

## **A DIRECT APPROACH FOR MEASURING HYDROGEN IN CANDU PRESSURE TUBE MATERIAL**

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The integrity of CANDU reactor core components, made of zirconium alloys, can be adversely affected by the ingress of hydrogen isotopes during operation. This is a major long-term concern for utilities where past failures have contributed to loss of capacity. For this reason, deuterium ingress is routinely monitored by selectively scraping the inner wall of pressure tubes and sending samples to the Canadian Nuclear Laboratories (CNL) for analysis.

The present procedure involves the transport of radioactive material off-site because the hot-vacuum extraction mass spectrometry (HVE-MS) facility that performs the hydrogen assessment is not intended for use within a reactor vault where scrapes are extracted. HVE-MS also relies on an isotopic dilution method to enhance the sensitivity to hydrogen which may introduce measurement error. This indirect approach requires rigorous preparation between analyses to reduce uncertainty.

To address these drawbacks, an experimental apparatus has been developed to directly measure hydrogen, based on first principles, which is independent of calibration standards and empirical correction factors. The apparatus is portable because of its small footprint and simplicity which would make it suitable for reactor vault access. It can compete with HVE-MS by integrating a molecular sieve upstream for isotopic analysis.

The sensor has been found to possess a superior sensitivity compared to HVE-MS. It can be implemented to add hydrogen to a sample using a prepared gas mixture for the purpose of producing hydrogen standards with high certainty and for biasing the baseline signal. Having on-site access to this cost-saving, portable, sensor technology could improve the time-sensitive scrape testing procedure because results would be readily available.