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National Institute of Standards and Technology
U.S. Department of Commerce

Nuclear and Radiological Security: Metrology Needs Survey[1]

The Radiation Physics Division (RPD) within the Physical Measurements Laboratory at the National Institute of Standards and Technology is developing a program focused on measurement science needs in the area of "nuclear and radiological security". This focus area may include measurements of radiation, radioactive nuclides, or radioactive materials associated with consequence management, food safety, and environment monitoring, border protection, nuclear forensics, nuclear safeguards and non-proliferation. As part of the planning process for this program, the RPD is soliciting feedback from stakeholders to identify and prioritize activities and research to best meet the needs of measurement community. The attached survey requests information about metrological needs under the broad umbrella of Nuclear and Radiological Security. There are four basic topic areas comprising the survey: Nuclear Data; Calibrations and Measurements Services; Standard Reference Materials; and Performance Testing.

You have been identified as an appropriate contact for nuclear or radiological measurements within your group/organization. The purpose of this survey is to provide an opportunity to make recommendations that will help determine the future direction of the NIST Nuclear and Radiological Security program. Accordingly, you are strongly encouraged to seek input from knowledgeable staff and colleagues within your group/organization. It is requested that all input be collated and provided in a single completed survey form.

Please submit the completed Questionnaire Form to Richard.essex@NIST.gov prior to **December 31, 2020**. All responses should be unclassified but may be Controlled Unclassified Information (CUI). If your group/organization wishes to provide information at a higher

[11] A Federal agency may not conduct or sponsor, and a person is not required to respond to, nor shall a person be subject to a penalty for failure to comply with an information collection subject to the requirements of the Paperwork Reduction Act of 1995 unless the information collection has a currently valid OMB Control Number. The approved OMB Control Number for this information collection is 0693-0033. Without this approval, we could not conduct this information collection. Public reporting for this information collection is estimated to be approximately 2 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the information collection. All responses to this information collection are voluntary. Send comments regarding this burden estimate or any other aspect of this information collection, including suggestions for reducing this burden to the National Institute of Standards and Technology, Attn: Richard Essex, 100 Bureau Drive, Bldg 456, Gaithersburg, MD 20899. E-mail: Richard.essex@nist.gov.

classification level, please contact Richard Essex (301-975-5541) to determine the best method for conveying that information.

Nuclear Data for Nuclear and Radiological Security

The RPD measures and evaluates a variety of nuclear data including half-lives of radionuclides and the neutron, Q values, emission probabilities, and branching ratios. NIST also maintains data bases for radiation stopping power (electrons, protons, alpha particles). In this section, the RPD is requesting input about the specific nuclear data values, categories of data, and improvements to existing nuclear data that will enhance your group/organization's ability to perform its mission:

1. What types of nuclear data does your group/organization use extensively?

Nuclear Data Used Extensively

2. Are there categories of nuclear data for which enhancements would represent a significant benefit to your group/organization? If so, what data and what improvements?

Nuclear Data Category	Desired Improvements

3. Are there nuclear data values for specific elements or nuclides that are critical to the missions of your group/organization but are not available or are otherwise unsuitable? Please list any such data along with estimates of what level of uncertainty would be adequate for your program needs.

Element / Nuclide	Desired Nuclear Data	Target Uncertainties

4. Please provide any additional comments or suggestion about nuclear data needs for Nuclear and Radiological Security.

Suggestions / Comments

Performance/Proficiency Testing for Nuclear and Radiological Security

Performance and proficiency testing (PT) programs are integral to quality control for Nuclear and Radiological Security. There a several PT programs that are directly relevant to measurements associated with Nuclear and Radiological Security; for example, the DOE Laboratory Accreditation Program (DOELAP), performance testing administered by the Radiological and Environmental Sciences Laboratory (RESL) and the NIST Radiochemistry Inter-comparison Program (NRIP). NIST also supports various PT programs by direct calibration measurements and by providing radioactivity Standard Reference Materials (SRMs) as calibration materials or as starting materials for preparation of PT test samples.

5. Does your group/organization currently administer, provide services for, or fund a PT program? Please indicate which program(s) and how your group/organization contributes to the PT program.

Performance Test Program	Contribution to the PT Program

6. Does your group/organization currently participate in a PT program(s) for measurement of radioactivity or radioactive materials? Please indicate what program(s) and the level of participation (frequency, specific measurands, etc.)

Performance Test Program(s)	Level of Participation

7. For the PT programs listed in Question 6, what requirements are driving your participation (internal QA/QC, accreditation requirements, analysis program requirements, etc.). Is NIST traceability for measurements a specified requirement for measurements performed by your group/organization?

Performance Test Program(s)	Drivers for PT Program Participation	NIST Traceability
		☐ Yes ☐ No
		☐ Yes ☐ No
		☐ Yes ☐ No
		☐ Yes ☐ No

8. If currently available PT programs do not meet the needs of your group/organization, please provide specific information about the parameters of a desired PT program (testing frequency, elements, matrices, nuclides, concentrations or activity levels, target uncertainties for measurands, etc.).

PT Program Parameters	Desirable Parameters
Testing Frequency	
Number of Samples	
Matrices	
Elements / Nuclides	
Concentrations / Activity Level	
Target Uncertainties	
Other	

9. Please provide any additional comments or suggestions about performance testing for Nuclear and Radiological Security.

Suggestions / Comments

Standard Reference Materials for Nuclear and Radiological Security

The radioactivity group within the RPD produces many SRMs for measurement of radioactivity. These SRMs are used for direct calibrations, performance testing, quality control measurements, and production of working standard as well as uses beyond the original intended purpose of the SRMs, such as use for isotope dilution mass spectrometry tracers. Extensive details about radioactivity SRMs can be found on the NIST website at: Radioactivity SRMs.

10. Table 1 provides basic information about the form and characterized attributes of SRMs that are currently available from NIST or were previously available and could be reproduced. Please review Table 1 and indicate which of these standards that your group/organization uses or would use if they were available by clicking on the Check Box on the left-hand side of the table.

Table 1. NIST Radioactivity SRMs (12/1/2019)

SRMs highlighted in red are out of stock but have been included in the table as SRMs that NIST has previously certified and may certify again depending on level of interest from the user community.

Check Boxes	SRM	Unit Description	Certified Attributes (expanded uncertainties k =2)
☐	**SRM 4222d**	5 mL n-Hexadecane in ampoule	^{14}C = (89.54 ± 0.75) kBq g^{-1}
☐	**SRM 4226d**	5 mL of 1.1 M HCl in ampoule	^{63}Ni = (85.94 ± 0.72) kBq g^{-1}
☐	**SRM 4223E**	5 mL of 1 M HCl in ampoule	^{137}Cs = (298.6 ± 2.1) kBq g^{-1}
☐	**SRM 4239**	5 mL of 1 M HCl in ampoule	^{90}Sr = (31.79 ± 0.15) kBq g^{-1}
☐	**SRM 4251C**	5 mL of dilute HCl in ampoule	^{133}Ba = (4.876 ± 0.025) Bq g^{-1}
☐	**SRM 4274**	5 mL of 1 M HCl in ampoule	^{166m}Ho = (19.3 ± 0.16) kBq g^{-1}
☐	**SRM 4288B**	5 mL of 0.001 M KOH in ampoule	^{99}Tc = (31.55 ± 0.21) kBq g^{-1}
☐	**SRM 4320b**	5 mL of 1 M HNO_3 in ampoule	^{244}Cm = (35.47 ± 0.50) Bq g^{-1}
☐	**SRM 4321d**	5 mL of 1 M HNO_3 in ampoule	NU = (486.2 ± 3.8) Bq g^{-1}
☐	**SRM 4322C**	5 mL of 1 M HNO_3 in ampoule	^{241}Am = (106.4 ± 0.3) Bq g^{-1}
☐	**SRM 4323c**	5 mL of 3.2 M HNO_3 in ampoule	^{238}Pu = (22.73 ± 0.11) Bq g^{-1}
☐	**SRM 4324B**	5 mL of 2 M HNO_3 in ampoule	^{232}U = (38.22 ± 0.31) Bq g^{-1}
☐	**SRM 4326a**	5 mL of 2 M HNO_3 in ampoule	^{209}Po = (39.01 ± 0.18) Bq g^{-1}
☐	**SRM 4328C**	5 mL of 1.1 M HNO_3 in ampoule	^{229}Th = (35.29 ± 0.21) Bq g^{-1}
☐	**SRM 4329**	5 mL of 1 M HNO_3 in ampoule	^{243}Cm = (69.50 ± 0.97) Bq g^{-1}
☐	**SRM 4330C**	5 mL of 3.4 M HNO_3 in ampoule	^{239}Pu = (38.41 ± 0.46) Bq g^{-1}
☐	**SRM 4332E**	5 mL of 1.1 M HNO_3 in ampoule	^{243}Am = (38.49 ± 0.35) Bq g^{-1}
☐	**SRM 4334j**	5 mL of 3 M HNO_3 in ampoule	^{242}Pu = (26.08 ± 0.13) Bq g^{-1}
☐	**SRM 4337**	5 mL of 1 M HNO_3 in ampoule	^{210}Pb = (9.037 ± 0.22) kBq g^{-1}
☐	**SRM 4338A**	5 mL of 2.8 M HNO_3 in ampoule	^{240}Pu = (40.88 ± 0.31) Bq g^{-1}

☐	**SRM 4339b**	5 mL of 1.3 M HNO_3 in ampoule	^{228}Ra = (195 ± 14) Bq g^{-1}
☐	**SRM 4340B**	5 mL of 2.8 M HNO_3 in ampoule	^{241}Pu = (258.5 ± 9.8) Bq g^{-1}
☐	**SRM 4341a**	5 mL of 2 M HNO_3 in ampoule	^{237}Np = (152.3 ± 1.4) Bq g^{-1}
☐	**SRM 4342A**	5 mL of 1.3 M HNO_3 in ampoule	^{230}Th = (40.83 ± 0.16) Bq g^{-1}
☐	**SRM 4361C**	500 mL of H_2O in serum vial	^{3}H = (2.009 ± 0.015) Bq g^{-1}
☐	**SRM 4370C**	5 mL of 1 M HCL in ampoule	^{152}Eu = (93.90 ± 1.0) kBq g^{-1}
☐	**SRM 4401L**	5 mL of H_2O in ampoule	^{131}I = (5.345 ± 0.037) MBq g^{-1}
☐	**SRM 4404L**	5 mL of dilute HNO_3 in ampoule	^{201}Tl = (8.208 ± 0.064) MBq g^{-1}
☐	**SRM 4407L**	5 mL of H_2O in ampoule	^{125}I = (2.703 ± 0.021) MBq g^{-1}
☐	**SRM 4410H**	5 mL of dilute KOH in ampoule	^{99m}Tc = () MBq g^{-1}
☐	**SRM 4412L**	5 mL of dilute HNO_3 in ampoule	^{99}Mo = (15.39 ± 0.11) MBq g^{-1}
☐	**SRM 4415L**	5 cm^3 of gas in ampoule	^{133}Xe = (XX ± 0.68%) GBq g^{-1}
☐	**SRM 4416L**	5 mL of dilute HCL in ampoule	^{67}Ga = (4.006 ± 0.024) MBq g^{-1}
☐	**SRM 4417L**	5 mL of dilute HCL in ampoule	^{111}In = (9.239 ± 0.050) MBq g^{-1}
☐	**SRM 4427L**	5 mL of dilute HCL in ampoule	^{90}Y = (7.385 ± 0.047) MBq g^{-1}
☐	**SRM 4915F**	5 mL of 1.1 M HCL in ampoule	^{60}Co = (58.29 ± 0.29) kBq g^{-1}
☐	**SRM 4919I**	5 mL of 1.0 M HCL in ampoule	^{90}Sr = (4.261 ± 0.020) kBq g^{-1}
☐	**SRM 4926E**	20 mL of ^{3}HHO in Serum Vial	^{3}H = (5.038 ± 0.036) kBq g^{-1}
☐	**SRM 4927g**	5 mL of ^{3}HHO in ampoule	^{3}H = (544.2 ± 5.2) kBq g^{-1}
☐	**SRM 4929F**	5 mL of 1 M HCL in ampoule	^{55}Fe = (58.43 ± 0.99) kBq g^{-1}
☐	**SRM 4943**	5 mL of H_2O HCL in ampoule	^{36}Cl = (10.95 ± 0.09) kBq g^{-1}
☐	**SRM 4949d**	5 mL of 1 M HCL in ampoule	^{129}I = (3.747 ± 0.024) kBq g^{-1}
☐	**SRM 4965a**	5 mL of 1 M HCL in ampoule	^{226}Ra = (30.32 ± 0.39) Bq g^{-1}
☐	**SRM 4966A**	5 mL of 1.4 M HCL in ampoule	^{226}Ra = (287.6 ± 3.7) Bq g^{-1}
☐	**SRM 4967A**	5 mL of 1 M HCL in ampoule	^{226}Ra = (2.482 ± 0.030) kBq g^{-1}
☐	**SRM 4969**	5 mL of 1.5 M HCL in ampoule	^{226}Ra = (3.047 ± 0.055) Bq g^{-1}
☐	**SRM 4350B**	**Powdered River Sediment** 85 g per Unit in a polyethylene bottle	Massic Activities (< 0.1 Bq g^{-1}) For: ^{241}Am ^{152}Eu ^{238}Pu ^{60}Co ^{154}Eu $^{239+240}Pu$ ^{137}Cs ^{226}Ra ^{240}Pu
☐	**SRM 4351**	**Freeze Dried Human Lung** 45 g per unit in a 125 mL glass bottle	Massic Activities (Bq g^{-1}) For: $^{239+240}Pu$ ^{234}U ^{232}Th ^{238}U
☐	**SRM 4352**	**Dried and Ground Human Liver** 45 g per unit in a 125 mL glass bottle	Massic Activities (< 0.01 Bq g^{-1}) For: ^{241}Am $^{239+240}Pu$ ^{238}Pu

☐	**SRM 4353A**	**Dried and Powdered Soil** 75 g per unit in a polyethylene bottle	Massic Activities (< 0.1 Bq g^{-1}) For: ^{137}Cs ^{238}Pu ^{234}U ^{228}Ra $^{239+240}Pu$ ^{235}U ^{210}Pb ^{90}Sr ^{238}U
☐	**SRM 4354**	**Powdered Lake Sediment** 25 g per unit in a polyethylene bottle	Massic Activities (< 1 Bq g^{-1}) For: ^{241}Am ^{235}U ^{228}Th ^{60}Co ^{238}U ^{137}Cs ^{238}Pu ^{232}Th ^{90}Sr $^{239+240}Pu$
☐	**SRM 4355**	**Dried and Powdered Soil** 75 g per unit in a polyethylene bottle	Massic Activities (< 0.1 Bq g^{-1}) For: ^{241}Am ^{154}Eu ^{228}Th ^{60}Co ^{155}Eu ^{230}Th ^{137}Cs $^{239+240}Pu$ ^{232}Th ^{152}Eu ^{125}Sb
☐	**SRM 4356**	**Ashed Human and Bovine Bone** 15 g per unit in a glass bottle	Massic Activities (< 0.1 Bq g^{-1}) For: ^{60}Co $^{239+240}Pu$ ^{230}Th ^{137}Cs ^{90}Sr ^{232}Th ^{226}Ra ^{234}U ^{238}Pu ^{238}U
☐	**SRM 4357**	**Powdered Ocean Sediment** 85 g per unit in a polyethylene bottle	Massic Activities (< 1 Bq g^{-1}) For: ^{40}K ^{238}Pu ^{230}Th ^{226}Ra ^{90}Sr ^{232}Th ^{228}Ra ^{228}Th
☐	**SRM 4358**	**Freeze Dried Shellfish** 150 g per unit in a polyethylene bottle	Massic Activities (< 1 Bq g^{-1}) For: ^{241}Am ^{238}Pu ^{228}Th ^{137}Cs $^{239+240}Pu$ ^{230}Th ^{40}K ^{234}U ^{232}Th ^{228}Ra ^{235}U ^{210}Pb ^{238}U
☐	**SRM 4359**	**Freeze Dried Seaweed Powder** 300 g per unit in a glass bottle	Massic Activities (< 1 Bq g^{-1}) For: ^{241}Am ^{210}Po ^{234}U ^{137}Cs ^{238}Pu ^{235}U ^{40}K $^{239+240}Pu$ ^{238}U ^{228}Ra ^{239}Pu ^{232}Th ^{210}Pb
☐	**SRM 4600**	**Silicate Glass Powder** 25 g per unit in a polyethylene bottle	Massic Activities (< 2 Bq g^{-1}) For: NU $n(^{234}U)/n(U)$ = TBD $n(^{235}U)/n(U)$ = TBD $n(^{236}U)/n(U)$ = TBD $n(^{238}U)/n(U)$ = TBD
☐	**SRM 4601**	**Silicate Glass Powder** 25 g per unit in a polyethylene bottle	Massic Activities (< 5 Bq g^{-1}) For: HEU $n(^{234}U)/n(U)$ = TBD $n(^{235}U)/n(U)$ = TBD $n(^{236}U)/n(U)$ = TBD $n(^{238}U)/n(U)$ = TBD

11. Are there particular radioactivity SRMs from Table 1 or other nuclear/radiological reference materials that are considered critically important by your group/organization? Please indicate which materials, how they are used, and estimate a rate of consumption.

Reference Material	Reference Material Use	Consumption Rate

12. If your group/organization has recommendations for improvements or comments about a specific reference material listed in Table 1, please provide them in the "Recommendations / Comments" field.

SRM	Recommendations / Comments

13. Does your group/organization perform or want to perform nuclear or radiological security measurements for which there is no suitable SRM or CRM? Please list the needed material(s), preferred characteristics for the material, and attributes for certification and/or characterization. Also, please estimate the target uncertainties for certified attributes that are necessary for the reference material to serve the intended purpose.

Material	Material Characteristics		Certified Attributes	
	Chemical Form		Activity Level	
	Matrix		Concentration	
	Unit Size		Isotopic Composition	
	Container		Uncertainty Level	
	Other		Other	
Material	**Material Characteristics**		**Certified Attributes**	
	Chemical Form		Activity Level	
	Matrix		Concentration	
	Unit Size		Isotopic Composition	
	Container		Uncertainty Level	
	Other		Other	

Calibrations and Measurement Services for Nuclear and Radiological Security

The RPD performs over 40 different calibration services for ionizing radiation. These include dosimetry calibrations, neutron source calibrations, radioactivity calibrations, and sealed source calibrations. Details about these calibration services can be found on the NIST website at: NIST Calibration Services

14. Table 2 provides basic information about radioactivity and ionizing radiation calibration services available from NIST. Please review Table 2 and indicate any of these services that your group/organization uses by clicking on the Check Box on the left-hand side of the table.

Table 2. NIST Ionizing Radiation Calibration Services (1/1/2020)

Check Boxes	Calibration Service	Notes:	Shop.NIST.gov SKU
☐	Absorbed Dose to Water Calibration of a Radiation Detector	In a Co-60 Gamma-Ray Beam (1 dose rate)	46110C
☐	Activation detector irradiation, californium fission neutrons		44080S
☐	Activation detector irradiation, thermal neutrons		44070S
☐	Activation detector irradiation, U-235 fission neutrons, thermal column cavity		44090S
☐	Additional irradiation at non-ambient temperature		49016C
☐	Additional irradiation of a customer supplied dosimeter		49011C
☐	Additional measurement of a transfer dosimeter in the same session		49032C
☐	Additional measurement session of a transfer dosimeter		49031C
☐	Additional measurement session of NIST transfer dosimeters		49021C
☐	Additional Sealed Gamma-Ray Sources	Calibration in terms of air-kerma for γ-ray I-125, Pd-103, & Cs-131	47021C
☐	Air Kerma Calibration of Radiation Detectors in γ -Ray Beams (Cs-137 or Co-60)	In a Cs-137 and/or Co-60 γ-ray Beam (1 dose rate, 1 beam)	46010C
☐	Air-Kerma Calibration of Radiation Instrument in X-Ray Beam		46011C
☐	Alpha and beta-particle-emitting Solid Sources, NIST 2π α/β	Proportional Counter Calibration	43030C
☐	Alpha and beta-particle-emitting Solid Sources, NIST 2π α/β	Proportional Counter Calibration	43031S
☐	Alpha-, Beta-, or Gamma-emitting Radionuclides	(solid, liquid, or gas; special test, other techniques)	43090S
☐	Beta particle source calibrated for radiation protection		47035C
☐	Beta-particle emitting radionuclides	(liquids; special test, liquid scintillation counter)	43060S
☐	Beta-particle emitting radionuclides (liquids; special test, other techniques)		43070S
☐	Beta-particle-emitting Solid Sources (Activity), NIST 2π α/β	Proportional Counter Calibration	43040C
☐	Calibrate additional sources		47011C

☐	Calibrate one source		47010C
☐	Gamma-ray emitting radionuclides (liquid; t1/2<15d)		43020C
☐	Gamma-ray emitting radionuclides (liquid; t1/2>15d)		43010C
☐	Ionization chamber calibrated w/ beta sources for radiation protection	Ionization chambers calibrated with beta-particle. Calibrated with Sr-90 + Y-90 or Kr-85	47036C
☐	Irradiation of a customer supplied dosimeter with Co-60 gamma-rays		49010C
☐	Irradiation of Passive Dosimeters (up to six), additional dosimeters		46021C
☐	Irradiation of Passive Dosimeters (up to six), first set-up		46020C
☐	Measurement of additional NIST transfer dosimeter, same session		49022C
☐	Measurement of calibrated alanine transfer dosimeters irradiated by the customer		49030C
☐	Measurement of calibrated alanine transfer dosimeters irradiated by the customer		49020C
☐	Mixed-alpha-particle-emitting Solid Sources, NIST 2π α/β	Proportional Counter in conjunction with Solid State Detector Calibration	43050C
☐	Neutron Personnel Protection Instrumentation/Dosimeters, Cf-252 fission neutrons	Irradiate dosimeters or calibrate instruments with unmoderated and/or D_2O-moderated neutrons	44060C
☐	Radioactive neutron sources emission rates (10^5 per second to 10^8 per second)		44010C
☐	Radioactive neutron sources emission rates (10^8 per second to 10^10 per second)		44020C
☐	Sealed Gamma-Ray Sources	Calibration in terms of air-kerma for γ-ray sources of I-125, Pd-103, & Cs-131	47020C
☐	Setup for non-ambient irradiation temperature		49015C
☐	Special Measurement Services		49050S
☐	Special Test of X and Gamma Ray Measuring Instruments		46050S
☐	Special Tests of Beam Dosimeters		48020S
☐	Special Tests of Gamma-Ray and Beta-Particle Sources		47040S
☐	Special tests of neutron instrumentation, dosimeters, or other devices		44100S
☐	Well ionization chamber calibration with electronic brachytherapy source		46012C
☐	Well ionization chamber calibration with electronic brachytherapy sources		46013C

15. Does your group/organization extensively use any of the NIST calibration services listed in Table 2 for nuclear and radiological security related measurements? Please indicate what

services your group/organization uses and to what extent these services are needed (number of calibrations, frequency, etc.).

Calibration Service	Extent of Calibrations

16. Does your group/organization currently provide calibration services for nuclear and radiological security related measurements? Please described the type of calibration services provided by your group/organization.

Calibration Services Provided

17. If currently available calibration services do not meet your group/organization needs, please provide specific information about the parameters of an adequate calibration program (specific calibration, turn-around times, etc.).

Calibration Service	Desirable Parameters
Calibration Type	
Turn-Around Time	
Target Uncertainties	
Other	

18. Please provide any additional comments or suggestions about calibration services for Nuclear and Radiological Security.

Suggestions / Comments