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COBALT BALANCE MEASUREMENTS AT RINGHALS-1 BWR

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Objectives: To investigate the main sources of cobalt-60 in a ABB-BWR.

Radiation fields in Swedish BWRs were expected to reach a steady level in a few years, nevertheless they are still increasing after 20 years. A intensive investigation is being carried out by the Nordic utilities and the vendor. Cobalt balance analysis has been performed and new knowledge about cobalt sources and their transport is emerging.

There are several reasons for the increasing dose rates:

-Higher burn-up of the fuel
-Fuel failures
-Hydrogen Water Chemistry (HWC)
-Continuous input of cobalt

It appears certain that the main cobalt contribution emanates from the Stellite hard-faced valves in the residual heat removal and clean up system and not from the large stainless steel surfaces in the steam and condensate cycles.

Comments: Improvements in fuel design has lead to increased burn-up. This has caused an increase in Co-60 activity in the fuel crud which has resulted in an increased activity release and increased radiation levels in the plant. The increased burn-up is regarded as one of the main causes for the increased radiation fields. This has had an impact on occupational exposure. Ringhals-1 has suffered from a severe fuel failure, releasing 250 grams of uranium to the reactor coolant system. The recoiling fission products from the tramp uranium knock out corrosion products like Co-60 from the crud deposited on the fuel. Ringhals-1 has used HWC since 1984. In 1994, due to problems with degassing in a newly installed preheater Ringhals was forced to increase the amount of hydrogen in the system. There have also been frequent shutdowns and consequently shut-offs of HWC so that personnel could enter the main turbine building for maintenance work. The final factor is continuous cobalt input. In ABB-BWRS Co-60 contributes typically 60-95% of the dose to personnel. However, at Ringhals-1 the contribution is greater than 95%.

Remarks: As a result of a series of careful measurements of the fuel crud, and the cobalt content of the feedwater and reactor water by various sensitive techniques it has been ascertained that the main source of cobalt is neither the large stainless steel surfaces (8,700 m^2)

BNL ALARA Center Data Base

SWEDEN **R-446**

in the feedwater system downstream of the condensate polisher filters, nor the turbine system upstream of the condensate polisher plant. The Co-60 emanates in fact from the relatively small surface area (5-10 m^2) of the stellite clad valves in the clean-up and cool down system, control rod crud removal system and other systems circulating reactor coolant water. There are numerous stellite clad valves of different types in these systems in various chemical environments, flow rates and temperatures. It is probably not possible to justify replacing every valve. The next phase of this program is likely to be to try to ascertain which are the critical valves that need replacement.

References: 1. Erixon, O., and B. Bengtsson "Which is the main Cobalt Source in an ABB-BWR?" Proceedings, EPRI Radiation Field Control and Chemical Decontamination Seminar, Tampa, Florida, November 1995, EPRI Distribution Center, P.O. Box 23205, Pleasant Hill, CA 94523.

2. Erixon, O. and G. Svedberg, "Radiological effects of fuel failures during 1993 and 1994 outages at Ringhals-1," Final report, Vattenfalls AB, Ringhals, S-43022 Vaeroebacka, Sweden.

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