RADIOACTIVE GASEOUS EFFLUENTS MONITOR UPGRADE AT THE BRUCE A NUCLEAR GENERATING STATION

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INTRODUCTION

Ontario Hydro is committed to the effective management and control of the radioactive gaseous effluents from the ventilation pathways within the limits established by the Atomic Energy Control Board (AECB), and within the design and operating targets associated with the ALARA (As Low As Reasonably Achievable) policy.

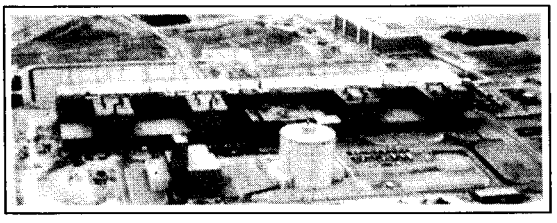

Fig. 1 Aerial View of Bruce A Nuclear Generating Station

The Bruce A nuclear generating station, fig. 1, is located on Lake Huron and is a 4-reactor power plant of 740 MW(e) net each. A major overhaul and upgrade of the radiation monitoring system has just been completed resulting in a system that effectively complies with current Canadian regulatory requirements.

THE MONITORING SYSTEM

Fig. 2 is a much simplified schematic of the Stack Monitoring flow diagram. In essence, the monitor draws a representative isokinetic sample conforming to ANSI 13.1 by a probe located in the stack above the station roof to minimize non-uniformity of the flow profile. The flow is maintained isokinetic and the sampling lines above the station roof are heat traced to forestall potential condensation.

The sampling stream then divides into two. The smaller stream passes through a desiccant which removes any water vapour for subsequent analysis for the presence of tritium. The larger stream is filtered to remove airborne particles and is monitored with a beta detector. The flow continues through a charcoal filter to remove gaseous halogen aerosols in the presence of an energy window to detect the presence of Iodine-131 photopeak. The sample is then pumped through a 7.5 litre Marinelli chamber where it is monitored for noble gas by a 2 channel NaI detector. The Marinelli chamber has a second port through which a germanium detector can be inserted for isotopic identification. Periodic purging of the chamber is performed to obtain updated background.

The monitoring system was supplied by Sorrento Electronics of San Diego whose microprocessor would continuously collect data and transmits hourly to the Control Room. Local data storage, with local alarms and displays are in place should communication between the microprocessor and the Control Room be disrupted.

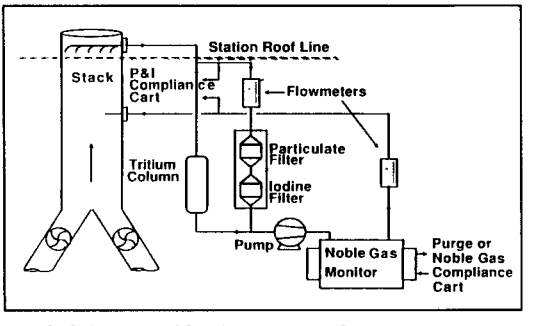

Fig. 2 Schematic of Stack Monitoring System

FUNCTIONAL REQUIREMENTS

The monitoring of the gaseous effluents is based on the most restrictive radionuclides via I-131 for radioiodines, Sr-90 for particulates both measured in curies and predominant matrix of noble gas mixture measured in γCi-MeV, Ref. 1 as well as tritium in water vapour form, measured in Ci.

The monitoring objectives are

For Compliance: where the continuous monitoring demonstrates compliance with regulatory limits and operational targets - by laboratory analysis

$$\text{Lower Limit} = \frac{\text{Concentration of 1\% Weekly Operating Target (WOT)}}{\text{Mean Weekly Flow at the Sample Point}}$$

Upper Limit = Concentration of $\frac{\text{100\% Weekly DEL}}{\text{Mean Weekly Flow at the Sample Point}}$

For Control monitoring: where on-line detectors continuously monitor the sample so that an operator can take corrective action to ensure limits are not exceeded.

Lower Limit = Concentration of $\frac{\text{0.1 Weekly Operating Target (WOT)}}{\text{Mean Weekly Flow at the Sample Point}}$

Upper Limit = Concentration of $\frac{\text{25 Weekly Operating Target (WOT)}}{\text{Mean Weekly Flow at the Sample Point}}$

Radiological releases are reported in Derived Emission Limits (DEL), or fractions thereof. The DEL is the amount of a radionuclide, or group of, which if released from the entire station in one year, would result in a member of the public at the station boundary receiving a whole body maximum permissible dose (500 mR/yr - 5 mSv/yr). The Ontario Hydro self-imposed target limit is 1% DEL (5 mR/yr - 50 μSv/yr).

Fig. 3 The Stack Ventilation Exhaust Fans

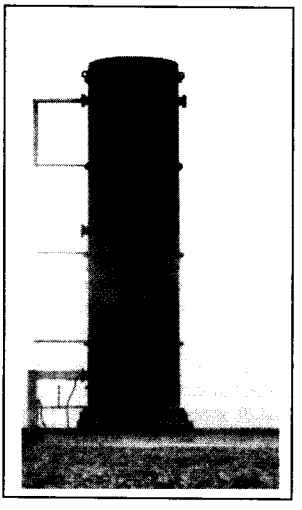

Fig. 4 Stack Probe Location Above Roof

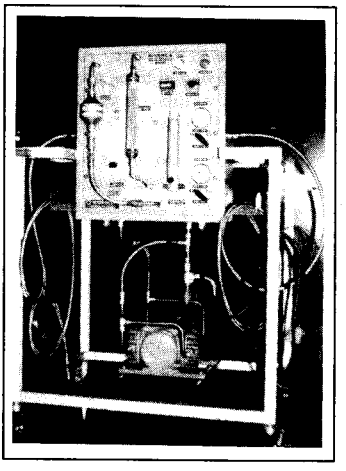

Fig. 5 The Particulates, Iodine and Tritium Compliance Monitoring Cart

For Bruce A the above translates to releases in table 1.

RADIONUCLIDE	1 DEL Ci/week regulatory compliance upper limit	1% DEL = WOT Ci/week Weekly Operating Target	1% WOT Ci/week compliance lower limit	0.1 WOT Ci/week control lower limit	25 WOT Ci/week control upper limit
H^3	$1.95\ E^{+5}$	$1.95\ E^{+3}$	$1.95\ E^{+1}$	1.95^{+2}	$48.75\ E^{+3}$
I-131	0.618	$0.618\ E^{-2}$	$0.618\ E^{-4}$	$0.618\ E^{-3}$	$15.45\ E^{-2}$
NG (Ci-MeV)	$1.29\ E^{+5}$	$1.29\ E^{+3}$	$1.29\ E^{+1}$	$1.29\ E^{+2}$	$32.25\ E^{+3}$
Particulates	1.38	$1.38\ E^{-2}$	$1.38\ E^{-4}$	$1.38\ E^{-3}$	$34.5\ E^{-2}$

Table 1: Regulatory and Target Release Rates

Out of Bruce A's nine stacks, the stack having the lowest activity concentration is shown in Table 2 which becomes the Minimum Detectable (MDA) to be measured.

STACK	RADIONUCLIDE	COMPLIANCE		CONTROL	
		Lower Limit	Upper Limit	Lower Limit	Upper Limit
Non Contaminated	H^3	0.418 $\mu Ci/m^3$	4.18 $\mu Ci/m^3$	4.182 $\mu Ci/m^3$	1.05 mCi/m^3
Stack	I-131	1.33 pCi/m^3	13.25 nCi/m^3	13.3 pCi/m^3	3.31 nCi/m^3
Reactor	NG	0.277 $\mu Ci/m^3$	2.77 mCi/m^3	2.766 $\mu Ci/m^3$	0.692 mCi/m^3
Building	Particulates (Sr-90)	2.96 pCi/m^3	29.59 nCi/m^3	29.6 pCi/m^3	7.40 nCi/m^3

Table 2: Target Minimum Detectable Activities

AREAS OF IMPROVEMENT

Stacks, fig. 3: The original regtangular ducts were replaced with circular stacks, the flow profile improved and the velocity probe was located to give an accurate average of stack velocity.

Relocation of Sampling Probe and Velocity Probe, fig. 4: The original sampling probe was some 8m above the roof and close to the edge. Any maintenance to be done required scaffolding and was hazardous to staff. The probes were lowered to be about 1.53m (5 ft) above the roof. This was about 3 stack diameters above the last confluence of ventilation streams. This was accepted since the flow profile was steady; representative sampling and averaged flow velocity were attainable, Ref. 2.

Leak Detection: Two mass flowmeters were added to the inlet and outlet of the sampling line to the Sorrento monitoring system; and usually read the same for no in-leakage or out-leakage. Useful for after cartridges are changed, and for pressurization/vacuum tests of the sampling system.

The Particulates and Iodine Compliance Monitoring Carts, fig. 5: Two mobile carts, each of which can be plugged into the sampling line as needed when the installed system was down for maintenance or during equipment failure, enhanced the reliability and availability requirements.

The Noble Gas Compliance Monitoring Carts, fig. 6: Each of the two carts has a High Purity Germanium (HPGe) detector; its liquid nitrogen cryostat, power supply, multi-channel analyzer, PC with screen display, printer, and software for data collection and analyses, isotope identification, quantification and trending. Its HPGe detector can easily fit the installed Marinelli chamber's second port. They are used when the installed noble gas system is unavailable, or when isotope identification is required.

Meeting Unavailability Requirements: A reliability of >99% as specified in Ref 3 is being met by the ongoing availability of the mobile carts figs. 5 & 6.

Interfacing with the Control Room: The installed monitoring system alarms in the Control Room on high release rates and on system malfunction. Emissions in %DEL rate/h are also displayed. This accelerating trend gives an operator advance warning of a potential problem before the alarm limit is reached.

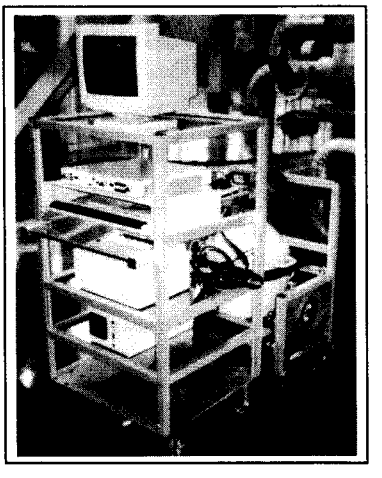

Fig. 6 The Noble Gas Compliance Monitoring Cart

REFERENCES

Ref. 1 R. Mourad, "The Use of Ci-MeV in Evaluating the Effective Does Equivalent from Noble Gas Release to the Atmosphere". 5th meeting of the Canadian Radiation Protection Association 1984.

Ref. 2 R.S. Dickson, "Bruce NGSA Stack Monitor Sample Integrity Tests, July-Sept. 1994". Ontario Hydro File #Nk21-REP-03480-0020-R01.

Ref. 3 Ontario Hydro Nuclear Generation Division Procedure 38. "Standards for the Monitoring of Radioactivity in Effluents in the Environment", Rev. 1, January 1990.