INTERNATIONAL ATOMIC ENERGY AGENCY
UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION
**INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS**
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College on Medical Physics:
Imaging and Radiation Protection

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*Overview of Radiological Accidents*

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# The Radiological Accident in Goiânia

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## GOIÂNIA - BRAZIL

A private radiotherapy institute moded to new premises

A Cs-137 teletherapy unit remained in the old premises

THE LICENSING AUTHORITY WAS NOT NOTIFIED

The old premises were subsequently partially demolished

THE Cs-137 THERAPY UNIT BECAME TOTALLY INSECURE

TWO PEOPLE ENTERED THE PREMISES REMOVED THE SOURCE ASSEMBLY FROM THE IRRADIATION HEAD AND TOOK IT HOME

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4 PERSONS DIED
(ACUTE RADIATION SYNDROME

112.000 persons monitored
249 contaminations
110 cytogenic studies

3.800 drums (200 l) wastes
1.400 metal boxes (5 Tonns)
10 shipping containers
3500 m³

## MEXICO (CIUDAD JUAREZ)

A medical center purchased a Co-60 Teletherapy unit.

The unit remained stored for several years. without being installed (It had been introduced into the country without compliance with import requirements).

THE SOURCE ASSEMBLY WAS REMOVED FROM THE UNIT. THE CAPSULE OF THE SOURCE WAS PERFORED.

THE SOURCE TOGETHER WITH SOME OTHER PARTS OF THE EQUIPMENT WAS SOLD TO A SCRAP SHOP.

THERE MUCH OF THE EXISTING SCRAP WAS CONTAMINATED. IT WAS SOLD TO DIFFERENT COMPANIES, AMONG THEM A STEEL COMPANY, WHICH MANUFACTURES RODS AND SIMILAR PRODUCTS.

IT WAS DETECTED IN THE USA, WHERE RODS (CONTAMINATED) WERE TRANSPORTED TO.

6000 TONES OF RODS WERE PRODUCED
3000 SETS OF FOOTS FOR DESKS

4000 persons were radiation exposed
2% > 0,25 Sv
5 persons: 3 to 7 Sv (2 month.)

- 17000 buildings (where contaminated rods might have been used) were monitored
- decision was taken to demolish 814 buildings
- 16000 $m^3$ of contaminated earth were accummulated in a repository built for the purpose

ACCIDENTS IN RADIOTHERAPY

CHRONOLOGY OF AN ACCIDENT

05-12-1990.-Radiotherapy staff operating the accelerator note that it does not work: absence of electron beam.

They communicate the failure to the technician of the company who was performing a maintenance to a Co-60 teletherapy machine, at the same hospital.

The technician carries out a first revision of the accelerator, and postpones the work 07-12 (the 6th is a holiday.

07-12-1990.-After his intervention, the display on the control panel shows always 36 MeV regardless of the selected energy (7,10 13 MeV), but there is an electron beam. That was interpreted as a jam of the needle at 36 MeV.

10-12-1990, Monday. The treatment of patients resumes.

20-12-1990. The staff informs the Radiation Protection Department about the incorrect energy display. The treatment are stopped. The physicians start correlating this fact with the poor tolerance and bad reactions observed in some patients.

21-12-1990. A dosimetry of the beam is carried out and it is found that the energy of the electron beam is always 36 MeV regardless of the energy selected on the control panel (7, 10 or 13 MeV).

The maintenance company is notified. It sends technicians to repair the failure and to make a general revision of the accelerator.

Technical description

The path (curvature) of the electron beam is a function of its energy and the intensity of the magnetic field generated by deviation coils. f(E, Ic).

For a given electron energy, there is only one coil intensity Ic, which can achieved the correct curvature. Vice versa for a given Ic there is only one electron energy for which the path is correct.

Under normal conditions, for each energy selected Ic, the proper Ic is automatically set by the accelerator.

It is admitted that there was a short circuit in the control unit of the coils so that Ic was always the maximal one.



**Annex 1 European Radiotherapy Accidents Reported after**

**1st January 1986 as know to EFOMP Accident Reporting scheme on 15th May 1992**

| Country | Approximate Dates | Number of Injured | Nature of Injury | Investigation | Probable Cause | EFOMP Accident |
|---|---|---|---|---|---|---|
| UK | 1983 | 1 | high morbidity(£455,000 damages) | ? | Prescription error + communication failure | - |
| (W) Germany | 6.86-3.87 | 96 | Increased morbidity possibly deaths | Criminal investigation (Failure to report) | Error in $^{60}$Co dose tables (7% overdose) | - |
| UK | 2.88-7.88 | 205 | " | Health authority Enquiry | Error in $^{60}$Co dose rate (25% overdose) | - |
| UK | 6.88-7.89 | 22 | increased morbidity or recurrence rate | Health Authority | Failure of label system for implant sources ($^{137}$Cs) (-20 to + 10% over/under | - |
| Spain | 12.90 | 27 | increased morbidity or recurrence rate | at national level | Maintenance error + communication failure | 9.91 |
| UK | 1982-1991 | 989 | increased risk of recurrence | Health Authority Enquiry | Inadequate QA of new procedure (5-30% underdose) | No |
| Czech. | 1987 | 1 | death probably attributable | At national level | treatment in non-clinical accelerator mode | - |

Negative reports or reports only of minor accidents have been received from Norway, Poland, Russia and Turkey.

NRC INFORMATION NOTICE 91-02
BRACHYTHERAPY

(1) The Medical Physicist noted that there were two instead of three Cs-137 sources in the storag safe drawer
Failure to return all brachy therapy sources promptly after removal.
The source was lost. A contributing factor ⇒ the source was coloured White
easy to loose among bedlinen... landfill

(2) Ir-192 endobronchial treatment
25 seeds of 3,5 mCi each in a nylon ribbon. It become dislodged from the catheter.
The duty nurse taped the end to the patients face. The charge nurse noticed... 1,032 rem to face
Corrective actions: 282 rem to eyes
removal of the nurse from caring brachytherapy patients
training + written examination

(3) Nylon ribbon with 7,2 mCi Ir-192 was cut into two pieces. Inventory
One piece was found 22 days later within a crack between the carpeting and the wall.

INCIDENTS AND ACCIDENTS IN BRACHYTHERAPY

LOSS OF CONTROL OF Ir-192 SOURCES (3 Cases during hospitalization).

A PATIENT WAS DISCHARGED FROM THE HOSPITAL WITH AN Ir-192 INCORPORATED.

RADIOACTIVE MATERIAL WAS USED IN NON-LICENSED HOSPITALS. THEY WERE CARRIED BY THE RADIOTHERAPIST FROM ANOTHER (LICENSED) HOSPITAL. THE UNAUTHORIZED USE OCCURRED WITHOUT SUFFICIENT RADIATION PROTECTION MEASURES, AND WITHOUT PERSONAL DOSIMETERS FOR THE NURSES.

# INCIDENTS AND ACCIDENTS IN BRACHYTHERAPY

ONE PATIENT WAS MOVED FROM ONE HOSPITAL TO ANOTHER WITH Ir-129 SOURCES IMPLANTED, WITHOUT NOTIFICATION TO THE PERSONAL RECEIVING THE PATIENT. ASSITANCE WAS GIVEN TO THE PATIENT DURING ONE DAY, IGNORING THAT HE HAD RADIOACTIVE MATERIAL.

SEVERAL AFTERLOADING Cs-137 EQUIPMENT WERE PURCHASED AND STORED IN HOSPITALS FOR YEARS WITHOUT ANY SURVEILLANCE.

# INCIDENTS IN BRACHYTHERAPY (RADIUM-226)

SINCE THE BEGINNING OF THE USE OF RADIUM SOURCES FOR RADIOTHERAPY, MORE THAN 100 SETS OF SOURCES WERE USED BY DIFFERENT SPECIALISTS: (RADIOLOGISTS, DERMATOLOGISTS, GYNECOLOGISTS...)

AT THAT TIME THERE WAS NO REGULATION, NOR REGULATORY CONTROL.

THE ORIGINAL OWNERS DIED IN MANY OF THE CASES. AFTER A LONG AND TEDIOUS PROCESS OF SEARCHING MORE THAN 110 SETS OF RADIUM SOURCES WERE DISPOSED OF IN SAFE STORAGE BY THE AUTHORITIES.

SOME 15% OF THE SETS OF SOURCES PRESENTED LEAKAGE. TWO OF THEM CAUSED CONTAMINATION OF LARGE PROPORTIONS (BUILDING, GARDEN)

11 OF THESE SETS WERE INCOMPLETE (RELATED TO THE ORIGINAL PURCHASE DOCUMENTS), ANOTHER 8 SETS COULD NOT BE CHECKED FOR COMPLETENESS BECAUSE OF LACK OF DOCUMENTS.

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NRC- INFORMATION NOTICE- 90-59
I-131

① Yearly control (whole body scan)
4.89 mCi I-131 Lactation
Synthetic hormone prescribed to the child with follow-up.

② Confusion :
Instead of thyroid scan ⇒ whole body scan
300 μCi I-123 ⟹ 3 mCi I-131
No written request from the n.m. physician was required

③ Confusion: Instead of ectopic thyroid evaluation ⇒ post-thyroidectomy neck scan was requested
100 μCi ⟹ 1 mCi I-131

④ Ectopic thyroid evaluation
50 – 100 μCi ⇒ 4.5 mCi I-131
List of dosage was wrong

⑤ 4-5 weeks pregnant
Failure to ask
15 μCi of I-131
total body ~ 2. to 4 mrem

## SAFETY CULTURE

1.- Good practice is essential but not sufficient.

2.- There is a requirement to go beyond the strict implementation of a good practice, so that all duties related with safety are carried out:

Correctly

with alertness

with due thought

with full knowledge

sound judgement

and a proper sense of accountability

The highest level of safety is achieved only when every one is dedicated to the common goal:

Individual awareness of the importance of safety

knowledge and competence conferred by training, instruction and self-education

commitment at senior management level

motivation through leadership

supervision including audits and review practices

responsibility trough formal assignment and description of duties

The SAFETY CULTURE involves all levels:

Policy level,

commitment of the management

response of individuals