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Dear Dr. Jones,

I am writing in regard to the recent report issued by the National Research Council of the National Academy of Science (NAS) entitled Radiation Source Use and Replacement. From an e-mail that you sent to Joe McDonald yesterday and that was forwarded to me today I was dismayed to hear that Nuclear Regulatory Commission might follow these recommendations to eliminate the use of cesium irradiators in the United States.

I would like to address here the particular case for cesium irradiators used for calibration of instruments, which is directly related to the national-standards work in which we are involved at NIST. This particular application is described very briefly (less than one page) in the last section of the abbreviated version of the report (a copy of this section of the NAS report is included at the end of this letter). In addition to its being brief, I find this particular section of the report to be inaccurate and misleading. As a result, I am surprised that steps are being taken to follow these recommendations without adequately analyzing the consequences of these actions.

In the paragraph below I will comment on the last section of the abbreviated NAS report (section 5, page 14) and why cesium irradiators, for the purpose of calibrations, should not be eliminated in the United States.

Although the NAS report briefly mentions that $^{137}$Cs irradiators are used to calibrate survey meters, it fails to present the relevance of the use of these irradiators in the US. It also fails to present the drastic consequences of eliminating the use of these irradiators for calibrating radiation detection equipment in the United States. Furthermore the arguments presented in the section entitled Calibration Systems are incomplete and based on medical applications. Other applications for which $^{137}$Cs is actually most used for are totally ignored (i.e., homeland-security and radiation-protection applications).

There is a well-established structure in our country (and most of the world) based on $^{137}$Cs irradiators for the dissemination of standards for radiation protection. This structure has been established more than 40 years ago and has been growing and expanding since then. Most radiation-detection instruments in the United States are calibrated with $^{137}$Cs irradiators for a large number of applications including: homeland-security applications, radiation protection, medical applications, etc. A conservative guess of the number of detectors in the country being calibrated today with $^{137}$Cs irradiators and sources is at least in the thousands. The section in the NAS report entitled "Calibration System" is misleading and gives the impression that $^{60}$Co irradiators are the ones mostly used instead. But this is true only for medical applications. It incorrectly concludes that $^{137}$Cs beam irradiators can be replaced by $^{60}$Co. The report supports this finding with a statement that says that most national and international protocols are based on measurements provided with $^{60}$Co beams. There are indeed national protocols such as AAPM TG-51[1] and international protocols such as IAEA TRS-398[2] that are based on $^{60}$Co. However these protocols address the calibration of instruments used for medical applications only. The main quantity of interest in this case is absorbed dose in water for this penetrating gamma-ray energy used as a basis for radiation therapy and does not apply to the calibration of survey meters for which the the $^{137}$Cs gamma-ray energy is more typical and the primary energy at which such instruments are calibrated. <u>Thus the conclusions suggested at the end of the report cannot be based on this argument.</u>

For radiation protection and homeland-security applications the quantity of interest is the air kerma and the SI unit is the Gray (Gy). The older quantity of exposure is used also in the U.S. with the unit the Roengten (R). As mentioned in the NAS report, The National Institute of Standards and Technology is the primary-standards radiation-dosimetry laboratory in the US. As do other National Metrology Institutes around the world, we maintain and disseminate the standard for air kerma from x-ray and gamma-ray beams for the U.S. and also perform intercomparisons with other countries around the world.

For radiation protection and homeland-security applications the beams that are most used for the dissemination of the standards are those provided by $^{137}$Cs irradiators.
The standard for air kerma is disseminated directly from NIST to Secondary Standard Dosimetry Laboratories (SSDL), and these in turn disseminate the standards to tertiary laboratories and ultimately to end-user facilities. <u>In this way measurements made with thousands of radiation detection instruments around the country are traceable to the primary standard determined by NIST</u>. Furthermore accreditation programs require calibration facilities to perform blind tests using $^{137}$Cs beams.

Because of the large network of measurements performed with instruments around the country that relies strongly on the use of $^{137}$Cs irradiators, we strongly recommend that two out of the three suggestions proposed in the Summary section of the abbreviated NAS report be rejected. We refer to suggestions 2 and 3 (page 15 of the abbreviated report). Suggestion 2 from the report proposes to replace $^{137}$Cs irradiators by $^{60}$Co, while suggestion 3 also proposes to eliminate $^{137}$Cs irradiators by replacing it by a non-radionuclide alternative.

The only option that could be considered for the long term would be suggestion 1 from that report (also found in page 15 of the abbreviated version), which allows to continue using $^{137}$Cs irradiators provided the sources in the irradiators are replaced in the long term by a less-hazardous form of radioactive cesium.

We look forward to hear your opinions about this and will be glad to answer any questions you may have.

Sincerely,

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**References**

1. P. R. Almond, P. J. Briggs, B. M. Coursey, W. F. Hanson, R. Nath and D. W. O. Roger, "AAPM's TG-51 protocol for clinical reference dosimetry of high-energy photon and electron beams," Med. Phys. **26**, 1847-1869 (1997).

2. IAEA, Absorbed Dose Determination in External Beam Radiotherapy: An International Code of Practice for Dosimetry based on Standards of Absorbed Dose to Water, Technical Report Series, Vol. 398, pp. (IAEA, Vienna, 2000).

(a) (b)

FIGURE 5-6 X-ray research irradiators from (a) Precision X-ray (X-RAD 225C) and (b) Rad Source Technologies (RS 2500). Sources: Rad Source Inc. and Precision X-ray Inc.

## CALIBRATION SYSTEMS

Calibration systems use high-activity radiation sources (approximately 15 to 82 TBq [400 to 2200 Ci]) to produce radiation fields of known intensity for calibration of radiation monitoring equipment and dosimeters, whereby the equipment and dosimeters can be evaluated for accurate operation. A source of measured activity is required to calibrate instruments and dosimeters to accepted standards. Figure 5-7 shows a diagram and a photograph of a typical gamma beam calibration source.

The system usually consists of radioactive sources, radiation shielding, a mechanism for positioning the source, and a track or internal chamber for positioning the items to be calibrated. Modern calibration systems may contain a computer controller and safety systems, such as video monitoring, radiation monitors, warning lights and indicators, and a safety interlock system. Although calibration systems may contain different sources for the calibration of gamma, neutron, and beta monitoring equipment and dosimeters, the typical Category 2 sources used for calibration of beta/gamma survey instruments and dosimeters are strontium-90, cesium-137, and cobalt-60. The U.S. NRC Interim Inventory reports 104 calibration irradiators using Category 2 sources in the United States, in addition to calibration irradiators at nuclear power plants. These are primarily located in commercial and government calibration facilities and state regulatory agencies. Additional security is required at most of these facilities, due to other nuclear material or radioactive sources that are used at the facilities or for other reasons. Replacement of the cesium chloride sources could be made with glass or pollucite forms of cesium since very high specific activity is not required.

According to contemporary national and international radiation dosimetry protocols, Primary Standards Dosimetry Laboratories (PSDLs) and Accredited Dosimetry Calibration Laboratories (ADCLs) are required to provide users' ionization chambers with calibration coefficients obtained in cobalt-60 gamma ray beams. Therefore, PSDLs and ADCLs incorporate cobalt-60 irradiators, usually decommissioned clinical teletherapy machines, with cobalt-60 teletherapy sources with an activity of the order of 50 to 370 TBq (1500 Ci to 10,000 Ci).

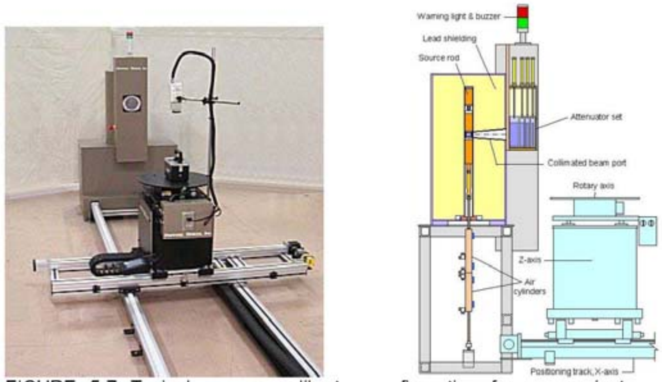


FIGURE 5-7 Typical gamma calibrator configuration for survey instrument calibration. SOURCE: Hopewell Designs (2007).

In the United States, the National Institute for Science and Technology (NIST) in Washington, D.C., serves as the primary radiation dosimetry laboratory and there are three accredited dosimetry calibration laboratories.

## SUMMARY AND FINDINGS

In most (and perhaps all) applications discussed in this chapter, radioactive cesium chloride can be replaced by (1) less hazardous forms of radioactive cesium, (2) radioactive cobalt, or (3) non-radionuclide alternatives. However, not all of these alternatives are available now, and all are currently more expensive than radioactive cesium chloride for the users. Use of the more robust but lower specific activity cesium-137 source matrixes may require re-design of some self-contained irradiators, although others might be able to use the new sources without retrofit or any significant change in performance.

**Finding: In most (and perhaps all) applications, radioactive cesium chloride can be replaced by (1) less hazardous forms of radioactive cesium, (2) radioactive cobalt, or (3) non-radionuclide alternatives. However, not all of these alternatives are available now, and all are currently more expensive than radioactive cesium chloride for the users.**

Some alternatives to radioactive cesium chloride include radioactive cesium glass and a mineral form (pollucite) loaded with radioactive cesium (described in Chapter 2). These alternative material forms use the same cesium-137 as radioactive cesium chloride, thus the gamma rays and the half-life are identical, but the specific activity of these sources is smaller and the pollucite is more difficult to fabricate, especially for high-activity sources. The committee judges that none of the current applications of high-activity cesium sources about which it was informed requires the higher specific activity afforded by cesium chloride. Accommodating the larger volume needed to achieve the same source activity would require redesign of some (not all) devices. High-activity cesium sources are not, however, available in