



# Implementation of a radiological emergency monitoring system for Bruce Power nuclear power plant (Canada)

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## INTRODUCTION

The Bruce Power nuclear power plant (BP NPP) in Ontario, Canada, is the largest nuclear generating station in the world, operating 8 nuclear reactors producing 6300 MW. In correlation with Bruce Power's safety culture, "Safety first" and continuous improvements are essential and substantial parts of the Bruce Power philosophy and management system.

## CONTEXT

After the Fukushima nuclear accident the Canadian Nuclear Safety Commission (CNSC) released recommendation 5c which asked for the improvement of tools to provide off-site authorities with automated real-time stations, appropriate back-up power, redundant communication channels etc. For BP it became essential to measure not only gamma dose rate, but additionally collect information about the composition of nuclides. Moreover the system should be able to measure and operate reliably even with gamma dose rate up to 1 Sv/h, as seen during the Fukushima event. Besides long-term reliable operation under harsh Canadian weather conditions, a key issue was the safe operation and data transmission during emergency conditions. Consequently the compatibility with seismic requirements, permanent autonomous operation and a reliable redundant communication interface were key specifications requested by Bruce Power.

## SPECTROSCOPIC MONITORING

The first part of the project comprised a total of 49 fixed and 10 mobile spectrometric stations to which Saphymo delivered the SpectroTRACER probes with LaBr<sub>3</sub>(Ce) scintillation detectors with additional GM tube and GPS. This probe is a fully autonomous self-contained gamma spectroscopic measurement station designed to comply with emergency situations also in worst case weather scenario, with a battery autonomy up to 10 days.



SpectroTRACER Station with solar system

Several communication interfaces are provided: cell/3G modem, Globalstar satellite modem, both integrated and operated over Virtual Private Network (VPN) for secure data transmission. The network interface is always active. Software functions provide an automatic switchover from cellular to satellite. A built-in webserver is available for easy remote control and setup. Beside, several meteorological stations have been integrated. After several months test run during 2013, all stations have been operational from fall 2014.



RTI International web-based central data management software

## SYSTEM PERFORMANCES

The 2014 winter showed a period with strong snowfall and temperatures down to -30° C (-22° F) in February. From Dec 9 to Dec 19, 2014 a period with very low solar insolation was present.

- **Overall operation:** Out of 59 gamma monitors delivered, 44 monitors were installed and in operation (5 are stored as spare and 10 are mobile units for emergency use). The complete system worked continuously without failure.
- **Detector performance:** The GM tubes and scintillation detector worked well stabilized without problem. The measured dose rate was stable, without any response to temperature variation, as expected due to the factory temperature quality tests.
- **Dose rate measurement:** The overall dose rate show the expected seasonal variation according to snow height and temporary peaks related to radon wash-out effects due to precipitation.
- **Cellular network data transmission:** The cellphone transmission showed periods of non-connection leading to an automatic switchover to satellite connection. These periods could be identified as a temporary problem in the public cellular network.
- **Satellite network data transmission:** During non-availability of the cellular network the monitors switched to satellite transmission. No loss of data was found.
- **Solar system / power consumptions:** The discharge of batteries and related battery voltage show different site dependent behavior, which is due to different site specific solar obstructions from trees, buildings etc. Even during a period of more than 10 days with very low solar insolation at Dec 9 – 19, 2014 the stations were in operation without problem.
- **SpectroTRACER enclosure tightness:** All humidity sensors report a low and stable humidity value. No problems found.

## CONCLUSION

- After 2 years operational experience, the system delivered by Saphymo proved its reliability and efficiency:
- The solar panels are supplying enough power to the monitoring stations, even under very rough weather conditions (with temperatures down to -30°C).
  - The redundant satellite transmission was confirmed as a very useful feature, particularly in remote areas not covered by the GSM/3G network.
  - The values measured with the LaBr<sub>3</sub> detectors did not show any impact due to high temperature fluctuations between day and night in Canada, which demonstrates the good functionality of energy stabilisation.



Bruce Power nuclear power plant (BP NPP) in Ontario, Canada

The SpectroTRACER monitor is a fully autonomous self-contained gamma spectroscopic measurement station. Its powerful hardware and software functions are designed to comply with emergency situations and harsh environmental conditions.

- LaBr<sub>3</sub>(Ce) crystal (size: 1.5" x 1.5")
- Measurement range: 1 nSv/h to 1 mSv/h
- Automatic stabilization and nuclide identification
- Redundant data transmission: GPRS/3G and satellite
- Built-in webserver for easy remote control and setup



## AEROSOL MONITORING

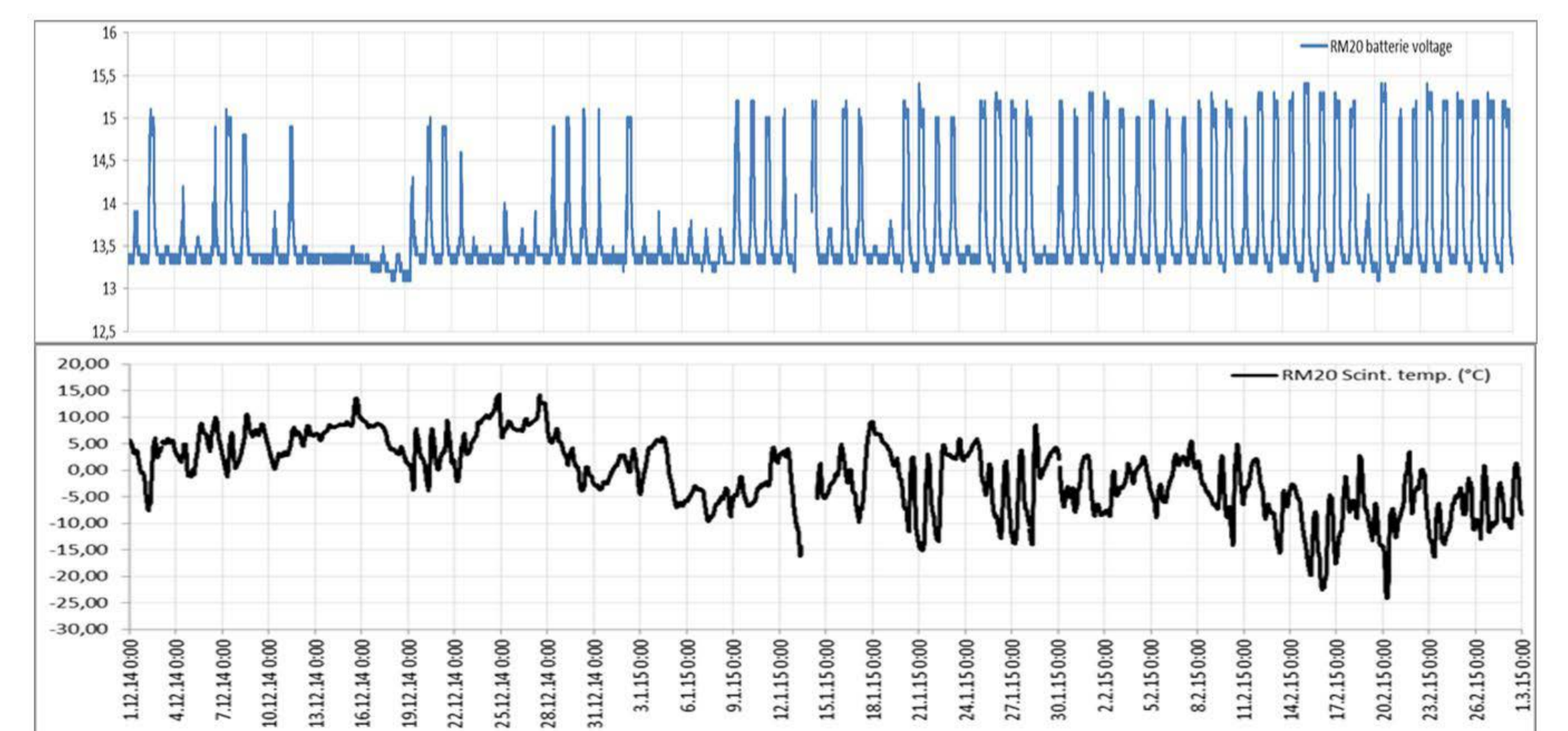
In the second part of the project Saphymo delivered 8 SA200NG and SA210ING spectroscopic air monitors. The air monitors have been designed for the detection of ultra-low activities of beta/gamma measurement for particulates, noble gas and iodine with spectroscopic functions. Redundant data transmission was also required. The SA210ING type air monitors are equipped with:

- Large silicon diode for β: (size: 2000 mm<sup>2</sup>)
- It allows LaBr<sub>3</sub>(Ce) crystal (size: 1.5" x 1.5") resolution for 137Cs: < 3 %
- Automatic stabilization and nuclide identification
- Dynamic compensations of gamma background and natural radon daughters
- 4 days battery backup (for SA210)



SA Air Monitor - Spectroscopic aerosol measurement

**Option - SpectroTRACER on the top for additional soil & noble gas measurement**



Battery voltage & temperature from Dec 9 to Dec 19 2014. The station worked without failure. The same for the low temperature period during Feb 20, 2015



SpectroTRACER mobile station