Integrated Management Program for Radioactive Sealed Sources in Egypt IMPRSS

Ahmed Hasan
Sandia National Laboratories
Department of Energy
Albuquerque, New Mexico 87185-0720

Karim El-Adham
National Center for Nuclear Safety and Radiation Control
Egyptian Atomic Energy Authoirty
Cairo, Egypt

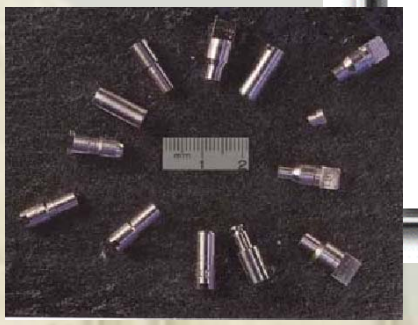
Presentation to
ANES/SENA 2004 Symposium
Miami Beach, Florida, USA

October 3-6, 2004

Sandia is a multi-program laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000

What Are Sealed Radioactive Sources (SRSs)?

- Usually in “capsules” made of stainless steel. The size of a pen or a finger
- Contains one of hundreds of radioactive elements (e.g., Iridium, Radium) or their isotopes
- Air-tight and very durable
- Radioactive material is contained but not radiation
- Radiation is used in applications – in the health sector, industry, military, and universities




Sealed Source Container


Radiochemical Transport Container

What Are Sealed Radioactive Sources (SRSs)?

TABLE I. APPLICATIONS OF SEALED RADIOACTIVE SOURCES

Application	Radionuclide*	Half-life	Comments
I. Industrial application			
Thickness gauge	^{85}Kr (gas)	10.8 a	To measure thickness of pa
	^{90}Sr	28.1 a	and similar materials.
	(^{14}C, ^{32}P,	(5730 a, 14.3 d	
	^{147}Pm, ^{241}Am)	2.6 a, 432.2 a)	
Level gauge	^{137}Cs	30.2 a	To measure levels in cont
	^{60}Co	5.3 a	silos) and packages (e.g. tin
	(^{241}Am)	(432.2 a)	
Density gauge	^{137}Cs	30.2 a	To measure mass tra
	^{241}Am	432.2 a	conveyor belts.
	(^{90}Sr)	(28.1 a)	
Moisture detector	^{241}AmBe	432.2 a	Neutron source to measure
	(^{252}Cf, ^{226}Ra-Be)	(2.6 a)	sand, soil, etc. May be portable equipment.
Industrial radiography	^{60}Co	5.3 a	Used for non-destructive te
	^{192}Ir	73.8 d	be used as fixed or portable
	(^{137}Cs, ^{170}Tm)	(30.2 a, 128.6 d)	
Eliminator for static electricity	^{210}Po	138.4 d	Used in film industry. May
	^{226}Ra	1600 a	fixed or portable equipment
	^{241}Am	432.2 a	
Roentgen fluorescence analyzer	^{55}Fe	2.7 a	Portable equipment used
	(^{238}Pu, ^{241}Am)	(87.7 a, 432.2 a)	metals
Well logging	^{241}Am-Be	432.2 a	Portables units
	^{137}Cs	30.2 a	
Sterilization	^{60}Co	5.3 a	Used to sterilize medical
	^{137}Cs	30.2 a	and for food preservation
II. Research application			
Electron capture detector	^{3}H	12.3 a	Used as detector in gas
	(^{63}Ni)	(100 a)	chromatographs
Tritium targets	^{3}H	12.3 a	Used to produce neutrons by D,T-reactions
Calibration sources	Many different radionuclides		Used for function and efficiency control of instruments and for calibration
Irradiator	^{60}Co	5.3 a	Fixed installation
Eliminator for static electricity	^{210}Po	138.4 d	Used in analytical balances
	^{226}Ra	1600 a	
III. Medical application			
Clinical teletherapy	^{60}Co	5.3 a	
	(^{137}Cs, ^{192}Ir)	(30.2 a, 73.8 d)	
Brachytherapy	^{137}Cs, ^{192}Ir,	30.2 a, 73.8 d,	Small portable sources
	^{226}Ra, ^{60}Co	1600 a, 5.3 a	
Eye applicator	^{90}Sr	28.6 a	Small calottes
	^{32}P	14.3 d	
Calibration of gamma camera	^{57}Co	5.3 a	
Heart stimulator	^{238}Pu	87.7 a	Batteries
Bone densitometer	^{241}Am	432.2 a	
	^{125}I	59.4 d	

* Other radionuclides which may also be used for the application are given in brackets.

Met Halfa, Egypt, 2000

- 3 TBq or 1.85 TBq of 192-Iridium
- Source used to inspect natural gas pipeline welds
- Source was not recovered after the job
- Authorities were not notified
- Farmer picked up, took home
- Farmer and son got skin burn
- Both farmer and son died
- Rest of family hospitalized
- 4 men charged with gross negligence and manslaughter

Goiania, Brazil, 1987

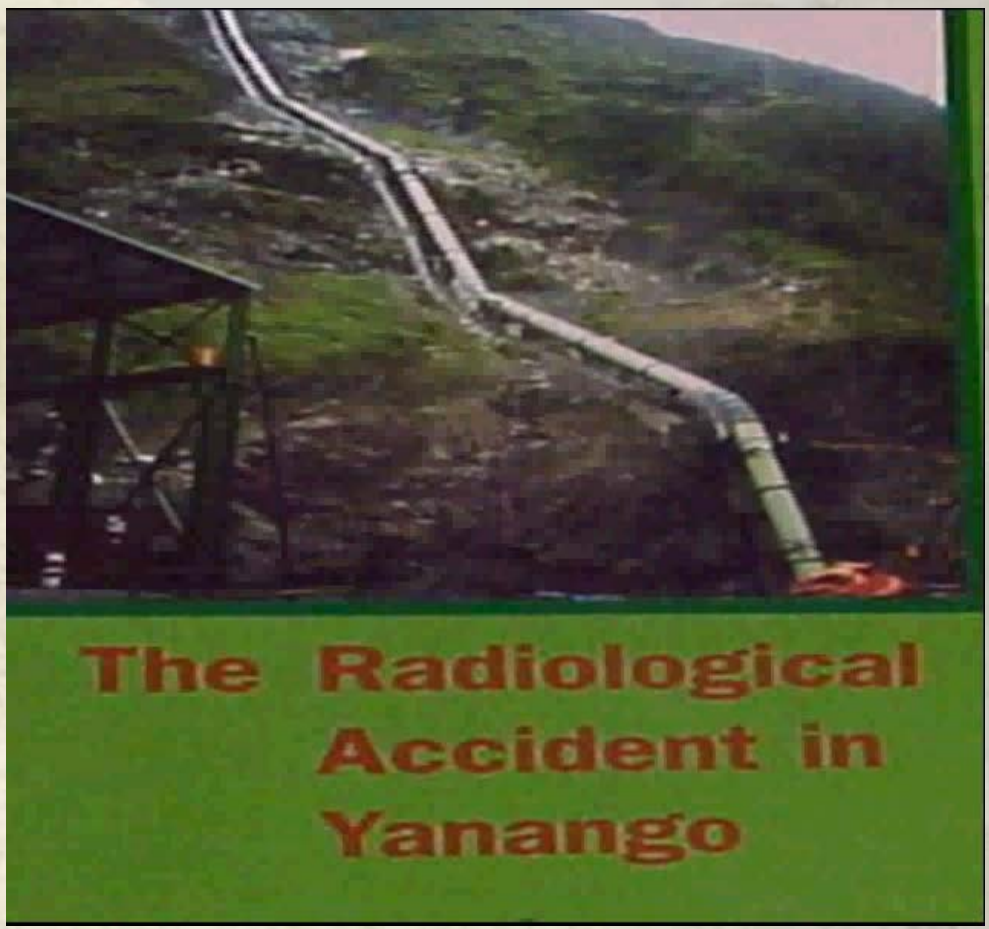
- Abandoned source from teletherapy
- 1,375 Curie of Cesium-137 (50.9 TBq)
- Stolen from a medical clinic and deliberately cut open
- Children played with glowing material inside
- 3,500 cubic meters of powder dispersed over a large urban area
- Waste, soil, and buildings had to be cleaned up
- 110,000 people sought medical attention
- Several hundred people with injuries
- 249 people contaminated
- 28 people with serious radiation burns
- 4 deaths within days
- Mass hysteria

Mexico and Southwest U.S., 1977 – 1984

- Began in Juarez
- 37 TBq of 60-Cobalt
- Insecure storage, key staff leave
- 6,000 metal pellets sold for scrap
- Source ruptured in transit to foundry
- Ended up in rebar in S.W. U.S.
- 814 homes torn down
- 2,500 pieces of furniture destroyed
- 4,500 tons of metal removed
- 16,000 cubic meters of soil

Peru, 1999

- Industrial source
- 1.37 TBq of 192-Iridium
- Welder took home
- Source recovered in 24 hours
- Family exposed
- Welder lost leg



Poland, 2001

- Neptun 10P Linear Accelerator
- Alycon Cobalt 60 machine
- Degradation of machine due to power outage
- New source miscalibrated, mistook hundreds of a minute for seconds
- Resulted in overdoses of about 60 %
- 5 patients affected

Reducing the Threat of SRSs: A Difficult Challenge

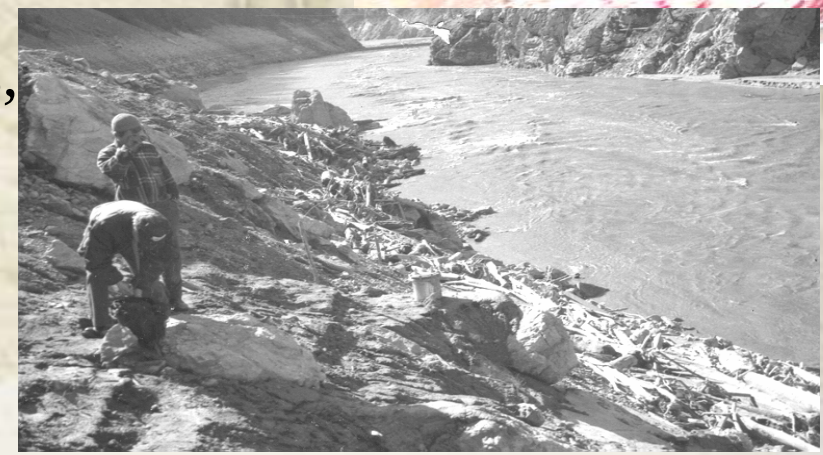
- Sealed sources enhance human welfare
- Sealed sources have enhanced the lives of millions of people
- Important for growth and progress
- We must respect sealed sources and properly manage them
- Source security is urgent
- Lack effective national radiological protection programs

Border Crossing

Airports

Reducing the Threat of SRSs: A Difficult Challenge

- Misuse causes injury, death, and panic
- Critical to prevent unintended access
- Orphan sources are a problem
- Lack effective regulations, regulatory bodies, and enforcement
- Lack effective training of workers and management



Reducing the Threat: It Can Be Done

Complacency or Commitment
--the Choice is Ours--

IMPRSS: Egypt

The IMPRSS Mission

- Protect human health and the environment in Egypt from mismanaged sealed sources
- Develop – jointly with MOH and EAEA – Cradle-to-Grave capabilities for managing radioactive sealed sources in Egypt
- Increase public awareness
- Provide education and training
- Improve emergency response capabilities
- Develop a permanent disposal facility
- Ensure the program is self-sustaining
- Ensure close coordination with the IAEA

The IMPRSS Vision

Build trust, transparency, and teamwork while transferring skills and technologies to create a sustained program

A joint partnership:

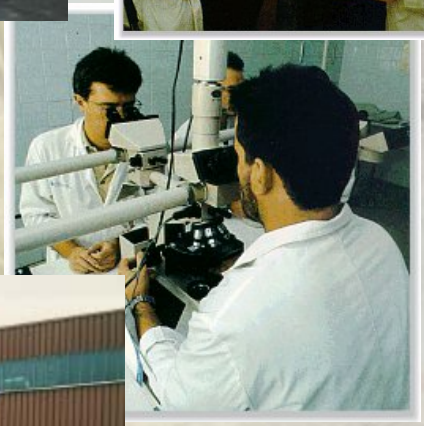
- Egyptian Atomic Energy Authority
- Egyptian Ministry of Health
- Sandia National Laboratories
- International Atomic Energy Agency
- Others

Cradle-to-Grave: What It Means

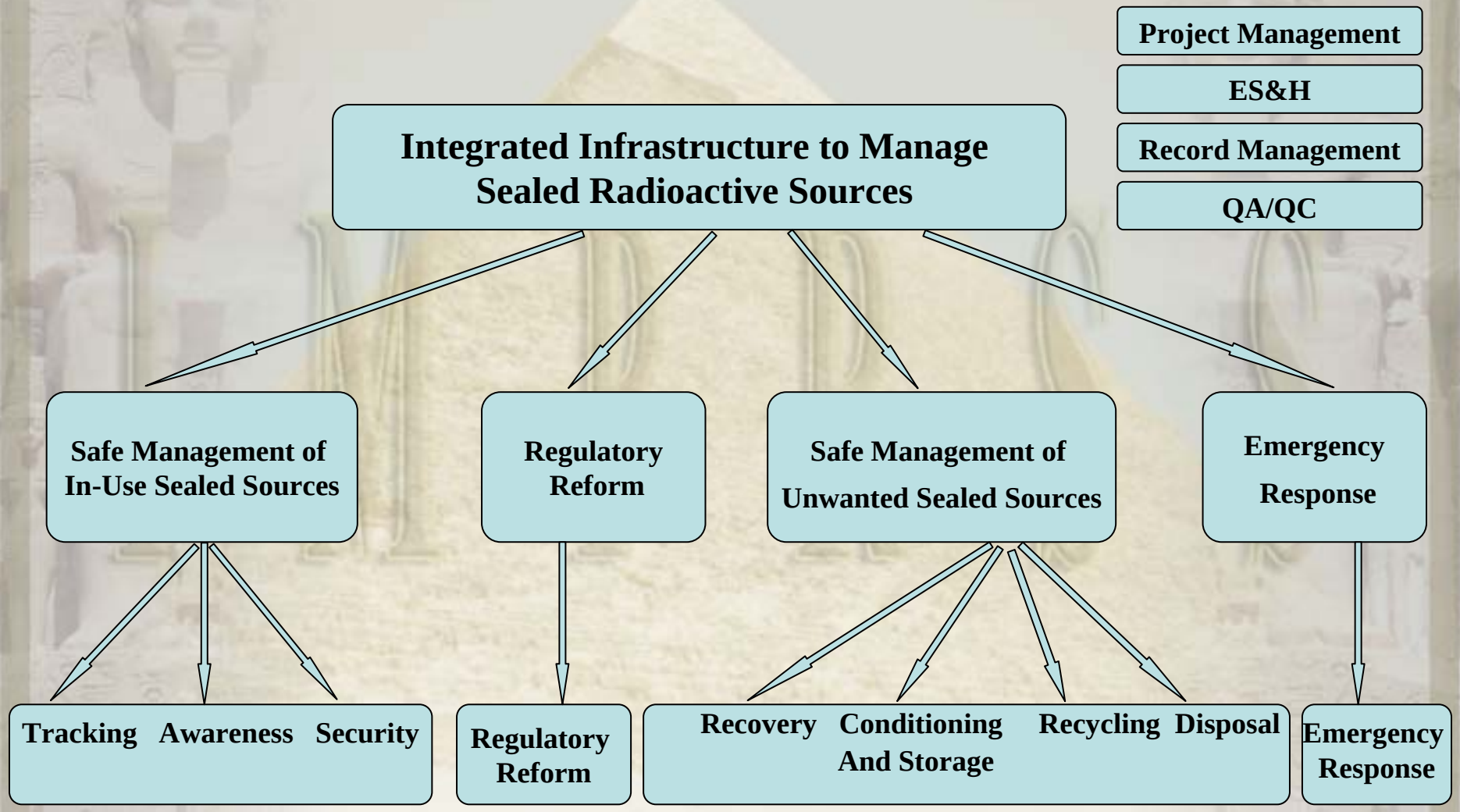
- Adequate management practices
- Handling and control of radioactive sealed sources through the lifecycle of the source
  - import into the country
  - exporting back to original manufacturer
  - final disposal in intermediate depth-bore hole

Cradle-to-Grave includes Everyone in Egypt who . . .

- Produces
- Sells
- Purchases
- Imports
- Exports
- Trades
- Possesses
- Processes
- Handles
- Transports
- Uses
- Stores, and/or
- Disposes
- of a Sealed Source



Cradle-to-Grave Infrastructure



Safe Management of In-Used Sealed Sources: Awareness

- Awareness
  - Develop awareness campaign
  - Distribute information to public
  - Develop training material for source owners
  - Train sealed sources owners
  - Joint workshop (EAEA, source owners, import agencies, universities, etc.)
  - Monthly newsletter

Safe Management of In-Used Sealed Sources: Tracking and Inventory Control

Tracking

Collect information about all imported and locally produced sealed sources

Purchase the necessary equipment (computers, printers, software, etc.)

Design the database

Populate the database

Maintain the database

Quality Assurance and Quality Control (QA & QC)

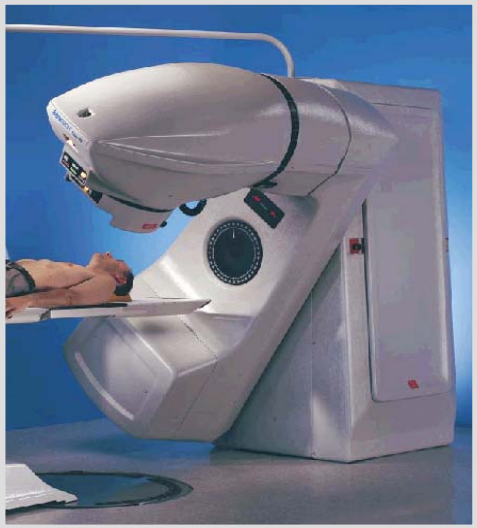
Safe Management of In-Used Sealed Sources: Security

Security

Develop security scenarios

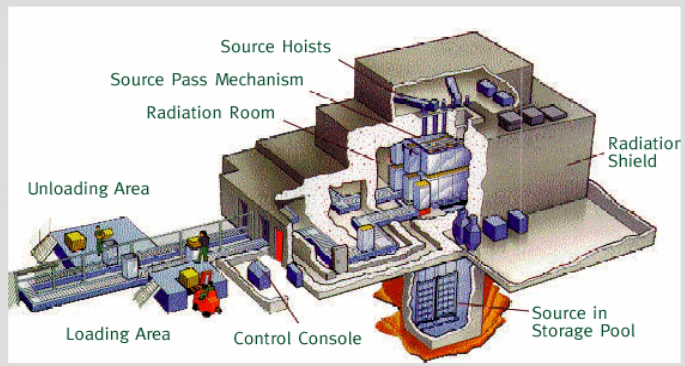
Review US and international standards

Train EAEA and MOH on security assessment



Teletherapy unit (500 TBq ^{60}Co)

Food irradiator 400 000 TBq ^{60}Co



Safe Management of Unwanted Sources: Recovery

Recovery

Gather information on the expired sealed sources

Evaluate EAEA capabilities for recovery

Purchase necessary equipment for recovery

Conduct training in the US and Egypt

Discarded teletherapy source in Thailand, ~25 TBq Co-60

Safe Management of Unwanted Sources: Conditioning and Storage

Conditioning

- **Evaluate the different conditioning techniques for different sources at the IAEA and different countries**
- **Purchase equipment and build conditioning facility**
- **Develop techniques for safe handling of radionuclides during conditioning**
- **QA & QC**

Storage

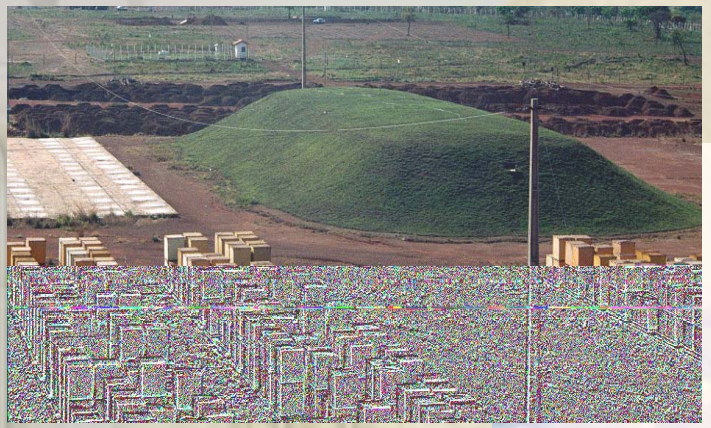
- **Evaluate the current storage facility at EAEA**
- **Update storage facilities at EAEA**
- **QA & QC**

Safe Management of Unwanted Sources: Recycling

Industrial radiography source

- Gather information on the expired sealed sources
- Develop database for recycled sources
- Refurbish, Calibrate, and certify recycled sources

Safe Management of Unwanted Sources: Disposal



Disposal

- **Review international practices**
- **Define site selection criteria for disposal**
- **Conduct site selection process**
- **Conduct safety analysis**
- **License, construct, and operate facility**
- **QA & QC**

Emergency Response

Equipment

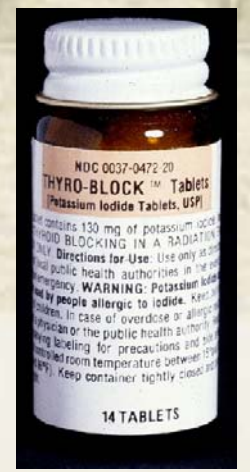
- Survey instruments
- Personal protective equipment
- Decontamination equipment
- QA & QC
- Uniforms, barricades, and other disposable materials
- Mobile response unit

Emergency Plan Development

- Draft response plans
- Coordinate with other government organizations (police, military, etc.)

Training

- Develop training material
- Conduct regular training drills
- Certify response team



Regulatory Reform

Regulatory Reform

Review Egyptian regulations

Review international standards

Develop regulatory recommendations

Support regulatory reform

Education and Training

- Training is the main engine for radiation protections.
- Human capacity development is key to the success of IMPRSS in Egypt.

Training Targets

- Radiological workers
- Radiological operations managers
- Radiological Protection Experts (RPEs)
- Other medical professionals
- Regulators
- Inspectors
- Customs and border police
- Police and other law enforcement
- Handlers
- Transport workers
- First responders

Training Approach

- Curriculum with needed knowledge and skills in Arabic
- Mix of courses, workshops, and on-the-job training
- Continuous post-graduate education and specialized training
- “Train the trainers” approach
- Examinations and assessments
- Certificates, licensing, and accreditation
- Update training curricula continuously
- Assess training programs – Are they effective? Successful?

It Can Be Done

- The government of Egypt can protect the people of Egypt – and be ready for emergencies
- Prevention is the first line of defense
- Detection is the second line of defense
- Adequate Emergency Response saves lives
- Adequate control reduces risk of mismanaged uses or deliberate misuses of sources
- Cradle-to-Grave approach is built on existing capabilities at EAEA and MOH