Transport of Cobalt 60 from the Argentine Nuclear Power Plant in Embalse

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COBALT 59 / COBALT 60 CYCLE

- FAE S.A. and CONUAR S.A.
  Special Alloy, and Fuel Element and Bar Facilities: manufacture of Zircaloy seamless tubes (treex), and reactivity control bars (cobalt target) containing Co-59

- N.A.S.A. (Nucleoeléctrica Argentina S.A.)
  Operates Embalse Nuclear Power Plant (ENPP)
  Including cobalt-related activities: product Co-60

- DIOXITEK S.A.
  Manufactures and commercializes Co-60 sealed sources, including part of its preparation for dispatch in ENPP, and their domestic and international transport

- ARN (Argentine Nuclear Regulatory Authority)
  Verifies the compliance with regulatory standards, including activities related to the transport of radioactive material
Involved organizations have implemented appropriate Management Systems

- FAE S.A. and CONUAR S.A.
- N.A.S.A. (Nucleoelectrica Argentina)
- DIOXITEK S.A.
- ARN (Argentine Nuclear Regulatory Authority)
  Regulatory Process “Protection against ionizing radiation in the transport of radioactive material”

*Certified by ISO 9001:2000*
COBALT 60 PRODUCED IN ARGENTINA

- Argentina: third world producer, after Canada & Russia
- Embalse Nuclear Power Plant
  - Co-60 produced between 1986 – 2008 (approx.):
    - 2600 PBq (70 MCi)
    - 250 Reactivity control bars
- Co-60 sold by DIOXITEK SA, period 1998 – 2007
  - **Export**: 1260 PBq (34.15 MCi) – 94% (bulk, industrial and medical purposes)
  - **Domestic**: 90 PBq (2.43 MCi) – 6% (industrial and medical purposes)
COBALT 59 / COBALT 60 CYCLE

EMBALSE NUCLEAR POWER PLANT - CANDU REACTOR

Co-59 REACTIVITY CONTROL BARS

Co-60 FOR MEDICAL AND INDUSTRIAL PURPOSES
# Reactivity Control Bars

<table>
<thead>
<tr>
<th>Reactivity control bar (RCB)</th>
<th>RCB Code</th>
<th>No. RCB in reactor core</th>
<th>No. Bundle per RCB</th>
<th>Active cobalt pencils/bundle(1)</th>
<th>Content of cobalt pencil</th>
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</table>
| Large                       | A, B or C| 15                      | 16                 | 1, 2 or 4                        | Slugs
φ = 6 mm
h = 25 mm |
| Short                       | D        | 6                       | 4                  | 1                                | Pellets
φ = h = 1 mm |

(1) Non-active pencils per bundle: made of Zircaloy

Average irradiation period in reactor: 18 months
Average activity concentration: 5.55 – 11.1 TBq/g  (125–150 Ci/g)

Activity concentration for manufactured sealed sources
• Industrial use: 4.62 – 5.55 TBq/g  (125 – 150 Ci/g)
• Medical use: 9.25 – 11.1 TBq/g  (250 – 300 Ci/g)
TYPE B(U) PACKAGE DESIGN FOR Co-60

- Approved package design meets the requirements of AR 10.16.1 (IAEA Transport Regulations, TS-R-1)
- Designed to demonstrate ability to withstand routine, normal and accident conditions of transport
- Overall dimensions
  Diameter: 1.0 m to 1.5 m
  High: 1.2 m to 1.8 m
- Gross mass: 6500 kg to 9500 kg
- Shielding: steel, lead, depleted uranium
- Radioactive contents: Co-60 sealed sources
PREPARATION OF TYPE B(U) PACKAGE

• Co-60 pencils activity uniformly distributed in capsule assemblies
• Vent and drain lines cleaned (wet loading)
• Appropriate o-ring condition
• Lid assembled/fitted by head bolts or socket screws
• Washed with deionized water
• Leaching test performed to verify water activity concentration below limits
• Argon purged performed
• Vent and drain holes properly plugged and capped
EMBALSE NUCLEAR POWER PLANT
POOL (RECEIVING BAY)

Reactivity control bars

Bundle disassembly equipment, Co-60 pencils, and capsule assembly
TYPE B(U) PACKAGE DESIGN FOR Co-60

Containment: cavity of the packaging to place capsule assembly

Removable fireshield ⇒
TYPE B(U) PACKAGE DESIGN FOR Co-60

Detail of the top cap of fireshield

Removable support base
To verify the compliance with AR 10.16.1, Rev. 1 [1996 Edition (Revised) of IAEA Regulations, TSR-1]

- External surface non-fixed contamination below limits
- Accessible surface temperature below limits
- Categorization of the package: maximum radiation level on external surface and Transport Index
- Radiation levels at any point on the external surfaces of vehicle and at 2 m of that surface
- Marking and labelling of package
- Placarding and labelling of vehicle / freight container
- Tie-down system of the package to vehicle
TYPE B(U) PACKAGE DESIGN FOR Co-60

Detail of the tie-down system

Labeled and marked package
TYPE B(U) PACKAGES CONTAINING Co-60 LOADED IN THE VEHICLE

Placarded vehicle ⇒

Package tied to vehicle
Thank you for your attention!