RADIATION SAFETY IN INDUSTRIAL RADIOGRAPHY

Riaz Akber

Safe Radiation Pty Ltd
www.saferadiation.com
Non destructive testing (NDT) using ionising radiation to investigate structural integrity of generally inanimate objects.

**Examples**

- Weldments on tubular and boilers
- Cracks in engines, axles, propellers
- Conveyor belt wear and tare - on-line testing
- Corrosion of ship hulls, containers, pylons
- Foreign objects in cans and boxes
- Security in goods forwarding
INDUSTRIAL RADIOGRAPHY SITES

- Open sites
- Enclosed sites
  - Fully enclosed
  - Partially enclosed
INDUSTRIAL RADIOGRAPHY SITES

Open sites

Enclosed sites

Fully enclosed

Partially enclosed

Store
INDUSTRIAL RADIOGRAPHY SITES

Open sites

Enclosed sites

Fully enclosed

Partially enclosed

Store

Transport
IAEA

Radiation safety in industrial radiography (2011)

The lessons learnt from the industrial radiography accidents (1998)

Radiation safety in industrial radiography: Technical meeting (June 2014)
RADIATION SAFETY INFORMATION

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Safe use of industrial radiography equipment (1989)
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Short link: http://saferad.co/IR
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STATE REGULATIONS AND SAFETY STANDARDS

ARPS JOURNAL
Hockings C (2006) Industrial radiography safety in Australia
Radiation Protection in Australasia 23 38-45
Photon emitting devices
X-rays
Accelerators
Sealed radioactive sources.
(Attenuated by denser, higher atomic mass materials)

Neutron industrial radiography
(Scattered by lower atomic mass material)
Less common but used in special applications
RADIOACTIVE SOURCES

- Activity in a litre of water
- Radon activity in 1 m³ of open air
- Activity in 1 kg of soil
- 1 kg waste of petroleum NORM
- Smoke alarm
- Sources used in teaching
- Nuclear medicine administration
- Industrial gauges
- Industrial radiography sources
- Sterilisation plants

Activity (Bq)
RADIOACTIVE SOURCES

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Activity (Bq)

$10^{-3}$  $10^3$  $10^6$  $10^9$  $10^{12}$  $10^{15}$

Strong sources often used at open sites

Security enhanced sources
### RADIOACTIVE SOURCES

<table>
<thead>
<tr>
<th>Isotope</th>
<th>$T_{1/2}$</th>
<th>Gamma ray Energy keV and (emission intensity %)</th>
</tr>
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<tbody>
<tr>
<td>$^{60}$Co</td>
<td>5.3 years</td>
<td>$1173 \quad (100.0) \quad 1333 \quad (100.0)$</td>
</tr>
<tr>
<td>$^{192}$Ir</td>
<td>73.8 days</td>
<td>$296 \quad (28.7) \quad 308 \quad (30.0) \quad 317 \quad (82.8)$</td>
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<tr>
<td>$^{137}$Cs</td>
<td>30.2 years</td>
<td>$662 \quad (85.1)$</td>
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<tr>
<td>$^{75}$Se</td>
<td>179.8 days</td>
<td>$121 \quad (17.2) \quad 136 \quad (58.3) \quad 265 \quad (58.9)$</td>
</tr>
<tr>
<td>$^{169}$Yb</td>
<td>32 days</td>
<td>$63 \quad (44.2) \quad 110 \quad (17.5) \quad 131 \quad (11.3)$</td>
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<td>$177 \quad (22.2) \quad 198 \quad (35.8) \quad 308 \quad (10.1)$</td>
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<tr>
<td>Isotope</td>
<td>T&lt;sub&gt;1/2&lt;/sub&gt;</td>
<td>Dose rate at 0.5m mSv per minute from 2 TBq source</td>
</tr>
<tr>
<td>---------</td>
<td>----------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>&lt;sup&gt;60&lt;/sup&gt;Co</td>
<td>5.3 years</td>
<td>41</td>
</tr>
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![Diagram of 25mm Pb 5 HVL shielding surrounding a 2 TBq $^{192}$Ir source, with a 200 mSv per minute dose rate at 0.5m from 2 TBq source.]

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RADIOACTIVE SOURCES

Connector

Source

Pig tail

Depleted uranium or lead shield inside a cover tube

Labels including container type
RADIOACTIVE SOURCES
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Cable welded to the cap

Cap welded to the base

Spring loading

Radioactive material

Double encapsulation

Cable welded to the cap
Radiation dose rate at 1m
4 GBq $^{226}$Ra 1 mSv h$^{-1}$
2 TBq $^{192}$Ir 230 mSv h$^{-1}$
Old X-ray machines were bulky and achieving a high voltage was a challenge.

Image
NASA 1944 X-ray machine
http://alchemipedia.blogspot.com.au
RADIATION SOURCES

Portable or stationary
High voltage ~ 150 – 300 kV
Current ~ 5 – 20 mA
Exposure time ~ from flash to 5 minutes
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High voltage ~ 150 – 300 kV
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Dose rate
X-ray machines ~ 1Sv h⁻¹
Linear accelerators 3 – 240 Sv h⁻¹

2.5 mGy s⁻¹
Other Devices

Linear accelerators (2-10 MeV photons)

Crawlers - remote controlled or programmed vehicles

Projector

External control source
Crawler inside pipe

Radiograph location
Some accidents in industrial radiography and loss of source have led to higher radiation dose and radiation injury:

- Amputation of body parts
- Death

**Influencing factors**
- Strong portable sources
- Difficult, temporary prepared work sites
- Controls managed by a small work team
- Transitory workforce
Emergency... an unexpected situation in which immediate action is necessary to prevent a bad situation from becoming worse.

Awareness and training can prevent an industrial radiography emergency from turning into a worse radiation accident.
Radiation dose during routine operation
Number of months of zero dose

Employee
By investigating and ensuring the integrity of different structures, Industrial Radiographers make a valuable contribution to the society.
CONCLUSIONS

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Industrial radiographers often work at difficult or complex field sites. They transport and operate high activity, high dose rate radiation sources.
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Industrial radiographers often work at difficult or complex field sites. They transport and operate high activity, high dose rate radiation sources.

Mishandling of industrial radiography sources can lead to high radiation dose and radiation injury.
CONCLUSIONS

In case of emergency, industrial radiographers are likely to be the response initiators, and may also need to take part in the recovery process.

Appropriate radiation safety training and cultivation of safety and security culture is relevant for reducing radiation accident probability.