# Irradiator Technology H-315

## Session 17

# Accidents

## Can Happen Anywhere!

# Overexposure

# Irradiation Facility Fleurus, Belgium

On 11 March 2006, the employee noticed that a radiation monitor alarm was activated with no irradiation in progress and the cell door open. He reset the alarm and entered the cell for 20 seconds to close the cell door.

The worker was not carrying a Geiger counter as required by company procedures.

It was determined he suffered an exposure of 420 rem.

# Overexposure

# Irradiation Facility Fleurus, Belgium

**Update: May 15, 2006**

**The man is back with his family in Belgium.**

**He has lost all of his hair and needs to go to IRE (hospital) once a week for blood work.**

**People believe that he survived because he is apparently a "super athlete" at 50 years of age. .**

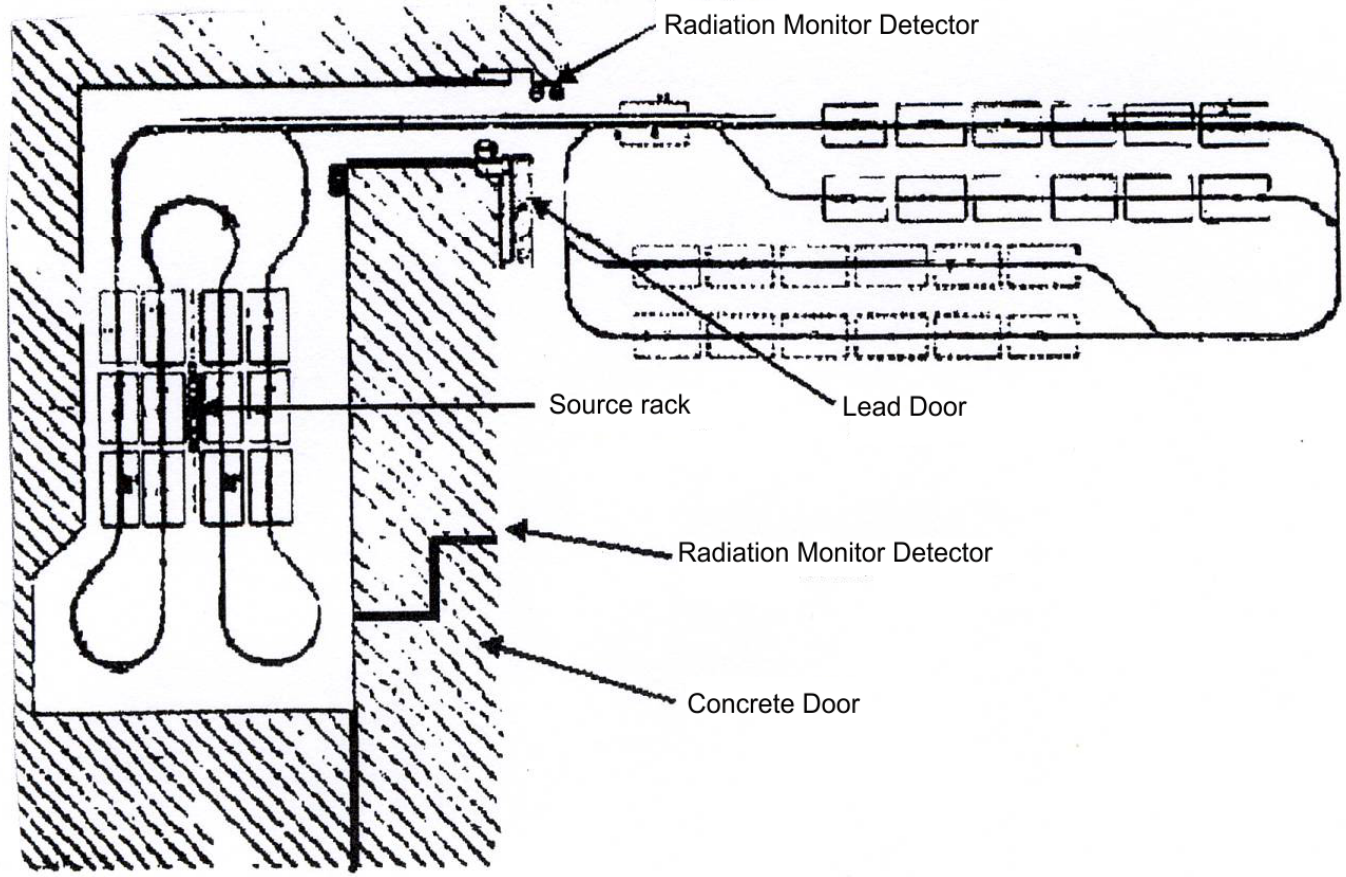
# Overexposure

# Irradiation Facility Fleurus, Belgium

**Because the source hoist hydraulic system was shared with the product conveyor and the revolving door of the second irradiator, there was apparently some "known" back pressure problems. The day this man was overexposed, the rack was probably moving up and down much more than usual.**

# Overexposure

# Irradiation Facility Fleurus, Belgium



# Overexposure

# Baxter Healthcare

**HEADLINE: NRC PROPOSES $44,400 CIVIL PENALTY FOR BAXTER HEALTHCARE CORP. OVER IRRADIATOR EVENT AT PUERTO RICO FACILITY.**

**On April 21, 2004, interlocks were bypassed. Workers partially entered the room, were exposed to 4.4 and 2.8 Rem. They would have received a potentially lethal dose if they had entered the room completely. A step ladder left over the path of the source rack after changing a switch was the cause of the stuck source**

# Personnel Fatality at Steris Isomedix

On June 7, 2002 an incident occurred at the Spartanburg facility. A maintenance worker 41 years old died when a 12 foot tall metal carrier crushed his neck. The incident occurred when the conveyor jammed and he climbed a ladder to see what was causing the problem, the monorail system had not been locked out, the carrier moved towards him while he was trying to free it and he was hit.

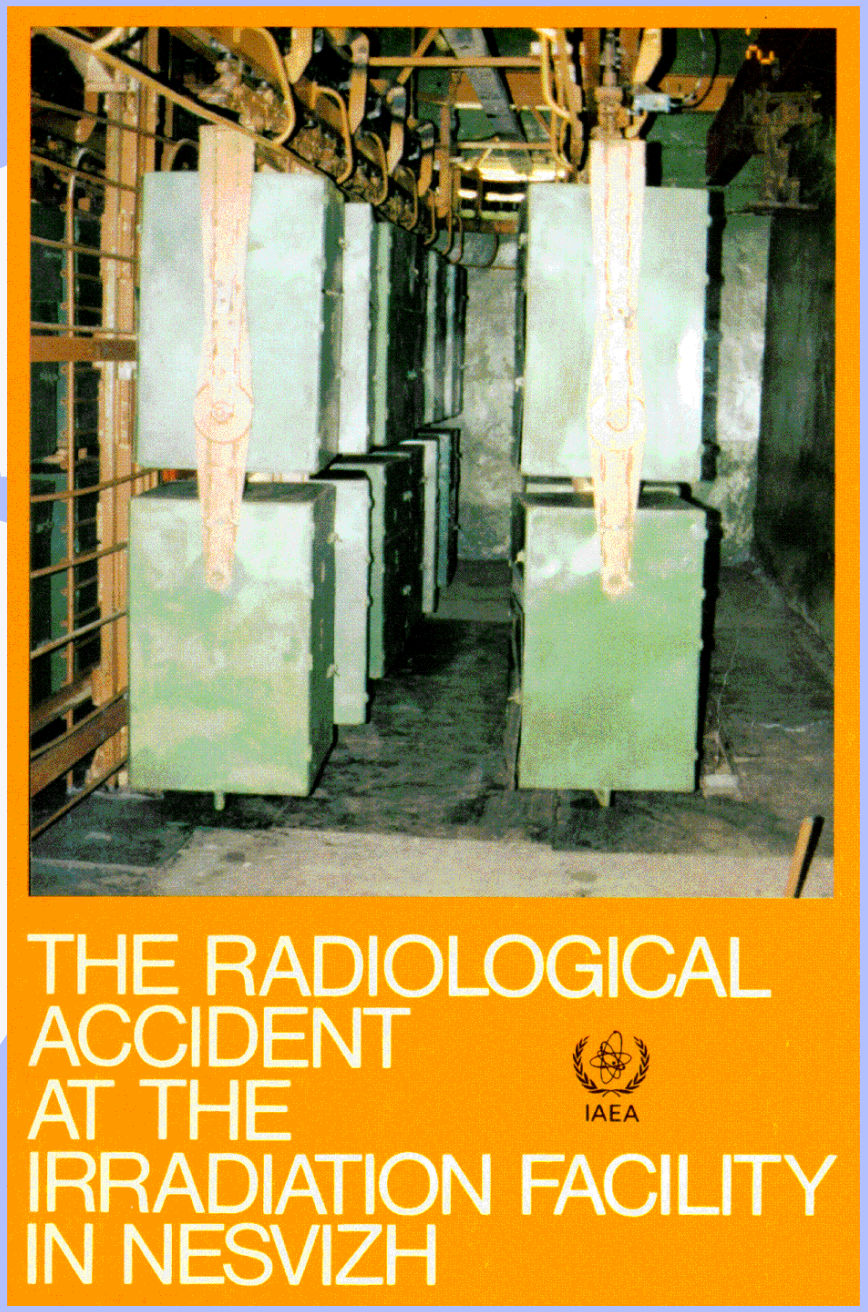
# Personnel Fatality at Baxter Healthcare

Baxter Healthcare Corporation operates an irradiator facility for medical product sterilization in Aibonito, Puerto Rico. The licensee reported that a fatality occurred on July 31, 1998. The irradiator has shutdown following a carrier jam condition. An operator entered the irradiator room to troubleshoot the problem. While troubleshooting, there was some unexpected movement of the product carrier and the operator was trapped and killed. The accident did not involve any exposure from the radioactive source. The licensee is also obtaining assistance from the manufacturer, MDS Nordion, to determine any potential equipment problems.

# October 1991

- Safe operating procedures were not followed

- Safety features were circumvented



# Radiological Accident In Nesvizh

11Gy - 18Gy

Whole body dose

Died 113 days later

# Radiological Accident In Nesvizh

# Accelerator Accident

Maryland 1991

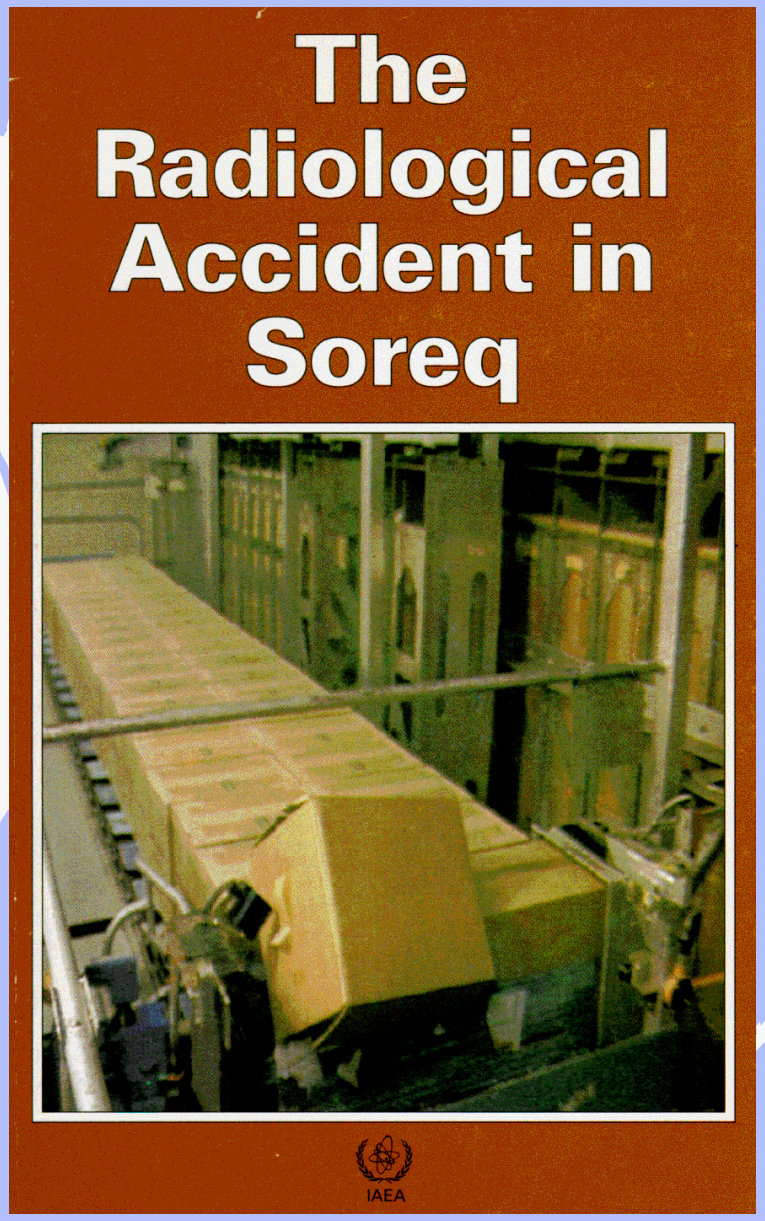
0.4 Gy/s - 13 Gy/s at various parts of body

Amputation of left and right hand digits 3 months later

… Also Hanoi Vietnam

June 1990

- Conflicting information on control console
- Safety systems bypassed
- Operating instructions not in local language
- Product boxes in poor quality
- Lack of shroud



# Radiological Accident In Soreq

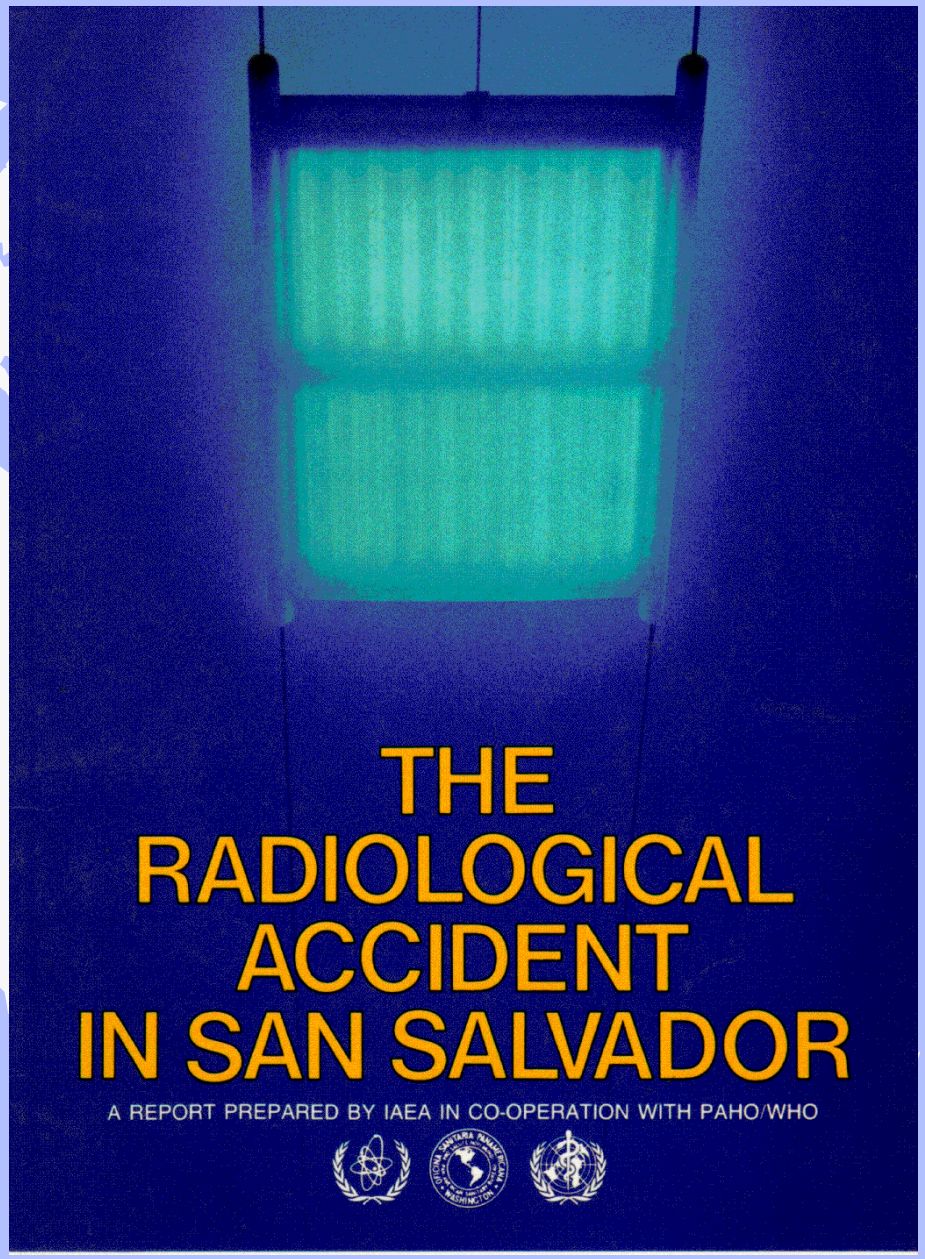
**10 Gy - 15 Gy**

**whole body dose**

**Died 36 days after exposure**

February 1989

- Lack of shroud
- Deformed source rack
- Product boxes in poor condition
- Degradation of safety procedures and systems
- Operators with informal training
- No relevant regulatory control



# Radiological Accident in San Salvador

**Worker 1: one leg amputated, died later**

**Worker 2: both legs amputated, prognosis good**

**Worker 3: residual effects**

# Other Incidents

- Kjeller, Norway, 1982
- RTI Rockaway N.J. 1977
- Stimos Italy 1975
- LINAC Illinois 1965
- USNRC Events at Large Irradiators (NUREG 1345)

# Lessons to be Learned

- Safety Audits (meet recommendations)
- National Infrastructure??
- Manufacturer safety Upgrades
- Training ! Training ! Retraining !
- RSO
- Preventative maintenance
- Never bypass safety systems
- Follow proper entry procedures
- Survey meter works Ok!! Battery + test
- Emergency procedures

# Lessons to be Learned

- Follow chain of command
- No disabling of safety systems
- No operation if safety system malfunctioning
- Redundancy in safety system
- Fix problem that can lead to source/product jam
- Operator's manual in  local language
- Management commitment to safety
- Conflicting signal (assume the worst, prove it wrong

# Where To Find The Info

- IAEA publications (many)
- ICRP Pub. 76 1997
- NUREG
  - Georgia leakage (1392)
  - Review of events (1345)
  - Working in Gamma Radiography (/BR-0024)

end

# BIOLOGICAL EFFECTS OF RADIATION

## Whole Body Exposure

**Acute dose:** (Massive dose in short time)

0-25 Rems: No serious injury

25-100 Rems: Blood cell changes, Possible injury

100-200 Rems: Nausea, possible disability

200-300 Rems: Nausea, Injury, disability, possible death, loss of hair…

300-600 Rems: **LD50, fatal to 50% of people**

600 Rems and up: Fatal

**Note: Acute lethal dose can happen in seconds inside the source pass of a Production Irradiator**

# BIOLOGICAL EFFECTS OF RADIATION

| Phase | Symptom | Exposure (Sv) | | | | |
|---|---|---|---|---|---|---|
| | | 1–2 Sv | 2–6 Sv | 6–8 Sv | 8–30 Sv | >30 Sv |
| Immediate | Nausea and vomiting | 5–50% | 50–100% | 75–100% | 90–100% | 100% |
| | *Time of onset* | 2–6h | 1–2h | 10–60m | <10m | immediate |
| | *Duration* | >24h | 24–48h | <48h | <48h | 48h–death |
| | Diarrhea | None | Slight (10%) | Heavy (10%) | Heavy (90%) | Heavy (100%) |
| | *Time of onset* | — | 3–8h | 1–2h | >1h | <30m |
| | Headache | Slight | Mild (50%) | Moderate (80%) | Severe (80–90%) | Severe (100%) |
| | *Time of onset* | — | 4–24h | 3–4h | 1–2h | <1h |
| | Fever | Slight–None | Moderate (50%) | High (100%) | Severe (100%) | Severe (100%) |
| | *Time of onset* | — | 1–3h | >1h | >1h | >30m |
| | CNS function | No impairment | Cognitive impairment 6–20 h | Cognitive impairment <20 h | Rapid incapacitation | Seizures, Tremor, Ataxia |
| Latent Period | | 28–31 days | 7–28 days | >7 days | none | none |
| Overt illness | | Mild Leukopenia; Fatigue; Weakness | Leukopenia; Purpura; Hemorrhage; Infections; Epilation | Severe leukopenia; High fever; Diarrhea; Vomiting; Dizziness and disorientation Hypotension; Electrolyte disturbance | Nausea; Vomiting; Severe diarrhea; High fever; Electrolyte disturbance; Shock | Death |
| | Mortality without medical care | 0–5% | 5–100% | 95–100% | 100% | 100% |
| | Mortality with medical care | 0–5% | 5–50% | 50–100% | 100% | 100% |

# Where To Find The Info

- USNRC web site
  - www.nrc/gov
- IAEA web site
  - www.iaea.org
- DOE web site
  - www.doe.gov
- Nuclear Material Events Database
  - http://nmed.inel.gov

NMED Home Page - Microsoft Internet Explorer

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Address http://nmed.inel.gov

Security/Privacy

# NMED

*Nuclear Materials Events Database*

**Search the NMED**

**Review Code Criteria**

**NMED Newsletter**

**Quarterly Reports**

The Nuclear Materials Events Database (NMED) contains records of incidents involving radioactive material licensed under NRC regulations or compatible Agreement State regulations and reported to the NRC by the NRC licensees and the Agreement States. Event records are maintained in the NMED for the period of January 1990 through the present.

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Chemical Leak Detected During Refueling of Oconee Nuclear Station

Fire Shuts Down Controversial New York Nuclear Plant

Worker Inhales Radioactive Materials

UPDATE: More Workers Exposed to Radioactive Material

Workers Undergo More Tests for Radiation Exposure

New SRS Chief Focuses on Reducing Risks

Cesium- 137 Stolen from Georgian Military Base

Worker Contaminated With Radiation

SureBeam Awarded Patent on Unique Electron Beam System, Giving Edge in Technological Leadership

## Articles/ Papers

"Candy Store" for Terrorists

A Soldier's Viewpoint on Surviving Nuclear, Chemical and Biological Attacks

Mars radiation too extreme for astronauts

Tensions Rise over North Korea's Nuclear Complex

Decommissioning and Disposal Optiions for Cesium-137 Blood Irradiators

Editorial: Plutonium Stockpiles in South Carolina

Britian's Nuclear Power Gone With The Wind

North Korea Keeps World Guessing

**Thought for the Day:**

"The ear tends to be lazy, craves the familiar and is shocked by the unexpected; the eye, on the other hand, tends to be impatient, craves the novel and is bored by repetition."
- W. H. Auden

Electrostatic Measuring Monitoring & Test Equipment

# Radiation burn

California 1979

28 Ci Iridium source

45 min exposure in back pocket

50 days after accident (photo)