



行政院原子能委員會  
Atomic Energy Council

# Radiation Protection in Taiwan

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AEC, TAIWAN  
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# Outline

## ■ Background

- Department of Radiation Protection
- Radioactive Sources in Taiwan

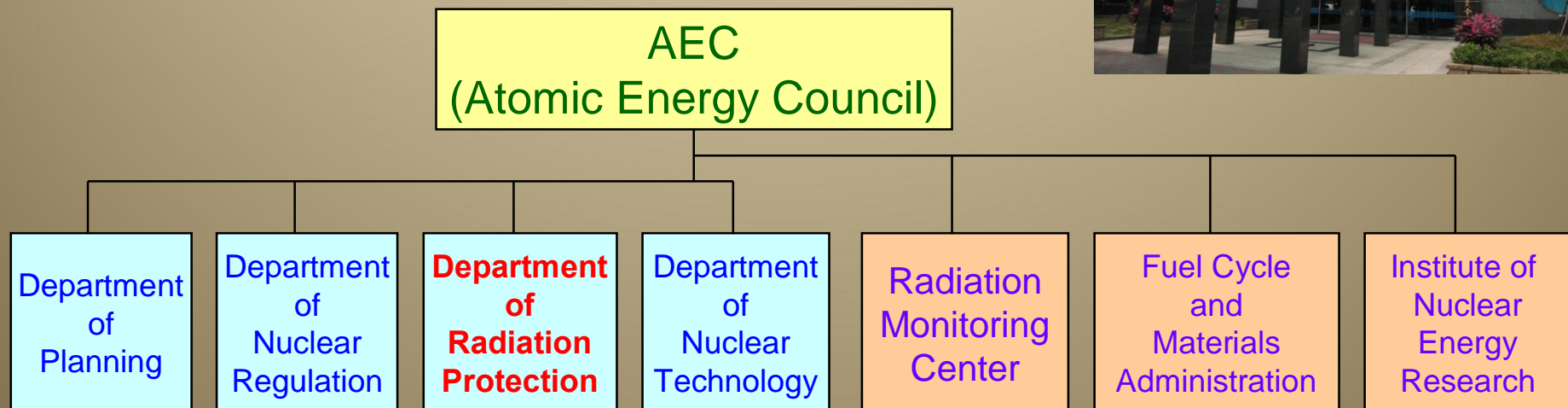
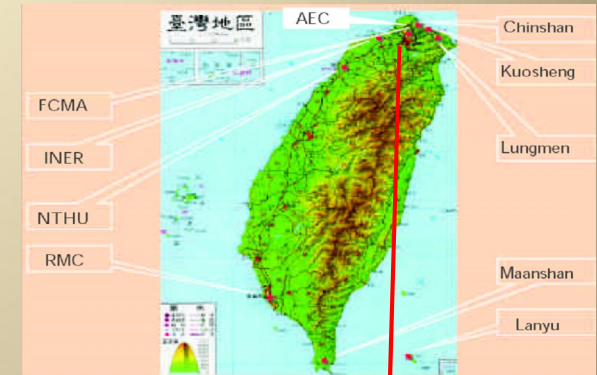
## ■ Highlights

- Regulation of radiation workers and radiation management
- Audit and Control of High Risk Radioactive Sources
- Computerized Monitoring
- Establishment of radioactivity detection system
- Medical Exposure Quality Assurance Program
- Re-evaluation of Nuclear Safety and Radiation Protection System



# Department of Radiation Protection (DRP)

- “ responsible for protection against ionizing radiation arising from working places of nuclear facilities, medical and non-medical institutions.
- “ to protect workers, the general public, **patients** and the environment.
- “ to issue licenses, and inspect nuclear installations and activities related to radiation.





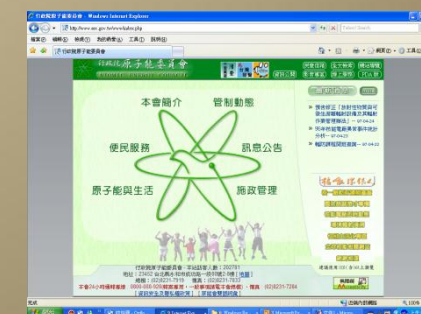
**AEC**

**DRP**  
**(Department of**  
**Radiation Protection)**

**INER**  
**(Institute of Nuclear**  
**Energy Research)**

<b>1st Section</b>	<b>Rules and Regulations</b>
<b>2nd Section</b>	<b>Nuclear Facilities and Environmental Monitoring</b>
<b>3rd Section</b>	<b>Industrial Radiographers</b>
<b>4th Section</b>	<b>Hospitals</b>
<b>5th Section</b>	<b>Non-Hospital Facilities</b>

Support of inspection,  
collection and receiving  
of radioactive materials  
for centralized storage



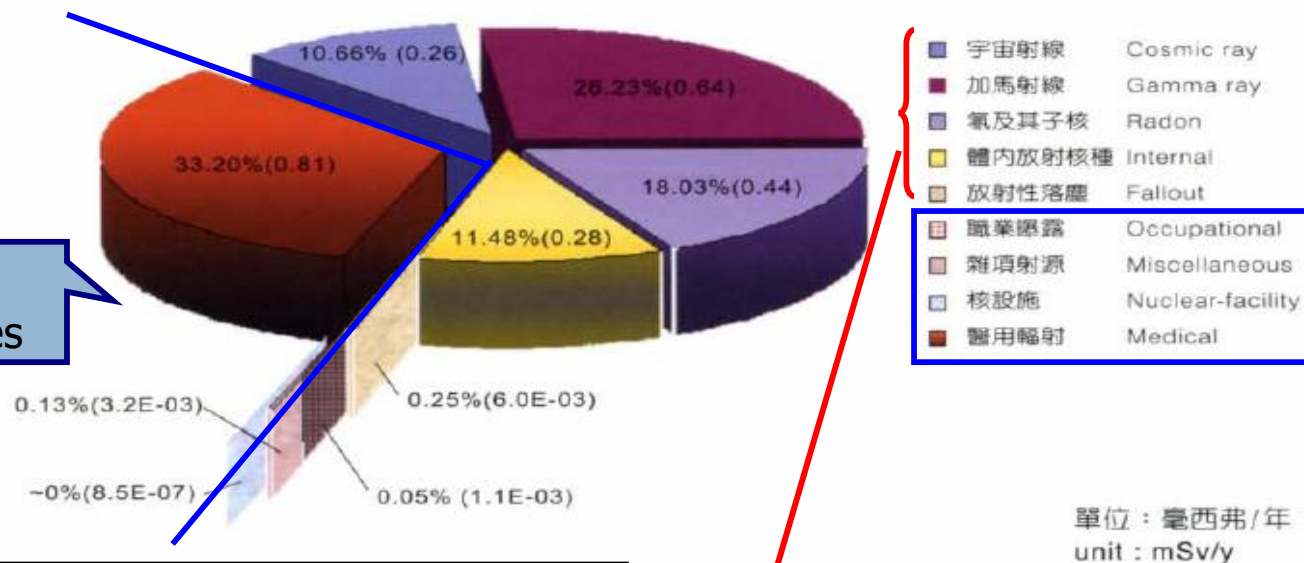
[WWW.AEC.GOV.TW](http://WWW.AEC.GOV.TW)





# Effective Dose per Individual in Taiwan

man-made  
radiation sources



單位：毫西弗/年

類 別	UNSCEAR	美國	英國	日本	臺灣
體外輻射					
宇宙輻射	0.36	0.28	0.25	0.38	0.26
地表及建物	0.41	0.28	0.35	0.29	0.64
小計	0.77	0.56	0.60	0.67	0.90
體內輻射					
氡等	1.26	2.0	1.30	0.41	0.44
鉀40等	0.36	0.39	0.30	0.40	0.28
小計	1.62	2.39	1.6	0.81	0.72
合 計	2.4	3.0	2.2	1.48	1.62

UNSCEAR：聯合國原子輻射效應科學委員會

Individual Dose in Taiwan  
avg. 2.44 mSv/y

Individual Annual Dose from  
Natural Radiation



# Nuclear Power Plants in Taiwan

**Nuclear Installed Capacity**  
**5,144 MWe**  
**Electricity generation 19%**

## Chinshan Nuclear Power Plant (1st)

GE BWR-4

636 MWe x 2

Commercial Operation Date

# 1 Dec. 1978

# 2 July 1979

**Chinshan**

**Kuosheng**

## Kuosheng Nuclear Power Plant (2nd)

GE BWR-6

985 MWe x 2

Commercial Operation Date

# 1 Dec. 1981

#2 Mar. 1983

**Lungmen**

## Lungmen Nuclear Power Plant (4th)

GE ABWR 1350 MWe x2

90.5% complete

## Maanshan Nuclear Power Plant (3rd)

WH PWR

951 MWe x 2

Commercial Operation Date

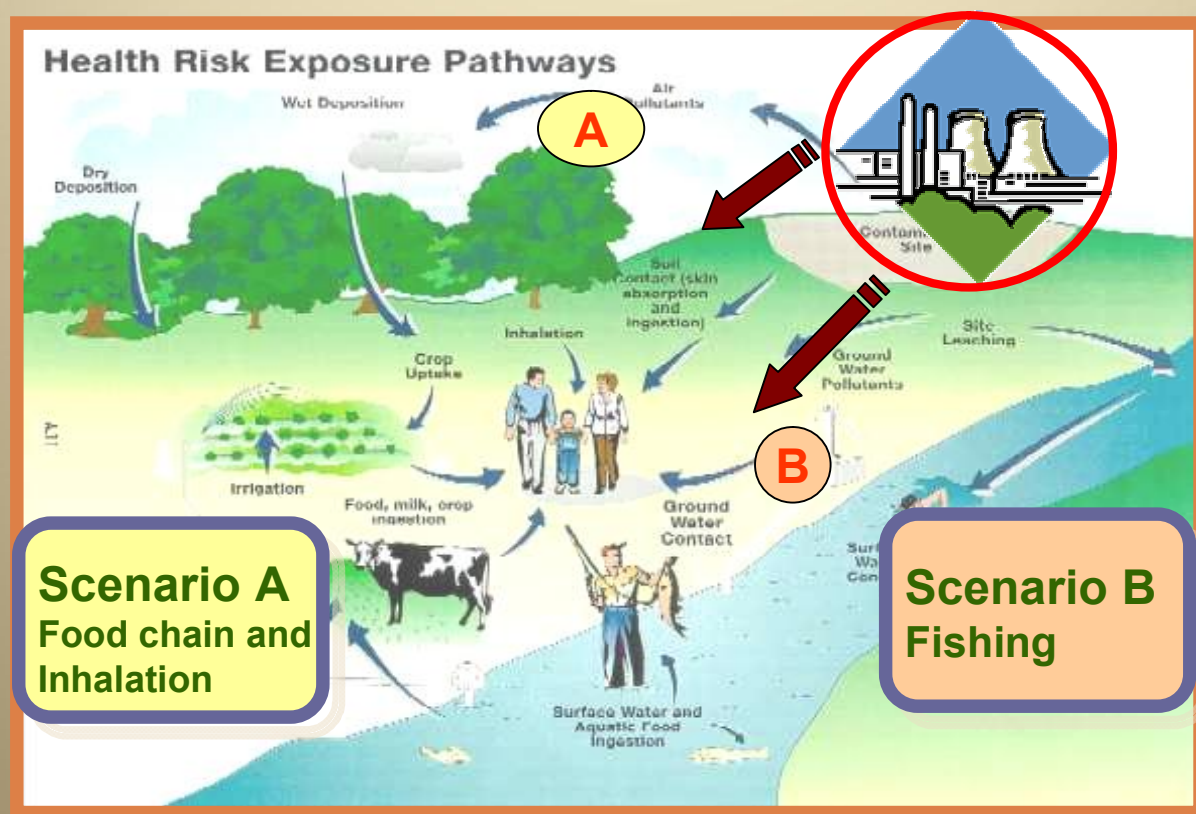
# 1 July 1984

#2 May 1985

**Maanshan**



# Monitoring Public Exposure





放射治療

100Sv

Medical

醫療輻射範圍

Natural

15mSv

天然輻射範圍

1.6mSv

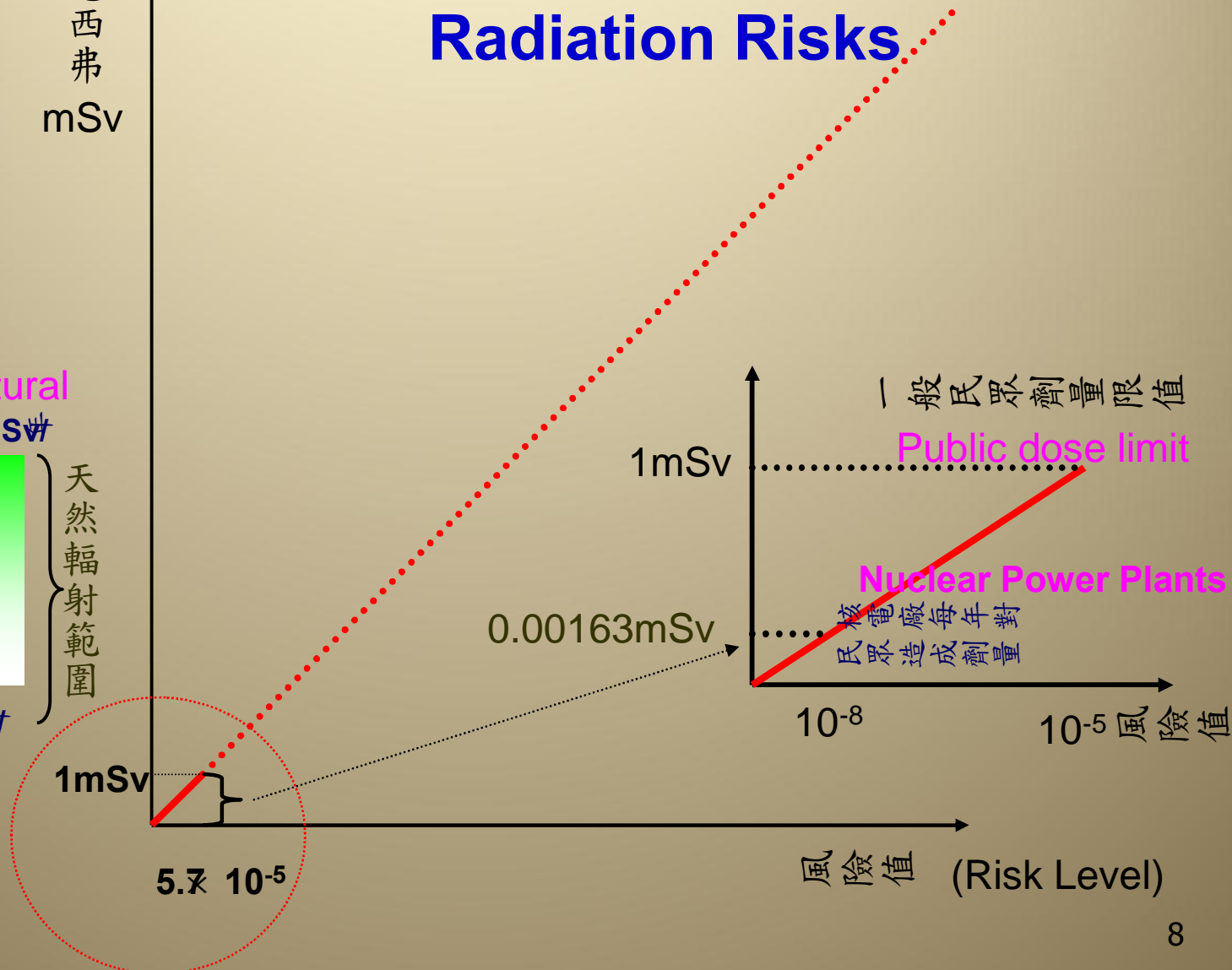
牙科光

0.005mSv

毫西弗  
mSv

# 微量人為輻射劑量風險圖

## Radiation Risks





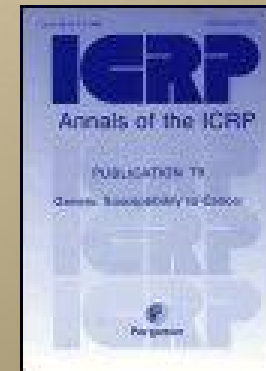
## Regulation of Users and Workers

	TYPE	Numbers (data collected on 2013.01.22)		
		TOTAL	MEDICAL	NON-MEDICAL
MATERIAL LICENSE	PERMIT	571	136	435
	REGISTERED	3,436	282	3,154
EQUIPMENT LICENSE	PERMIT	536	176	360
	REGISTERED	24,385	17,699	6,686
RADIATION WORKERS		46,546		



# **Ionizing Radiation Protection Act**

- Effective on Feb. 2003
- In compliance with ICRP-60 IAEA-115 report







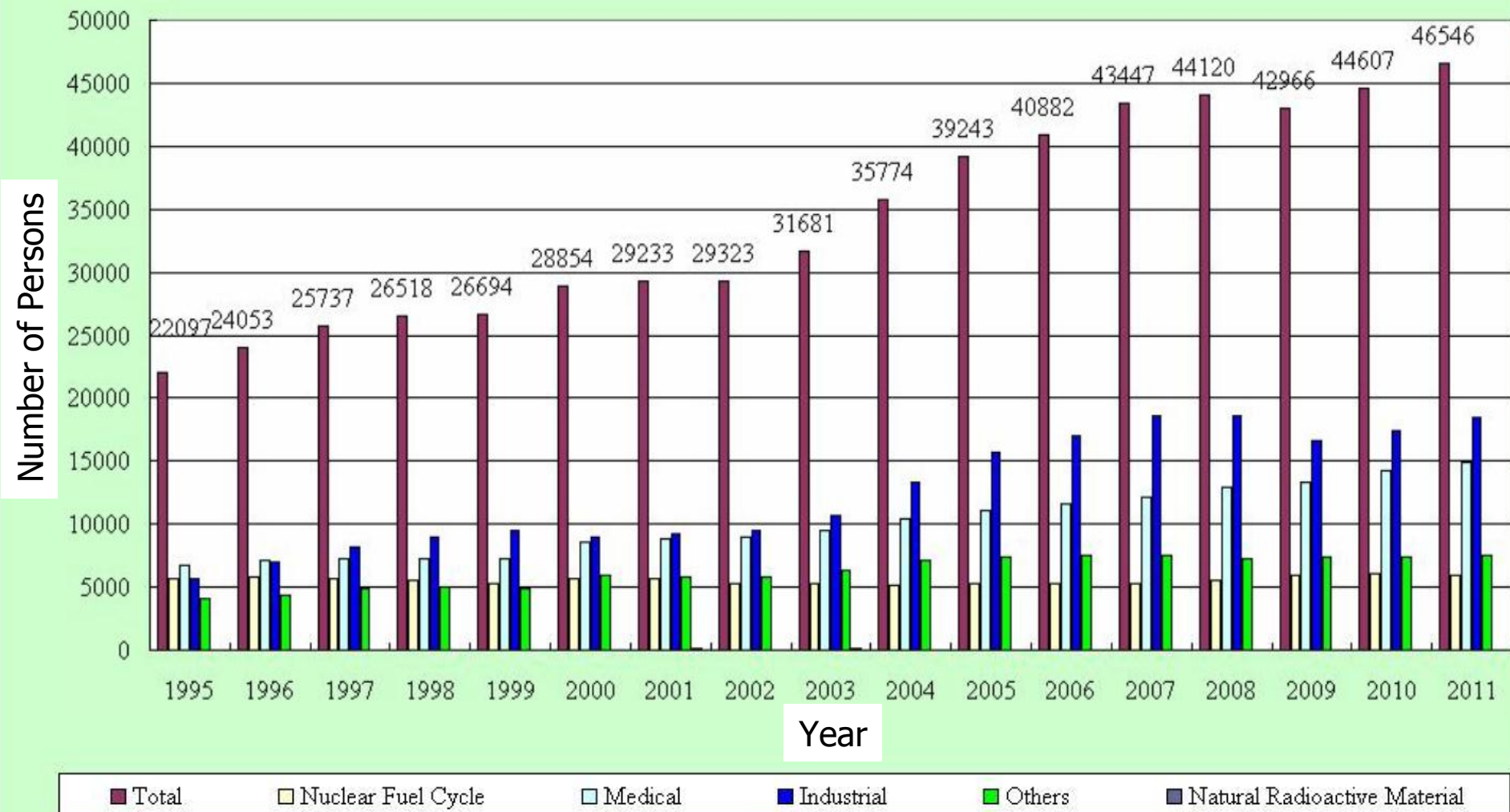
# Radiation Protection Regulations

- **Ionizing Radiation Protection Act**
- **Enforcement Rules for the Ionizing Radiation Protection Act**
- **Safety Standards for Protection against Ionizing Radiation**
- **Administrative Regulations for Radioactive Material and Equipment Capable of Producing Ionizing Radiation and Associated Practice**
- **Standards for Medical Exposure Quality Assurance**
- **Administrative Regulations on Establishment of Medical Exposure Quality Assurance Teams and Assignment of Specialists and Commissioning of Jobs to Relevant Organizations**



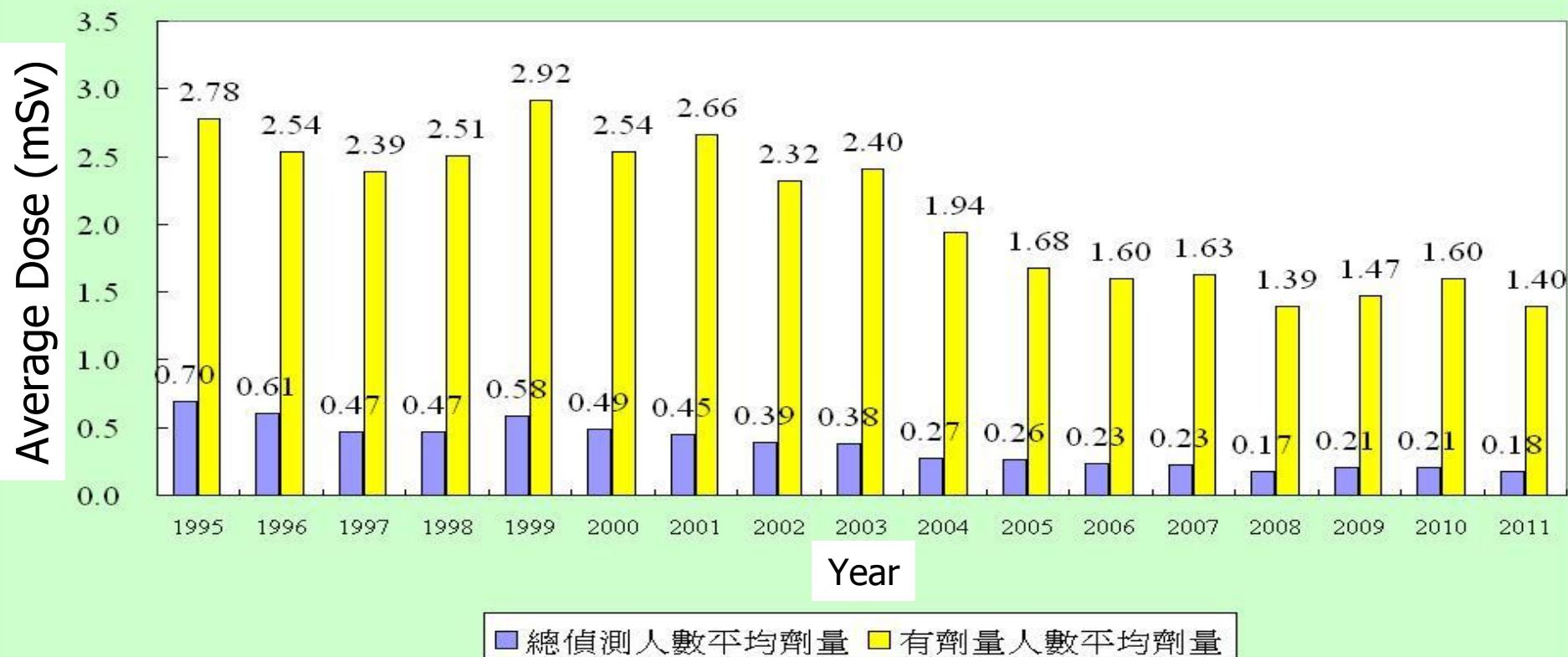


## Domestic Population of Radiation Workers (1995-2011)





## Average Annual Dose Value of Radiation Workers (1995-2011)



(Average dose of total monitored persons)

(Average dose of persons with measurable dose)



## Emergency response mechanism in case of overexposure

- Have developed dose assessment techniques such as dicentric biodosimetry and expertise, in response to radiological accidents
- There are 19 Radiation Accident Medical Centers in Taiwan.





# **Audit and Control of High Risk Radioactive Sources**

- For IAEA Category 1 and Category 2 Higher Risk Source, implement annual inspection.
- The Security Plan for Regulating Category 1 and Category 2 Higher Risk Source was promulgated in 2011.





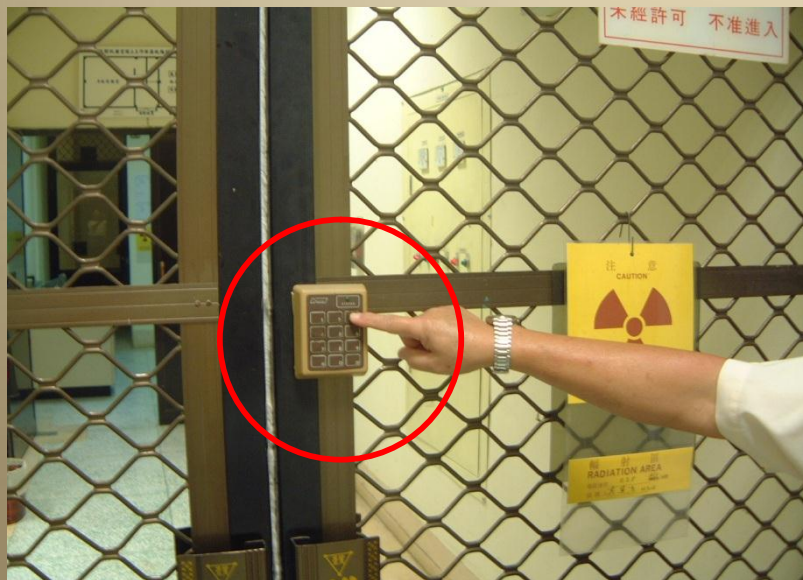
- + **Conform with international standards**
- **To Strengthen import/export control**
  - “ Basis: IAEA Radioactive Materials Safety and Security Action
  - “ Revised Radioactive Materials Import/Export Regulation







## ■ Strengthen radioactive sources control and security



Access control  
(Entrance of the Storage room)



Locked cabinet holding  
the source



## ■ Strengthen security management

- “ Basis: IAEA Radioactive Materials Security Technical Document TECDOC-1355 & IAEA Safety Guide RS-G-1.9 (2005)
- “ Install intrusion detection/monitoring alarms and CCTV



Area monitor



CCTV surveillance and  
intrusion alarm



# Transparency of Radiation Safety Information

- Licenses of Radiation equipments and radioactive materials
- Certifications of RSOs and radiation workers
- Radiation Safety warning label and apparatus
- Procedures of handling of Emergency Accident
- Radiation safety and training information

輻射工作人員與相關證照  
Radiation Staff and License

本設備為Ir-192射源  
The equipment is using Ir-192 radioisotope.

本射源係供放射腫瘤科使用。  
The purpose of this source is only for radiotherapy.

依據游離輻射防護法第29條，本輻射作業場所業經輻射安全評估及檢查合格，並取得原子能委員會核可之可發生游離輻射設備登記證，證書字號為醫物字第 1100136 號。  
This radiation workplace has been evaluated and examined by Atomic Energy Council, and has been granted a Registration Certificate for Ionizing Radiation Equipment pursuant to Article 29 of Ionizing Radiation Protection Act; the Registration Number is 1100136.

警示紅燈亮時係操作中，請勿靠近。  
Don't come close when red alert light is on- It is in operation.

懷孕婦女請事先告知工作人員。  
Pregnant woman should notify working personnel beforehand.

緊急及諮詢聯絡電話：  
02-66289779/8855 張秋雄先生

For any questions or in the event of emergency, please contact :  
02-66289779/8855, Mr. Chio-Shuang Chang

本醫院 診所：佛教慈濟綜合醫院台北分院  
This hospital/clinic: Buddhist Tzu Chi General Hospital, Taipei Branch

原子能委員會核安監管中心廿四小時緊急通報專線：02-82317250  
Atomic Energy Council 24 hrs emergency call: 02-82317250

**RADIATION**  
輻射管制區  
CONTROLLED AREA

如果你可能有懷孕的話  
在照X光之前請告知檢查人員

PLEASE MUM,  
TELL THEM  
I'M HERE  
(請告訴他們我在這裏)

Xin chú ý :  
Nếu có thai hoặc cảm giác có thai ; trước khi khám hãy báo  
trước với nhân viên kiểm tra sức khỏe .

Notice:  
If you are pregnant or suspected to be a mother, Please  
inform it to our staff.

HARUS DIPERHATIKAN:  
KALAU ADAHAMIL ATAU MERASA HAMIL, HARUS  
MEMBERI TAHUKAN PETUGAS RUMAH SAKIT TERLEBIH  
DAHULU.

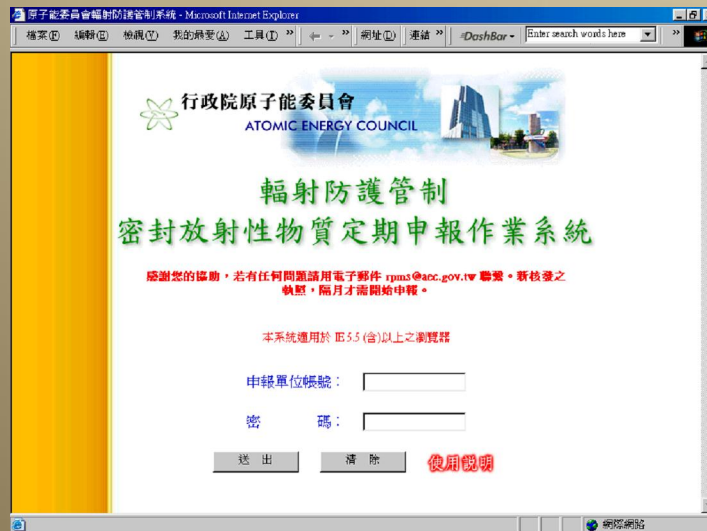
คอยระวัง :  
ถ้าหากเกิดมีท้องขึ้นนาในบอกพนักงานที่ทำการตรวจสุขภาพด้วยคะ





# Computerized Monitoring

- **E-Trade Facilitation and Control Project**
  - Deploy Customs Approval System and Radiation Protection Registration and Control System, to verify import, export, use, transfer, and disuse of sources.
  - Develop online source tracking system.





# Establishment of radioactivity detection system

- In 1992, some apartments built between 1982-84 were first discovered containing  $^{60}\text{Co}$ -contaminated steel rebar.
- Since 1995, iron and steel makers who own smelting furnace(s) are required to install **portal type radiation detector(s)** being able to effectively prevent from mis-smelting of radioactive sources.
- When imported metal scrap is detected containing radioactive materials, the **materials** is required to be sent back to the original export country.





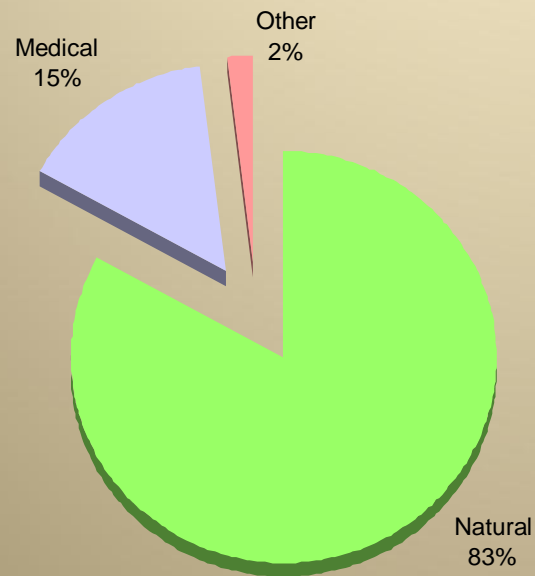
# Medical Exposure Quality Assurance Program

- Optimize patient doses and image qualities
- Give QA label to each qualified machine

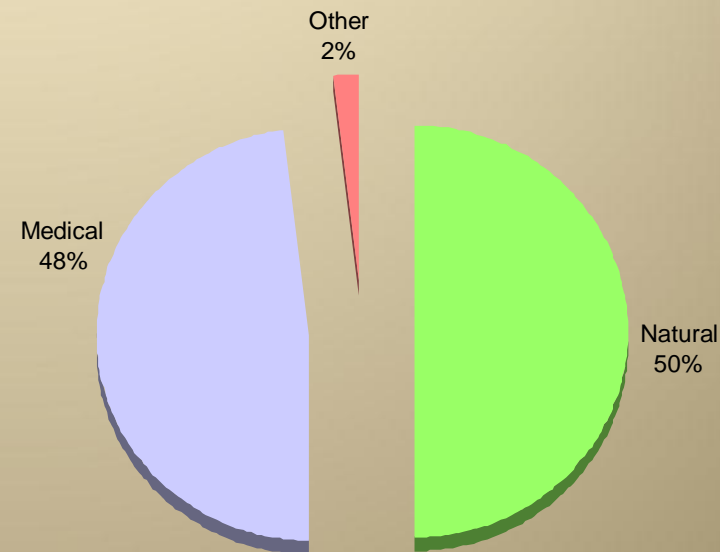




**NCRP Report No. 93  
(Early 1980s)**



**NCRP Report No. 160  
(2006)**



**Radiation Exposure of the Population of the U.S.**



# Radiation Safety in Hospital

- Licensing radiation instruments, radio-materials and radiation workers.
- Initiate Medical Exposure Quality Assurance Program since 2005.
- Annual inspection of radiation safety and Medical Exposure QA program.





## Numbers of Treatments and Scans in TAIWAN

<b>Machine Type</b>	Linear Accelerators, Gamma knife, Cyber knife, Tomotherapy machine	Teletherapy and Brachytherapy	<b>Mammography</b>	<b>CT</b>
<b>Annual No.</b>	<b>1,148,461<sup>a</sup></b>	<b>6,251<sup>a</sup></b>	<b>627,000<sup>b</sup></b>	<b>1,568,422<sup>a</sup></b>
<b>Total</b>	<b>3,350,134</b>			

a. Source from Department of Health, Taiwan, 2011

b. Source from Bureau of Health Promotion, Department of Health, Taiwan, 2012



# **Medical Exposure Quality Assurance Plan**

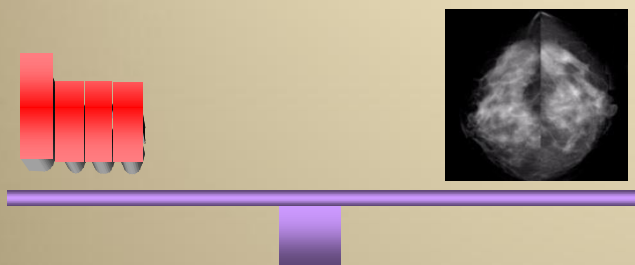
shall include:

1. QA Organization
2. Procedures
3. QA Calibration items
4. Frequency, results and tolerance of Calibrations
5. Responding and resolving methods when tolerance is deviated

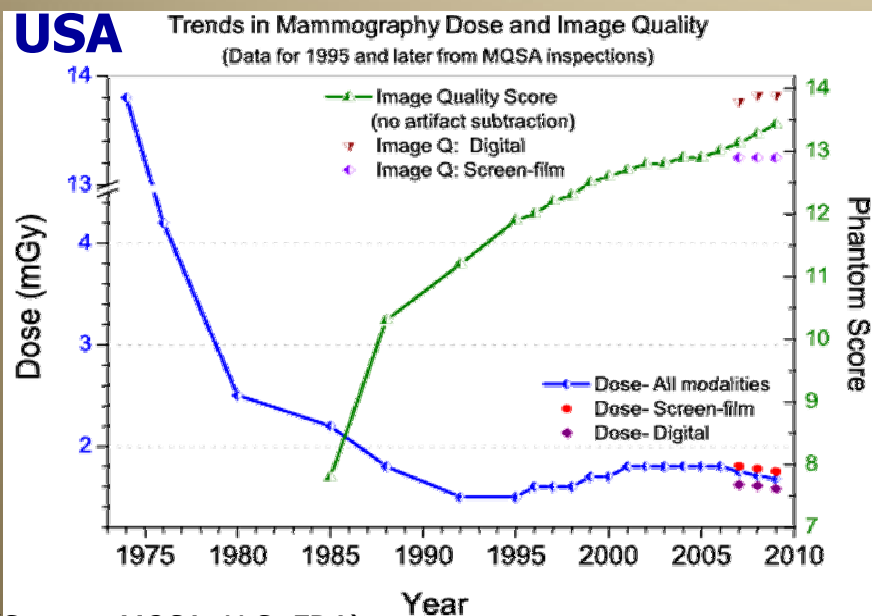
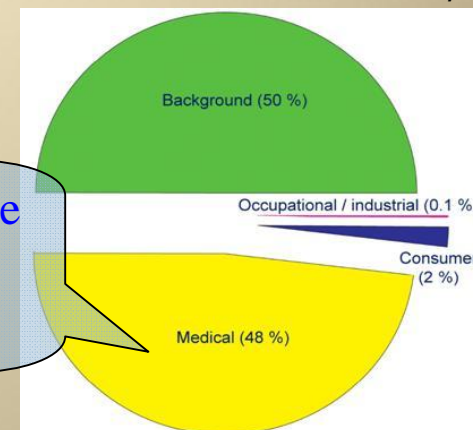


# Mammography QA: Patient Dose Management

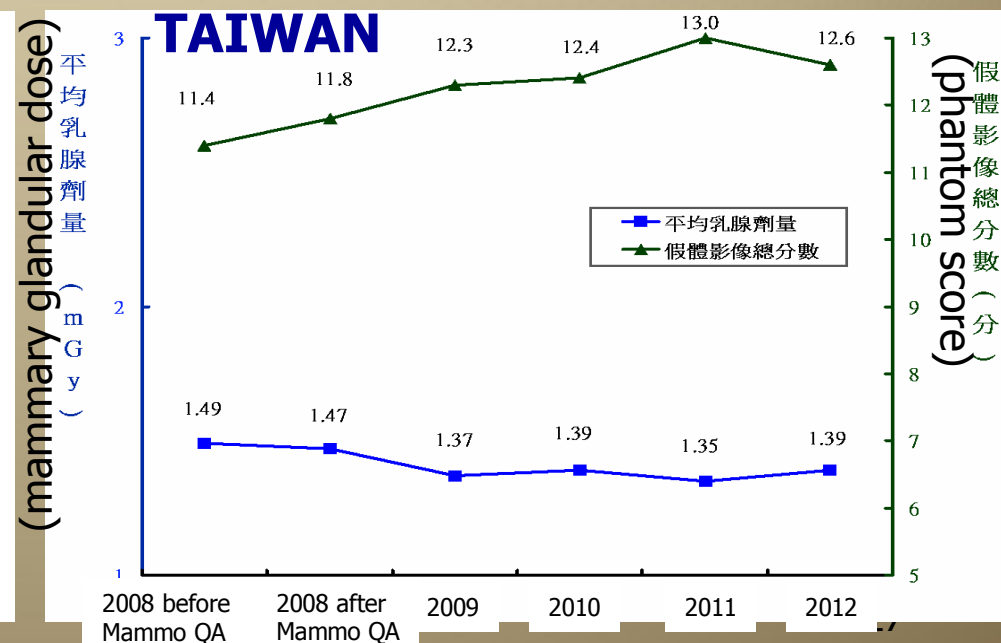
Source: NCRP-160, USA



96 % of man-made dose  
is from radiological  
practice in medicine.



(Source: MQSA, U.S. FDA)





## Test Items for CT

### ■ CT dose

- Adult Head
- Adult Abdomen
- **Pediatric Abdomen (5 y/o)**

### ■ Image quality

- CT number accuracy
- Slice thickness
- Low contrast
- Uniformity
- Artifacts
- High contrast resolution





# **Re-evaluation of Nuclear Safety and Radiation Protection System**



# 311 Fukushima Nuclear accident Created A Tremendous Shock to Taiwan

國內核電爭議 A6 中國時報

## 福爾摩沙別成輻島

拒核災 環團逾千人大遊行 貢寮人:就業比生命重要?

中央社東京4月21日電 日本福島核電廠發生核災後，台灣各界對核能安全問題高度關注。環保團體昨日在台北舉行大規模遊行，呼籲政府全面檢討核能政策，並要求核電廠廠主負起安全責任。貢寮地區居民則表示，在核能與就業之間，他們更傾向於保障就業機會。

環保團體表示，福島核災發生後，台灣民眾對核能安全的信心受到嚴重打擊。他們要求政府立即停止所有核能擴建計畫，並加強對現有核電廠的安全檢查。此外，他們也呼籲政府加強對核廢料的處理，確保環境安全。

貢寮地區居民則表示，該地區是台灣重要的漁業基地，如果核能事故導致海產污染，將對當地居民的生計造成巨大影響。他們認為，在核能與就業之間，政府應該優先考慮民眾的生計問題。

## 輻射後天若飄台 原能會:微量

輻民眾勿恐慌 大陸昨有31省市測到碘-131

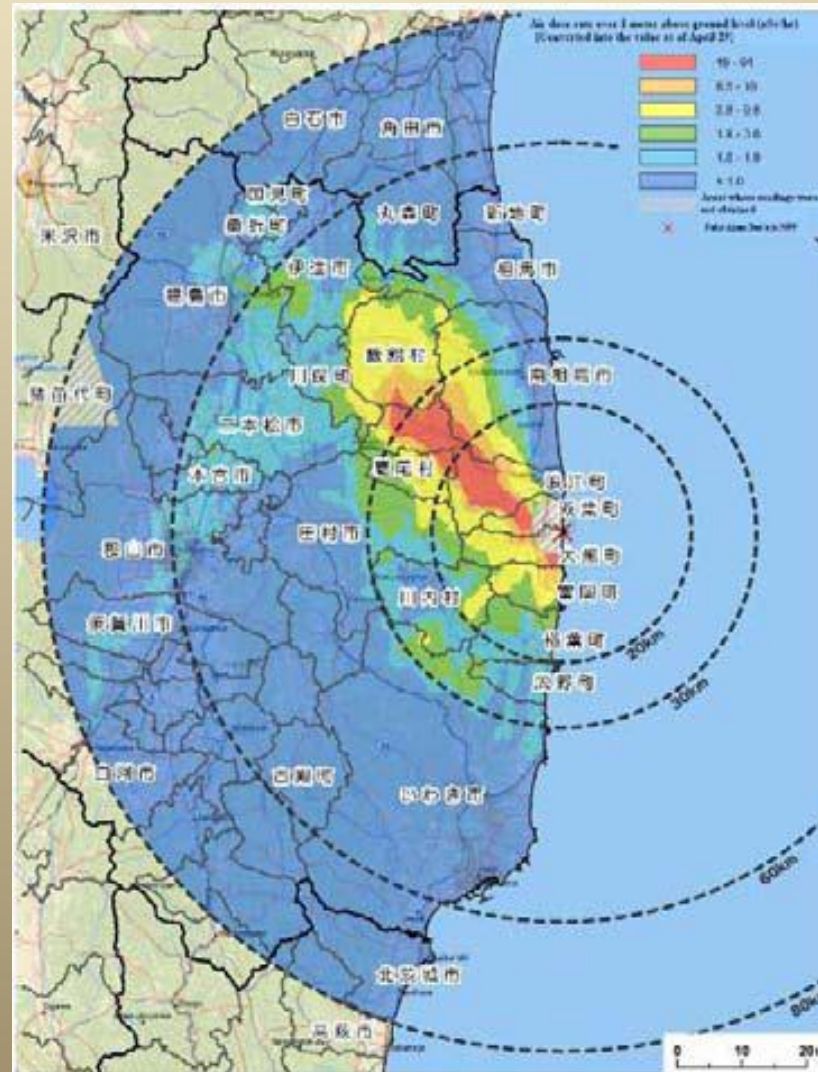
【本報記者張國威、鄭金隆報導】日本福島核電廠發生核災後，台灣民眾對核能安全問題高度關注。原能會昨日表示，目前台灣尚未測到任何輻射，但大陸已有31個省市測到微量碘-131。原能會呼籲民眾不要恐慌，並提醒民眾注意飲食安全。

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# Results of airborne monitoring by MEXT and DOE



Source: MEXT



## Lesson Learned from the Fukushima Accident

- Establish integrated emergency environmental radiation monitoring capabilities
  - *prompt* land and air monitoring
  - using *computer forecasts* to provide *immediate* alarms for evacuation and taking shelter at indoors
- Mobilize and coordinate man power and equipments of relevant organizations

# Re-evaluation of Nuclear Safety

## Radiation release control

- strengthen on-site safety system
- take measures as Ultimate Response
- enhance off-site emergency response

Methods of water  
treatment, storage

Water  
treatment

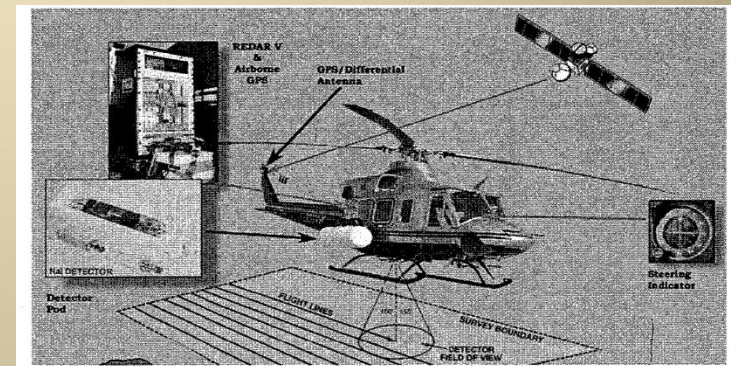
Water  
treatment





# Re-evaluation of Radiation Protection System

- Enhancing capabilities to assess atmospheric dispersion and radiological impact
- Advancing Emergency Response Dose Assessment System in response to nuclear accidents
- Developing aerial monitoring techniques
- Enhancing capabilities of environmental monitoring



# Actions taken

## Establishment of Integrated Emergency Environmental Radiation Monitoring platform

Collect environ. radiation information

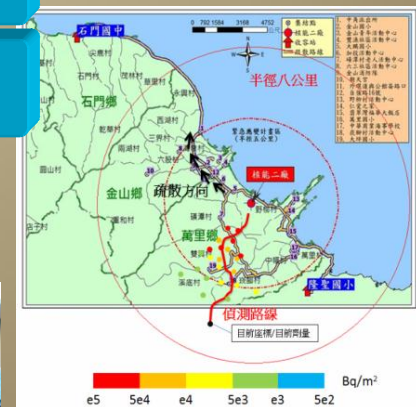
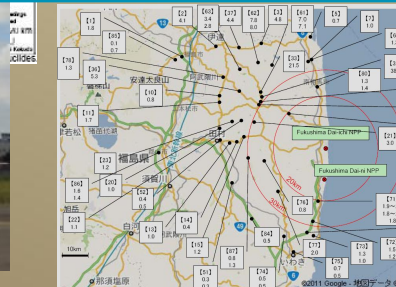
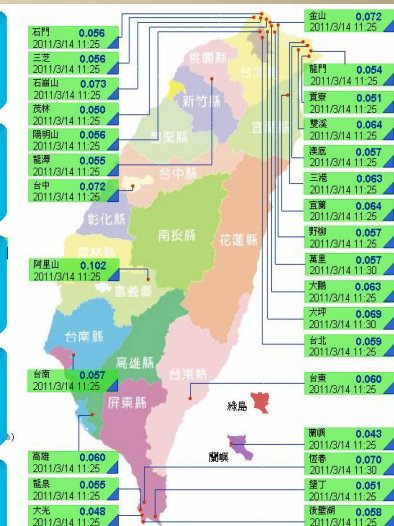
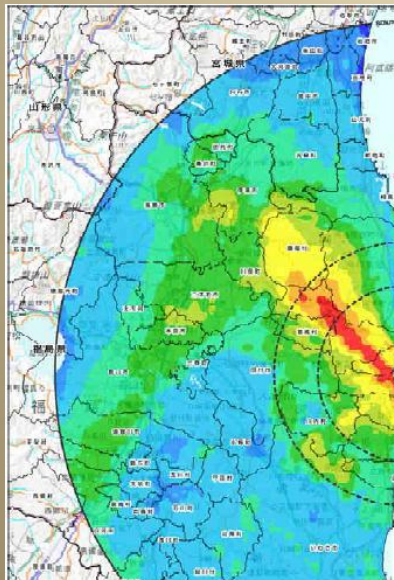
Integrate capacities for environ. monitoring

develop environ. monitoring plans

Establish environ. radiation information system

Promptly collect related information for decision making

Basis for public emergency response





# Conclusions

- Fukushima accident was made in Japan and **preventable**, due to multitude of errors and willful negligence-2012 Diet report
- The countermeasures taken in Japan after Fukushima nuclear accident provide extremely valuable lessons for us to learn , and help us strengthen our radiation protection capabilities.



A nighttime photograph of a city skyline. On the left, a large Ferris wheel is illuminated with green and blue lights. In the center, the Taipei 101 skyscraper stands out with its blue and white lights. The rest of the city is filled with various buildings, some with red and white lights. The sky is a deep blue with some clouds.

**Thank You for  
Your Attention**