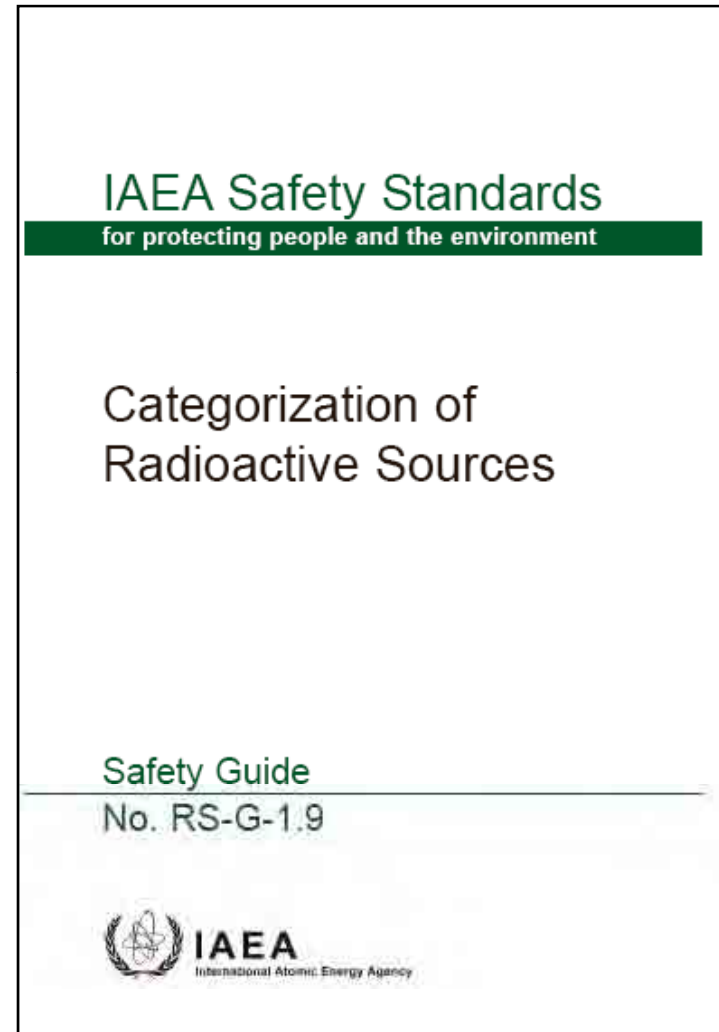


# CATEGORIZATION OF RADIOACTIVE SOURCES

## OBJECTIVE

- Provides a system for ranking of sources and practices in terms of their potential to cause harm to human health.





## OBJECTIVE

- Categorization supports international harmonization of controlling radioactive sources and their security
  - Code of Conduct on the Safety and Security of Radioactive Sources
  - Guidance on the Import and Export of Radioactive Sources



## APPLICATIONS OF CATEGORIZATION

- Developing or refining national regulatory infrastructures
- Developing national strategies for improving control over radioactive sources
- Optimizing use resources by setting priorities for regulation
- Optimizing security measures for radioactive sources
- Emergency planning and response



## SCOPE OF CATEGORIZATION

### Radioactive sealed sources

- Sources used in industry, medicine, agriculture, research and education
- Categorization is concerned with sealed sources.
- However, the method can also be used to unsealed sources.



## CATEGORIZATION **NOT** APPLICABLE TO

- ❑ Radiation generating devices (x-ray machines, accelerators)
- ❑ Nuclear material
- ❑ Sources within military or defence programmes
- ❑ Waste management of disused radioactive sources
- ❑ Packages of radioactive material in transport



## CATEGORIZATION SYSTEM

- The categorization is based on the concept of dangerous sources which are quantified in terms of D values.
- The D value is the radionuclide specific activity of a source which, if not under control, could cause severe deterministic effects.
- D values are used as normalizing factors to provide a reference for comparing risks.



## EXPOSURE SCENARIOS USED IN DERIVING THE D VALUES

- An unshielded source
  - carried in the hand for one hour
  - carried in a pocket for 10 hours
  - being in a room for days to weeks
- Dispersal of a source by fire, explosion or human action
  - inhalation, ingestion and/or skin contamination

## DOSE CRITERIA USED IN DERIVING THE D VALUES

Tissue	Dose criteria
Bone marrow	1 Gy in 2 days
Lung	6 Gy in 2 days from low LET 25 Gy in a year from high LET
Thyroid	5 Gy in 2 days
Skin/tissue (contact)	25 Gy at a depth of 2 cm (or 1 cm for the hand), for a period of 10 h
Bone marrow	1 Gy in 100 h for a source that is too big to be carried

## EXAMPLES OF THE D VALUES

Radionuclide	D Values
Am-241	0.06
Co-60	0.03
Cs-137	0.1
Ir-192	0.08
Pu-238	0.06
Sr-90	1.0
Tc-99 <sup>m</sup>	0.7



## CATEGORIZATION SYSTEM

Initial ranking of sources:

- the activity (A) of a source is divided by the corresponding radionuclide specific D value.
- for commonly used sources the ratio A/D ranges from  $10^6$  to  $10^{-6}$ .
- to obtain useful number of categories also other factors are considered:
  - physical and chemical form
  - type of shielding
  - circumstances of use
  - accident case histories

## CATEGORIZATION SYSTEM (CONT)

- Five categories are introduced

CATEGORY	ACTIVITY RATIO (A/D)
1	$A/D \geq 1000$
2	$1000 > A/D \geq 10$
3	$10 > A/D \geq 1$
4	$1 > A/D \geq 0.01$
5	$0.01 > A/D$ and $A > \text{exempt}$

# CATEGORY 1

$A/D \geq 1000$

Examples :

- Radioisotope thermoelectric generators (RTGs)
- Irradiators
- Teletherapy sources
- Fixed, multi-beam teletherapy (gamma-knife) sources



# CATEGORY 2

$$1000 > A/D \geq 10$$

Examples :

- Industrial gamma radiography sources
- High/medium dose rate brachytherapy sources

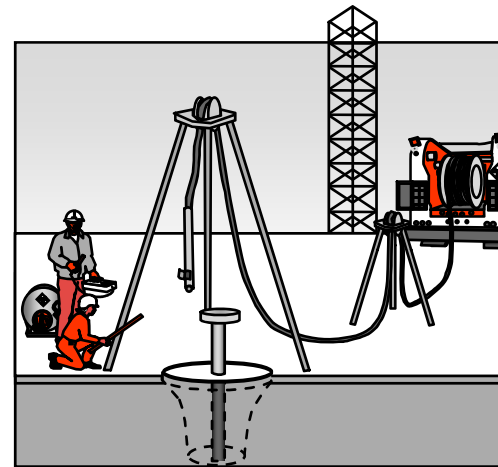


# CATEGORY 3

$$10 > A/D \geq 1$$

Examples :

- Fixed industrial gauges that incorporate high activity sources
- Well logging gauges

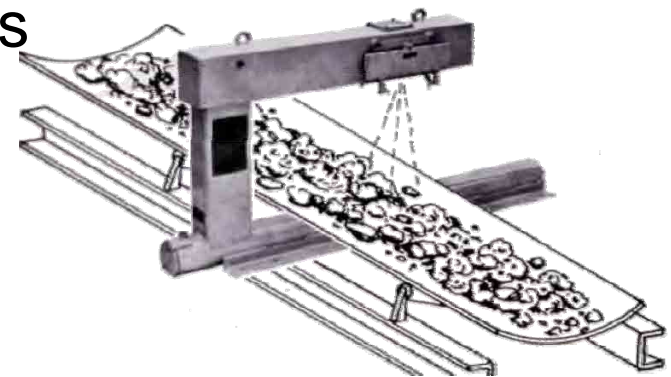


# CATEGORY 4

$$1 > A/D \geq 0.01$$

Examples :

- Low dose rate brachytherapy sources (except eye plaques and permanent implants)
- Industrial gauges that do not incorporate high activity sources
- Bone densitometers
- Static eliminators



# CATEGORY 5

## 0.01 >A/D AND A > EXEMPT

Examples :

- Low dose rate brachytherapy eye plaques and permanent implant sources
- X-ray fluorescence (XRF) devices
- Electron capture devices
- Mossbauer spectrometry sources
- Positron emission tomography (PET) checking sources





## CATEGORY : EFFECT vs TIME

CATEGORY	PERMANENT INJURY	FATALITY
1	SEVERAL MINUTES	SEVERAL MINUTES TO HOUR
2	SEVERAL MINUTES TO HOUR	SEVERAL HOURS TO DAY
3	SEVERAL HOURS	SEVERAL DAYS TO WEEK
4	SEVERAL WEEKS TO MONTH (not permanent)	-
5	-	-



## SUMMARY OF CATEGORIZATION SYSTEM

		Activity ratio A/D
	Teletherapy sources Irradiators	1000
<b>1</b>	Industrial gamma radiography sources High/medium dose rate brachytherapy sources	10
<b>2</b>	Industrial gauges with high activity sources Well logging gauges	1
<b>3</b>	Low dose rate brachytherapy sources Industrial gauges with moderate/low activity sources	0.01
<b>4</b>	X-ray fluorescence (XRF) devices Electron capture devices	exempt

**5**



## USE OF THE CATEGORIZATION SYSTEM

### Regulatory measures

- A factor to be taken into account in a graded system for notification, registration and inspections.
- Assist in ensuring that allocation of resources to protection measures is commensurate with the degree of risk.

### Security measures

- To optimize security measures for radioactive sources, including measures directed against their possible malicious misuse.



## USE OF THE CATEGORIZATION SYSTEM (CONT)

### National register of sources

- To optimize decisions regarding which sources should be included and what level of detail should be used in a national

### Import/export controls

- To optimize decisions regarding which sources should be subject to import and export controls, in meeting national and international standards.



## USE OF THE CATEGORIZATION SYSTEM (CONT)

### Labelling of high activity sources

- To guide decisions regarding which sources should be marked with an appropriate label warning of the radiation hazard.

### Emergency preparedness and response

- To ensure that emergency preparedness plans and response to accidents are commensurate with the hazards posed by the source.

# EMERGENCY PREPAREDNESS AND RESPONSE

CATEGORY	EMERGENCY RESPONSE PLAN
1	Specific Plan
2	
3	
4	Generic Plan
5	



## USE OF THE CATEGORIZATION SYSTEM (CONT)

Prioritization for regaining control over orphan sources

- To inform decisions relating to how efforts should be focused to regain control over orphan sources.

Communication with the public

- To provide a basis for explaining the relative hazard associated with events involving radioactive sources.



# COMMUNICATION WITH THE PUBLIC

In summary:

Category	Risk in being close to an source
1	Extremely dangerous
2	Very dangerous
3	Dangerous
4	Unlikely to be dangerous
5	Most unlikely to be dangerous

# SECURITY OF RADIOACTIVE SOURCES



# SAFETY

- Radiation safety was the prime focus, and the sources could be used for their intended beneficial purposes without harming either the user or the public.
- Safety deals with attempt to prevent/ minimize the exposure to radioactive sources, that may cause harm to human health.
  - e.g Application of shielding when handling radioactive sources



# SAFETY AND SECURITY

- Security is a prerequisite to safety
- Safety and security aspects of sources are intimately linked and share a common aim
- However security measures need enhancement to take into account the threat of people acquiring control of radioactive sources for malevolent purpose.



# SECURITY

- Security deals with attempting to prevent unauthorized or illegal acquisition and use of radioactive sources, with or without intention, including act for malevolent purpose.
  - e.g; CCTV at the radioactive sources storage facility
  
- Security failure, may lead to the safety incident/accident.
  - Gamma projector theft may lead to accidental radiation exposure to the public.



# PURPOSE OF SECURITY MEASURES

## To prevent

- Unauthorised access to radioactive sources at all stages of their life cycles (storage, use, transport, decommissioning and disposal)
- Damage to radioactive sources
- Loss of radioactive sources
- Theft of radioactive sources
- Unauthorised transfer and use and of radioactive sources

# Loss of Control of Radioactive Sources can be;

## ■ Inadvertent:

- Misplaced
- Forgotten
- Dispersed (such as in an accident)
- Insecurely stored
- Unintended or collateral theft (e.g. vehicle containing material stolen)

## ■ Intentional:

- Abandoned
- Dumped
- Directly stolen

# Criminal Purposes Involving Radioactives Sources can be;

## ■ Malevolent:

- Radiological Disperse Device (RDD)
- Intent to harm others
- Terrorist threats

## ■ Financial:

- Illegal sale for profit
- Avoidance of costs or other burdens of ownership (e.g. dumping to avoid disposal fees)
- Extortionist threats

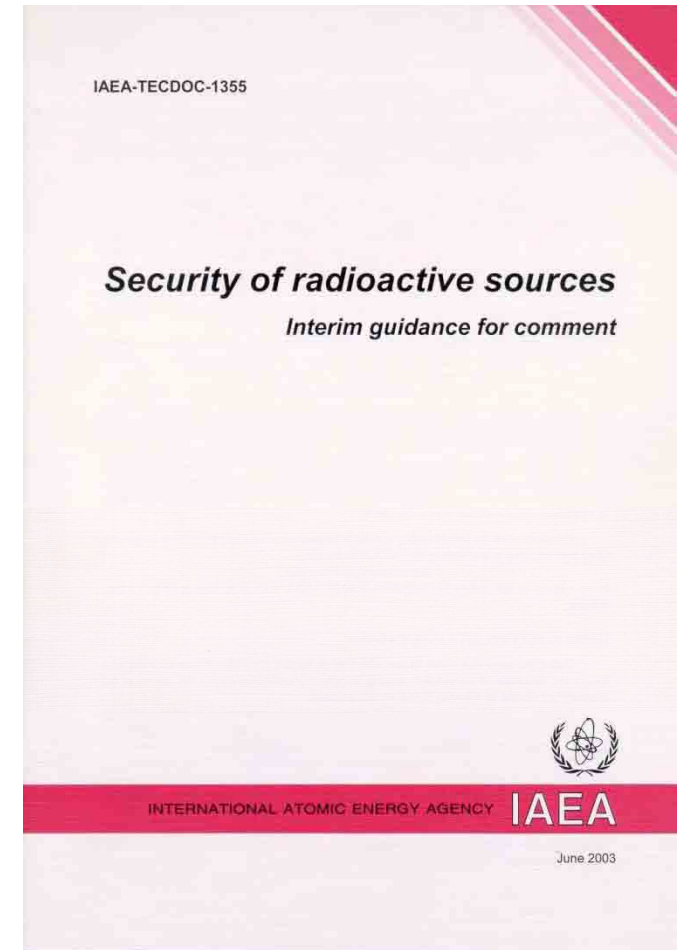
# SECURITY EVENTS INVOLVING RADIOACTIVE SOURCES

1.	<b>Missing Sources</b> (Medical) K.L	<b>1990s</b>
2.	<b>Sources Theft</b> (Industrial Radiography) Kuantan	<b>1990s</b>
3.	<b>Sources Theft</b> (Industrial Radiography) Taiping	<b>1990s</b>
4.	<b>Sources Storage Intrusion</b> (Industrial Radiography) Kemaman	<b>2001</b>
5.	<b>Sources Storage Intrusion</b> (Industrial Radiography) Miri	<b>2004</b>
6.	<b>Sources Storage Intrusion</b> (Industrial Radiography) Kemaman	<b>2006</b>
7.	<b>Missing Sources</b> (Oil Logging) Kemaman	<b>2007</b>
8.	<b>Sources Theft</b> (Industrial Radiography) Sibul	<b>2007</b>

# SECURITY OF RADIOACTIVE SOURCES

## Tecdoc 1355

- Intended to provide guidance to regulatory body, manufacturers, suppliers and users of sources in deciding which security measures are needed to ensure consistency with the International Basic Safety Standards and the Revised Code of Conduct for the Safety and Security of Radioactive Sources.





# OVERVIEW

- It is recognized that there must be a balance between managing sources safely and securely, while still enabling them to be used by authorized personnel without undue hindrance
- The level of security should be commensurate with the potential hazard posed by the source, recognizing the need to ensure appropriate use of the source for beneficial purposes.



# OVERVIEW

- To ensure security of sources requires that measures be applied to prevent unauthorized access to radioactive sources at all stages of their life cycle, as well as loss, theft, and unauthorized transfer of sources.
- To ensure the safety of radioactive sources requires controlling exposure to radiation from sources, both directly and as a consequence of incidents, so that the likelihood of harm attributable to such exposure is very low.



# OBJECTIVES

## ■ IAEA - TECDOC 1355

### Security of Radioactive Sources

- To assign radioactive sources into Security Groups
- To ensure security measures in place
- To prevent unauthorised access/acquisition
- To detect actual theft or loss
- To perform respond and recovery



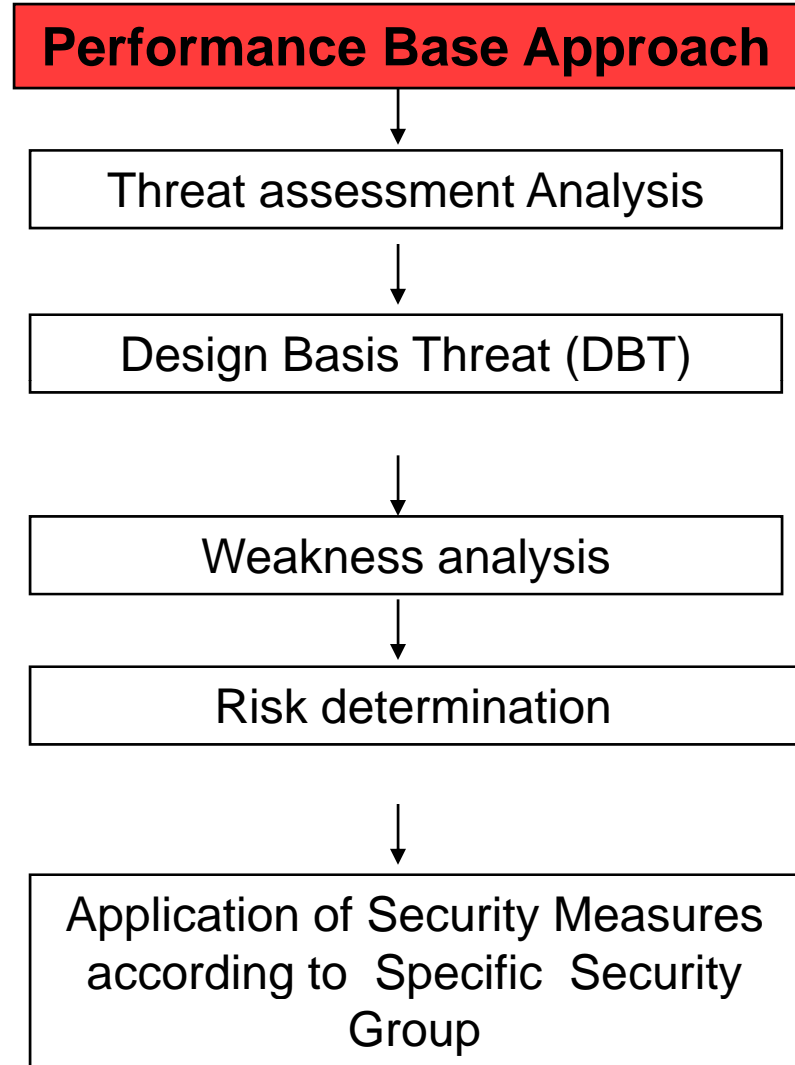
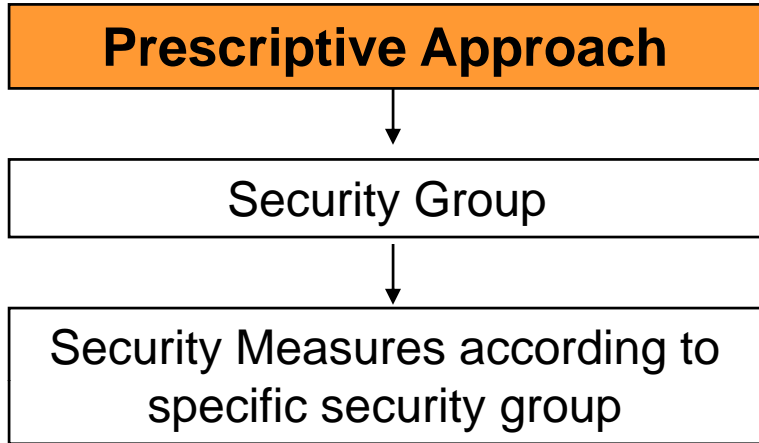
# OVERALL STRATEGY

- Radioactive sources is assigns to one of four“Security Groups,” based on either
  - National Threats and Vulnerabilities Assessment (*Performance Base Approach*), or
  - Assignment based on Categorization (*Prescriptive Approach*)
    - Category of source to Security Group



# OVERALL STRATEGY

- The security measures applies should meet specified Performance Objectives
  - For Applicable Security Group A,B,C and D
  - Through a combination of Technical and Administrative Measures





# BASIC APPROACH

- Design the security system for a given source according to a three-step process
  - Determine the security risk
  - Establish performance objectives for the security system commensurate with the risk
  - Identify a combination of security measures that meets the performance objectives



# DETERMINING THE RISK

- Determine the risk in either of two ways:
  - Threat assessment and vulnerability analysis
  - “Default” assignment of sources to one of four security groups(A,B,C,D) ased on the category of the source (1,2,3,4,5)
    - Each security group corresponds to a different general level of risk
    - Specific circumstances could justify moving a given source up or down to a higher or lower security group

# SECURITY GROUPS BASED ON CATEGORIZATION

Security Group	Source Category	Examples of Practice
A	1	Radioisotope thermoelectric generators (RTGs) Irradiators Telegraphy Fixed multi-beam teletherapy (Gamma Knife)
B	2	Industrial radiography High/Medium dose rate brachytherapy
	3	Fixed industrial gauges (eg. Level, dredger, conveyor) Well logging gauges
C	4	Low dose rate brachytherapy (except those below) Thickness/fill-level gauges Portable gauges (eg. Moisture/density) Bone densitometers Static eliminators
D	5	Low dose rate brachytherapy eye plaques X ray fluorescence devices Electron capture devices



# ESTABLISHING THE PERFORMANCE OBJECTIVES

- Base the capability required from security systems on the level of risk
  - As determined by threat assessment and vulnerability analysis, or
  - By default assignment to security groups based on the category of the source in Table 2
  
- Express the required level of capability as performance objectives on the security system

# PERFORMANCE OBJECTIVES

Security Group A	Security Group B	Security Group C	Security Group D
<b>Safe management and protect as an asset</b>			
<b>Deter unauthorized access</b>			<b>Verification of source presence at set intervals</b>
<b>Timely detection of unauthorized access</b>			
<b>Timely detection of unauthorized acquisition of the radioactive source</b>			
<b>Delay acquisition until response is possible</b>			



# DESIGNING THE SECURITY SYSTEM

- Design the security system to meet the applicable performance objectives through a combination of security measures, including
  - General administrative measures (common for the management of all sources)
  - Administrative measures (graded according to security group)
  - Technical measures (graded according to security group)

# RECOMMENDED SECURITY MEASURES

Group A	Group B	Group C	Group D
<b>General Administrative Measures</b>			
<b>Daily Accounting</b>	<b>Weekly Accounting</b>	<b>Semi-annual Accounting</b>	<b>Annual Accounting</b>
<b>Access Control to Source Location Allowing Timely Detection of Unauthorized Access</b>		<b>Access Control to Source Location</b>	<b>No Specific Provisions. Routine Measures to Ensure Safe Use and Protect as an Asset</b>
<b>Deterrence provided by:</b>			
<b>Two Technical Measures Separating the Source from Unauthorized Personnel</b>	<b>Two Measures (one technical) Separating the Source from Unauthorized Personnel</b>	<b>One Technical Measure Separating the Source from Unauthorized Personnel</b>	
<b>Specific Emergency Response Plan</b>		<b>Generic Emergency Response Plan</b>	
<b>Background Checks</b>			
<b>Security Plan</b>			
<b>Information Security</b>			
<b>Upgrade Security for Increased Threat</b>			
<b>Timely Detection Provided by:</b>			
<b>Remotely Monitored Intruder Alarm</b>	<b>Local Alarm</b>		
<b>Timely Response to an Alarm</b>			



# GENERAL ADMINISTRATIVE MEASURES

- Develop and maintain Security Culture
- Prepare and exercise emergency plans for loss of control of sources
- Protect the confidentiality of security-sensitive information
- Manage sources in accordance with authorization
- Promptly store sources not in use in an approved manner
- Transfer sources only to authorized recipients



# GENERAL ADMINISTRATIVE MEASURES

- Ship and receive sources in accordance with regulatory requirements
- Ensure that personnel with access to sources are reliable, authorized, and have proper training
- Inventory sources at least annually
- Maintain and update source records are maintained and updated
- Promptly report unusual events that may affect security



# ADMINISTRATIVE MEASURES

- Administrative measures
  - Policies, procedures, and practices that direct personnel to securely and safely manage sources
  - Support or supplement technical measures



# APPLICABLE ADMINISTRATIVE MEASURES

Appropriate administrative measures include:-

- source inventories;
- regulations and guidance;
- reliability and trustworthiness of personnel;
- information security;
- quality assurance measures; and
- establishment of a safety culture and security culture.



# APPLICABLE ADMINISTRATIVE MEASURES

Appropriate administrative measures include:-

- access control procedures;
- alarmed access points (e.g. with radiation detectors);
- key control procedures;
- video cameras or personal surveillance;
- records related to the management of sources;



# TECHNICAL MEASURES

- Technical measures
  - Measures that pose a physical barrier to the source, device or facility
    - To separate it from unauthorized personnel
    - To deter or prevent unauthorized access or removal of a source

# APPLICABLE TECHNICAL MEASURES

Appropriate technical measures include:-

- fences;
- walls;
- cages;
- transport packaging;
- locks and interlocks for doors (or access points)
- locked, shielded containers;



# Adoption of CoC

## Way Forward?

- AELB make compulsory to licensee to implements the elements of Code of Conduct on the Safety and Security of Radioactive Sources and the three supporting documents;
  1. **Categorization of Radioactive Sources**
  2. **Security of Radioactive Sources**
  3. **Guidelines on Import and Export of Radioactive Sources**

in **License Conditions, Radiation Protection Program** and **all Approval Application Procedures**

effective January **2009**



*Thank  
you*