Examination of National and International Impacts of Adoption of ICRP Recommendations

Introduction

The U.S. Nuclear Regulatory Commission (NRC) staff has engaged in multiple domestic and international activities to obtain information on potential costs and impacts of the three options described in this Commission Paper. This enclosure summarizes the results of information-gathering efforts in support of delineating the options and impacts of moving the NRC's radiation protection standards toward greater alignment with recommendations outlined in the International Commission on Radiological Protection (ICRP) Publication 103, "The 2007 Recommendations of the International Commission on Radiological Protection." These efforts focused on identifying specific impacts, costs, benefits, and burdens of making changes to the NRC's radiation protection regulatory framework.

Dose limits

The NRC staff investigated potential impacts of making changes to the occupational dose limit by collecting and analyzing information about the actual dose distributions from NRC and Agreement State licensees. Technical reviews of historical occupational exposure records were conducted to assess potential impacts to changes in the existing annual occupational dose limit of 5 rem (50 mSv) and the lens of eye dose limit of 15 rem (150 mSv). Data was analyzed from several information sources, including the NRC's Radiation Exposure Information and Reporting System (REIRS) database[1], data maintained by commercial dosimetry vendors, discussions with industry groups, and data submitted from a limited number of Agreement States in response to the Office of Federal and State Materials and Environmental Management Programs (FSME) letter, FSME-2010-072, "Request to Provide Occupational Radiation Dose Data from Industrial Radiography and Nuclear Pharmacy Licensees," dated August 6, 2010. This combination of data analyses allowed the staff to collect and analyze additional occupational exposure information that is not routinely obtained solely from NRC licensees. Although it captured the majority of NRC- and Agreement State-licensed facility categories, only limited occupational dose information for medical institutions was obtained by the NRC staff using alternative data collection methods because the REIRS database collects occupational exposure information for only a small sector of medical licensees (nuclear pharmacies). Also, this database does not include other facilities such as those regulated by the U.S Departments of Energy (DOE) and the Defense (DOD).

[1] The NRC licensee categories contained in the REIRS database are commercial nuclear power reactors; fuel processors (including uranium enrichment facilities), fabricators, and reprocessors; industrial radiographers; manufacturing and distribution of byproduct material (including nuclear pharmacies); and independent spent fuel storage installations. The Agreement State licensee categories are industrial radiographers; waste disposal service processing and/or repackaging; irradiators; well logging companies; sealed source facilities; measuring systems and portable gauge facilities; calibration services; veterinary (non-human) facilities; and other facilities. The Agreement State licensee information contained in REIRS was provided voluntarily by these licensees.

The number of individuals exceeding 5 rem/yr (50 mSv/yr) total effective dose equivalent (TEDE) in REIRS for NRC and Agreement State licensees is 21 for the 1994 to 2010 reporting period. The number of individuals exceeding 5 rem/yr (50 mSv/yr) to the lens of the eye (lens dose equivalent or LDE) during these years was also 21, as the TEDE is generally the same as LDE in most monitoring situations. Individuals exceeding 5 rem (50 mSv) TEDE have exceeded a regulatory limit and generally represent situations where an incident or accident has occurred, not during normal operating conditions or processes. Exceeding 5 rem (50 mSv) LDE is not in excess of the current regulatory limit of 15 rem (150 mSv) for LDE. Only one individual exceeded 15 rem (150 mSv) LDE from 1994 to 2010.

The staff's analysis indicates the number of individuals exceeding 2 rem/yr (20 mSv/yr) TEDE has decreased by 80 percent from a high of over 1,000 in 1995 to about 200 in 2010. Thus, 99.7 percent of individuals with measurable TEDE and LDE were below 2 rem/yr (20 mSv/yr) in 2010.[2] As a general trend, relatively few individuals in the nuclear power reactor category routinely exceed 2 rem/yr (20 mSv/yr), whereas individuals working in other licensee categories such as temporary job site radiography routinely exceed 2 rem/yr (20 mSv/yr) without a significant decrease in their reported occupational doses. For example, in the most recent reporting period (2010), 75 percent of the individuals exceeding 2 rem/yr (20 mSv/yr) were reported from industrial radiography licensees. Also, dosimeter readings above 1 rem (10 mSv) are typically associated with hospitals and medical clinics.

The staff continues to actively collect and analyze information about the actual dose distributions from NRC and Agreement State licensees to gauge the impacts of reduced dose limits at medical and other specific categories of non-reactor licensed facilities, such as industrial radiographers. The staff is preparing an update to the 1995 report, NUREG/CR-6112, "Impact of Reduced Dose Limits on NRC Licensed Activities," which will provide limited preliminary information on potential costs and impacts of reduced dose limits. The update is expected to be released later this year.

Historical Information on Costs and Impacts of Implementing ICRP Publication 60

The staff has sought information from domestic and international information sources to estimate the resources expended to implement the recommendations of International Commission on Radiological Protection (ICRP) Publication 60, "1990 Recommendations of the International Commission on Radiological Protection," as a possibly useful comparative tool for estimating the costs of implementing ICRP Publication 103, "The 2007 Recommendations of the International Commission on Radiological Protection." The intent of gathering this information was to supplement information obtained by FSME from various stakeholder workshops and *Federal Register* Notices regarding possible revision of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 20, "Standards for Protection Against Radiation."

In 2010 and 2011, the staff collaborated with the Nuclear Energy Agency in conducting a survey of representative European, North American, and Asian countries to obtain available information from a cross section of countries that implemented ICRP Publication 60 recommendations and are now considering implementation of ICRP Publication 103 recommendations. The survey includes information from 11 small and large countries from 4 continents with different

[2] For most occupational exposure situations, the dose to the lens of the eye will be the same as the TEDE. However, for some exposure situations, the lens dose may be higher than the TEDE.

economic conditions, thereby providing a reasonable but limited representation of current international experience in implementing ICRP Publication 60 recommendations. This survey was supplemented with supporting information from the European Commission on its draft impact assessment for the next EURATOM Basic Safety Standards Directive; information from the International Atomic Energy Agency concerning occupational exposures in interventional cardiology; and ICRP Publication 60 implementation considerations at a large European nuclear power licensee.

Although the survey was designed to obtain cost information from these supplemental information sources, it actually obtained little cost information because such data had not been acquired or retained. When ICRP Publication 60 was prepared in 1990, cost-benefit analyses in support of new regulations were typically not conducted in most countries. No survey participants assessed the no-action alternative of not implementing ICRP Publication 60, and no participant identified a reduction of cost resulting directly from ICRP Publication 60 implementation. Survey participants noted, however, that cost-benefit impact analyses will likely be required for implementation of ICRP Publication 103. These analyses have not been conducted to date.

Two countries (Canada and United Kingdom) reported additional costs for implementing ICRP Publication 60 that were associated with increased dose monitoring and upgraded dose registries. In Canada, the overall cost to implement new radiation protection regulations was 5.9 million CAD (46 percent is attributed to new security requirements), and the annual incremental cost was 4.5 million CAD (56 percent for new security and 22 percent attributable to the new ICRP Publication 60 dose limits). In the United Kingdom, the overall cost to implement new radiation protection regulations was 0.84 million GBP (about 2 million CAD) of which 78 percent is attributed to licensee costs and 12 percent to regulatory costs. The annual incremental cost was 1.2 million GBP (about 2.8 million CAD) of which 99.7 percent is attributed to licensee costs and 0.3 percent to regulatory costs.

Overall, occupational doses are trending downward since issuance of ICRP Publication 60, which can be attributed to more rigorous optimization programs and a reported increased focus on training and radiation protection by implementation of ICRP Publication 60. However, the trend of decreasing occupational exposures varies among countries and licensee category. Some countries, such as Norway and Canada, reported increased occupational exposures for medical staff.

All survey respondents have adopted the recommendations of ICRP Publication 60 and they expect only minor changes to existing radiation protection regulations to implement ICRP Publication 103. Regulatory topics that may require change are nomenclature, use of new weighting factors, optimization and use of constraints and reference levels, and new dose limits for the lens of the eye. However, survey respondents anticipated little change in the resources required of regulatory agencies to implement ICRP Publication 103. Thus, the overall cost impact of ICRP Publication 103 is expected to be minimal and less than that of ICRP Publication 60. A few European countries may analyze the no-action alternative as part of a regulatory impact assessment, but there will be little or no analysis of the cost of not implementing ICRP Publication 103 because the updated EURATOM Basic Safety Standards Directive will make ICRP Publication 103 mandatory in member countries. The European Commission's September 2011 draft impact assessment for the next EURATOM Basic Safety Standards

Directive did not contain quantitative cost information for the regulatory options evaluated for member country implementation.

The increased emphasis in ICRP Publication 103 on the use of dose constraints is expected to pose difficulties in countries that have not adopted the dose constraint concept but will be only a limited problem for countries that already use this concept. Significant problems are not expected with the implementation of new dose coefficients, calculation methods, and terminology. However, according to information provided by the International Atomic Energy Agency, compliance with wearing dosimeters may be an issue for the medical community.

In addition to the aforementioned efforts to obtain ICRP Publication 60 implementation costs from other countries, the staff also pursued collection of similar information from domestic sources. For example, the DOE revised its regulations for occupational radiation protection (10 CFR Part 835, 72 FR 31094; June 8, 2007) and radiation protection of the public and environment (Order O 458.1, February 11, 2011) to incorporate updated radiation dosimetry methodologies (ICRP Publication 68, "Dose Coefficients for Intakes of Radionuclides by Workers," and Publication 71, "Age- Dependent Doses to Members of the Public from Intake of Radionuclides: Part 4 Inhalation Dose Coefficients"). These methodologies are used to implement the recommendations of ICRP Publication 60.

Both of these relatively recent DOE rulemakings involved extensive stakeholder involvement over several years. DOE decided not to adopt all ICRP Publication 60 recommendations in these regulatory revisions. Most notably, DOE did not change the annual occupational dose limit from 5 rem (50 mSv) to the ICRP Publication 60 recommendation of 10 rem (100 mSv) over 5 years. However, for occupational exposures, DOE adopted an annual administrative control level of 2 rem (20 mSv) that requires administrative approval for higher occupational exposures, which functions similarly to the ICRP Publication 60 dose constraint concept. Also, DOE formally established dose constraints in Order O 458.1 for the release or clearance of property with residual radioactivity. Regarding costs for developing and implementing these regulations, DOE was not required to estimate or track costs as part of these rulemaking activities, so there is no summary information available on either DOE's costs for promulgating and implementing these regulatory changes or DOE operators' implementation costs.

Another potential source of domestic cost information on incorporating the radiation dosimetry methodologies of ICRP Publications 60 and 68 is the fuel cycle facility licensees regulated by the NRC. The staff tried to obtain information on actual costs incurred by the fuel cycle licensees when they adopted the updated ICRP methodology in their radiation protection programs during the 1990s. The fuel cycle licensees did not track this information, so no cost estimates are available of the licensees' cost to update their radiation protection programs. However, there were cost savings for implementing revised uranium dose coefficients associated with the ICRP Publication 68 methodology.

Similar to the approach used by NRC fuel cycle facilities, other Federal agencies have adopted portions of ICRP Publications 60 and 68 for radiation dosimetry purposes. For example, the Energy Employees Occupational Illness Compensation Program Act, administered by the U.S. Department of Health and Human Services' National Institute for Occupational Safety and Health (NIOSH), uses ICRP Publication 60 radiation weighting factors and updated ICRP models to calculate radiation doses to occupationally exposed workers. However, staff of the

Office of Nuclear Regulatory Research is not aware of NIOSH or any other Federal regulatory agency possessing cost information.

Based on the results of the information-gathering efforts to date on ICRP Publication 60 implementation costs, it is apparent that most countries, including the United States, did not conduct a comprehensive assessment of the costs of promulgating and implementing regulations, guidance, or licensee radiation protection programs because either this type of assessment was not required or regulators and licensees considered the costs sufficiently small that they were not worth tracking. Other possible explanations are that anticipated improvements in operational efficiencies were expected to offset implementation costs, regulators and licensees were afforded ample time for planned implementation, and that the net benefits of harmonization amongst countries were viewed as advantageous in comparison to implementation costs.

From the international perspective, implementation costs for ICRP Publication 103 are expected to be less than those for ICRP Publication 60 because there is no major change in the recommended dose limits between the two publications, excluding the April 2011 ICRP recommendations for a reduction in the annual limit for the lens of the eye. However, the NRC has not updated 10 CFR Part 20 to comport with ICRP Publication 60, so the costs associated with an update of 10 CFR Part 20 to either ICRP Publication 60 or ICRP Publication 103 may be similar, and higher than the costs expected by countries that have adopted ICRP Publication 60. A detailed comparison of the costs of implementing ICRP Publication 60 and Publication 103 is not possible at this time because the ICRP has not yet issued updated dose coefficients and biokinetic models corresponding to the recommendations in ICRP Publication 103. This information is essential for estimating potential changes to regulations, guidance, and licensee operations. It is expected that in comparison to other countries, NRC and licensee costs would likely be significantly higher because of the more comprehensive analyses required for NRC rulemakings.