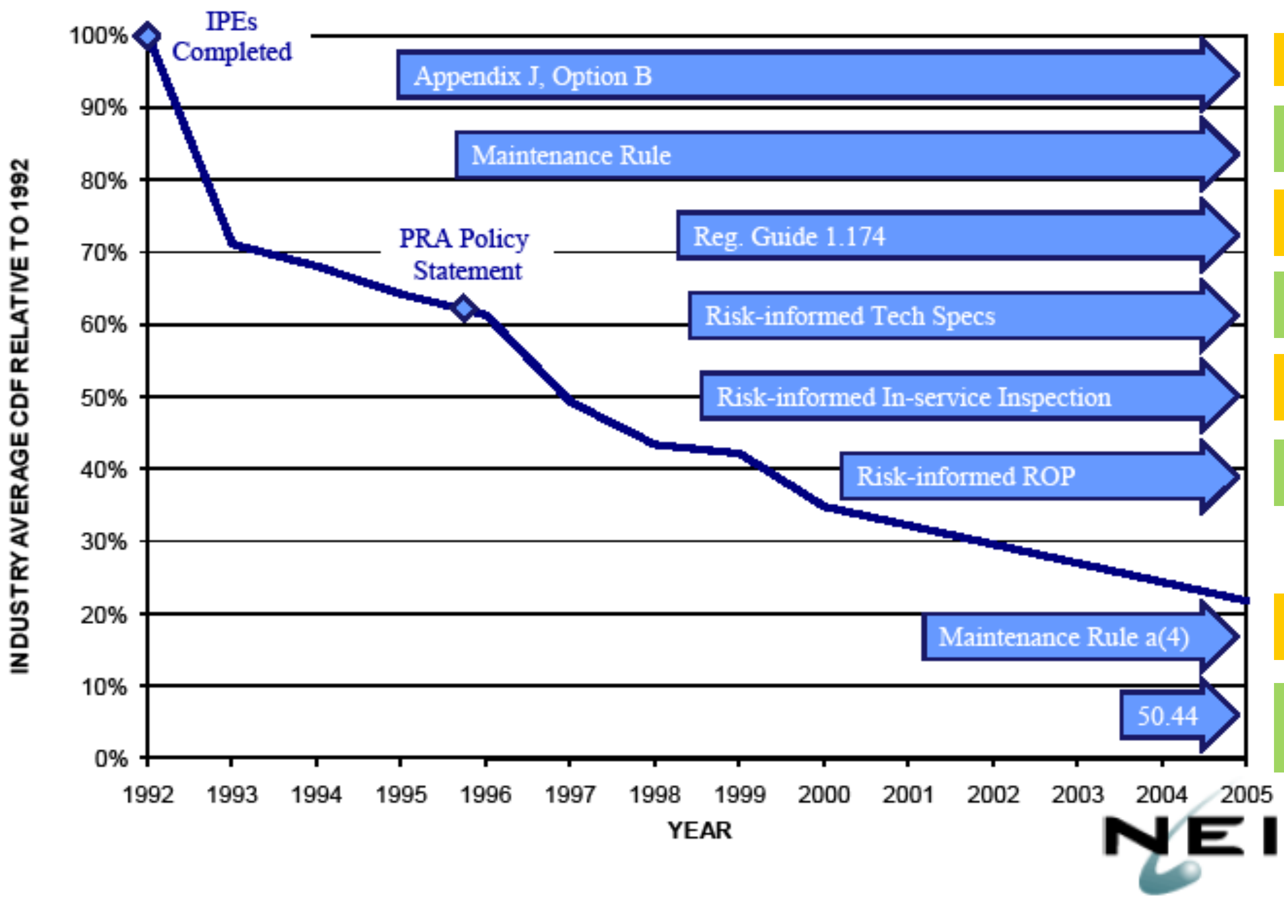
6. Emergency Plan





Physical barriers between reactor core and the environment

3. Reducing Nuclear Risk through Risk Management of Nuclear Regulation



CTMT Leak Rate Test

MR

RIR

RI-TS

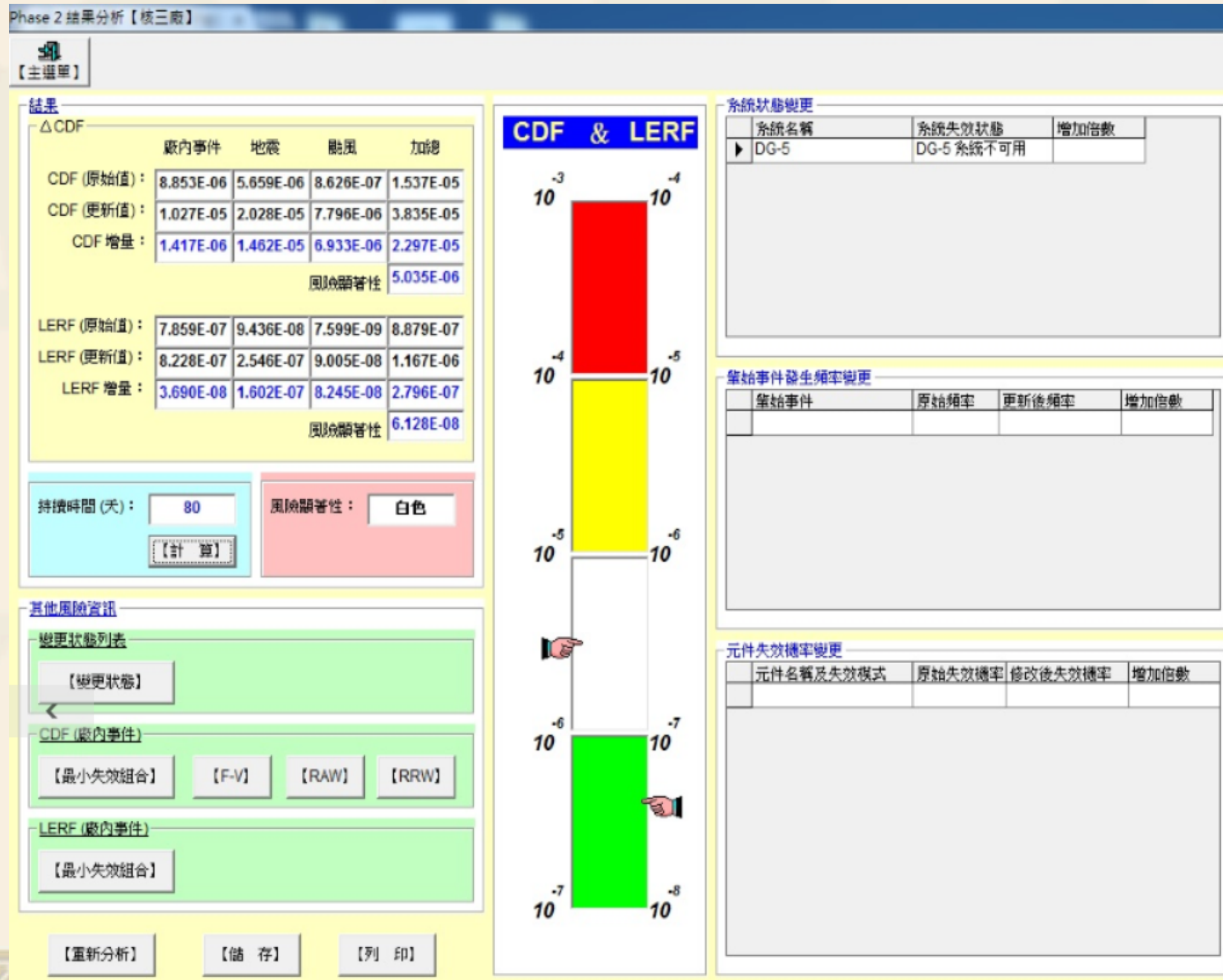
RI-ISI

RI-ROP

MR Risk

Combustible Gas Control

3、Development of the Risk-Informed Regulatory Tools for Site Resident Inspectors of Taiwan's NPPs



3. Risk Perception

- **Risk Perception is not equal to Risk Assessment**
- **The general public vs experts have different perceptions towards risk**
  - **Subjective factors in assessing risk**
  - **"Voluntary risk" is more tolerable than " Non-Voluntary risk"**
  - **General public expect a zero-risk society**

Ratio of persons who fear the foods from Fukushima (Questionnaire by Univ. Tokyo & Fukushima Univ. in 2017)	
Taiwan	81.0 %
Korea	69.3 %
China	66.3 %
Russia	56.0%
Germany	55.7%
Singapore	52.7%
France	39.7%
U.S.A	35.7%
Japan	30.3%
UK	29.3%

3、Ordering of Perceived Risk

(Paul Slovic, "The Perception of Risk", *Science* 236: 280-285, 1988)

Activities	League of Women Voters	Colleague students	Expert
Nuclear Power	1	1	20
Motor Vehicles	2	5	1
Handguns	3	2	4
Smoking	4	3	2
Motorcycles	5	6	7
Alcoholic beverages	6	7	3
Private aviation	7	15	12
Police work	8	8	17
Pesticides	9	4	8
Surgery	10	11	5
Fire Fighting	11	10	18
Bicycles	16	24	14
Swimming	19	30	10
Skiing	21	26	30
Vaccinations	30	29	25

1. There are significant gaps between general versus expert opinions

2. It is important to present communicate this gap with the intent to help the general public realize the mismatch

3. Only through constant communication and public education can the gap be closed.

4. Risk Communication of Imported Food from Japan after the Fukushima Nuclear Accident

- The EU introduced the General Food Law Regulation No. 178 in 2002 to establish a set of risk analysis-centered food safety control mechanisms and scientifically based "risk assessment”
- The United States established a similar mechanism on January 4, 2011, President Obama signed off the Food Safety Modernization Act (FSMA)
- On December 10, 2014, Taiwan’s Food Safety and Sanitation Management Law amendment "Food Safety Risk Management" Article 4 state that food safety management measures should be based on risk assessment

4. Radiation Detection Approach for Imported Food from Japan

- INER and RMC's radiation detection methods are all certified by the Taiwan Accreditation Foundation (TAF), which are the same as those used in EU and Japan
- Radionuclide species with half-life of more than 1 year (such as: Cs-134, Cs-137, Sr-90, Ru-106 and the like) has been revised into account. The Japanese limits is given for Cs including contribution of Sr-90, Ru-106, Pu (their contribution is only 12% of the sum of effective dose and the sum of effective dose does not exceed 1mSv/year), so that only the detection of gamma (γ) nuclear species (such as cesium-134 and cesium-137) is necessary
- According to the EU Regulation, the amount released to the environment by Sr, sodium and potassium is very limited according to the accident status of the Japanese power plant, Therefore, it is not necessary to control or carry out special tests on Japanese food such as Sr and Pu , and only the detection of gamma (γ) nuclear species (such as Cs-134 and Cs-137)

4. TAF Certification of INER Lab.

證書編號：L0604-170616

財團法人全國認證基金會
Taiwan Accreditation Foundation

認 證 證 書

茲證明

行政院原子能委員會核能研究所
環境試樣放射性核種分析實驗室

桃園市龍潭區佳安里文化路 1000 號

為本會認證之實驗室

認 證 依 據 ： ISO/IEC 17025：2005
認 證 編 號 ： 0604
初 次 認 證 日 期 ： 八十九年五月十五日
認 證 有 效 期 間 ： 一百零四年六月二十二日至一百零七年六月二十一日止
認 證 範 圍 ： 測試領域，如續頁

董事長
王聰麟

中華民國一百零六年六月十六日

本認證證書與續頁分開使用無效　　第 1 頁，共 10 頁

證書編號：L0604-170616

財團法人全國認證基金會
Taiwan Accreditation Foundation

認 證 編 號 ：0604
實驗室主管 ：武及蘭

◤ 09. 99　食品
食品
I001　加馬核種分析
「105 年 5 月 19 日部授食字第 1051900834 號公告訂定，食品中放射性核種之檢驗方法(MOHWO0015.00)」文件編號: EMRAL-EO-020
碘-131: (1 to 37000)　Bq/kg
銫-134: (1 to 37000)　Bq/kg
銫-137: (1 to 37000)　Bq/kg

報告簽署人:王正忠; 李綉偉; 武及蘭

◤ 13. 08　環境保護
土壤試樣
I001　加馬核種分析
自訂之測試程序
(文件編號:EMRAL-EO-011, EMRAL-EO-001)
(3.0 to 37000) Bq/kg Dry (Mn-54)
(6.0 to 37000) Bq/kg Dry (Fe-59)
(3.0 to 37000) Bq/kg Dry (Co-58)
(3.0 to 37000) Bq/kg Dry (Co-60)
(7.0 to 37000) Bq/kg Dry (Zn-65)
(6.0 to 15000) Bq/kg Dry (Zr-95)
(6.0 to 15000) Bq/kg Dry (Nb-95)
(3.0 to 37000) Bq/kg Dry (Cs-134)
(3.0 to 37000) Bq/kg Dry (Cs-137)
(10.0 to 50000) Bq/kg Dry (Ba-140)
(10.0 to 20000) Bq/kg Dry (La-140)
(3.0 to 37000) Bq/kg Dry (I-131)
(3.0 to 37000) Bq/kg Dry (鈾系)(Bi-214)
(3.0 to 37000) Bq/kg Dry (釷系)(Ac-228)
(3.0 to 37000) Bq/kg Dry (K-40)

報告簽署人:王正忠; 李綉偉; 武及蘭

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4. IAEA Evaluation Results for INER Lab. in Year of 2016

Individual Evaluation Report

for the World-Wide Open Proficiency Test IAEA-TEL-2016-03

Individual Evaluation Report
for
Laboratory Nr. 236

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Evaluation Tables for Labcode 236.

Evaluation Result Table for Sample 1

Sample Code	Analyte	Target Value	Target Unc.	MARB	Rep. Value	Rep. Unc	Rel. Bias	Robust SD	Z-Score	U-Test	Accuracy	P	Precision	Final Score
1	Cs-134	19.9	0.6	15 %	21.6	1.9	8.54 %	1	1.70	0.85	A	9.30	A	A
1	Cs-137	39.6	1	15 %	41.8	3.8	5.56 %	1.5	1.47	0.56	A	9.44	A	A
1	Na-22	53.2	1.5	15 %	53.7	4.6	0.94 %	3.5	0.14	0.10	A	9.02	A	A
1	Sr-90	14.7	0.5	15 %	14.1	1.3	-4.08 %	1.6	-0.38	-0.43	A	9.83	A	A

Evaluation Result Table for Sample 2

Sample Code	Analyte	Target Value	Target Unc.	MARB	Rep. Value	Rep. Unc	Rel. Bias	Robust SD	Z-Score	U-Test	Accuracy		Precision	Final Score
2	Am-241	26.7	0.7	15 %	27.8	2.7	4.12 %	1.9	0.58	0.39	A	0.06	A	A
2	Sr-89	373	15	30 %	350	33.3	-6.17 %	72	-0.32	-0.63	A	0.33	A	A
2	Sr-90	20.5	0.5	20 %	20.2	1.8	-1.46 %	3.1	-0.10	-0.16	A	.24	A	A

Evaluation Result Table for Sample 4

Sample Code	Analyte	Target Value	Target Unc.	MARB	Rep. Value	Rep. Unc	Rel. Bias	Robust SD	Z-Score	U-Test	Accuracy		Precision	Final Score
4	Cs-137	209	11	20 %	208	20.4	-0.48 %	17	-0.06	-0.04	A	1.13	A	A
4	Sr-90	17	2	30 %	18.4	2.2	8.24 %	4.2	0.33	0.47	A	6.77	A	A

4. Food Inspection Equipment of EMRAL

Pure germanium gamma spectroscopy system—HPGe

Food Inspection

INER's EMRAL participated " Environmental samples irradiative nuclide analysis and their comparison" in 2015. EMRAL obtained the same measured data as those of JCAC and RMC.

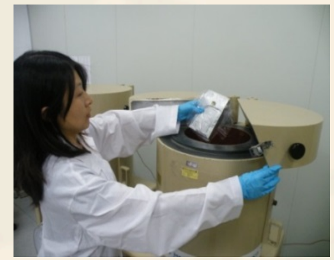
EMRAL (Environmental Media Radioanalytical Lab., INER, Taiwan)
JCAC (Japan Chemical Analysis Center)
RMC (Radiation Monitoring Center, AEC, Taiwan)

4. Food Inspection Procedure of Gamma Radioactive Nuclide

Phase I Screening Procedure (10 Bq/kg)

1. Put sample in a bag

2. Weighting it



3. Put it into Detector for 1000sec counting

Once Finding I-131、Cs-134 and Cs-137 Radioactive Nuclide, Performing Phase II works

Phase II Quantification Analysis (1 Bq/kg)

4. Open the bag of Sample and Smash it, put it into Marin Cup and weighting it

5. Put it into Detector for 6000sec. counting

4、Case Study of Risk Communication

- **(The myth of Zero detection) To control the risk of concerns should be reasonable to reduce detection value, but also take into account the practical aspects. For example, the instrument needs to measure the time is too long, it will affect the freshness of imported dairy products, seafood and other food. Required detection time of 100Bq/kg needs around 300sec, 10Bq/kg needs 1,000sec, and 1Bq/kg needs 6,000sec. Considering background radiation factors, the measurement uncertainties below 0.1Bq/kg will become larger and reliability of the measured data will be reduced**
- **Without overdemanding low detection value can relocate regulatory resources to inspect items and scopes of general food safety and to better ensure overall food safety**
- **If our country still has to adopt more stringent standards, we must put forward relevant scientific evidence for proof of necessity, otherwise exposes us to potential hidden dangers that countries under regulation may complain to the WTO at any time**

4. Limitation Value of Radioactive Nuclei for different Countries

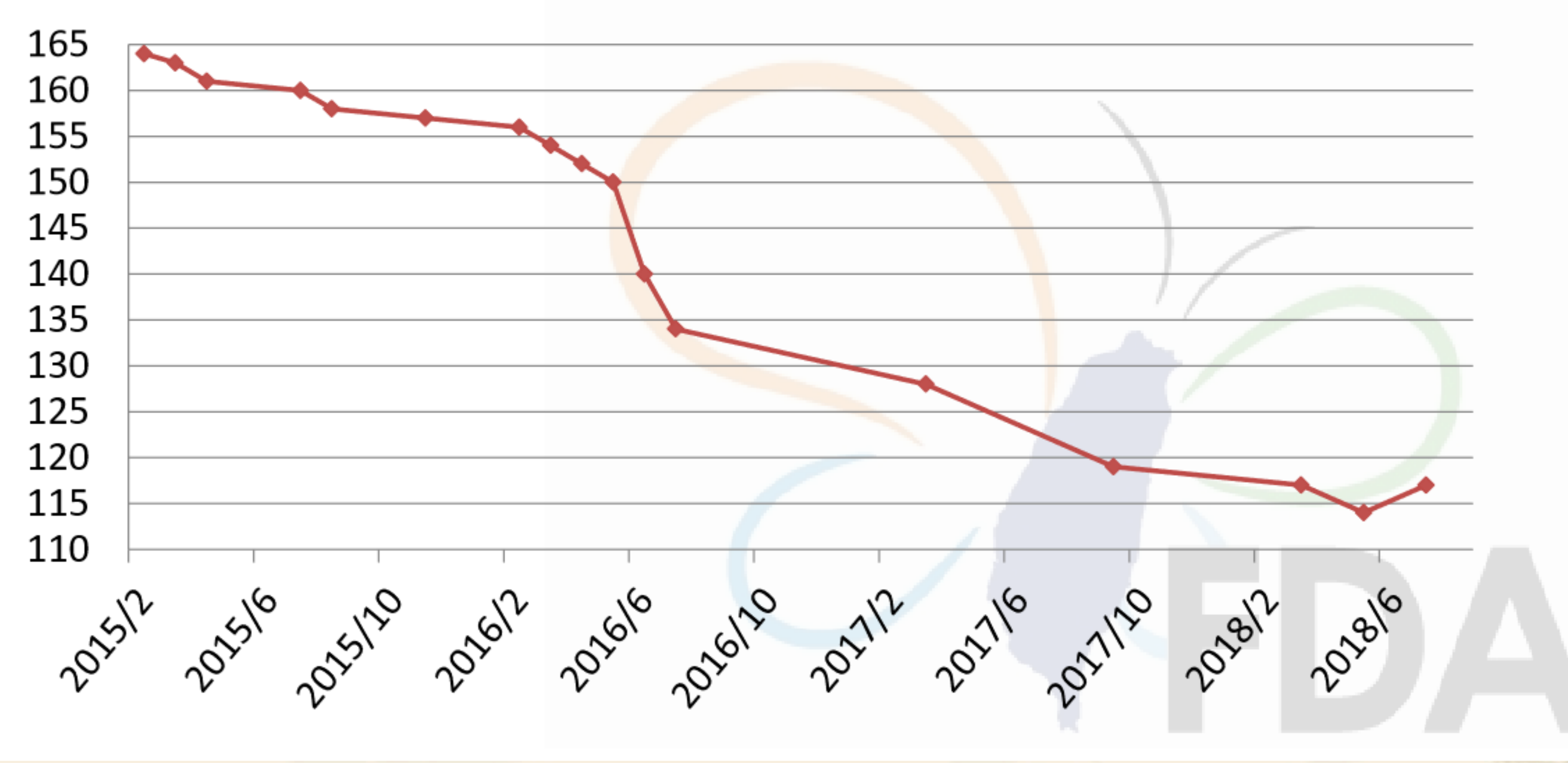
Nuclei	Food	Taiwan	CODEX (#)	Canada	EU	USA	Singapore/ Hong Kong	Japan
I-131	Milk	55	–	100	500	–	–	–
	Infant Food	55	100	–	–	–	100	–
	Other Food	100	100	1000	2000	170	100	–
Cs-134 +Cs-137	Milk	50	–	300	370	–	–	50
	Infant Food	50	1000	–	–	–	1000	50
	Other Food	100	1000	1000	600	1200	1000	100

At present, only the detection of Cs-134, Cs-137 and I-131, and detection of Sr-90 are not allowed in food radiation tests. Cs limit set at 100 Bq / kg has taken into account the factors affecting human health, thus it does not need parallel analysis of other nuclear species

 # CODEX: Codex Alimentarius Commission, CAC

4. Case Study

In August 2018, the United States controls a total of 119 items of Japanese food (U.S. FDA Import Alert 99-33)



5. Conclusions

- Risk decision-making should not be passive, nor should it just be relief after the fact of a disaster. If we can analyze the possible causes and trajectory of risk, we can find ways to prevent them beforehand.
- In the long term, risk analysis can promote the overall public awareness towards risk
- Risk analysis can construct a mechanism which meets both scientific standards and communication of risk control

5. Conclusions (Cont.)

- The general public often has unnecessary fear towards unidentified affairs, yet scientific methods provides a means to deal with this problem. Risk Analysis is an important and accurate tool for the formation of public policies in modernized countries

- We strive for food safety policy to be in keeping with scientific methods while balancing the interests of all parties. However, the final choice is still in the hands of the people

Thank You for Your Attention