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Fuel Performance in Aging CANDU Reactors – A Quick Overview of the CNSC Regulatory Oversight Activities of the Past 15 Years and of the Lessons Learned

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Abstract

The operating conditions (coolant flows, temperatures, pressures) of the Heat Transport System (HTS) of a CANDU reactor are affected by the aging of its components. For a given fuel bundle design, those changing conditions result in *lower dryout powers*, and in the absence of any corrective actions addressing the root cause of those changes, the decrease will continue as the aging of the HTS components progresses. As a result of this situation, safety margins for several relatively high frequency Design Basis Accidents (DBAs) in Deterministic Safety Analysis will also be decreasing as a function of time. Eventually, defence-in-depth will be compromised if no corrective actions are taken, and ultimately reactor de-ratings (reactor operating at less than 100% full power) will be required in order to ensure, for those postulated DBAs, that shutdown system effectiveness at protecting the integrity of physical barriers to the release of radioactive materials is maintained at all times. Depending on its size and duration, the economic impact of deratings on licensees could be significant.

The situation described above, as well as means to address it, has been at the heart of numerous discussions and licensing activities between the CNSC and the industry for more than 15 years now. During that period, licensees developed HTS aging management strategies aimed at delaying as long as possible the need to derate , strategies which led to many developments including new fuel designs with better heat transfer properties, new methodologies to calculate safety margins in deterministic safety analysis including the use of less conservative CHF correlations, and to the proposal by an expert panel, after a review of the experimental data on CANDU fuel behaviour in post dryout conditions, of a new set of less conservative derived acceptance criteria that could in principle be used to assess, for certain DBAs, safety margins in aging CANDU reactors.

All this development work was aimed at either increasing safety margins by physical changes such as the introduction of new fuel designs and/or by showing, through the removal of certain conservatisms that were used in past evaluations, that the safety margins for those DBAs are in fact larger than initially thought, and

therefore pushing at a later date the need to derate in order to compensate for the negative impact of HTS aging on fuel dryout powers.

HTS aging could also impact fuel performance in normal operations. A recent example is the "black deposits" on fuel that have been observed in Pickering reactors, and which have led the CNSC to de-rate unit 1 in order to ensure that adequate safety margins are maintained until corrective measures are implemented, and shown to be successful.

In this presentation, a quick overview of the CNSC's fuel oversight program will be given with a focus on past and more recent CNSC activities related to fuel performance in aging CANDU reactors. Some of the challenges that the CNSC has faced in evaluating the technical basis of the safety margins claimed by the licensees, and the lesson learned will be mentioned. Fuel related R&D activities that would contribute to a better characterization of safety margins in aging CANDU reactors will also be briefly discussed.