Design Study of A Real Time Radiation Monitoring System For Severe Accident Conditions at a CANDU NPP

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Abstract

If a severe nuclear power plant accident occurs, instrumentation designed for normal operation will not be able to provide a sufficient assessment of the changing radiological situation. Measuring techniques with extended range are needed to supply reliable data even under extreme environmental conditions (pressure, temperature, humidity) and to be largely protected from the loss of power. The radiation measuring techniques for nuclear reactor accident conditions should serve in particular to determine the radioactivity in the air and the dose rate in the reactor building and to be able to provide an assessment of the situation even in locations of high activity concentration and dose rate. The assessment of the radiation conditions inside containment also has to provide sufficient characterization of releases in terms of the beta activity of radioactive gases and fission products to enable real-time updates on the type and extent of the accident, so enabling rapid response decisions concerning re-entering affected locations.

This work will describe the design a prototype dosimetric system that will be self-powered, robust and capable of measuring accurately over a wide response range under harsh operating conditions the rate at which both the ambient gamma ray and the β and γ gas-aerosol radioactive impurities change with time inside a CANDU NPP during a severe accident.

The prototype design consists of paired flow and non-flow ionization chambers with identical dimensions. The non-flow ionization chamber will be sensitive to ambient gamma radiation only. The flow through chamber will be sensitive to both ambient gamma radiation and air borne γ and β emitters transported through the chamber with the airflow. This arrangement makes it possible to determine the emission rate of β activity for some individual radionuclides and the total emission rate of all nuclides.

An optimization of the design of the ionization chambers by computational modelling will also be performed by comparing Monte-Carlo simulations with early experimental results.

Keywords: CANDU Nuclear Power Plant, Severe Accident, Instrumentations Design, Flow and Non-Flow Ionization Chambers, Monte-Carlo Modelling.