PORTABLE RADIATION INSTRUMENTATION TRACEABILITY OF STANDARDS & MEASUREMENTS

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ABSTRACT

Portable radiation measuring instruments are used to estimate and control doses for workers. Calibration of these instruments must be sufficiently accurate to ensure that administrative and legal dose limits are not likely to be exceeded due to measurement uncertainties. An instrument calibration and management program is established which permits measurements made with an instrument to be traced to a national standard. This paper describes the establishment and maintenance of calibration standards for gamma survey instruments and an instrument management program which achieves traceability of measurement for uniquely identified field instruments.

INTRODUCTION

The authors of this paper are employees of Ontario Hydro at the Bruce B Nuclear Generating Station, working with the Portable Radiation Instrument group. This group is responsible for the maintenance and calibration of all 2700 portable radiation instruments and sources at the Bruce Nuclear Power Development facilities in Tiverton as well as Ontario Hydro Technologies in Toronto. Calibration and maintenance facilities are located at the NWESD central facility, at Bruce A and at Bruce B. With the availability of these calibration facilities, virtually any portable radiation instrument can be calibrated on the Bruce site.

DISCUSSION

In order to control occupational doses below administrative and legal limits, hazard level measurements must be performed with known, acceptable accuracy. This means that the methods and equipment employed in the calibration process for the survey instruments must be accurate, i.e. their accuracy must be traceable. The purpose of a portable radiation instrument management program is to establish a process that ensures instruments are properly controlled and calibrated.

Traceability is the ability to relate the accuracy of measurements to appropriate standards through an unbroken chain of comparisons. The AECB with Regulatory Guide R-117 has stated that the calibration equipment must be implicitly traceable i.e. as a minimum to national standards and the calibration process (for gamma survey meters) must be approved by the AECB. Ontario Hydro recognized the needs for and benefits of having a radiation protection instrument program with demonstrated accuracy and reliability and has gone further than the AECB requirements with the issuance of Technical Report NOB-03420-002. This report deals with the calibration and standards for all portable radiation instrumentation used by OH Nuclear.

Most industry standards suggest the use of a free air calibration facility but some recognize the usefulness of calibration boxes for production style calibration of field instruments. All stipulate the traceability of the field instrument calibration through to a national standard.

The first stage in the process (see Figure 1) is to transfer standard from an appropriate national standard via a high quality, stable instrument to a local secondary or laboratory standard. Our Central Health Physics Department provides us with calibration for our Cs-137 track calibrator at Bruce B using a transfer standard calibrated against a national standard in Ottawa.

The national standard is Co-60 and our track source is Cs-137. A conversion factor has been established for the transfer standard using NIST Co-60 and Cs-137 sources. The track is calibrated using the conversion factors following calibration of the transfer standard in Ottawa.

The track itself approximates free air exposure conditions although there is some departure due to scatter close to the source. This source is decay corrected on a regular basis since it is used at least monthly for calibrations of various instruments.

The bulk of our gamma survey instruments are not calibrated on this track but rather in a cabinet calibrator at the maintenance shop, remote from the track. Reference fields are established in the cabinet for each type of survey meter using instruments of each type calibrated on the track. The cabinet is then used to calibrate the field instruments since it is convenient and efficient to do this for large numbers of instruments. It is expected that the AECB will approve this alternate practice since the relationship to the national standard, although indirect, is reliably established.

The traceability of individual field instruments must be established as well. This is accomplished by having in place an instrument management system whereby the instruments can be identified and retrieved as necessary for the required calibrations. At the BNPD this is accomplished with Radiation Control and Control Maintenance working together to ensure a reliable system exists.

An electronic information management system (BIMS) is used for much of the tracking necessary, providing an equipment database, identification system, calibration management, and history files (see figure 2).

Each of the instruments is assigned a unique equipment code which is entered into the equipment database of BIMS. In this database is specific information pertaining to this instrument such as facility owner, serial number, etc. The equipment code employs the standard Ontario Hydro USI or SCI identification system. An example of this is

CM67877BA-GM01-0001

where **CM** is Central Maintenance, **67877** is the USI assigned to portable radiation instrumentation, **BA** designates that this instrument is owned by Bruce A, **GM01** designates gamma meter type Scintrex model 189A and **0001** tells us that it is gamma meter number 1 of this type. This identification is placed on the instrument with a alpha/numeric and bar coded label for use by Radiation Control for retrieval and Control Maintenance for tracking, calibration scheduling and history files.

Included in BIMS is a callup database with a callup for each instrument. Information in the callup includes last completion and next due dates, calibration frequency, calibration procedure reference number, and any special considerations. From the callup database a calibration schedule is produced which is forwarded to each facility's Radiation Control unit so that they may begin the retrieval process from the field units. The instrument is transported to the Control Maintenance unit and the calibration process begins.

A calibration certificate is started and all measurements and data are recorded on it. The pre-calibration radiological measurements stated in the calibration procedure are performed using a traceable source of the appropriate isotope. The instrument then has the required functional and operational checks (high voltage, alarms, etc.) done and any necessary servicing or repairs are carried out. Once satisfied that the instrument is in good working order, the instrument is again exposed to the source and the necessary calibration adjustments are made. The final step is to conduct post calibration radiological measurements on every scale to ensure that the entire instrument range falls within acceptable tolerance. When the instrument has successfully passed calibration, a new calibration sticker is affixed. The calibration certificate is issued with all measurements recorded and errors calculated and any repairs and adjustments noted. This hard copy calibration certificate is stored in the Records department under the instrument's equipment code. In addition to the calibration certificate, an electronic report is required to be filed and kept in BIMS referenced to the instrument's callup and equipment code. The information written into this report will include the work done, that the calibration was successful or failed, and any unusual conditions. When the calibration process is complete, the instrument is then returned to the Radiation Control unit for issue to the field staff.

Once instruments are calibrated and returned to the field, there is still a requirement for checking to see that the instrument is functioning correctly prior to each use. For this reason, check sources are placed in the field, generally at the point of instrument issue. These sources are calibrated annually using calibrated instruments. Instruments failing the constancy check are removed from service and repaired and recalibrated.

Since the calibration for each instrument is traceable to a national standard and since each is constancy checked against a stable source whose calibration is also traceable to the same national standard prior to each use, each measurement made with the instrument is bracketed by confirmation of its calibration. Confidence in the accuracy of field instruments is thus assured.

FIGURE 1

Traceability of Calibration

LEVEL	FREQUENCY
National Standard • NRC Co-60 • NIST Cs-137, Co-60	
Transfer Standard • OHN-HPD Ionex 3 chambers (0.6cc, 35cc and 600cc)	• 1 to 2 years
Laboratory Standard • Shepherd Model 81 Cs-137 (0.1 Ci, 10 Ci and 1000 Ci)	• Calibrate using transfer standard • Periodic constancy check using BNPD Ionex • Decay correct quarterly
Calibrated Instruments • 1 of each model against Laboratory Standard	• Annual following decay correction
Reference Radiation Fields • Cabinet Calibrator Cs-137 (130 Ci and 5 mCi)	• Establish reference fields annually with calibrated instrument of each model
Field Instruments and Sources • Various models, including Constancy Checkers	• Calibrate against reference fields annually. Calibration recorded on sticker, calibration certificate and in BIMS

FIGURE 2

Field Instrument Management and Calibration BNPD