The National Academies of
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Adopting the International System of Units for Radiation Measurements in the United States

A Workshop

September 29-30, 2016

Auditorium
National Academy of Sciences Historic Building
2101 Constitution Ave NW, Washington, DC 20418

The workshop is hosted by the Nuclear and Radiation Studies Board of the National Academies of Sciences, Engineering, and Medicine, and sponsored by the Centers for Disease Control and Prevention

AGENDA

DAY 1: September 29, 2016

8:30 AM

PLENARY SESSION
Moderated by Steven L. Simon, National Cancer Institute

Call to Order and Welcome (10')
Steven L. Simon, National Cancer Institute

Overview of the Issue and Study Request (20')
Armin Ansari, Centers for Disease Control and Prevention

Comments from the Office of Science and Technology Policy (10')
Matt Heavner, Office of Science and Technology Policy

9:15 AM

SESSION 1: Current Practices in Utilization of Units for Radiation Measurements
Moderated by E. Vincent Holahan, Nuclear Regulatory Commission

by U.S. Federal and State Government (15')
Michael Boyd, Environmental Protection Agency

by the Nuclear Industry (10')
Ellen Anderson, Nuclear Energy Institute

in Medical Response to a Radiological Incident (10')
Nicholas Dainiak, Radiation Emergency Assistance Center/Training Site (REAC/TS)

in Providing Traceability to the National Standard for Dose (10')
Ronaldo (Ronnie) Minniti, National Institute of Standards and Technology

by Advisory Bodies
Steven L. Simon, National Cancer Institute (on behalf of the National Council on Radiation Protection and Measurements) **(5')**

Paul M. DeLuca, Jr., University of Wisconsin Medical School Madison, Provost Emeritus (on behalf of the International Commission on Radiation Units & Measurements) **(10')**

in Publications (10')
Marc S. Mendonca, Radiation Research (Journal)

10:35 AM **BREAK**

10:55 AM **Questions and Discussion for Session 1 with Audience Participation**

11:45 AM **LUNCH (Available for Purchase at the Refectory—Lower Level)**

1:00 PM

SESSION 2: Potential Communication Improvements of Conversion

Moderated by Jessica Wieder, Environmental Protection Agency

in Domestic Emergency Response and Guidance (10')
Sara DeCair, Environmental Protection Agency

in Response to an International Radiological Incident (10')
Rajah Mena, Department of Energy

in Radiation Safety (10')
Steven H. King, Penn State Hershey Medical Center

in Radiation Safety Training (10')
Alexis L. Reed, Counter Terrorism Operations Support

with the Public (15')
Jessica Wieder, Environmental Protection Agency

in Media Outreach (20')
David P. Ropeik, Risk Communication Consultant

2:30 PM **Questions and Discussion for Session 2 with Audience Participation**

3:15 PM **BREAK**

3:30 PM

SESSION 3: Practical Considerations for Conversion

Moderated by Mark L. Maiello, New York City Department of Health and Mental Hygiene and Joseph J. Cordes, George Washington University

by the Nuclear Industry (10')
Willie Harris, Exelon Nuclear

by the Nuclear Industry's Regulator (10')
William C. Ostendorff, Nuclear Regulatory Commission (former Commissioner)

in Emergency Response (10')
Stephen V. Musolino, Brookhaven National Laboratory

by the Instrumentation Industry (10')
Frazier Bronson, Canberra Industries

in First Responder Radiological Response Training (10')
Mark L. Maiello New York City Department of Health and Mental Hygiene

by the U.S. Military (10')
Col John P. Cuellar, Department of Defense
Lt Col Ricardo A. Reyes, Department of Defense

4:45 PM	**Questions and Discussion for Session 3 with Audience Participation**
5:30 PM	**Closing Remarks, Adjourn Day 1** *Mark L. Maiello New York City Department of Health and Mental Hygiene*

DAY 2: September 30, 2016

8:30 AM	**Call to order and welcome (5')** *Steven L. Simon, National Cancer Institute*
8:40 AM	**Session 4: Cost-Benefit Analysis Considerations** *Moderated by Steven L. Simon, National Cancer Institute* *Joseph J. Cordes, George Washington University* **(20')**
9:05 AM	**Questions and Discussion for Session 4 with Audience Participation**
9:40 AM	**BREAK**
9:55 AM	**Session 5: Lessons Learned** *Moderated by Daniel J. Blumenthal, Department of Energy* **on Conversion from Medicine (20')** *Fred A. Mettler Jr., University of New Mexico School of Medicine (Professor Emeritus)* **on Conversion from International Experience** *Alan Du Sautoy, Canadian Nuclear Safety Commission* **(15')** *Bliss Tracy, Health Canada (retired)* **(15')** *Peter H Burgess, Radiation Metrology Ltd (UK)* **(20')** **on Harmonization of Radiation Protection (15')** *Stefan Mundigl, European Commission*
11:30 AM	**Questions and Discussion for Session 5 with Audience Participation**
12:00 PM	**General Comments and Discussion with Audience Participation** *Moderated by Steven L. Simon, National Cancer Institute*
12:30 PM	**Closing Remarks, Day 2** *Steven L. Simon, National Cancer Institute*

SESSION ABSTRACTS

PLENARY SESSION

Overview of the Issue and Study Request
Armin Ansari, Centers for Disease Control and Prevention

More than 40 years ago, the International Commission on Radiation Units and Measurements formally adopted the International System of Units (SI)-derived units with special names for radiological quantities. In 1977, the International Commission on Radiological Protection began using the SI units exclusively. In 1985, with increasing use of SI units by international organizations, scientific journals, and many countries around the world, the National Council on Radiation Protection and Measurements (NCRP) charged an ad hoc committee of distinguished members to study the issue. The Council recommended the change to SI units in the United States within a 5-year transition period. NCRP has been using the SI units exclusively in all its publications. Other U.S. scientific organizations and publications in the United States, such as the Health Physics Society and the Health Physics Journal, also use SI units exclusively in their communications, conferences and publications. Furthermore, the National Institute of Standards and Technology (NIST) continues to strongly discourage the use of the curie, roentgen, rad, and rem as documented in NIST publications and in the *Federal Register.* We now have evidence of successful implementation and decades of exclusive use of SI units in nearly all countries in the world. These countries, many with well-established nuclear industries, have affected the transition to SI units successfully, without compromising health and safety, and have demonstrated that complete conversion to current international units is certainly practical and doable. Yet, the system of radiation protection in the United States has not implemented this change to internationally-accepted scientific units. Continued use of outdated units hinders the exchange and interpretation of information even among radiation safety professionals, especially during a radiation emergency, and provides an unnecessary barrier to public communication. The Centers for Disease Control and Prevention has asked the National Academies of Sciences, Engineering, and Medicine to organize a workshop to obtain perspectives from the radiation protection and user communities on potential benefits of using SI units for scientific exchange and public communication, and discuss possible steps towards implementing the exclusive use of SI units of radiation measurements in the United States.

SESSION 1: Current Practices in Utilization of Units for Radiation Measurements

by U.S. Federal and State Government
Michael Boyd, Environmental Protection Agency

U.S. federal and state regulatory agencies responsible for controlling the use, discharge and disposition of radioactive material must often navigate among at least four generations of radiation dosimetry, all tied to the traditional units of rad, rem, curie, and, occasionally, the long outdated exposure unit, roentgen. For example, many emergency responders in the U.S. still rely on field instruments reading in microroentgen per hour. There are at least two principal reasons why the U.S. has not moved to SI units. First, existing regulations have codified the old units in place at the time each regulation was issued. Some agencies now have enforceable regulations that require compliance based on methods given for critical organ dose (ICRP

Publication 2), effective dose equivalent (circa ICRP Publication 26), and effective dose (ICRP Publication 60), depending on the law being enforced. Recent efforts to update federal radiation protection regulations based on the latest radiation and tissue weighting factors given in ICRP Publication 103 are either stalled or moving slowly. The second reason we have not embraced SI units is the reluctance of U.S. radiation protection professionals to use them, even though the Health Physics Society (HPS), virtually all peer-reviewed scientific journals, the NCRP, and the National Academies have long had an SI-only policy. The challenge for federal and state regulators to overcome is the absence of a strong stakeholder voice encouraging the adoption of SI units and the historic reluctance of the U.S. population to embrace the metric system of weights and measurements.

by the Nuclear Industry
Ellen Anderson, Nuclear Energy Institute

As the United States examines the adoption of the International System of Units for Radiation Measurements, the Nuclear Energy Institute (NEI) represents the nuclear industry's perspective on this matter. This presentation provides an overview of NEI's role in policy development and member representation, nuclear industry workforce demographics, and current industry radiation measurement unit practices.

in Medical Response to a Radiological Incident
Nicholas Dainiak**,** Radiation Emergency Assistance Center/Training Site

The mission space of the Radiation Emergency Assistance Center/Training Site (REAC/TS) includes (1) provision of 24/7/365 emergency radiation medicine advice and consultation to medical professionals and other health care providers responding to a radiological/nuclear incident; and (2) delivery of regularly scheduled and just-in-time education and training to radiation specialists, healthcare providers, law enforcement, administrators, planners and others. The use of units for radiation measurements by REAC/TS faculty must address the needs of not only emergency responders but also healthcare providers who receive victims and provide their definitive medical management. Within this context, a hybrid approach that employs rad/rem units for emergency responders and Gy/Sv for healthcare providers best fits our mission. Emergency responders must read instruments that provide dose rates in rad/unit time. For them to be forced to convert these units into Gy would result in a very small number, as the Gy is too large a value (i.e., 5 rad/hour would be 0.005 Gy/hour). On the other hand, the Bq (based on disentegrations per second) is too small a unit, as it requires the use of GBq (where 1 Ci = 3.7 x 10^10 Bq). Making conversions to Gy and Bq will at the least, impede the performance of emergency responders and will at most, cause confusion in an urgent/emergent situation. The situation is different for first receivers in the hospital and healthcare providers whose major concern is determining the criticality of physical injuries and radiation-associated injuries within the context of acute radiation syndrome (ARS). Here, the Gy/Sv is the most convenient unit since ARS is completely reversible at 1 Gy/Sv and is 100% fatal at 10 Gy/Sv. The LD 50/60 for otherwise healthy adults receiving no therapy is approximately 3.5-4.5 Gy/Sv. Confusion and delays will occur for hospital workers in the emergency department where triage decisions are made and medical care is quickly initiated, and for healthcare providers who recommend surgery and prescribe cytokines and antibiotics, if they were forced to convert to the much smaller rad/rem (the LD 50/60 would be 350-450 rad/rem without therapy). This is particularly true when providers try to evaluate the meaning of a dose in terms of background radiation level (in mSv) where they would need to convert rem to mSv. With that said, radiologists and radiation oncologists are historically familiar with rad/rem, making this a convenient unit. Therefore, communication among these specialists and other clinicians must be

optimized. Finally, the use of the roentgen is preferred to Coulomb/kg, even though the meaning of an exposure in air is lost on first responders and healthcare providers alike. In summary, the faculty at REAC/TS is comfortable with using a hybrid approach to meet the needs of both emergency responders and healthcare providers.

in Providing Traceability to the National Standard for Dose

Ronaldo (Ronnie) Minniti, National Institute of Standards and Technology

The Dosimetry Group at the National Institute of Standards and Technology (NIST) maintains the national standards for radiation dose and disseminates routinely these standards through calibrations to users of radiation instruments throughout the country. In particular, the group maintains the standards for air kerma (dose in air) from x-rays, ^{137}Cs and ^{60}Co gamma-ray beams and absorbed dose to water from ^{60}Co gamma-ray beams. The SI unit of air kerma and absorbed dose to water is the gray which corresponds to an energy of 1 Joule per kilogram of mass (1 Gy = 1 J/kg). More than one million radiation detection instruments are calibrated annually in the U.S. in terms of these and other derived radiation quantities to ensure traceability to the national standard and therefore the accuracy of measurements performed with a broad range of radiation measuring and detection instruments such as ionization chambers, optically stimulated luminescent (OSL) and thermoluminescent dosimeters (TLDs), solid state detectors, survey meters, electronic personal dosimeters (EPDs), portal monitors, isotope identifiers, etc. Such instruments are used by radiation workers and users in the field of medicine, radiation protection, industry, manufacturers of instruments, U.S. military, emergency response and homeland security. The ability to transfer the primary standard measurement of dose maintained at NIST through the traceability chain to end users of instruments is currently challenged by the mixed use of SI and non SI units. Furthermore, international efforts involving dose measurements and development of standard documents is often complicated due to the mixed use of SI and non SI units in the U.S.

by Advisory Bodies

Steven L. Simon, National Cancer Institute (on behalf of the National Council on Radiation Protection and Measurements)

In 1985, the NCRP recommended in their Report 82, *SI Units in Radiation Protection and Measurements*, the gradual adoption of SI units over a transition period beginning immediately and ending about five years later, i.e., around the end of 1989. However, in 2010, NCRP Report 165 for *Responding to a Radiological or Nuclear Terrorism Incident: A Guide for Decision Makers*, the primary radiation quantities and units endorsed for emergency response were those in common use in the United States, and it was recommended that the corresponding SI quantity and unit be displayed in parenthesis after the commonly used quantity and unit. It is clear that the NCRP strongly supports use of SI units but understands that the transition period now has to consider current needs in emergency response.

Paul M. DeLuca, Jr., University of Wisconsin Medical School Madison, Provost Emeritus (on behalf of the International Commission on Radiation Units & Measurements)

The International Commission on Radiation Units and Measurements (ICRU) has been the recognized international organization responsible for recommending appropriate units and measures for the use of ionizing radiation in medical applications. This includes the special use of units in radiation quantities such as absorbed dose, effective dose equivalent, and

radioactivity. In this brief report, the historical context of these activities with respect to the unit system are discussed. These remarks include elaboration of the long standing recommendations of the ICRU and the implications of using or not using SI units are presented with the special focus on medical and regulatory activities.

in Publications
Marc S. Mendonca, Radiation Research (Journal)

The adoption of SI units in Radiation Physics, Biology, Medicine and Epidemiology publications began with discussions in the early 1970s that led to the issuance of formal recommendations by the ICRU in 1974. Once approved, the ICRU's recommendations for the adoption of SI units in the measurement of ionizing radiation doses were widely disseminated, with a series of publications in a variety of radiation journals over the next few years by H.O. Wyckoff, A. Allisy, K. Liden, and others. Investigation into the relative speed of adopting the new SI radiation dose units in radiation science publications suggests that generational differences in training of scientists, the slow process of updating radiation science textbooks, and the necessity of referencing older source literature were major factors in delaying the adoption of SI radiation dose standards. Interestingly, however, the single overarching concern of all radiation science disciplines regarding adoption of the new SI radiation dose units was the fear that doing so would cause confusion and/or misunderstanding among experts in the field as well as in communications with the public.

SESSION 2: Potential Communication Improvements of Conversion

in Domestic Emergency Response and Guidance
Sara DeCair, Environmental Protection Agency

Providing Protective Action Guides (PAG) Manual guidance for use by state, local, tribal governments in crafting emergency management plans is one of EPA's primary radiation protection roles. The PAG Manual is a product of an interagency consensus process involving all the federal agencies with a role in radiological emergency preparedness. In the interest of best serving our customers, especially state agencies, the interagency federal team decided specifically to use the US units and put SI units second, in parentheses, to be more easily translated to instrument readings and dose assessment quantities used in tools of radiation emergency response. Tools include continuous nuclear power plant monitoring data, modeling in RASCAL, monitoring, sampling & dose assessment using FRMAC Manual methods, and then comparing the results to trigger levels for implementing the PAGs. The presentation will focus on considerations for making the switch to SI units for these tools, and discuss ways that the Advisory Team and the radiation protection community can ease a transition, if one is made.

in Response to an International Radiological Incident
Rajah Mena, Department of Energy

Consistent use of radiological units during a response to a radiological emergency outside of the United States is an important issue. In general, scientific and laboratory personnel who support response assets have experience with SI units. However, lack of regular use in operations and training may reduce their fluidity. Difficulties with converting between units in technical documentation, data assessment, and briefings have been observed in US responders. To

reduce potential opportunities for error and increase effectiveness of the radiation response community of the US, progress should continue in converting fully to SI units.

in Radiation Safety
Steven H. King, Penn State Hershey Medical Center

The American public is very much interested in radiation exposure from medical exams as well as from nuclear incidents worldwide. Concurrent use of English and SI units creates confusion with both the public and even with workplaces that use or regulate radiation. Most scientific organizations require the use of SI units for publications and meetings. In order to bring the public, government and industry understanding together, the global use of SI units is encouraged. A description of the current potential areas of confusion will be discussed.

in Radiation Safety Training
Alexis L. Reed, Counter Terrorism Operations Support

Dr. Alexis Reed of the Nevada National Security Site's Counter Terrorism Operations Support (CTOS) program will discuss the effects of conversion to SI units on large-scale radiation training programs. CTOS has trained over 170,000 first responders on employing radiation detection instruments and concepts during their operations. This training is, of course, currently conducted using traditional unit nomenclature.

with the Public
Jessica Wieder, Environmental Protection Agency

Pulling from 12 years of experience communicating radiation data, this presentation focuses on the when and why do radiation units matter to the public. People look for radiation information when they are concerned. The high stress nature of radiation information needs must be met with simple, easy-to-understand responses. This presentation discusses pros, cons and consideration of using SI units in the United States from the perspective of public communication.

in Media Outreach
David P. Ropeik, Risk Communication Consultant

Sievert, Rad, Curie and Gray. No, It’s Not A Law Firm. It's the confusing world of metrics used to measure radioactivity, a tangle of different terms that makes it difficult for the public, and the media who inform the public, to figure out the only measure that really matters to most people; the actual risk that radiation might pose. Confusion over terminology contributes to uncertainty about the potential danger of ionizing radiation, which contributes to fear and apprehension, which in turn does real harm to public health. The adoption by the United States of the same metrics and terminology used around the world provides an indirect opportunity to reduce some of that confusion. As the conversion is rolled out, concerted effort should be made to explain what the new metrics mean in terms of health risk. A proactive outreach campaign to the news media should emphasize that the conversion is intended to provide clarity and reduce confusion for the public, not just for individuals and organizations that deal with radioactivity professionally. Much more attention should be devoted to what the new terminology means for health than to the technical and scientific meanings behind those terms.

Session 3: Practical Considerations for Conversion

by the Nuclear Industry
Willie Harris, Exelon Nuclear

This paper will discuss the potential issues and barriers associated with conversion to the SI units for the commercial nuclear power plant operators and fleets. Many of these barriers will cost a significant amount of money and could potentially lead to increased human performance events. In addition, opinions will offered relative to the methods to overcome these barriers and timing for implementation.

by the Nuclear Industry's Regulator
William C. Ostendorff, Nuclear Regulatory Commission (former Commissioner)

A nuclear regulator's perspective on whether to require the US commercial industry to shift to SI units.

in Emergency Response
Stephen V. Musolino, Brookhaven National Laboratory

The implications of the change to SI units will be discussed from two points of view. First from that of health physicists who train for and staff positions in an emergency that are experienced dealing with the scientific data, associated assessments for protective action decisions, and subsequent communications between assessment scientists and decision makers. Second from first responders who generally operate instrumentation their protection, characterization of radiation levels, and are not and need not be trained in health physics. After a change to SI units, both communities may be affected, positively or negatively depending on who you are. With respect to the inevitable complications to communicate scientific information to the public in the information age, a change would be beneficial.

by the Instrumentation Industry
Frazier Bronson, Canberra Industries

Since this presentation is intended to represent the entire nuclear instrumentation industry, rather than just the opinions of the author, a background statement and a questionnaire was submitted to various US instrumentation companies. Of the 27 questionnaires sent, 13 were to small instrument companies, 3 to dosimetry service providers, 5 to analytical service labs, 2 to source manufacturers, and 4 to large instrument manufacturers. The summary of responses is as follows:

- All companies will have expenses for internal documentation, training, external documentation, and perhaps new SI-compliant instruments.
- The large companies generally do not have a problem with this, as their instruments are already designed for sale to both the domestic and international markets.
- The small companies mostly didn't reply, which implies that they don't have big problems with this. Those with instruments that have electronic displays generally have settings to convert output to US or SI units. But some small companies with primarily analog displays and with primarily a US market will have more financial burden.

- The dosimetry companies and analytical service labs would be more affected, as they both have large amounts of historical data which would be in “old” units. The large labs are the most affected.
- The source manufacturers that do international business welcome SI-only units, as it simplifies transportation documents. The smaller domestic company will have more initial work.

Major questions came up about the ability to use existing non-SI instruments. This applies to the internal instruments the companies use, and the instruments that their customers buy. Using existing non-compliant instruments will cause the same conversion difficulty and errors that started this workshop, but on a much wider scale. However, a requirement to change to all SI-compliant instruments on a single date will be a difficult burden on both the users, and the instrument manufacturers.

Recommendations for the conversion process to SI radiological units:

- The NRC, DOE, EPA, DOT, OSHA, and States must ALL change their regulations requiring the use of SI units, perhaps with a 1y phase-in period;
- Advance notice [perhaps 3-5 years] of the exact date for the new rule is needed, so that users and providers can prepare;
- All companies must expect to have some expenses associated with the SI units change, but small companies doing primarily domestic business should expect a larger relative impact.
- Assistance should be available; e.g. training modules, computer games as teaching tools, small business financial assistance, …

This is long overdue and not a big deal – just get on with it and join the rest of the world.

in First Responder Radiological Response Training
Mark L. Maiello New York City Department of Health and Mental Hygiene

The New York City Police and Fire Departments along with the Department of Health and Mental Hygiene have much invested in first responder training. A change to SI will obviously affect internal agency training. The short-term consequences could affect communications between first responders, agencies, and the reporting of radiological data to collaborators such as Securing the Cities partners, state agencies and federal organizations that would be part of a response to a NYC radiological incident. Other protocols or functions tied to first responder training could be affected as well including use of Rad-Responder, the calibration of instruments and some operations in Community Reception Centers. This presentation will highlight the issues associated with adoption of SI varying from those of little to greater concern as predicted from three participants of NYC’s Radiological Response and Recovery Committee.

by the U.S. Military
Col John P. Cuellar, Department of Defense and
Lt Col Ricardo A. Reyes, Department of Defense

One hundred and fifty years after the “Metric Act of 1866” and one hundred and forty one years after the “Convention of the Meter” diplomatic treaty signed in Paris in 1875, U.S. Government Agencies continue a slow transition to the use of SI units. Through the Metric Conversion Act of 1975, as amended by the Omnibus Trade and Competitiveness Act of 1988 and an Executive

Order (Presidential Executive Order 12770, 15 July 1991), Federal Agencies were told to establish guidelines for transitioning to the metric system for conducting business. The “America Competes Act of 2007” replaced the definition of the metric system with the International System of Units (SI). However, this regulatory movement has not influenced private and government agencies in the U.S. enough to stop using traditional units. The DoD and its Services continue to use both systems of units in the nuclear/radiological fields of interest. There are no recent policies or regulations for the implementation of the exclusive use of SI units across the DoD, its Services, organizations, and supporting agencies. Whereas the use of SI units is recommended and encouraged, it is not enforced because of the following factors: (1) Most radiation related regulatory policies and safety limits are in traditional units; (2) training provided to radiation/nuclear professionals includes SI units; however, it also includes traditional units that people become familiar with in practice; and (3) the commercial technology for radiation and dose measurements commonly use traditional units. DoD doctrine is an example where SI units are the primary units of measure. NATO driven policy and doctrine has triggered the use of SI units in DoD with an adaptation of the units to accommodate traditional units. For example, the use of cGy was specifically put in place to accommodate its equivalence in rads. Army radiation detection systems use SI units as the primary unit of measure. The U.S. Army, Navy, and Air Force continue the use of a combination of SI and traditional units in the practices of radiological and nuclear fields to accommodate present rules and regulations from Federal and Regulatory Agencies.

SESSION 4: Cost-Benefit Analysis Considerations

Joseph J. Cordes, George Washington University

Professor Cordes will discuss the general process for a cost benefit analysis (CBA) and describe how such an analysis differs from a “traditional” business or financial analysis. He will then attempt to apply CBA to the potential adoption of SI units for radiation protection measurements in the United States by including the social costs and benefits of adoption that were discussed during the workshop.

SESSION 5: Lessons Learned

on Conversion from Medicine

Fred A. Mettler Jr., University of New Mexico School of Medicine (Professor Emeritus)

The adoption of SI units in medicine has been promoted for at least 40 years and currently remains incomplete and often confusing. Some of this is because there are pure SI units, hybrid units, derived units, accepted conventional units and exceptions. In diagnostic radiology, there has been wide use of a number of confusing terms that are conjunctions of SI units. In nuclear medicine, while Gy and Sv are commonly used, mCi still remains in wide usage. In many instances rad/hr etc are used commonly as operational units. In radiation oncology, SI units have been used for several decades although there is a problem using them with encapsulated brachytherapy sources. Use of the SI system in medicine is not just related to radiation exposure and physicians are often in hospital systems which use conventional units for many purposes (e.g. pounds and inches). There is a problem with an inconsistent mixture of SI and

conventional units with regard to machine specifications, construction of facilities, and input into computer systems. Any attempt to increase the use of SI units should be very careful to get buy-in from the users who may have very good reasons to use other units.

on Conversion from International Experience
Alan Du Sautoy, Canadian Nuclear Safety Commission

The Canadian Nuclear Safety Commission (CNSC) regulates the use of nuclear energy and materials to protect health, safety, security and the environment; to implement Canada's international commitments on the peaceful use of nuclear energy; and to disseminate objective scientific, technical and regulatory information to the public. The presentation will give an outline of why the country decided to convert to SI and the issues it faced. It will provide CNSC experiences in transition to SI units for radiation measurements in Canada and will review the history of the gradual introduction of metrication and regulatory changes since the Canadian government issued a white paper on the adoption SI units in 1970. It will also review how far CNSC has progressed in terms of metrication and adopting SI units now and where it may go in the future. Clearly many of the challenges and benefits in moving to SI units in Canada would of course be amplified, if USA decided to transition to SI for radiation measurements. Finally, the presentation will review the difficulties presented currently in communication with the USA and make clear recommendations from the CNSC view point for the future.

Bliss Tracy, Health Canada (retired)

The Radiation Protection Bureau of Health Canada has several broad areas of responsibility:

- Occupational radiation exposures in Canada
- Coordination of the Federal Nuclear Emergency Plan
- Radiation surveillance across Canada
- Establishment of limits for radionuclides in water and food and for radon in homes.

The transition from conventional to SI units for radiation measurements began in earnest around 1980 and proceeded gradually until it was virtually complete by 1984. The main driving force behind the conversion was the adoption of SI in the late 1970s by international agencies, notably ICRP, UNSCEAR, and IAEA. The change-over was also greatly aided by the Canada-wide adoption of the metric (SI) system at the same time. Conversion costs were minimal, since conventional-reading instruments continued in use up until their normal replacement time. Each of the above areas of responsibility was impacted to some extent by the conversion. Challenges still arise in dealing with our American counterparts and with nuclear energy workers who have been trained in the United States. Often there has been confusion in the public mind about the differences between Canadian and American radiation standards.

Peter H Burgess, Radiation Metrology Ltd (UK)

The UK was very involved in the development and implementation of all the quantities that fall under the sievert banner. This presentation describes the time line, the way we dealt with the change for survey instruments and how the change was implemented in UK law and, hence, in operational RP. Inevitably, there was a degree of confusion associated with the change. Hopefully the UK experience can help to make the USA's transition smoother.

on Harmonization of Radiation Protection

Stefan Mundigl, European Commission

Already in 1959, the European Community created with the Euratom Treaty the basis for a harmonised approach to radiation protection. The Euratom Treaty empowers the Community to establish uniform basic safety standards to protect the health of workers and the general public against the dangers arising from ionising radiations and to ensure that they are applied. Based on this Treaty, a powerful set of secondary legislation has been developed, the major piece being the Euratom Basic Safety Standards Directive. This Directive, the latest version of which was published in early 2014, provides for detailed requirements for the protection of workers, members of the public, patients and the environment, exposed to all relevant radiation sources, including natural radiation sources, covering planned, existing, and emergency exposure situations, and harmonising numerical values with international standards. The Member States of the European Union are obliged to transpose the Directive into national legislation.

The free market of goods and the free market of labour are two cornerstones of the European Union today. To ensure the free movement of goods and workforce within Europe, any numerical constraint and the corresponding measurement approach need to be harmonised and applied uniformly. In radiation protection, there are quite some numerical values, such as the dose limits for occupational exposure, which need to be applied uniformly in Europe to allow radiation workers to move freely within Europe. Clearance levels and restrictions on building materials are further examples where harmonisation of numerical values, the corresponding measurement approach, and the application of the international system of units for radiation measurements are essential for a free movement of goods. Further to this, in a densely populated Europe with nuclear and non-nuclear countries, a nuclear or radiological emergency in one country will affect many other countries and requires a harmonised approach to emergency preparedness and response, including numerical reference values, measurement strategies and decision criteria.

Committee on Adopting the International System of Units for Radiation Measurements in the United States: A Workshop

Steven L. Simon, Chair
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U.S. Department of Energy

E. Vincent Holahan, Jr.
U.S. Nuclear Regulatory Commission

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New York City Department of Health and Mental Hygiene

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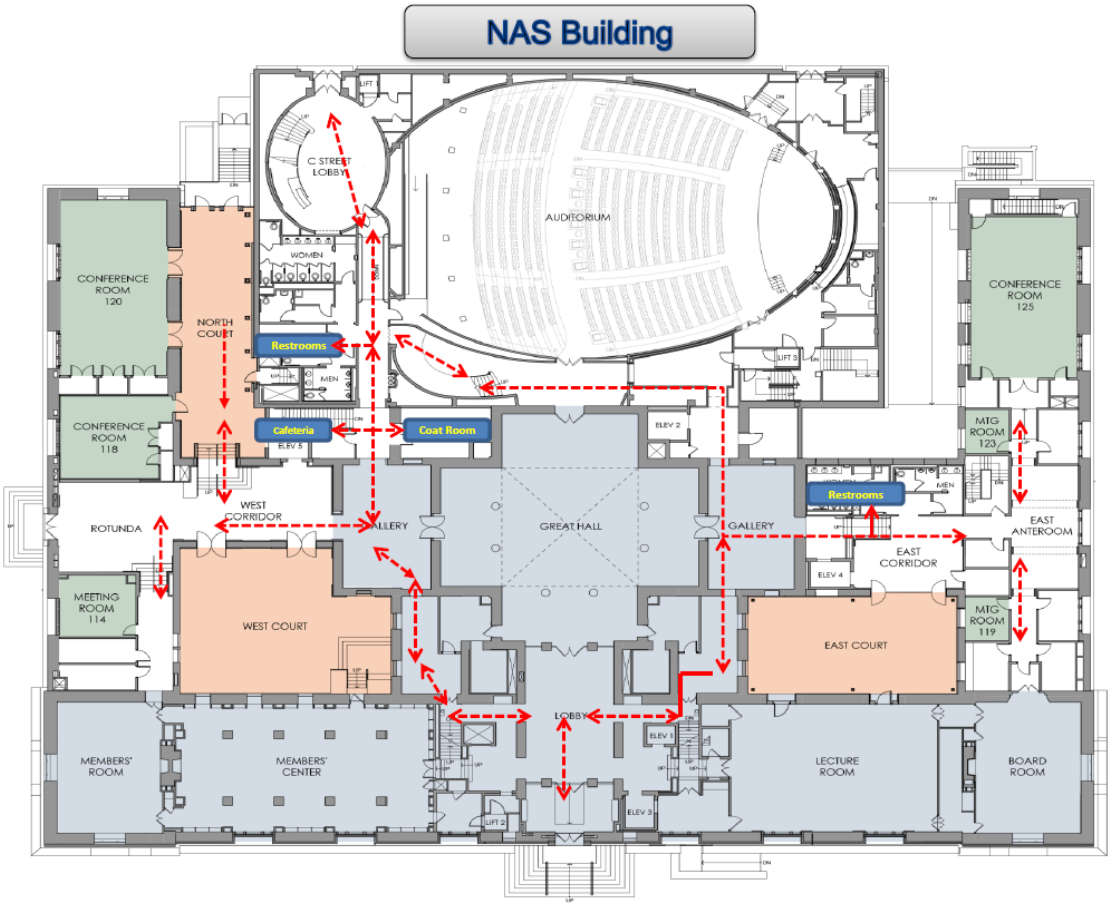

Email us at nrsb@nas.edu to be notified about other events like this.