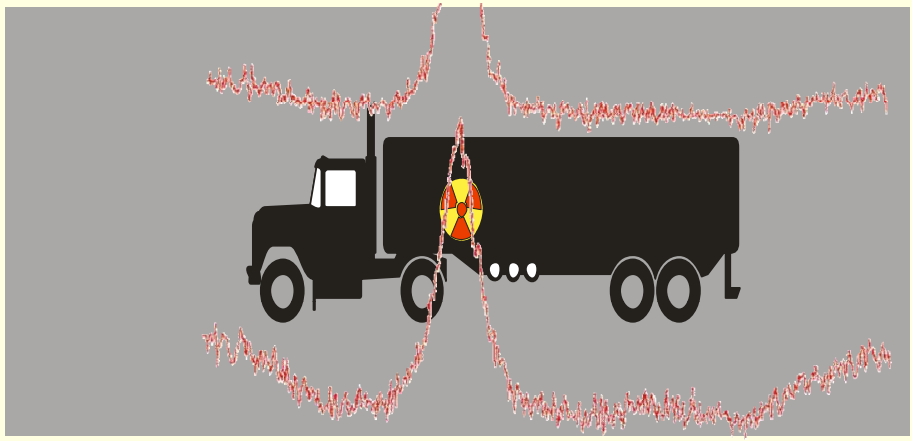
National Dept. Health

Radio-nuclides in Scrap Metal



Emma Snyman
Sub-Directorate: Radio-nuclides
Directorate Radiation Control
14 Sep 2011

Overview

- Legislation
- Response – Guideline & Example
- Reporting of Incidents
  - National- & International responsibility
  - ITDB (Illicit Trafficking Database)
  - INES (International Nuclear Event Scale)

Legislative framework

Sub-Directorate: Radio-nuclides

- **Hazardous Substances Act** (Act 15 of 1973)) - **Group IV** Hazardous substances
- **Regulations R246 & 247 (1993)**
- Conditions & Codes of Practice

- The Radioactive Waste Management Policy and Strategy for the Republic of South Africa
- Disaster Management Act
- National Radioactive Waste Disposal Institute Act, Act No. 53 of 2008

Regulatory Requirements

Hazardous Substance Act (15 of 1973)

Regulations (R247 of 1993) related to Group IV hazardous substances

Regulation 16: Reporting of Radiation Occurrences

- Every Authority Holder must **notify** the **Directorate Radiation Control** **immediately** by telephone, e-mail or facsimile of any radiation occurrence that took place.
- The RPO must also conduct a **full investigation** and compile a report which must be sent to the Directorate within **7 days** following the radiation occurrence

- **National Responsibility**
- **International Responsibility: SA Reports to IAEA: ITDB & INES**

Regulatory Requirements

Hazardous Substance Act (15 of 1973)
Regulations (R247 of 1993) related to Group IV hazardous substances

Regulation 25: Investigation into and notification of overexposure

- (1) Where an **employer who works with or transports a Group IV hazardous substance** suspects or is informed that any employee or other person has probably **received a radiation dose greater than four millisievert** as a result of that work or transport, he shall **immediately conduct an investigation** and shall forthwith by telephone, telegram, telefacsimile or other similar rapid means **notify-**

  (a) the Director-General; and
  (b) such employee or other person, of the suspected overexposure

  and **shall investigate, or arrange for an investigation** into the circumstances of exposure to ionising radiation, **make an assessment of the dose received** and forthwith notify the persons referred to in paragraphs (a) and (b) above of the results of that investigation and assessment.

- (2) An employer who conducts any investigation in terms of subregulation (1) shall **compile a report** on that investigation and **shall keep that report** and not destroy it except with the written consent of the Director-General.

Response

- **Scrap Metal Industry:** Contact SAPS Bomb Squad to secure safety
- **SAPS Bomb Squad:** Refer either to NNR or Radiation Control
- **Radiation Control:** Assess magnitude of situation
  Either assist in retrieval process or
  Call NECSA SHEQ to do retrieval
- **Call NECSA SHEQ:** Emergency Control Center to arrange safe retrieval & removal for final disposal
- **Report all incidents involving Radioactive sources:**
  Radiation Control Emergency contact numbers
  072 511 5046
  076 449 5675
- **Procedure manuals:** Response teams – to be developed
  Guidelines: Scrap Metal Industry – to be developed
- **Cooperation & Collaboration & Communication between all stakeholders**

Response

ALWAYS KEEP IN MIND:

Radiation Safety Principals:

- Distance
- Time
- Shielding

Response

Measuring maximum radiation levels on truck (± 930 µSv/h)

Response

Grapple

Measuring radiation levels

Second empty truck

Response

Measuring radioactive source with scrap inside grapple

Scrap spread out on tarred surface

Identification of radioactive source

Response

Steel rod to isolate radioactive source from scrap

Radioactive source

Radioactive source appears to be the bottom end of a borehole logging probe

Maximum radiation level measured on radioactive source was ±90 mSv/h with a level of ±200 µSv/h at 1 meter distance.

Response

Team from NECSA getting ready to retrieve the source

Final measurements and taking of smear sample

Response

Using of tongs to pick up source

Placing of source in container

Final identification of source type before removal from site

Response

This incident showed once again that

proper monitoring

is the only way to guarantee the detection of orphan sources in scrap. Even with the scrap spread out on the tarred surface and with the source clearly visible, it was **not possible** to identify the piece of metal as a radioactive source **without using a radiation monitor**.

Reporting of Incidents retreval

National Database Tracking of Incidents

National Responsibility

Ministry of Provincial and Local Government

Disaster Management Act (15 of 2002)

NIA (National Intelligence Agency)

Regulatory Authority

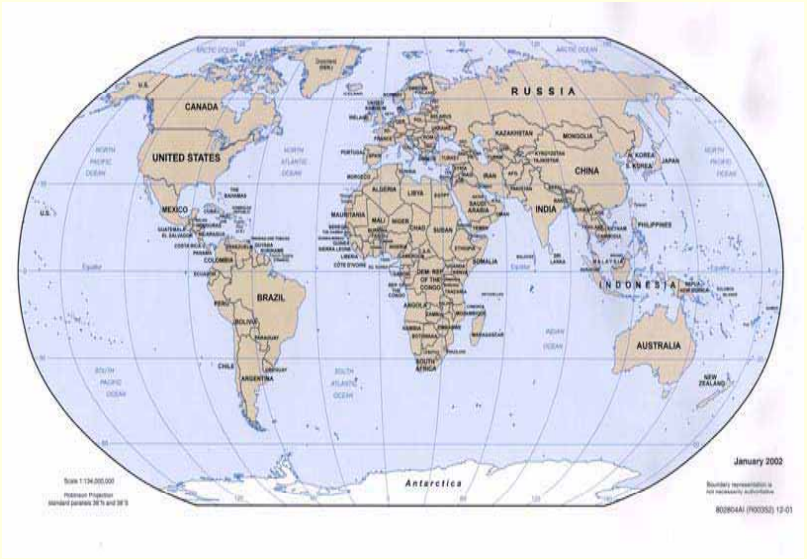
Sub-Directorate: Radio-nuclides

Authority Holders - Customs - Scrap Metal Industry - Public

Global Tracking of Incidents

International Responsibility

IAEA: ITDB (Illicit Trafficking Database) & INES



Interpol

NIA (National Intelligence Agency)

Sub-Directorate: Radio-nuclides

ITDB (Illicit Trafficking Database)

- **Group 1: Unauthorized possession & related criminal activities**
  - Unauthorized possession
  - Attempted sale
  - Unauthorized movements (or attempted)
  - Unauthorized transaction (or attempted)
- **Group 2: Theft and losses**
  - Theft
  - Loss
  - Missing
  - Misrouting
- **Group 3: Other unauthorized activities**
  - Discovery (orphaned or under no control)
  - Unauthorized disposal
  - Unauthorized shipment
  - Unauthorized /undeclared storage

ITDB: Materials covered

- **Nuclear material** (including uranium, plutonium, thorium)
  - Responsible Authority: **NNR**
- Other **radioactive materials**
  - Sealed radioactive sources or bulk radioactive materials)
  - Responsible Authority: **Radiation Control**
- Other materials - radioactively **contaminated materials**,
  - E.g. contaminated equipment, scrap, metal, agricultural products, other materials involved in incidents)
  - Responsible Authorities:
    - **NORM, including uranium contaminated scrap - NNR**
    - **Other - Radiation Control**

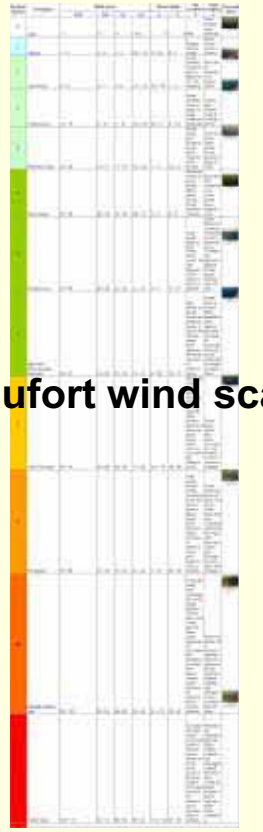
INES
International Nuclear Event Scale

Scales are inherent forms of measurement used in daily life

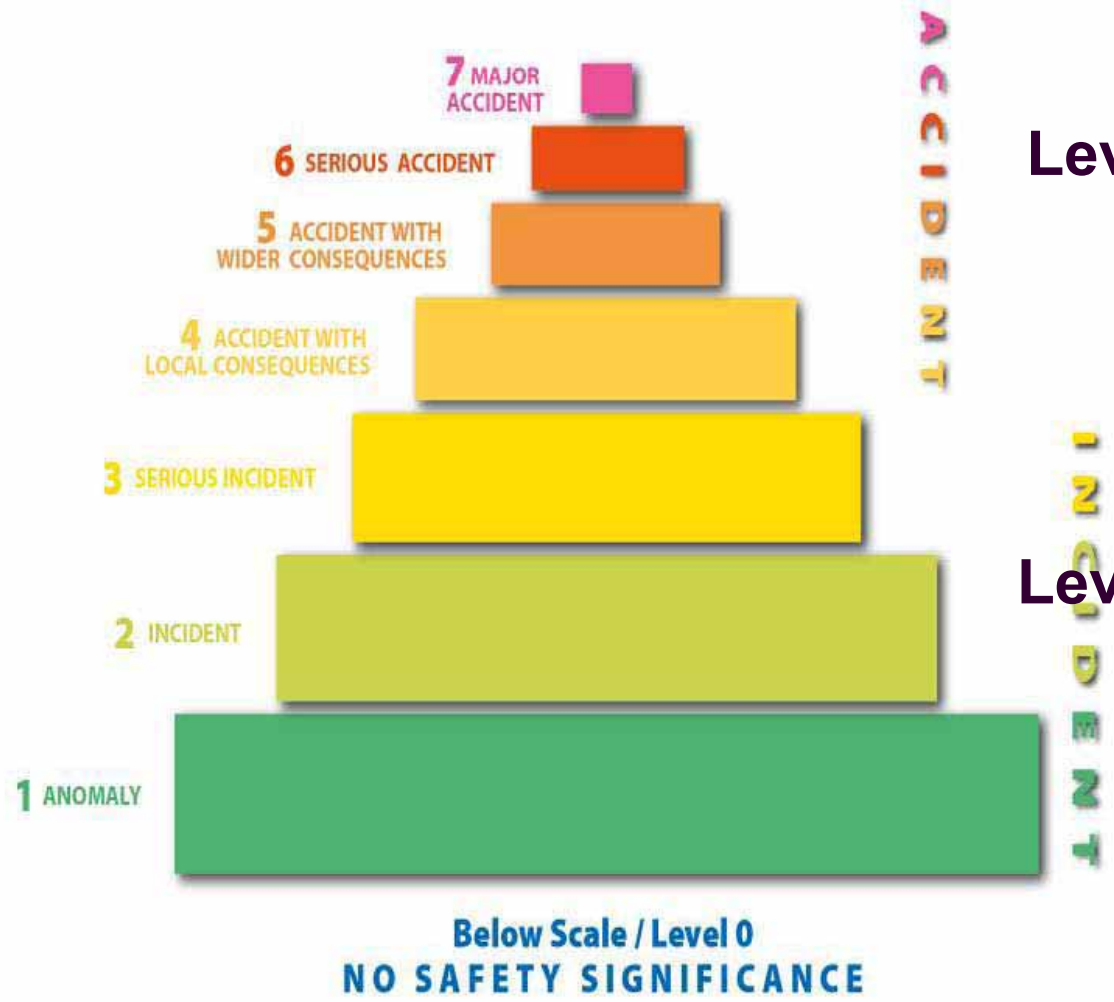
Richter scale for earthquakes

Celsius or Fahrenheit scales for temperature

Beaufort wind scale



Terminology: Scale with 7 levels



Levels 4-7:"Accidents"

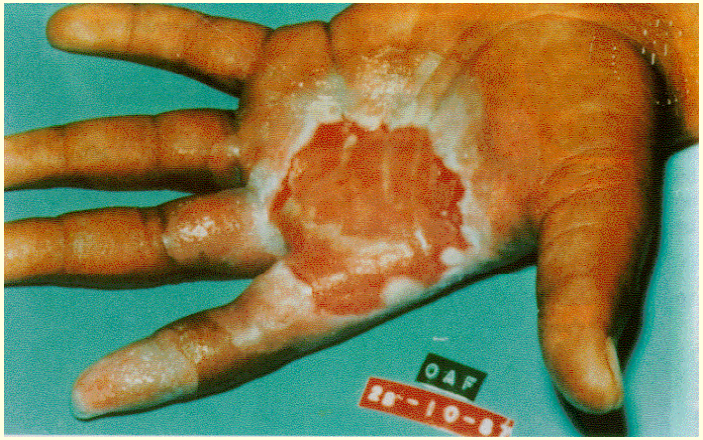
Levels 1-3: "Incidents"

INES: Examples

(International Nuclear Event Scale)

Chernobyl (1986)	7
Kyshtym (1957)	6
Goiania (1987)	5
Three mile island (1979)	5
Tokaimura (1999)	4
A death for radiation	4
Vandellos (1989)	3
Industrial radiographer worker overexposure	2

INES Level 5



INES
International Nuclear Event Scale

- "To help **communicate the safety significance** of nuclear and radiological **events** to the public"

- A technically sound tool for communicating the **right message**, the **safety significance** of events **at the right time**

"Make everything as simple as possible, but not simpler."

A. Einstein

INES
International Nuclear Event Scale

Scope

Any event associated with the transport, storage and use of radioactive material at facilities or not

Main Features

- Prompt communication to the public
- Consistency in terms of safety significance
- Can be applied to any event associated with radioactive material
- Events are classified on a scale from 1 to 7

INES
International Nuclear Event Scale

- **INES DOES:**

  - Put the event into PROPER safety significance perspective
  - Contribute to COMMON understanding of incidents and accidents
  - Bring TRANSPARENCY
  - Bring UNIFORM terminology
  - Increase CREDIBILITY and REASSURANCE

INES
International Nuclear Event Scale

- **INES DOES NOT:**

  - Does NOT REPLACE the existing national criteria for the reporting of events

  - Can NOT be used to COMPARE safety or regulatory programmes between countries

Who is responsible for Radioactive Sources in SA?

Three Regulators involved in Radiation Protection in SA

1. **Department of Energy - NNR (National Nuclear Regulator)**

   Responsible for: Nuclear Materials (Uranium, Plutonium, Thorium) and NORM (Natural Occurring Radioactive Materials)

2. **Department of Energy - Directorate: Nuclear Safeguards**

   Responsible for: Depleted uranium

3. **Department of Health - Department: Radiation Control**

   Responsible for: Regulates Group III & **IV Hazardous Substances**
   Radio-nuclides
   Materials contaminated with radioactive material

Dept of Health: Radiation Control Mandate

The promotion and maintenance of health within the framework of the National Health Plan and specifically the protection against injury or disease caused by technological devices, including **hazardous sources of ionizing radiation**, by furthering the safe and legal use of such devices.

Hazardous Substances Act (15 of 1973)

Group III **Hazardous Substances** : Electronic generators of ionizing radiation
E.g. X-ray machines, linear accelerators, etc.

Group IV **Hazardous Substances - Radio-nuclides** Regulations 247 (of 1993)

How do radioactive sources end up in Scrap?

Sub-Directorate: Radio-nuclides has National Source Register

- Authorities holders (posses & use)
- Authority to import, export, buy/sell, final disposal

Radioactive sources escapes regulatory control

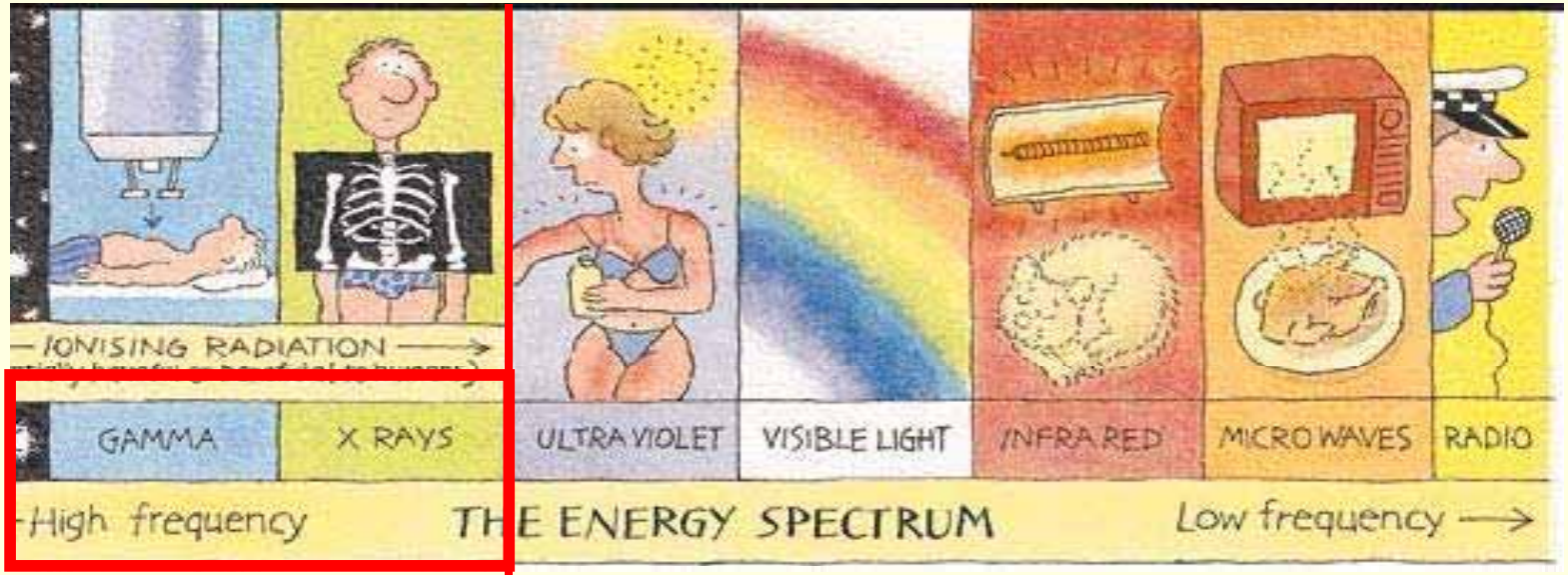
- ❑ Theft, vehicle hijackings
- ❑ Scrap scavengers
- ❑ Liquidations & auctions
- ❑ Illegal imports of radioactive sources
- ❑ Scrap metal imports – no detection at borders
- ❑ Contaminated metal imports
- ❑ Unauthorized transactions
- ❑ Unauthorized disposals

Ionizing Radiation vs. Non -ionizing Radiation

Ionizing radiation

Electromagnetic of particle radiation capable of producing ions, directly or indirectly, while passing through matter, and "radiation" as a corresponding meaning

Electromagnetic Spectrum



High Energy ← - - - - - - - - **Low Energy**

Ionizing Radiation | **Non-ionizing Radiation**

Health Effects

NO immediate effects OR ability to sense danger or injury

Diagnoses & Treatment highly technical, expensive

Extent of injury increases over time - effective treatment often limited

- **Early effect**
  - A radiation induced health effect that **occurs within weeks or months** of the exposure that caused it.
- **Late effect**
  - A radiation induced health effect that **occurs years after the exposure** that caused it.
  - The most common late effects are stochastic effects, such as **leukaemia and solid cancers**, but some deterministic effects (e.g. **cataract formation**) can also be late effects.
- **Hereditary effect**
  - A radiation induced health effect that occurs in a descendant of the exposed person.

Health Effects

- **Deterministic effect** ***(exposure to single large dose – acute effects)***
  - A health effect of radiation for which generally a threshold level of dose exists above which the severity of the effect is greater for a higher dose.
  - Such an effect is described as a severe deterministic effect if it is fatal or life threatening or results in a permanent injury that reduces quality of life.
  - The level of the threshold dose is characteristic of the particular health effect but may also depend, to a limited extent, on the exposed individual. Examples of deterministic effects include **erythema and acute radiation syndrome (radiation sickness**).

First consultation

3½ months later

Following plastic surgery (9½ months after first consultation)

Radiation induced lesion

Radiation damage to right hand

Right hand

Deterministic effects resulted from Industrial Radiography Accident – Member of the public injured.

Industrial Radiography Equipment

Examples of Industrial Radiography

source container

Radioactive source inside Industrial Radiography source container

Industrial Radiography Equipment

Source guide tube & winding gear

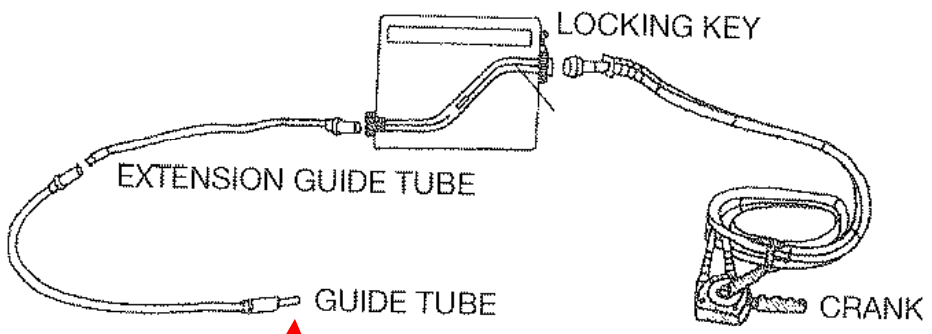
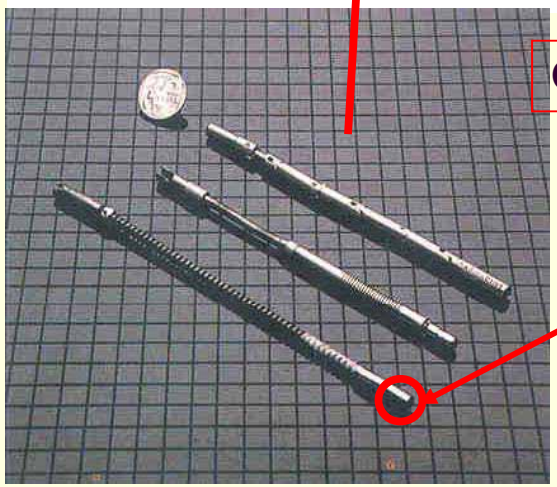


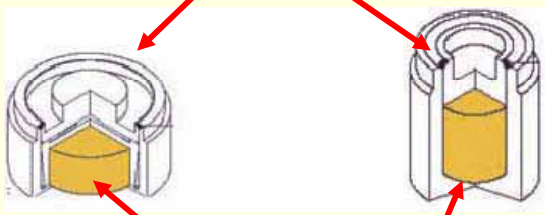
FIG. 55. Radiography guide.



Gammamat pigtail

Sealed radioactive source

Steel capsule

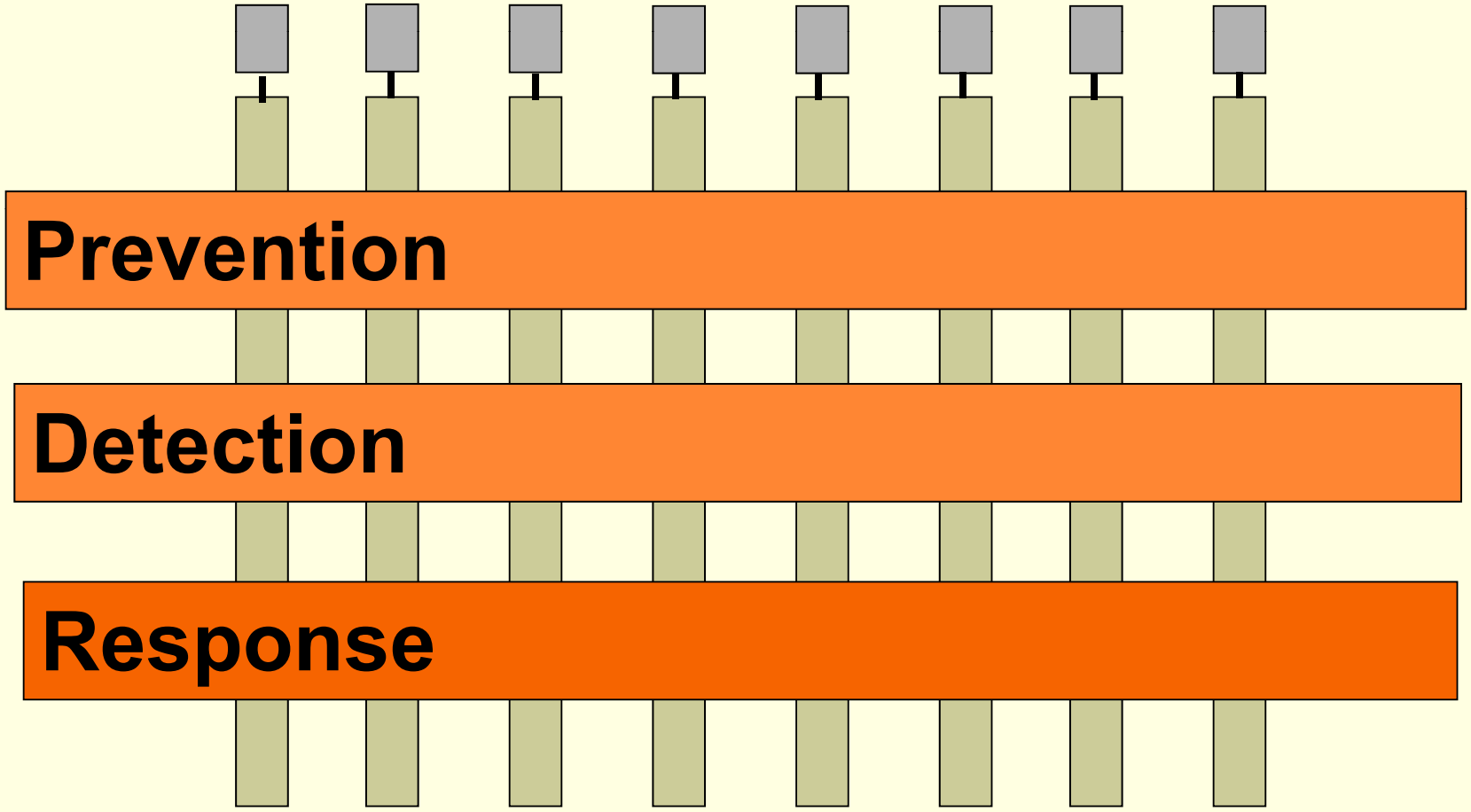


Radioactive material inside

Who are the Stakeholders?

- Regulator
- SAPS (Bomb-squad to secure safety)
- NECSA (Safe retrieval & final disposal)
- Sub-directorate: Radiation Control (tracking)
- SARS Customs (Import/Export)
- ITAC (Permits)
- Scrap Metal Industry
  - Detection equipment, Documentation, Procedures, etc.
  - Imported Scrap – verification & detection at ports of entry – send back to origin
- Carriers
- Dealers of Detection Equipment

Stakeholders: Common goals



Prevention

Scrap Metal Industry

- Awareness
- Training / Workshops
- Buy from reputable companies
- Documentation
- Ensure cleaning of transport vehicles
- Use detection equipment – regular procedures
- **DO NOT allow transport vehicle to leave with radioactive source on board** – report , remove.

Prevention

Directorate Radiation Control:

- **Source register**
  - Authorities holders (posses & use)
  - Authority to import, export, buy/sell, final disposal
- **Cradle-to-Grave Tracking:**
  - Serial No. Radioactive Source
  - Serial No. Container
- **PROBLEMS:**
  - Legacy from neighboring countries - lack of regulation
  - Illegal imports (radioactive sources or scrap metal containing it)
  - Un-authorized disposal
  - Un-authorized transactions

Detection

- **Identification - Difficult to Recognize**
  - Unsealed sources: Liquids, capsules, mostly for medical & research
  - Sealed sources: Very small - usually inside containers
  - Container - Various shapes & size
  - Containers very heavy (Mostly made of lead, depleted uranium, tungsten)
  - Radiation warning sign (trefoil)
- **Hand-held detectors**
- **Portal monitors**
- **Electronic personal devices**

Examples

of Equipment containing Radioactive Sources

Commonly found in South Africa

- Category 1 Sources – well controlled in SA
- Category 2 Sources – mainly Industrial Radiography widely used
- South Africa has a large Industrial-, Mining- and Construction industries
- Category 3 Sources – measure & control devices widely used in
  - mines, including off-shore vessels
  - other industries such as level- and thickness gauges
  - construction industries, mainly road construction
  - bore-hole logging

Categorization of sources: Examples

Source category	Risk in being close to an source	Examples of practices (uses)
1	Extremely dangerous	Teletherapy Units Irradiators
2	Very dangerous	**Industrial radiography** After-loaders (High/medium dose rate)
3	Dangerous	**Fixed gauges (density-, level-, dredger, conveyor, belt mass, etc),** **Soil gauges** **Well-logging gauges**
4	Unlikely to be dangerous	After-loaders (Low dose rate) Thickness-fill-level gauges Bone densitometers Static eliminators
5	Most unlikely to be dangerous	Low dose rate brachytherapy (eye plaques, permanent implants) X-ray fluorescence devices Electron capture devices

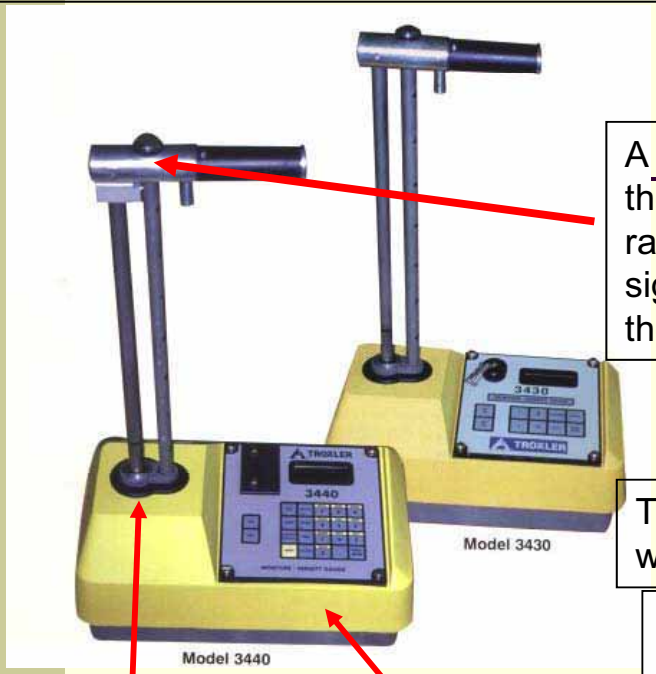
Categorization of sources

Category of source	Risk to person in being close to a person	Risk if source is dispersed by fire or explosion This amount of radioactive material could
1	**Extremely dangerous** **Permanent injury** if handled more than few minutes **Fatal** if close to unshielded source for **few minutes - an hour**	Permanent injury/life threatening in immediate vicinity Little/no risk if beyond **few hundred meters** away
2	**Very dangerous** **Permanent injury** if in contact for minutes to hours **Fatal** if close to unshielded for source **hours - days**	Permanent injury/life threatening in immediate vicinity Little/no risk if beyond a **hundred meter** away
3	**Dangerous** **Permanent injury** if in contact for some hours **Fatal** if close to unshielded source for **days - weeks**	Permanent injury possibly, but unlikely in immediate vicinity Little/no risk if beyond **few meters** away

Categorization of sources

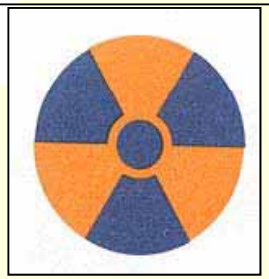
Category of source	Risk to person in being close to a person	Risk if source is dispersed by fire or explosion This amount of radioactive material could
4	**Unlikely to be dangerous** Permanent injury unlikely, Temporarily injured if handled unshielded	Could not be permanently injured
5	**Most unlikely to be dangerous** No one could be permanently injured	Could not be permanently injured

Soil gauges / density gauges



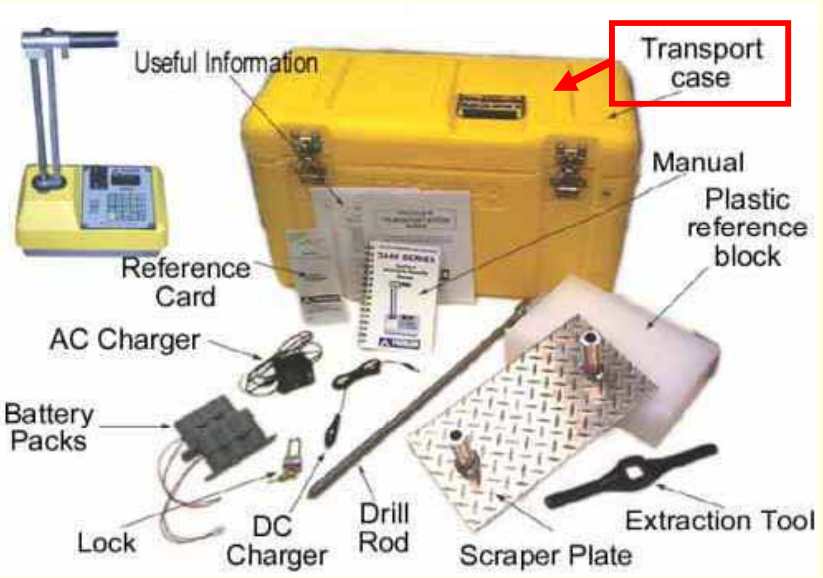
A serial number of the Cs-137 and a radiation warning sign will appear on the handle

Trefoil / radiation warning sign

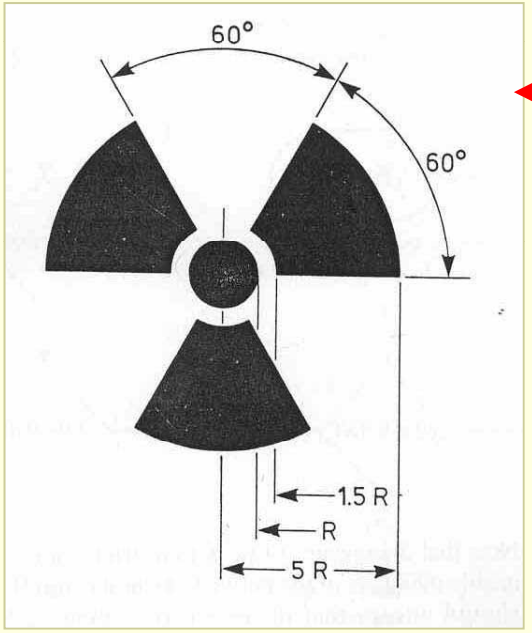


We refer to the instrument itself as the container (of the source) and is has a serial number of its own

The Cs-137 source is at the bottom of the vertical rod – as it is now it is inside the container, shielded by the lead casing in the yellow part. There is also an Am-241/Be-9 source inside the instrument.
The lead causes the instrument to be fairly heavy. The shutter is underneath. If it is open or the rod sticks out at the bottom, it is dangerous. Do not look at it directly – rather use a mirror placed on the floor to verify this.



Radiation Symbol and Warning signs



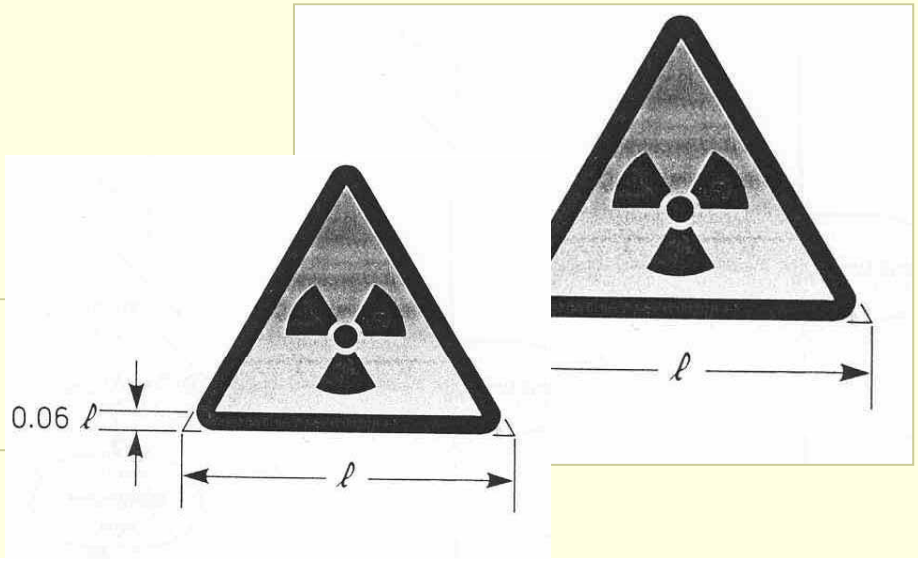
Basic **Radiation Warning symbol** must be displayed on a metal plate fixed to all source containers. It is yellow and black. Next to it two serial numbers must be indicated:

Serial number of the source

Serial number of the container

Type of radio-nuclide – quantity - date

Radiation warning sign displayed on entrances of controlled areas, storage places and barriers to prevent access



Transport containers
(measure & control sources)

Transport label

RADIATION WARNING SIGN

Label containing source information: type of source & serial number

Various transport containers are used to convey mainly Cs-137 or Co-60 sources used for measure and control devices

Transport containers
(measure & control sources)

Various transport containers use to convey usually Cs-137 or Co-60 sources used for measure and control devices

Radiation warning signs is mandatory on all radioactive source containers

Labels used on transport packages containing radioactive material differs from radiation warning signs

Labels used on Transport packages

Note the indications on the labels referring to the Content and Activity. E.g.

Contents: Cs-137 (type of radioactive source)

Activity: 1.85 MBq or 30 mCi

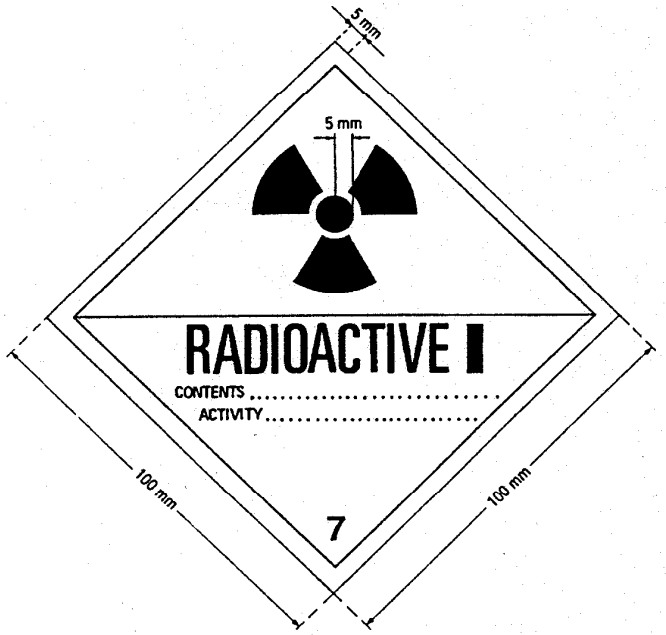


Fig 2: Category I-WHITE label. The background colour of the label shall be white, the colour of the trefoil and the printing shall be black, and the colour of the category bar shall be red.

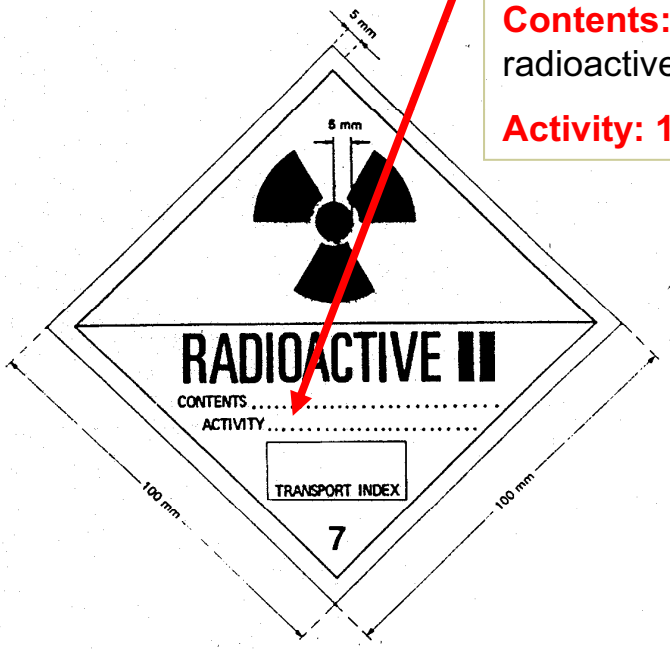


Fig 3: Category II-YELLOW label. The background colour of the upper half of the label shall be yellow and of the lower half white, the colour of the trefoil and the printing shall be black, and the colour of the category bars shall be red.

Labels used on Transport packages

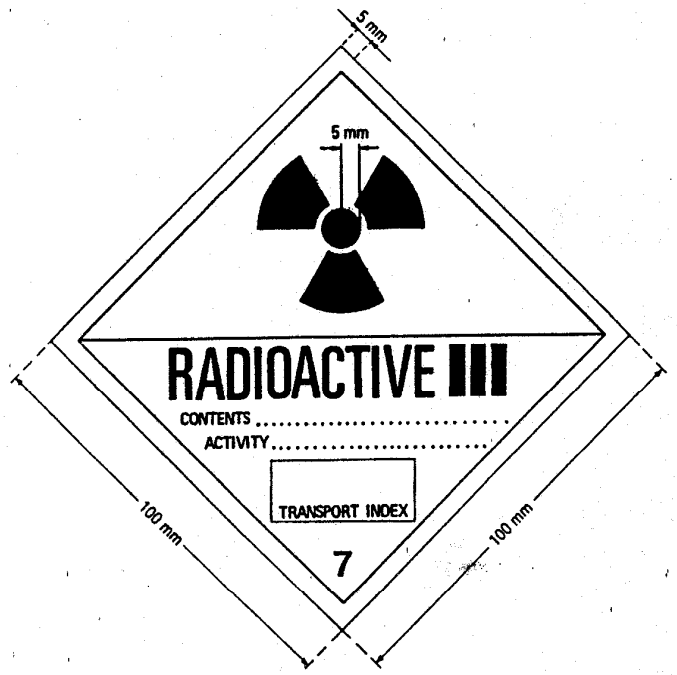


Fig 4: Category III-YELLOW label. The background colour of the upper half of the label shall be yellow and of the lower half white, the colour of the trefoil and the printing shall be black, and the colour of the category bars shall be red.

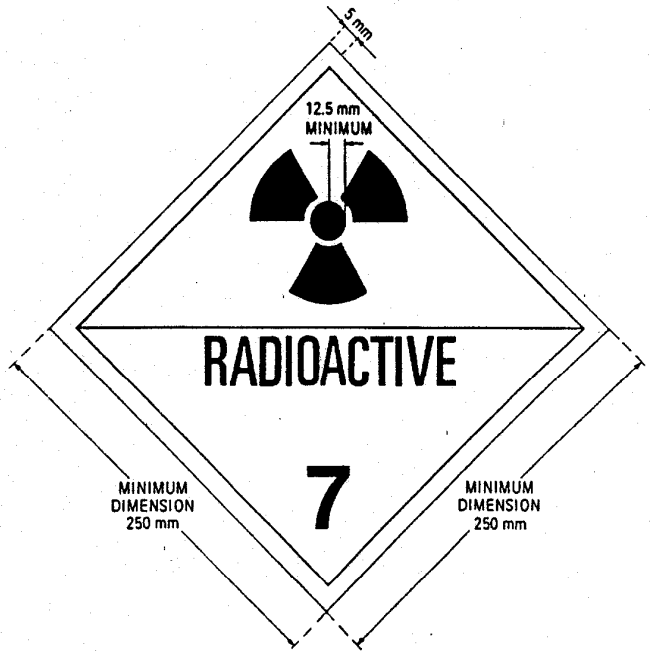


Fig 5: Placard. Minimum dimensions are given; when larger dimensions are used the relative proportions must be maintained. The figure '7' shall not be less than 25mm high. The background colour of the upper half of the placard shall be yellow and the lower half white, the colour of the trefoil and the printing shall be black.

Transport containers
(measure & control sources)

Disused transport containers used to convey usually Cs-137 or Co-60 sources used for measure and control devices

Labels are often rusted, illegally painted or removed

Measure & Control

Density gauges are used to measure the content of tanks in mining- or processing industry or on pipes through which materials moves, sewerage pipes

Lead pin (dimensions 49mm x 70 or 80 or 110mm) inside9

- Density gauges contain a Cs-137 source with a half-life of ± 30 years. It can cause harm for ±300 years. It may also contain aa Co-60 source, half-life 5 years.
- A density gauge has a shutter. If the shutter is open, it is very harmful.

Source contained in this cavity

Radioactive source found in Scrap Gauteng

Plastic Drum found at bucket shop

Objects recovered

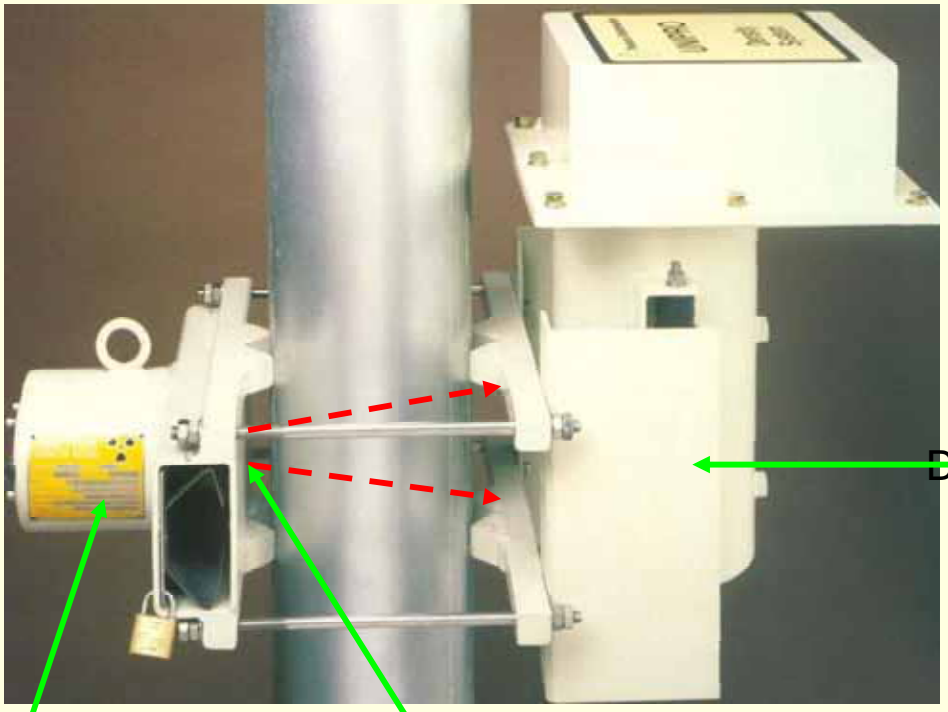
One of the two source pins recovered

plastic bucket

ty lead pots in bag

D FOR UNSEALD SOURCES

Measure & Control



Density gauge mounted on a pipe

Detector

Radioactive source inside lead container

Shutter

Open: Directional beam of gamma rays

Closed: Save

Measure & Control

Belt mass meters are similar to density gauges but it is mounted over a conveyor belt and used to measure the mass of ore passing through it

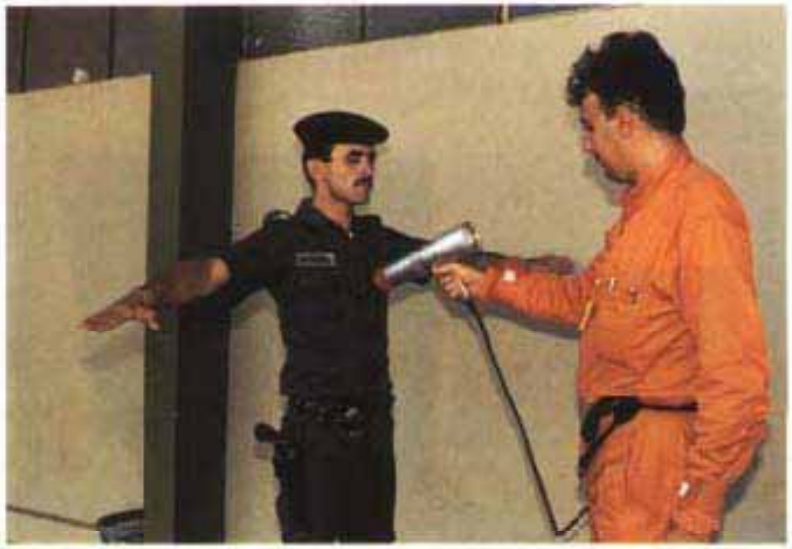
- Density gauges contain a Cs-137 source with a half-life of ± 30 years. It can cause harm for ±300 years
- A density gauge has a shutter. If the shutter is open, it is very harmful.

Bore-hole logging

Cs137 Activity 3.7GBq
Caesium 137 density (gamma) source housed in its lead lined orange shield.
(Approx weight 15 kg).


DANGER
RADIOACTIVE MATERIAL
TYPE B(U) PACKAGE UN2915
USA/9269/B(U)-96TYPE B

5. *Monitoring people for contamination at the Olympic stadium.*



4. *The physicist W.F. monitoring for contamination at the Olympic stadium.*

25. *A radiation induced lesion on the thigh about 25 days after irradiation.*

26. *Injury has extended into musculature of the thigh. Lesion 100 mm × 120 mm.*

8. *Monitoring the roof of the house of E.F.2 and S.F.1 during demolition.*

15. *Removing contaminated items from Junkyard III.*

11. *Clearing the site at Junkyard II on 6th Street.*

13. *Contaminated rubble from the demolition of R.A.'s house on 57th Street.*

20. *One of the specially made 5 tonne waste storage boxes.*

22. *Stacking waste containers to be taken to the temporary storage site.*

24. *The temporary storage site, showing concrete bases with runoff sampling channels.*

27. *Waste containers at the temporary storage site.*

Indian Man Dies After Radiation Exposure

(Radio-nuclide: Co-60 source used in Food-irradiator)

NEW DELI – 9 April 2009

…"Rajender, 35, was one of seven people hospitalized after being exposed to radioacte materials at scrap metal shops in an industrial area known as Mayapuri, located barely 10 miles from India's Parliament. …."

…" Police cordoned off a large section of Mayapuri while scientists removed 11 samples of material contaminated with Co-60, …"

Radioactive source found in Scrap

Density gauge found at scrap metal processing plant on 26 June 2010.

It was used on an off-shore vessel in Cape Town harbor and used in the diamond mining industry.

Source information:

1.85 GBq C3-137 source found between scrap with shutter open, probably a transport container or density gauge.

The label was coverer with yellow paint.