SOFE 2017 SHANGHAI

Contribution ID: **463** Type: **Oral**

Proposed methodology for unplanned repair scenarios in ITER

Thursday 8 June 2017 16:00 (20 minutes)

Extensive nuclear analysis has been performed for ITER fusion device in order to determine the shielding requirements to minimize radiation exposure to operational personnel and sensitive equipment. The radiation exposure evaluation has been focusing on the areas in which personnel access is anticipated for planned maintenance, such as in the port interspace for diagnostic systems. This contribution focuses on the regions where hands-on repair activities may only occur if any components fail to function due to unexpected accidents or faults, and where short personnel access can be more efficient than remote repair. All ITER superconducting magnet components are housed within the cryostat and no maintenance is needed during nuclear operation of ITER. The ITER toroidal field coil terminal box region has been taken as a typical example for which the radiological impact is assessed and a methodology is sought to develop realistic and feasible repair scenarios. The assessment has been conducted in four stages: 1) roughly estimate the contact dose for materials which have received different irradiation times; 2) calculate the shutdown dose rate counting all decay gammas in a simple rectangular box shape; 3) obtain and compare the shutdown dose rate in more detailed terminal box models (simplified from CAD models); 4) analyse the shutdown dose rate in the global environment with all other components included to contribute to the shutdown dose rate.

If components failed due to unexpected accidents, repair would always be before the end of ITER life time. The calculations show that the contact dose rate is 20 times different between ITER life-time irradiation and 2-year irradiation therefore thorough testing and commissioning of components in the early part of the ITER operational life, designed to improve long-term reliability is essential. In case of an accident driven repair, we may propose countermeasures against excessive doses exposure by carefully planning the repair steps, routes and duration of work.

Moreover, with the ITER construction progressing, the phase has been moving from design to procurement and manufacture. At this stage of the project, procured components may be found to be made of materials containing different content of impurities to those in the specifications. It is generally possible to reject materials with higher impurity content such as cobalt which would create a local increase of the shutdown dose rate, an important parameter to estimate the radiation exposure level to radiological workers, but at the cost of replacing the component and a schedule delay. The methodology proposed in this contribution would also accommodate such materials reducing risk of failure in nuclear operation by an unrepairable component which cannot be easily foreseen in the stage of design and construction.

Eligible for student paper award?

No

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Session Classification: R.OP6: Safety, Operations, and Maintenance

Track Classification: Operations and maintenance