

## ISSUE PAPER 5

### METRICATION—UNITS OF RADIATION EXPOSURE AND DOSE

#### I. Introduction

In Staff Requirements Memorandum (SRM) SECY-12-0064, “Recommendations for Policy and Technical Direction To Revise Radiation Protection Regulations and Guidance,” dated December 17, 2012,<sup>1</sup> the Commission disapproved the elimination of traditional units from U.S. Nuclear Regulatory Commission (NRC) regulations. The SRM-SECY-12-0064 further states that the regulations should maintain both traditional units and the international System of Units (SI).

#### II. Objective

Develop the regulatory basis information necessary for addressing the use of both traditional (also known as non-SI) and SI units in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 20, “Standards for Protection against Radiation,” consistent with the Commission’s metrication policy.

#### III. Background

On August 23, 1988, Congress passed the Omnibus Trade and Competitiveness Act of 1988 (the Act), Public Law 100-418, which amended the Metric Conversion Act of 1975 (15 U.S.C. §§ 205a.-I). Section 5164 of the Act designated the metric system as the preferred system of weights and measures for U.S. trade and commerce. The Act also required that all Federal agencies convert to the metric system of measurement in their procurements, grants, and other business-related activities by the end of fiscal year 1992, “except to the extent that

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<sup>1</sup> SRM-SECY-12-0064 is available on the NRC’s public Web site at <http://www.nrc.gov/reading-rm/doc-collections/commission/srm/2012/>.

such use is impractical or is likely to cause significant inefficiencies or loss of markets to United States firms, such as when foreign competitors are producing competing products in nonmetric units.”<sup>2</sup>

President Bush signed Executive Order (E.O.) 12770, “Metric Usage in Federal Government Programs,” on July 25, 1991. Its purpose is “to implement the Congressional designation of the metric system of measurement as the preferred system of weights and measures for United States trade and commerce.” Furthermore, Section 2 of E.O. 12770 directs all executive branch departments and agencies “to take all appropriate measures within their authority to carry out the provisions of this order.”

On February 10, 1992, the NRC published a proposed metrication policy statement for comment in Volume 57 of the *Federal Register*, page 4891 (57 FR 4891) and a policy statement on October 7, 1992 (57 FR 46202). The October 7, 1992, policy statement called for the NRC to assess metric use by the licensed nuclear industry in the United States after a 3-year period to determine whether the policy should be modified. On September 27, 1995, the NRC published a request for public comment on the October 7, 1992, policy to learn whether any modifications were necessary (60 FR 49928). After reviewing the comments received and after concluding that the October 7, 1992, metrication policy did not need any changes, the NRC published a final policy statement on June 19, 1996 (61 FR 31169). This final policy statement states that the “Commission does not intend to revisit this policy unless it is causing an undue burden or hardship” (61 FR 31171).

In 2008, the National Institute of Standards and Technology (NIST) published, “The International System of Units (SI),” discouraged the use of the traditional radiation units (i.e., the curie, roentgen, rad, and rem) (NIST Special Publication 330, 2008). In February 2012, the Health Physics Society (HPS) issued a final position statement entitled, “Exclusive Use of SI

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<sup>2</sup> See 15 U.S.C. § 205b(2).

Units to Express Radiological Quantities,” which states that “the continued use of traditional units to express radiological quantities in the United States...can have significant repercussions with regard to effective response to radiation emergencies.” (See the HPS position statement at [http://hps.org/documents/Slunits\\_ps025-0.pdf](http://hps.org/documents/Slunits_ps025-0.pdf).)

A practical approach to using the metric system is one that is both consistent with the intent and direction of the Act and does not introduce safety concerns or result in an economic burden to licensees or applicants. This type of approach would result in the use of the metric system by those licensees and applicants for whom the use of the metric system presents no economic disadvantage and no safety detriment to the public.

The Commission’s policy on metric system conversion remains as stated on October 7, 1992, and as reaffirmed by its June 19, 1992, final policy statement. Under the NRC’s 1992 metrification policy, the Commission supports and encourages the use of the metric system of measurement by the nuclear industry. Beginning in 1993, the NRC began to publish the following documents in dual units with the SI units listed first followed by the English units in parentheses: new regulations, major amendments to existing regulations, regulatory guides, NUREG series documents, policy statements, information notices, generic letters, bulletins, and all written communications directed to the public. The NRC policy further directs that documents specific to a licensee, such as inspection reports and docketed material concerning a particular licensee, will include the system of units used by the licensee. Furthermore, all event reporting and emergency response communications between licensees, the NRC, and State and local authorities will use the traditional system of measurement.

In a number of the previous stakeholder interactions, representatives from various groups asked whether the use of the SI units would be part of any revision to the NRC radiation protection regulatory framework. In general, these stakeholders stated that this was another factor in aligning the NRC’s regulatory framework with the international recommendations. The

stakeholders also presented a number of areas in which SI units are used as the primary units, such as in transportation manifests. Some stakeholders, such as HPS, included this change both in comments during meetings and as a recommendation in written comments submitted in response to NRC staff requests for comments on possible revisions to the radiation protection standards (74 FR 32198, July 7, 2009; 75 FR 59160, September 27, 2010; and 76 FR 53847, August 30, 2011). The HPS noted that the rest of the world uses the SI units exclusively.

Essentially all scientific literature uses SI units, and HPS and other scientific organizations have adopted this approach. Furthermore, HPS has indicated that the differences in units between the English and the SI systems could create issues of miscommunication. Other stakeholders, such as those in the radiopharmacy industry, noted that their business arena requires the use of SI units because of the global movement of materials. These stakeholders suggested that using SI units exclusively would be an advantage.

#### **IV. Discussion**

The use of SI units versus the English system of measurement continues to be a point of dialogue. The staff recognizes the interest on the part of some stakeholders for a more uniform recognition of the SI units. However, the staff also recognizes that there are significant issues in moving further toward alignment with the use of SI units. The same public communication and emergency response communication issues remain as they were in 1995. These issues were highlighted during the response to the Fukushima event in which confusion resulted from the use of different units.

Another significant factor in any increased use of the metric units will involve interactions with other Federal agencies and the States. A move to applying the Commission's metrification policy when amending NRC regulations would need to be in agreement with a general move in that direction across the entire radiation protection community. Without such an agreement, a

change toward the sole use of metric units would not likely be made. For example, one State noted that it did not support a change toward the use of SI units and that its current practice of including both units (i.e., English units listed first followed by SI units in parenthesis) would continue. The NRC metrication policy applies to the formatting and structure of the NRC regulations and guidance. Specific requirements in the regulations address the units used.

The current radiation protection regulations at 10 CFR Part 20 were issued approximately 1 year before the publication of the NRC's metrication policy (57 FR 46202; October 7, 1992). Therefore, most NRC dose limits and other units of measurements are listed in the regulations with the traditional or "English" units first followed by the metric units in parentheses. Some NRC regulations list metric units first followed by traditional or "English" units in parentheses. Numerical information in the appendices to 10 CFR Part 20 is a mixture of traditional and metric units. For example, the DACs in Table 1, Appendix B, Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage," of 10 CFR Part 20 are in units of microcuries per milliliter; thus, the activity is in traditional units and the volume is in metric units. Whereas, the numerical information in Appendix C of 10 CFR Part 20 only uses traditional units of measurement.

In addition, the issue of the units used in recordkeeping and reporting must also be addressed. The regulation at 10 CFR 20.2101(a) currently requires licensees to use the traditional units; therefore, licensees cannot use metric units if they wanted to do so. The regulation at 10 CFR 20.2101(b) allows licenses to record quantities in SI units in parentheses following the traditional units. The regulation at 10 CFR 20.2101(c) requires information recorded on shipping manifests, as required by 10 CFR 20.2106(b), to be listed in SI units or both SI and traditional units.

The requirement to keep all records in traditional units or in both sets of units could be

seen as inconsistent with a revised regulation in which the dose criteria are expressed first in SI units followed by the traditional units. One alternative could be to amend the regulation to allow a licensee to maintain records in either set of units as long as it uses only one set of units throughout its recordkeeping system. Another alternative could be to allow a licensee to use either set of units in measurements and calculations; however, it would need to present the final values that support regulatory compliance in one or both sets of units. These various alternatives apparently have different regulatory burdens and implementation issues. The NRC staff is seeking to gain additional information from stakeholders on the implications of the various alternatives, including the option that no change should be made.

As part of its draft regulatory basis development for a possible revision to 10 CFR Part 20, the NRC staff is examining the implementation of the Commission's metrification policy in regard to how the units should be presented in Appendix B to 10 CFR Part 20. The staff believes that the unique nature of Appendix B to 10 CFR Part 20 with its detailed numeric information for each radionuclide may pose a situation in which a deviation from the metrification policy may be necessary. The staff needs to address two different issues for Appendix B to 10 CFR Part 20.

Two issues need to be address regarding the application of the Commission's metrification policy to Appendix B to 10 CFR Part 20. The first issue is the selection of the value that the NRC will consider as the regulatory standard. The values in Appendix B are currently given in the traditional activity units (microcuries) with a certainty of one significant digit. One microcurie ( $\mu\text{Ci}$ ) is equal to  $3.7 \times 10^4$  becquerels (Bq) in the SI units; therefore, the conversion from microcurie to becquerel is completed by multiplying the activity in microcuries by  $3.7 \times 10^4$ . The resulting values in SI units (becquerels) could be more or less restrictive than the original microcurie values depending on the number of significant digits the value is rounded. For example, currently Appendix B to 10 CFR Part 20 provides the oral ingestion *ALI* for *Actinium-*

224 as  $2 \times 10^4 \mu\text{Ci}$ . The corresponding value in the SI units before rounding to one significant digit is  $7.4 \times 10^7 \text{ Bq}$ . If rounded to one significant digit, using the standard rounding conventions, the value in Bq would be smaller than the value in  $\mu\text{Ci}$ , and would be more restrictive.

Therefore, the NRC staff is exploring the implications of addressing the numerical values in Appendix B of 10 CFR Part 20 in a manner similar to that used in Appendix A to 10 CFR Part 37, "Physical Protection of Category 1 and Category 2 Quantities of Radioactive Materials."

In the development of the Appendix A to 10 CFR Part 37, the NRC stated that the SI units provided the regulatory standard and the traditional units were provided for practical use only. The Appendix A to 10 CFR Part 37 provides in column 1 the name of the radioactive material, column 2 provides the source activity in terabecquerel (TBq), and column 3 provides the source activities in curies. In Appendix A to 10 CFR Part 37, the NRC also chose to forgo the conventional rounding to the nearest whole number or the rounding to the first significant figure after the decimal point. Rather, Appendix A to 10 CFR Part 37, column 3 listed curie activity equivalents as three significant figures because many NRC licensees use curies instead of becquerels for source radioactivity. The 10 CFR Part 37- approach of rounding to three significant figures greatly reduces any discrepancies between the two values--the source strength in curies and the source strength in becquerels.

The second issue is the presentation of numerical information in the Appendices to 10 CFR Part 20. If the NRC staff implements the Commission's metrication policy in Appendix B to 10 CFR Part 20 (i.e., SI units listed first followed by traditional units in parentheses), the table could become incredibly more complicated. At present, Appendix B of 10 CFR Part 20 consists of three columns providing each radionuclide's name, symbol, and the solubility class, followed by six additional columns providing each radionuclide's ALIs and DACs, concentration limits for airborne and liquid effluents released to the general environment, and concentration limits for discharges to sanitary sewer systems in microcuries ( $\mu\text{Ci}$ ) or microcuries per milliliter ( $\mu\text{Ci/ml}$ ).

Implementation of the metrication policy would effectively add six additional columns to provide the traditional unit numeric counterpart for each value in parentheses next to the corresponding values in the SI units. An alternative could be to publish the traditional unit values in a separate guidance document for the convenience of users; this alternative would be an exception to the Commission's metrication policy. One alternative could be to provide an expanded table, or a table that only contained the traditional units, as a NUREG publication for the convenience of users. These options would be exceptions to the metrication policy. The NRC is interested in views on possible alternatives and the implications of such alternatives on the format of the regulations, the usefulness of the regulations, and the operations of licensees. The agency is particularly interested in whether each option would provide benefits, would entail impacts or burdens, or would result in undue hardship.

## **V. Proposals**

Consistent with the Commission's direction in SRM-SECY-12-0064 and the Commission's current metrification policy statement, the staff proposes to reverse the order of the units so that the values are presented in SI units first followed by the traditional units in parentheses in 10 CFR Part 20. The NRC staff also wishes to consider whether Appendix B to 10 CFR Part 20 should list the tabular values in SI units, traditional units, or both SI units and traditional units.

The NRC staff further proposes that licensees should be allowed to keep records, under 10 CFR Section 20.2101(a), in either traditional units or SI units as long as all their records are kept in the same system. Under this proposal, the flexibility to keep records with both sets of units (currently under 10 CFR Section 20.2101(b)) would be retained.

Using traditional and SI units poses significant communication challenges due to the potential confusion caused by the use of different sets of units. Therefore, the staff is interested



in the implications and impacts of aligning any potential revisions to 10 CFR Part 20 with the Commission's existing metrication policy and with other possible changes that could be considered as aligning to such a change.

The NRC staff believes that additional input from the public, the regulated community, and other stakeholders is necessary to understand the implications of potential options on this issue.