



Contribution ID: 234

Type: Poster

## Core Neutronic and Source Strength Analyses of Co-60 Production in Local Power Reactors

*Wednesday, 26 April 2017 14:15 (2 hours)*

A detailed analytical study on the feasibility of local production of cobalt-60 in power reactors of Pakistan, C-1 & C-2 (Chashma Nuclear Power Plant, unit-1/unit-2, PWR type), has been made by irradiating metallic pencils of cobalt-59 in-core and out-of-core locations. In the first scheme, four fresh fuel assemblies with 4 guide tube locations per fuel assembly have been selected for in-core Co-59 loading. A total of about 150000 curies of Co-60 are produced in these locations over a period of one fuel cycle (~ 385 days). Detailed neutronic analysis of C-1/C-2 core was carried out in order to determine the effect of samples irradiation upon core performance at full power. The reactivity calculations show that fuel cycle length would be slightly shortened approximately by 1 day without affecting the safety parameters due to Co-59 loading at in-core locations. The estimated specific activity of cobalt pencil at the end of 1 year is 19.25Ci/g.

Alternatively, in C-1 & C-2 reactors the four out-of-core vacant locations on the outer surface of Reactor Core Barrel, which were earlier occupied by the now-withdrawn Surveillance Capsules Assemblies (SCAs), have been selected for Co-60 production. In this scheme four bundles in the form of stainless steel tube, each tube containing 18 concentric cobalt pencils would be loaded in SCA hanger assemblies. An estimated 30,000 curies of Co-60 are produced in these locations over two core cycles (~ 770 days). Since cobalt targets are placed in the same ex-core locations that earlier contained the stainless steel and other RPV material samples in SCAs, the cobalt loading would have no impact on nuclear reactor safety. In order to determine the effect of Cobalt-59 irradiation upon core reactivity, a detailed neutronic analysis of C-1/C-2 core was also carried out at full power. The core design calculations show that there is no significant effect on critical core parameters and reactor operation, and fuel cycle length is not reduced. The calculations show that the estimated specific activity of capsule at the end of 2 years is 0.83Ci/g at the cobalt loaded SCA location. For a total mass of 35kg of 72 Cobalt-59 samples, the total activity from the production of Co-60 is estimated to be 30,000 Curies. Detailed shielding analysis and dose rates of irradiated Co-60 pencils have also been carried out. Thicknesses of shielding materials have been optimized based on the surface dose rate criteria of  $\leq 2\text{mSv/h}$ . Based on these analyses, the cylindrical shielded transport containers with different loading combinations have also been designed for safe transportation.

From these analyses, feasibility of production of cobalt-60 at the in-core and out-of-core vacant locations of SCAs in power reactor has been demonstrated without any major modification in reactor core and imposing any serious impact on reactor core performance and plant safety.

### Country/Organization invited to participate

Pakistan

**Primary author:** Mr IHSAN, Aamir (PAEC, Pakistan)

**Co-author:** Mr CHUGHTAI, M. Kamran (PAEC, Pakistan)

**Presenter:** Mr IHSAN, Aamir (PAEC, Pakistan)

**Session Classification:** P-A1

**Track Classification:** IRRADIATION FACILITIES