Nuclear Disaster Medical Care and Response in Taiwan

台湾における原子力災害医療とその対応

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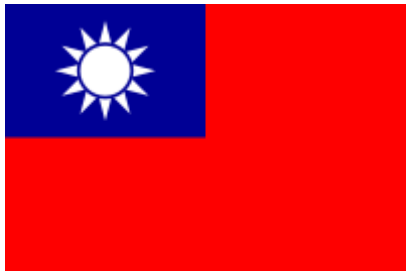
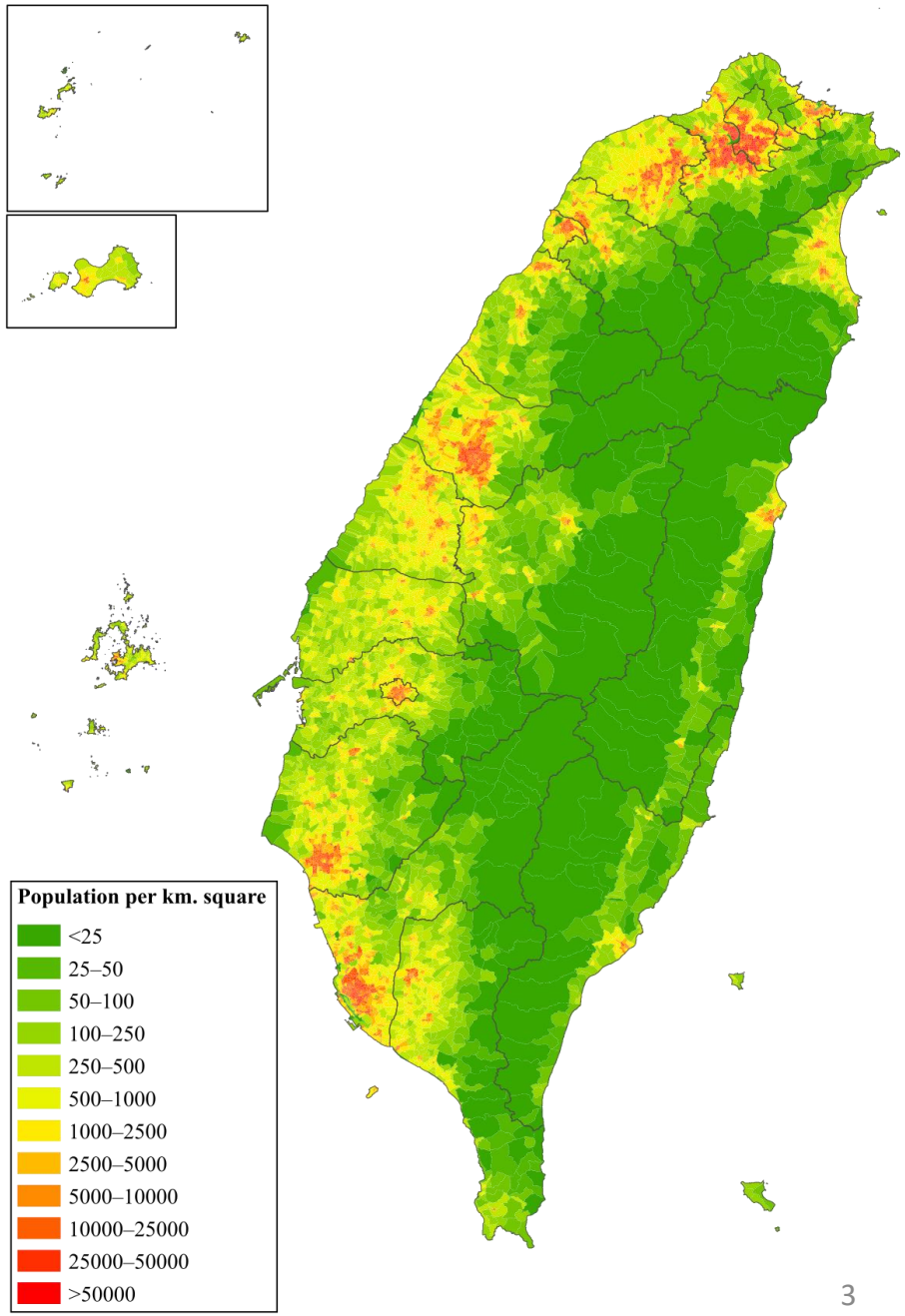
Content

REM = Radiation Emergency Medicine

Taiwan





- Area: 36,193 km^2
- Population: 23,413,608 (2024)
  (Density 646/km^2)
- GDP: $791.61 billion/$35,129 per capital (2024)
- GDP by sector: Agriculture: 1.8%,
  Industry: 36%, Services: 62.1% (2017)
- Capital: Taipei City

*Picture Credit: Wikipedia

Taiwan's Radiation Emergency Response System and Medical Network

Central Regulating Authority of Radiation Disaster in Taiwan: **Nuclear Safety Commission** (NSC)

- The NSC is the safety authority over atomic energy-related affairs, previously known as the AEC (Atomic Energy Council).
- Mission of NSC: Develop and enforce regulations, and to conduct R & D of nuclear technology.

2023-9-27

restructured

Taiwan NSC-Defined 5 Categories of Radiological Emergencies

- Nuclear Power Plant Accidents
- Cross-Border Nuclear emergency
- Radioactive Material Accidents
- Transportation of nuclear materials Accidents
- Radiological Dispersal Device Accidents

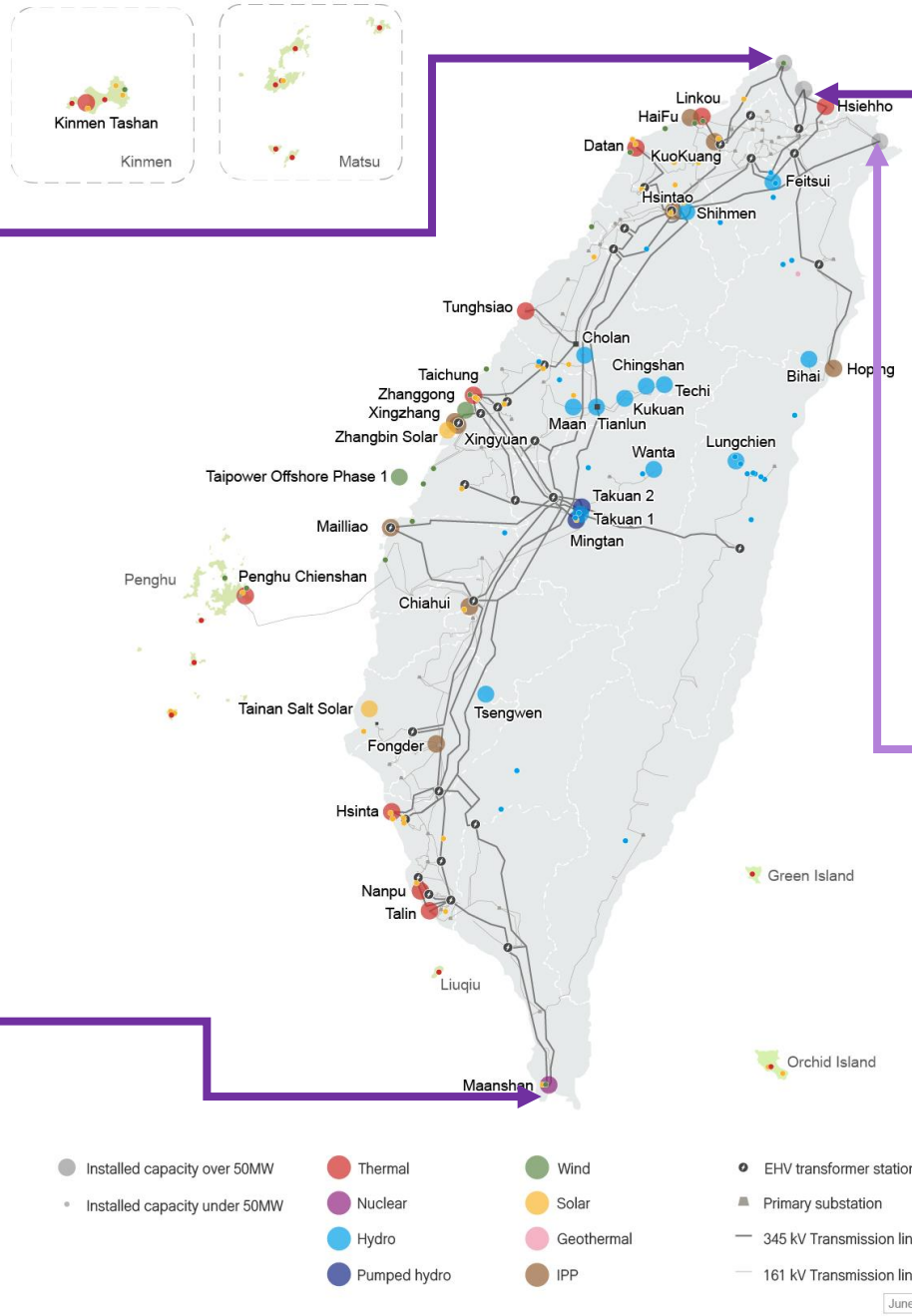
Disaster Prevention and Protection Act, Article 3

Official Website of NSC, Taiwan

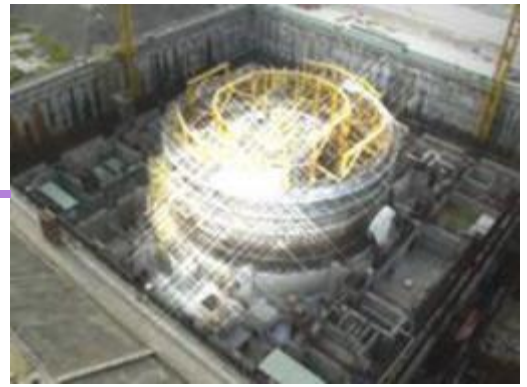
NPP = Nuclear Power Plants

NPP 1 (1978): 2 reactors. Decommissioning

Taipower's Power Plants and Power Grid



NPP 2 (1981): 2 reactors. Decommissioning



NPP 4 (X): Unfinished

NPP 3 (1984): 1/2 Operation

Picture Credit: 台灣電力公司 TAIWAN POWER COMPANY

https://www.taipower.com.tw/2764/2809/2814/25012/normalPost

Distance between NPPs and hospitals in Taiwan

- Within 3 km: No hospitals.
- Within 5 km: 4 hospitals.
- 5–8 km: No hospitals.
- 8–16 km: 8 hospitals.
- Within 30 km: 43 hospitals in total.

If a nuclear disaster occurs, what should these hospitals do? flee or fight ?

Radiation Beyond Nuclear Plants: Taiwan's 1982 Contaminated Rebar Incident

*Photo Credit: ETtoday News Cloud

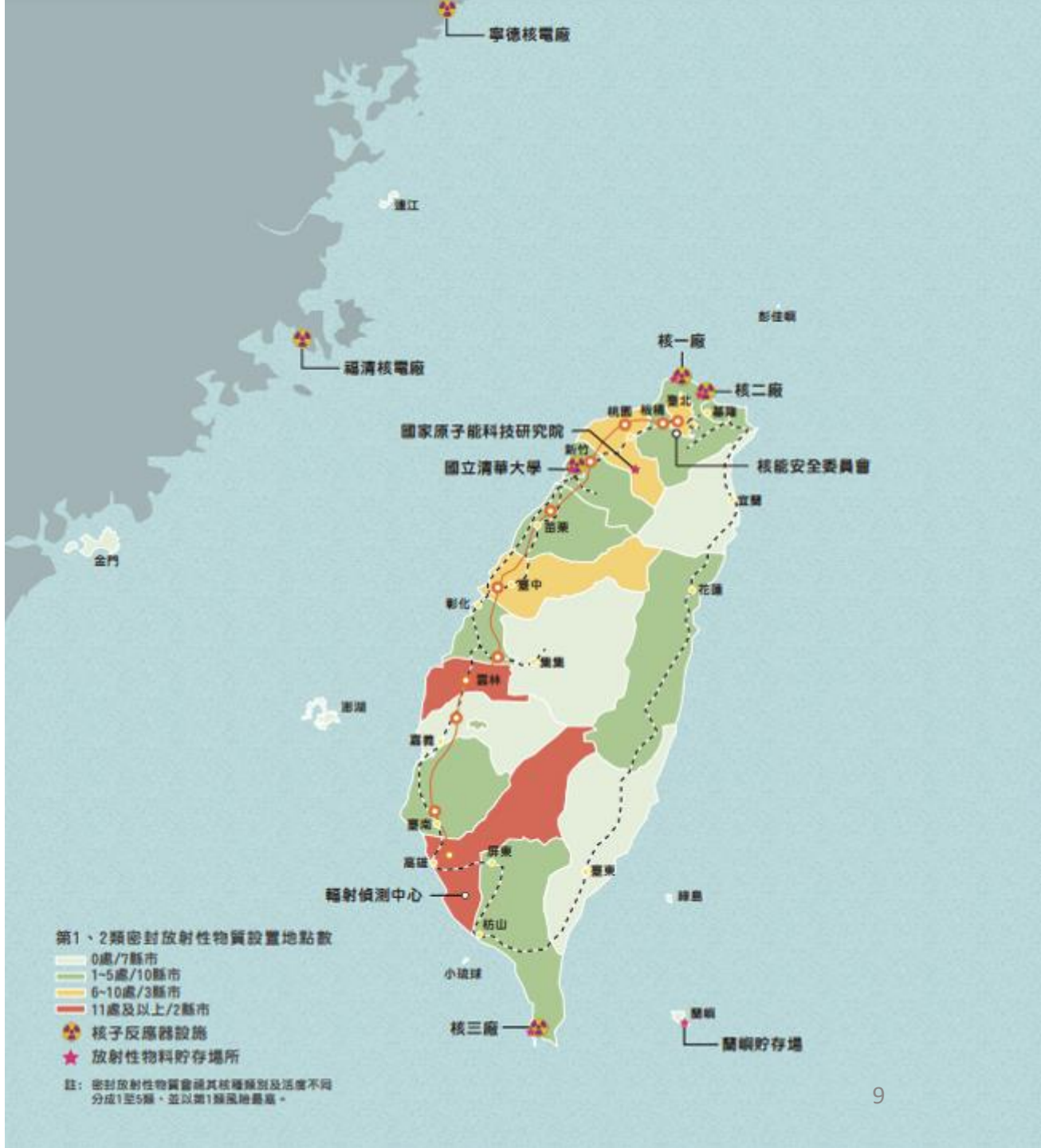
- Discovery:
  - In 1982, radioactive materials (Cobalt-60) were found in imported scrap metal, which had been used to produce construction materials.
- Impact:
  - 1,669 housing units (or buildings) were identified as contaminated.
  - 98 units exceeded radiation levels of 15 millisieverts per year.
- Response:
  - Affected units underwent demolition, improvement, or were left vacant.
  - Nationwide inspections and reinforced regulations on scrap metal imports followed.

The Control Yuan Investigation Report No. 109-JD-0030, R.O.C.(Taiwan)

Vulnerable areas of Radiation hazard

- Municipalities and counties (cities) with facilities such as nuclear reactors, locations storing sealed radioactive sources of Category 1* or 2**, places with other radioactive materials that could potentially cause radiation disasters.

*Category 1: Extremely dangerous sources
**Category 2: Very dangerous sources



Official Website of NSC, Taiwan

The Emergency Hospital Network:
Three levels of hospitals by medical care capabilities

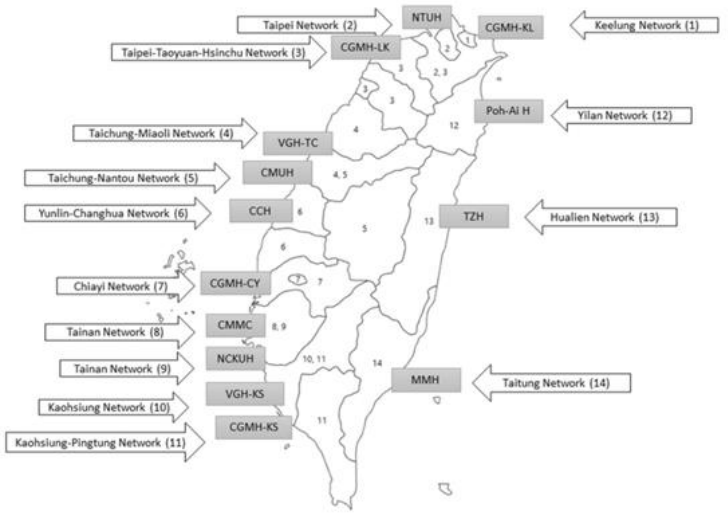
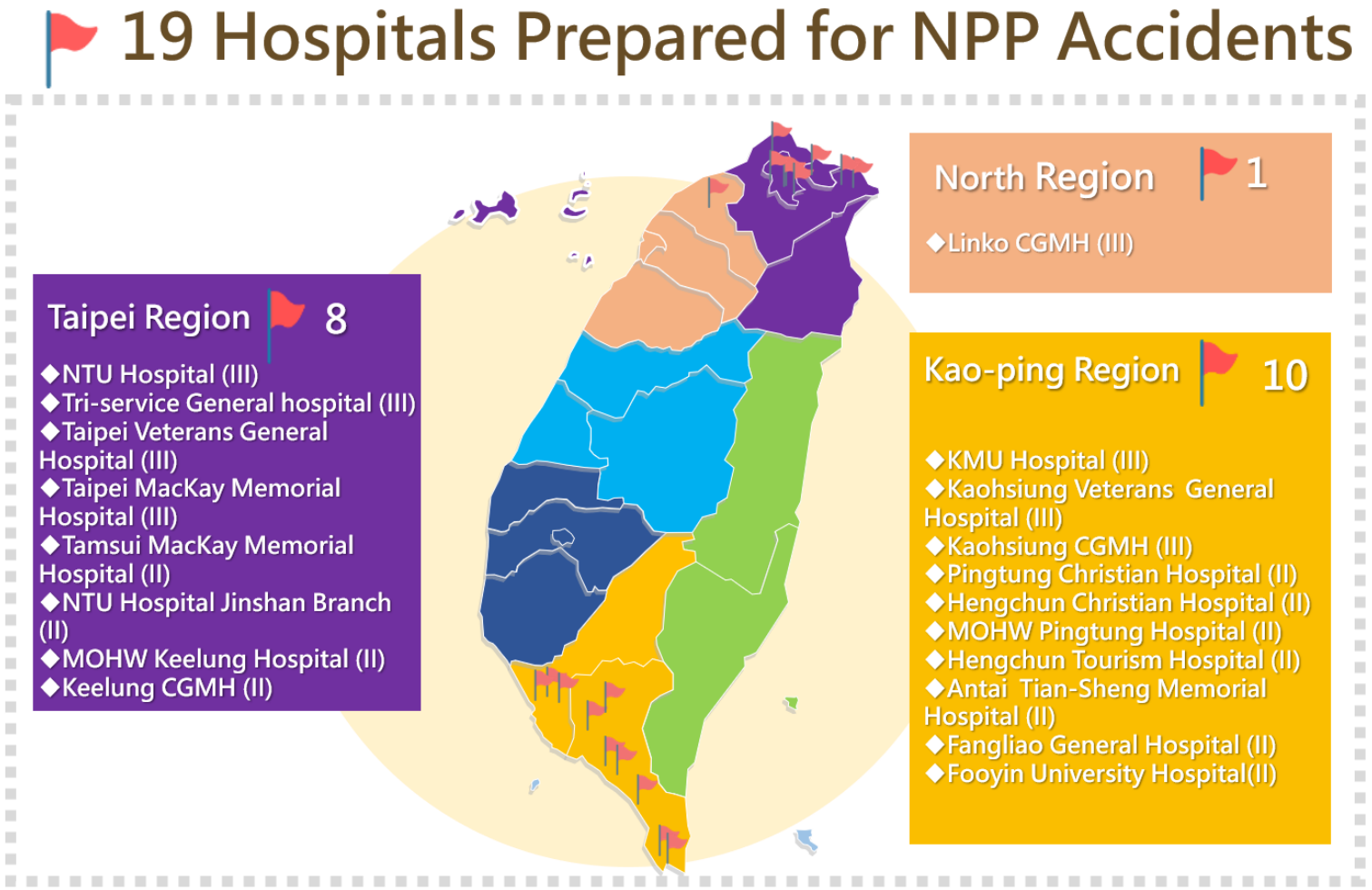


Figure 1. The 14 emergency care referral networks designated by the Ministry of Health and Welfare of Taiwan. Each of the 14 referral networks has a base hospital, which is highlighted in gray. The figure was created using Microsoft PowerPoint 2019 (www.microsoft.com).

- Emergency Responsibility Hospital System （Since 2009; 205 hospitals(2024)）
- 3 Emergent Rescuer Responsiveness levels
  - **Basic** Emergency Responsibility Hospitals （79）
  - **Intermediate** Emergency Responsibility Hospitals （74）
  - **Advanced** Emergency Responsibility Hospitals （52）
- 14 Emergency Referral Network

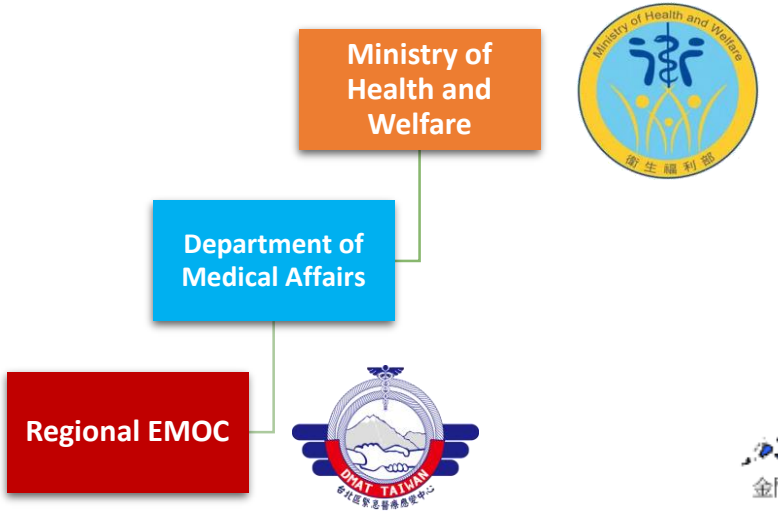
Radiation Injury Emergency Response Hospital

- **Level I**
  - 3 clinics inside NPPs
  - Provides basic emergency medical care for NPP employees.
- **Level II**
  - 11 Hospitals near NPPs
  - Offers "triage", "medical decontamination", and "supportive care".
- **Level III**
  - 8 Medical Centers
  - Specializes in “definitive radiation injury treatment”

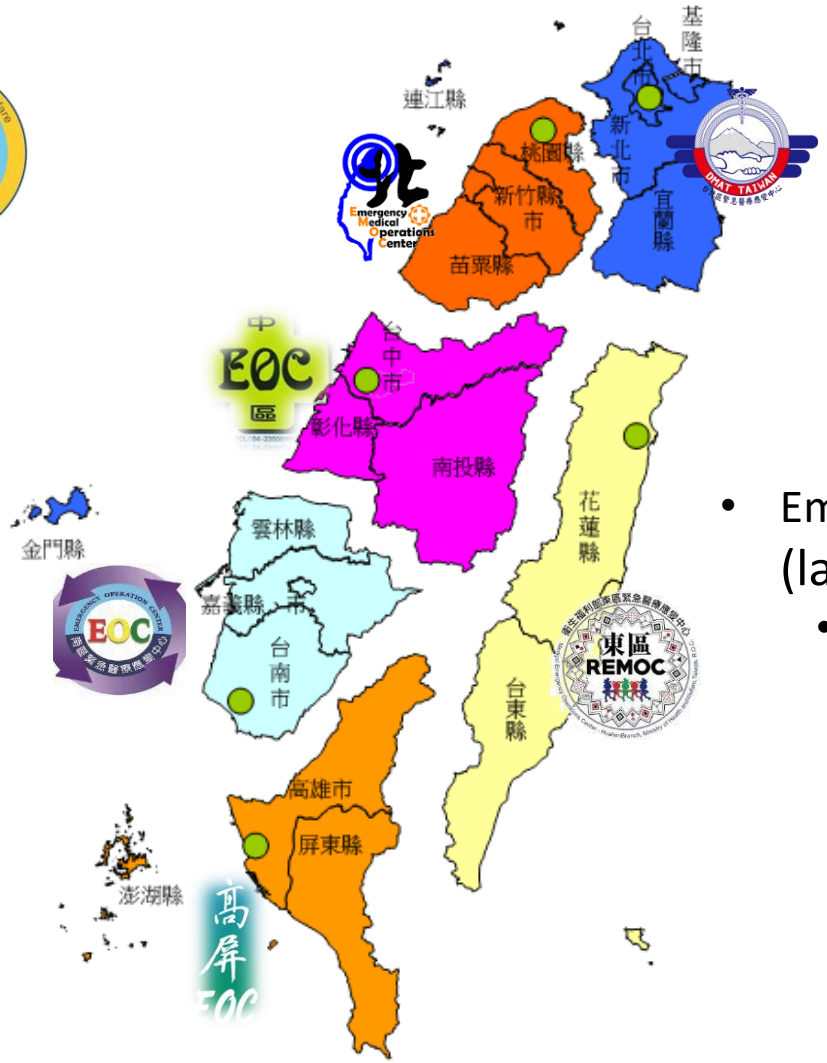


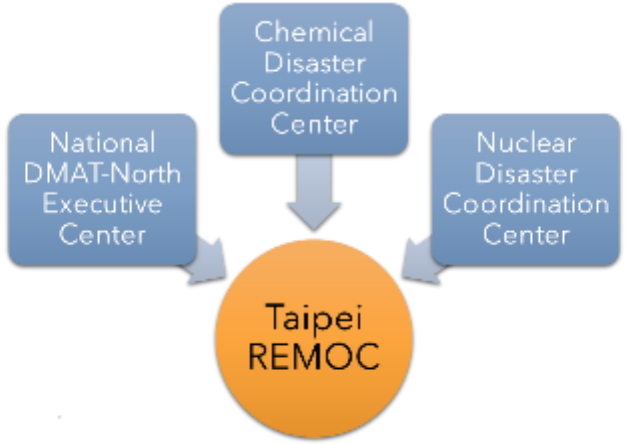
Nuclear Disaster Response Mechanism Report, MOHW, April 24, 2014

6 Regional EMOCs, MOHW



Emergency Medical Management System, MOHW





- Emergency Medical Services Act (latest revision in Jul. 11, 2007)
  - Article 9
    - The central competent health authority shall entrust medical care institutions to establish **Regional Emergency Medical Operation Centers (REMOC)** in all regions

Central EOC

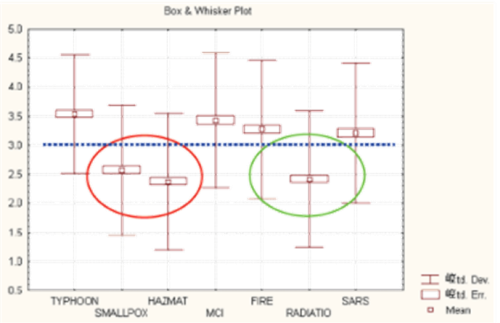
中央災害應變中心
Central Emergency Operations Center

Radiation Disaster Medical Personnel Training: Enhancing Radiation Emergency Preparedness in Taiwan

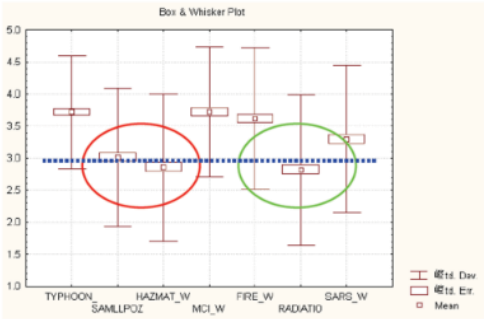
About 20 years ago, the medical staff's awareness of radiation emergency medicine

- A small-scale Survey in my hospital
  - Survey Findings: Medical staff lack training in radiation management, decontamination, and self-protection, leading to low willingness to handle radiation-contaminated patients.
  - Key Concern: Fear of public panic and perceived inability to manage radiation incidents, especially compared to biological or chemical events.
  - Impact: Low interest among medical personnel in learning Radiation Emergency Medicine

Do you feel that your abilities are sufficient to respond to various disasters?



What is your willingness to support in various disasters?



*As referenced by Dr. Frank Fuh-Yuan Shih

NIRS Training Course for Taiwanese Medical Professionals on Radiation Emergency Medical Preparedness & Medicine in Asia
Dec. 4-6 2007

Originally, the Taiwanese government, public, and medical community did not place much emphasis on Radiation Emergency Medicine.

However, there was a significant shift in attitude following the Fukushima nuclear disaster in 2011.

Challenges and Opportunities in Taiwan's REM Education years ago……

- Resource and Infrastructure Challenges
  - Limited resources and funding, outdated equipment, insufficient institutional support, regulatory gaps, and policy development barriers.
- Collaboration and Engagement Issues
  - Lack of cohesive networks, limited expert involvement, insufficient interdisciplinary and international cooperation, and underdeveloped public-private partnerships.
- Education and Awareness Gaps
  - Inconsistent training standards, lack of specialized programs, insufficient public awareness, limited virtual training adoption, and inadequate community and media engagement.

Grateful Connection with Fukushima Medical University (2012–Present)

International Collaboration in Radiation Emergency Training: Russia and USA Experiences (2012–2015)

Burnasyan Federal Medical Biophysical Center of Federal Medical Biological Agency, Russia. 2015

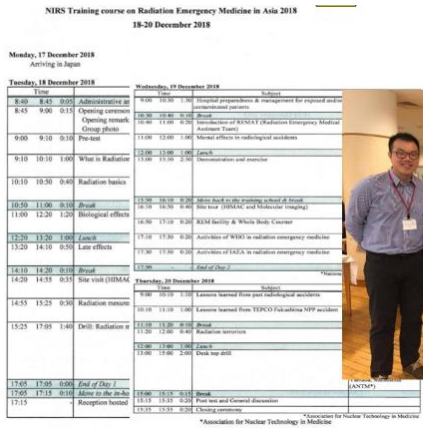
Radiation Medicine Department of the Institute of Biophysics, Clinical hospital №6, Moscow, Russia 25

Taiwan Advanced I-Med By REAC/TS (Taiwan - USA) 2012, 2013 & 2015

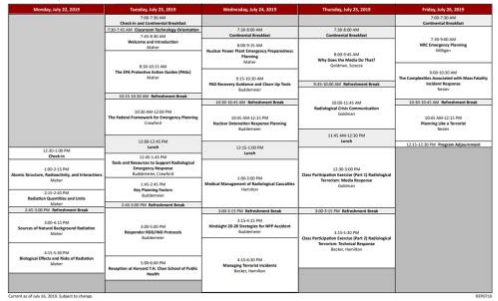
25

2018 FMUH

2018 NIRS



Radiological Emergency Planning: Terrorism, Security, and Communication 2019 (USA)



2019 SAGA

2023 Hirosaki

2024 Hiroshima

Ongoing Participation in Training Programs and Visits to the Japan and United States.

Current Edition of REM Training Course for Medical Personnel

- After the COVID-19 global pandemic, concerns arose about gatherings for classes, and medical personnel increasingly lacked time to attend courses. Therefore, the program was modified to include both online courses and practical sessions
- Online Training Course
  - Basic Level – 6 subjects, 18 topics
  - Advanced Level – 6 subjects, 18 topics
- Hand-on Training Course
  - 6 hours (1 day course)

Hands-On REM Training course - NTUH Jin-Shan Br.

Taipei MMH, Taipei REMOC

Superintendent’ s speech

Hand-on Training Course NTUH Jinshan

Contaminated Casualty Evacuation Training

Small Group Teaching

Taipei REMOC REM Course

Seed Teachers instruction

Support by Taipei MKH

Detection & Decontamination Training

PPE Donning and Doffing

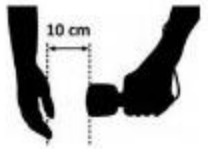
Training Isotope: Thorium 232

Air Mannequin

Taiwan's Radiation Medical Response Framework: From Pre-Hospital Care to National Exercises

First responder’ s Manual for Radiological Disaster. NSC, Taiwan. Dec. 2021 2nd edition

PPE donning and doffing

步驟 1	選擇適當輻射偵檢儀器： 最低應至少可量測到 0.1 微西弗/小時 (μSv/h)。
步驟 2	開機並記錄環境背景值： 於一般環境輻射劑量率(參考值 0.2 微西弗/小時 (μSv/h))區域完成開機程序，確認儀器功能正常，並記錄儀器號碼與背景值。(可參考附件一「輻射災害現場人員紀錄表」進行記錄)
步驟 3	人員輻射偵檢： 偵測人員應戴手套並穿著防護衣，距離被偵測人員手部 10 公分處進行偵測，如圖 11 所示。  圖 11 人員輻射偵檢示意圖
步驟 4	偵測結果處理原則如下： **小於 1 微西弗/小時 (μSv/h)** • 不須現場除污 • 返家後可參考表 9「除污程序」自行進行清潔 **大於 1 微西弗/小時 (μSv/h)** • 進行表 9「除污程序」 • 若無法立即進行，應於指定區域等候安排除污 • 若無法在場等候，離開後應盡速依表 9「除污程序」自行除污

Prehospital Radiation Quick Survey

Zoning and Medical Activities On-Site

Zoning

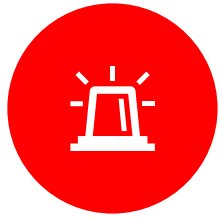
圖 8　輻射災害現場管制區域示意圖

On-site medical activities

TRIAGE　TREATMENT　TRANSPORT

First Responder’ s Manual for Radiological Disaster. NSC, Taiwan. Dec. 2021 2nd edition

Response Protocol for Radiation Accidents in Hospitals



ACTIVATION & NOTIFICATION (ALERT PROCESS)

INFORMATION SYNTHESIS

ED PREPARATION (IF ABLE)

PATIENT PROCESSING

TREATMENT

DECONTAMINATION

PATIENT DISPOSTION

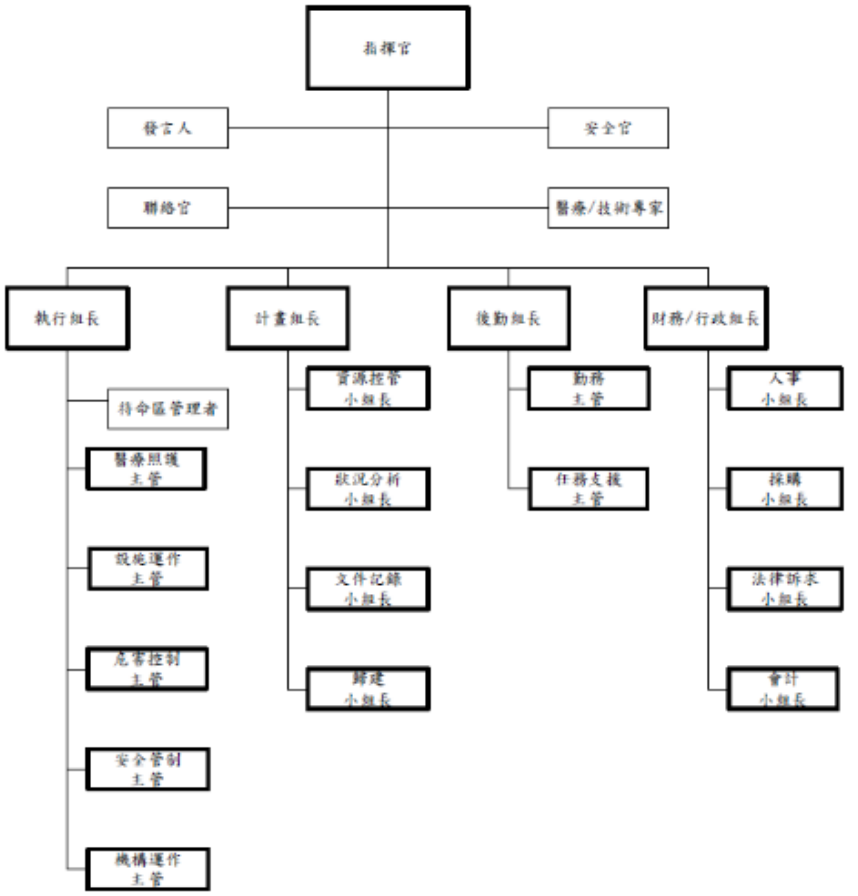
CLEAN-UP & RECOVERY

REAC/TS
Radiation Emergency Assistance Center/Training Site
Managed by ORAU for DOE

Triage Area of NTUH ED

Activation and notification (alert process)

- Who activates Emergency Operation Plan?
- Who is notified and by whom?
- Where, When, and How to report in?
- Assigned Position and Function?



Hospital Incident Command System (HICS)

Information Synthesis

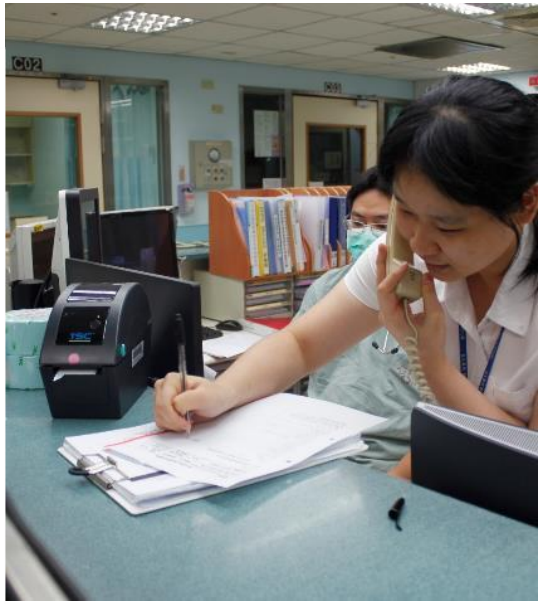
- Scene communications
- Incident commander/point of contact/designee
- Location and Time of accident
- Mechanism of injury
- Use a Formal Checklist

台北區 REMOC 輻傷事件收治病患標準聯絡表

紀錄者		紀錄時間	＿＿＿年＿＿＿月＿＿＿日＿＿＿時＿＿＿分
一、事故說明			
詢問重點		說明	
1.發生什麼意外事件？			
2.工作別？			
3.發生時間及地點？			
4.有多少人員發生狀況？			
5.送來病患人數？			
6.病患傷勢如何？			
7.曝露何種輻射源？			
8.哪些部位受到暴露？			
9.有無污染？			
10.除污狀況如何？		輻傷：除污是否至 2 倍背景值以下	
11.是否有急性輻射傷害？			
12.有 EPD 讀值？是多少？			
13.運送工具為何？		車牌號碼：＿＿＿＿＿	
14.預計抵達時間？		上、下午 ＿＿＿時＿＿＿分	
二、事故聯絡單位資料			
1.現場負責人與電話	姓名：＿＿＿＿＿＿	電話：＿＿＿＿＿＿	
2. 現場負責人所在地址			

備註
1.請對方傳真書面文件至○○醫院急診室（傳真電話 02-XXXXXXXX）
2.請通報並再確認事件台北區 REMOC（02）7726-0456（02）7726-0458
台北市 EMOC（02）8786-3120（或 1） 台北市衛生局（02）2720-5270
新北市政府衛生局（02）22577155 值班手機 0972-971-530
3.請將此表單交給急診現場指揮官

Checklist for Communication



119 hotline

ED Preparation

- Receiving Area Preparation
- Mobilize the Staff
  - Put on personal protective clothing (Donning Procedure)
  - Obtain survey instruments and perform operational checks
  - Issue personal dosimeters, if available
  - If a MCI is possible, activate the MCI code and extend the HICS accordingly

Patient Processing

- Triage (Medical)
- Triage (Radiological)
- Identification, history and physical, laboratory and radiological tests
- Psychosocial support

Notice: Risk to hospital staff is minimal in a radiological event

Treatment - Patient Arrival and Stabilization

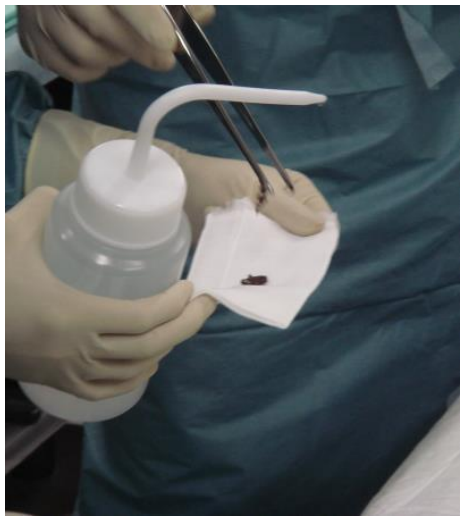
- Manage life threatening problems first
  - Airway
  - Breathing
  - Circulation
  - Disability
  - Exposure ←
- Contamination Assessment
- Remove patient's clothing and shoes
  - Double bag, label
  - Change gloves

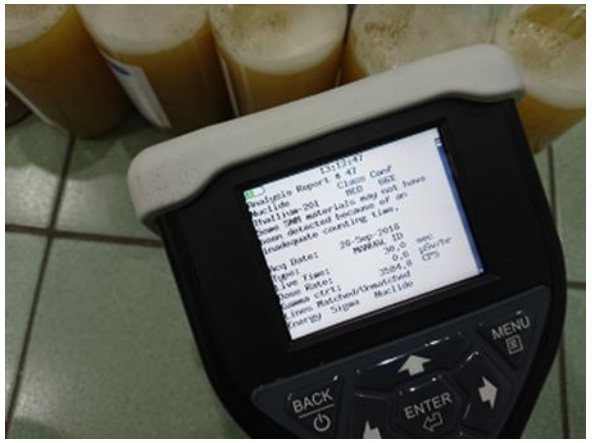
Decontamination- External

- Clothing Removal:
  - Follow radiological decontamination principles to log roll and wrap clothing in a sheet.
- Wound & Skin Cleaning:
  - Perform decontamination as per SOP.
- Sample Collection:
  - Swab nostrils and oral cavity.

Decontamination- Internal

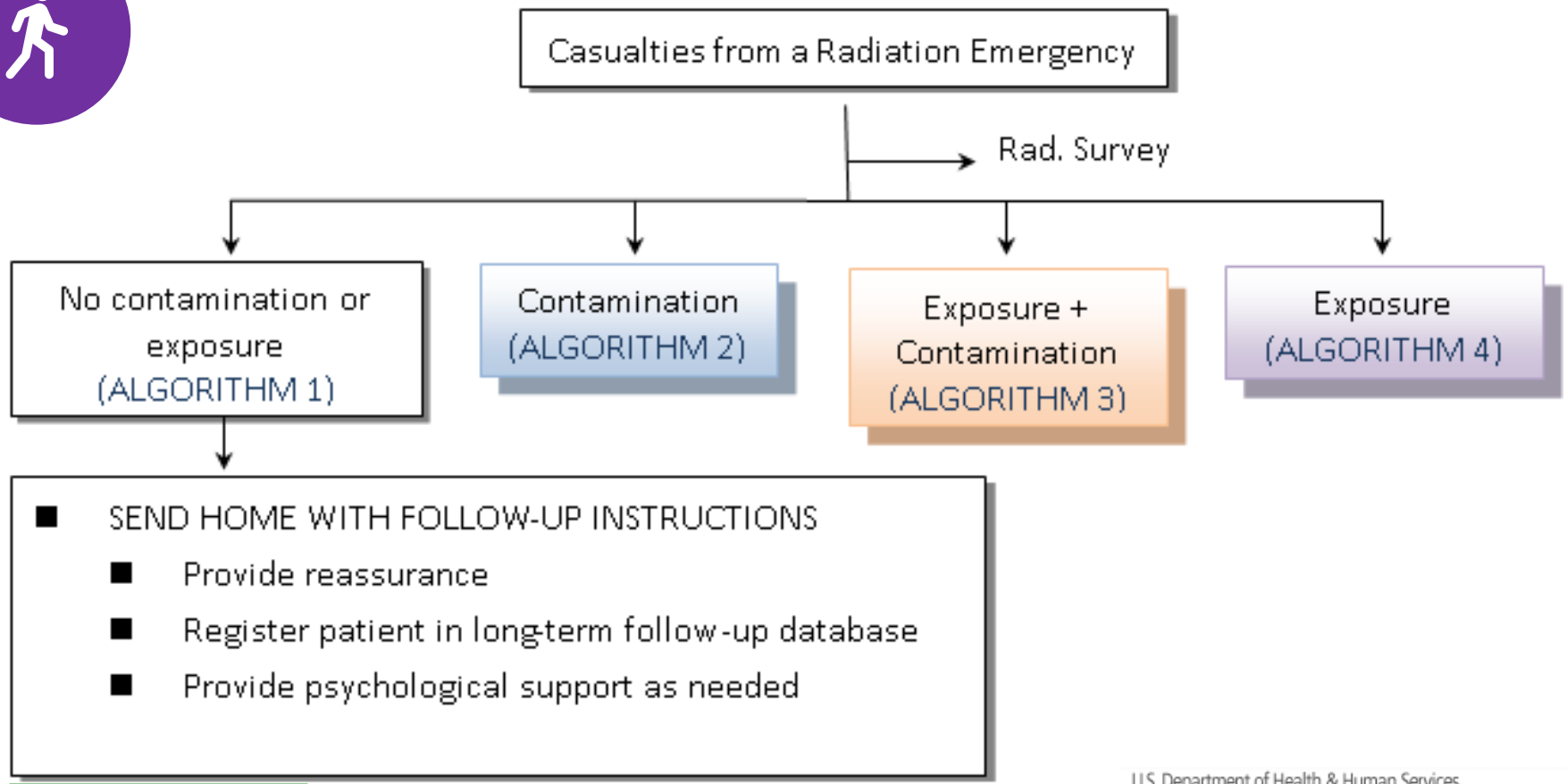
- Wound Care
  - Explore, irrigate, debride, close.
- Isotope Handling
  - Identify and measure isotopes.
- Key Treatments
  - Blocking, dilution, chelation, lung lavage.





Medical Management of Persons Internally Contaminated with Radionuclides in a Nuclear or Radiological Emergency. IAEA 2018

Management Algorithms



Algorithm 1 No contamination or exposure

U.S. Department of Health & Human Services
REMM RADIATION EMERGENCY MEDICAL MANAGEMENT

Clean-up & Recovery

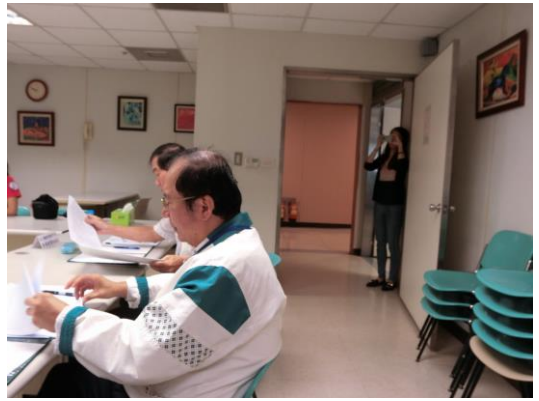
- Double-bag contaminated clothes
- Remove the waste from the decontamination room every 20-30 minutes
- Place in holding area or transfer to lab for analysis
- Dispose of radioactive waste in accordance with national regulations.

Annual Radiation Emergency Drills in Hospitals

- Exercise Assessment Model
  - Emergency Response Plan Document Review and Assessment
  - Standard Evaluation Format Usage
  - Fixed Assessment Committee Evaluation
    - **Nuclear Medicine Representative** (Emergency Medical Decontamination Procedures & Further Management)
    - **Emergency Medical Representative** (Emergency Medicine and Hospital Emergency Response Procedures)
    - **NSC Representative** (Radiation Protection Regulations and Radiation Detection Technology)
    - **Health Bureau Representatives**

Standard Evaluation Form for Radiation drills

- I. Organization and Response
- II. Assessment of Patient Transport Routes
- III. Radiation Detection Process
- IV. Decontamination Process
- V. Medical Personnel Protection Measures
- VI. Contaminated Waste Disposal
- VII. Material and Equipment Management
- VIII. Comprehensive Evaluation



衛生福利部輻傷事故緊急應變評核表

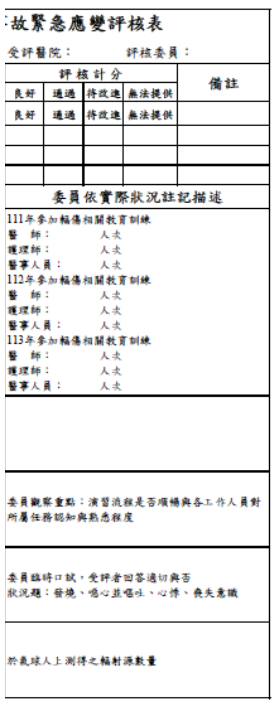
評核日期：112年　月　日　　受評醫院：　　評核委員：

評核項目	評核計分 G	P	F	NA	備註
一、組織與應變					
1.輻傷事件醫療應變計畫內容完整、適當，每年進行版本修訂並有紀錄					
2.緊急應變計畫組織架構明確並在啟動後有指定之指揮官，整體團隊表現良好					
3.計畫中有寫明人員之工作職責					
4.有人員調度及召回計畫					
5.緊急應變成員曾受過適當訓練(受訓紀錄)					
6.有維持與當地主管衛生單位、其它輻傷急救責任醫院及所在地區域緊急應變中心間的通訊聯法					應明顯張貼或擺在固定位置
二、傷患運送動線評核	G	P	F	NA	備註
1.輻射病人運送動線規劃是否適宜					
2.設有檢傷、除污及初步醫療之區域，各區之標識明確，並與非污染區之區隔明顯					
3.污染區內皆鋪設防污地墊，且接縫處皆有黏貼，以防輻射污染物外漏					
4.除污站週邊有足夠警戒人員及安全管理措施					
5.污染及非污染區各有偵檢人員，且偵檢與紀錄者分開					
6.污染廢棄物收集桶數量足夠且貼有輻射標誌並放置於污染區					
7.進行輻射背景偵測並記錄					
三、偵檢流程	G	P	F	NA	備註
1.優先評估及處理病人醫療狀況					
2.除去病人污染衣物					
3.選擇適當偵檢器材					
4.偵檢時，偵檢器探頭與傷患體表保持適當距離					
5.偵檢時，探頭移動速度適當					
6.有系統做全身偵檢					
7.是否有對孔洞及皺褶處進行偵測					
8.正確記錄偵檢單位數值					
9.是否有對救護車及隨車人員進行偵檢及紀錄					

利部輻傷事故緊急應變評核表

受評醫院：　　評核委員：

	評核計分 良好	通過	待改進	無法提供	備註
飞象					
且穿著正確，被					
5應除污設備之使					
示					
附近					
3，不可讓液體流					
予適當醫療處置					
2通)					
	良好	通過	待改進	無法提供	備註
1					
再進行全身偵檢					
E後之適當沖洗設					
	良好	通過	待改進	無法提供	備註
E記清楚(包括姓標示					
5射警告標示					
飞設備					
飞報					
E流程					



故緊急應變評核表

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評核計分 良好	通過	待改進	無法提供	備註
良好	通過	待改進	無法提供	

委員依實際狀況註記描述

111年參加輻傷相關教育訓練
醫　師：　　人次
護理師：　　人次
醫事人員：　　人次
112年參加輻傷相關教育訓練
醫　師：　　人次
護理師：　　人次
醫事人員：　　人次
113年參加輻傷相關教育訓練
醫　師：　　人次
護理師：　　人次
醫事人員：　　人次

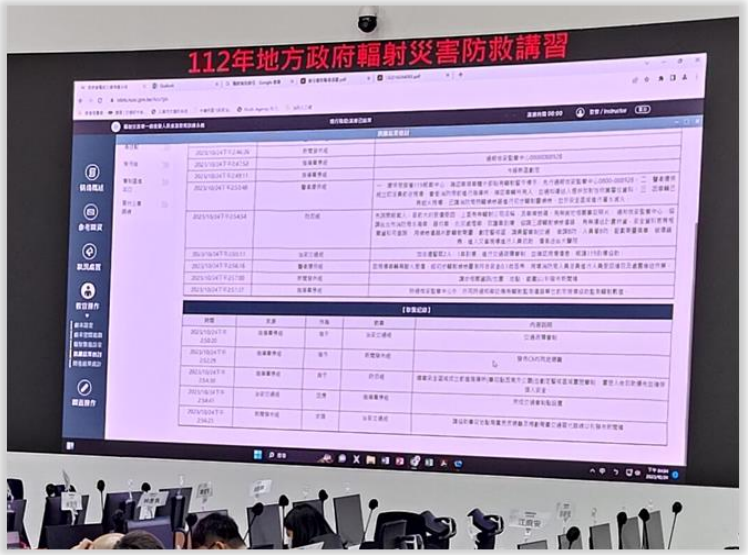
委員觀察重點：演習流程是否順暢與各工作人員對所屬任務認知與熟悉程度

委員臨時口試，受評者回答適切與否
狀況題：昏燒、噁心並嘔吐、心悸、喪失意識

於氣球人上測得之輻射源數量

G:Good, P:Pass, F:failure, NA: Not Available



Local Government Radiation Disaster Prevention and Rescue Training 2023 & 2024

Participants include the Police Department, Environmental Protection Agency, Fire Department, Health Department, and representatives from the NSC

Consistent Scenarios in Hospital Emergency Drills: Transportation of Radiological Materials Accident 2023

Chiayi Chang Gung Memorial Hospital

2023 National Nuclear Emergency Exercise

- Date and Location:
  - Held on September 12-14, 2023, at NPP 2.
- Focus:
  - Preparedness for complex disasters and nuclear accidents.
  - Included scenarios inspired by the Ukraine-Russia conflict.
- Objectives:
  - Validate the facility's emergency self-defense abilities.
  - Demonstrate response capabilities.

Participants include representatives from both the central and local governments, including the Military (Army Chemical Corps & Troops).

2024 National Nuclear Emergency Exercise

- Date and Location:
  - September 10-11, 2024, at NPP 1.
- Scenario:
  - Nuclear accident during NPP 1 decommissioning.
  - Included response under military threats.
- Focus Areas:
  - Spent fuel pool cooling.
  - Backup communication systems.
  - Radiation injury rescue.

Conclusion: Nuclear Disaster Medical Care and Response in Taiwan

- Integrated System:
  - Effective multi-agency coordination ensures robust radiation emergency response.
- Education and Innovation:
  - International collaboration enhances sustainable training and preparedness.
- Comprehensive Framework:
  - Holistic response spans pre-hospital care to national exercises.

Thank you for listening !

Any question ?