

Standard Radiation Safety Requirements for DRS Protocols

Standard Requirements for ALL DRS Protocols:

- ❑ Work involving radioactive materials (RAM) will be conducted with ALARA in mind to include: utilizing shielding as appropriate, limiting exposure time, maximizing distance from RAM, and using automation and remote equipment as necessary.
- ❑ Personnel protective clothing must be worn while working with RAM. At a minimum, a lab coat and gloves must be worn.
- ❑ Tongs, forceps, and other remote handling devices must be used when opening or otherwise manipulating source containers.
- ❑ Following work with RAM, hands, arms, clothing, shoes, and work areas (including the floor), must be monitored for contamination using an appropriate survey meter. Contact your Area Health Physicist (AHP) for guidance on survey meter selection. Any contaminated areas must be decontaminated immediately.
- ❑ The limit for beta/gamma surface contamination is 2,200 dpm/ 100 cm² inside posted areas. In non-posted areas and corridors, this limit is 220 dpm/ 100 cm². The limit for alpha contamination is 220 dpm/ 100 cm² and 22 dpm/ 100 cm² for posted areas and unrestricted areas, respectively. ALARA dictates that known contamination levels below these limits be cleaned to background levels when possible.
- ❑ DRS shall be notified immediately if there is a spill involving more than 1 mCi of activity, 1 liter of radioactive liquid, a spill over an area greater than 10 ft² (not necessarily contiguous), contamination is discovered in a public/office area, personnel contamination, injury/illness by worker during a procedure, or any airborne release of radioactivity.
- ❑ All RAM in use or storage, including waste, must be secured from unauthorized removal or access when unattended.
- ❑ Transport of RAM shall be via “double containment.” Transportation routes shall minimize travel through unrestricted areas. Transporting radioactive materials through or near any food areas is strictly prohibited. DRS at its discretion may specify a transport route to use.
- ❑ RAM waste with a half-life of < 120 days should be segregated and disposed of separately than that with a half-life of > 120 days. Decay-in-storage is not permitted, and all radioactive waste shall be picked up by the NIH Radioactive Waste Service (496-4451). Radioactive waste pickups must be scheduled frequently so that high activity waste does not accumulate in laboratories.
- ❑ Any MPW that is contaminated with RAM will be disposed of through the radioactive waste service after any infectious agents have been deactivated using an appropriate method.
- ❑ Protocol work with RAM may require whole body and/or ring dosimeters. The Division of Radiation Safety shall evaluate potential users via the Dosimeter Evaluation Form (DEF) located at https://drsportal.ors.od.nih.gov/pls/onlinecourse/training/dosimetry_form.html. Each potential user of RAM must submit a DEF to the DRS. Any issued dosimeters must be worn when working with RAM at any stage and returned by the wearer in a timely manner upon receipt of replacement dosimetry.
- ❑ If RAM is in a volatile state (or has a potential to become airborne), personnel air samples will be required. Environmental air samples may also be necessary. The individual protocol will detail specific instructions and requirements for air monitoring. Nuclides with a half-life of <10 days must have their environmental air samples pulled following the procedure instead of monthly.
- ❑ Bioassays may be required at the discretion of the DRS. Working with volatile RAM requires periodic bioassay. For additional information, consult the specific protocol requirements regarding bioassays. RAM users shall comply with any requests for bioassay in a timely manner.
- ❑ Dose-rates shall be < 2 mR/hr in laboratories and < 5 mR/hr at 30 cm in clinical center areas, unless the area is posted as a radiation area.
- ❑ DRS shall be contacted if there is any significant change in procedures already approved by DRS.

- ❑ Work involving animals is subject to DRS-213: Standard Radiation Safety Requirements for Animal Studies involving RAM document.

Additional Requirements for PET Lab Use/Production Protocols:

Common positron emitters used in Nuclear Medicine include ^{11}C , ^{13}N , ^{15}O , ^{18}F , ^{64}Cu , Zr^{89} , and ^{68}Ga .

- ❑ A NIH 88-1 Radioactive Materials Order Form shall be completed and submitted to DRS for receipt of PET isotopes from the Cyclotron or NIMH Hot Cell Facilities.
- ❑ Hot Cell manipulation shall be performed with lab coat and gloves at a minimum. Reaching into the Hot Cells requires double gloves. The outer pair of gloves should be removed within the Hot Cell before removing the hands. Sleeve covers are highly recommended.
- ❑ Processing of PET isotopes must be accomplished in a hot cell at all times with ALARA in mind. Direct handling of the target shall be minimized.
- ❑ If an automated portion of the process fails, contact DRS prior to attempting a manual operation. Any exemptions granted by DRS will be specified in individual protocols.
- ❑ All hot cell exhaust failures must be promptly reported to the DRS for assessment.
- ❑ PET products shall only be released to those individuals who are authorized to receive them and produce a NIH 88-1. As an alternative, recipients may maintain a log documenting product transfer.
- ❑ Re-use of phantoms is permitted as long as they are properly shielded while in storage.
- ❑ Isotopic contaminants/impurities present in radionuclides must be considered when working with RAM, including when disposing and handling radioactive waste (i.e. half-life, emissions, etc.). Contact your AHP for guidance regarding contaminants in nuclides of interest.
- ❑ Dose-rates shall not exceed 100 millirems in one hour at 30 cm in any posted "Radiation Area".
- ❑ All areas of target processing and subsequent separations shall be monitored for contamination at the conclusion of the process.
- ❑ For Br^{76} , target dismantling shall take place on absorbent paper inside a suitable enclosure, such as a beta-box.

Additional Requirements for Alpha Protocols:

- ❑ Prior to working with alpha emitters, users must undergo radiation safety training specific for the nuclide(s) being used. Refresher training requirements will be specified in the specific protocol and/or conducted at DRS discretion.
- ❑ An operable ZnS meter must be present during work with alpha materials, even if other kinds of instruments (e.g. Pan-GM) can detect the nuclides.
- ❑ DRS shall be notified at least one workday prior to the use of alpha emitters to allow the opportunity to observe procedures. DRS may observe work the first time it occurs.
- ❑ Transfer of alpha materials to other lab groups is allowed only if the receiving lab has a DRS Protocol authorizing the possession and use of the material.
- ❑ Routine air monitoring is required only for volatile forms of alpha emitters, e.g. At-211. It has been shown through previous sampling that air monitoring is not required for Ra-224 work. Additional requirements exist for Ac-225 and Ra-224 and should be outlined in the specific protocols covering those nuclides.
- ❑ Ventilation is an essential aspect of radiation safety for all procedures involving volatile radioactivity and necessitates precaution. In the event of compromised (lack of or inadequate) ventilation, one should immediately STOP all procedures and notify DRS (301-496-5774) in order to receive a bioassay.

Select Laboratory Research Nuclides										
Nuclide	H ³	C ¹⁴	P ³²	P ³³	S ³⁵	Cl ³⁶	Ca ⁴⁵	Cr ⁵¹	Se-75*	Rb ⁸⁶
Half-Life	12.3 y	5,730 y	14.3 d	25.4 d	88 d	300,000 y	163 d	28 d	120 d	19 d
E _{b-max} (keV)	18.6 (100%)	156 (100%)	1710 (100%)	249 (100%)	168 (100%)	710 (99%)	257 (100%)	4.4 (67%)	-	698 (9%) 1774 (91%)
E _{γmax} (keV)	-	-	-	-	-	-	-	320 (10%)	265 (60%) 136 (59%) 121 (17%) 401 (11%)	1077 (9%)
γ dose-rate (Γ _D) @ 10 cm (mrem h ⁻¹ mCi ⁻¹)	-	-	-	-	-	-	-	2.3	86	86
Skin dose-rate (mrem h ⁻¹ μCi. cm ⁻²)	-	1199	6993	3201	1310	6586	3101	55	529	6993
Select PET Nuclides										
Nuclide	C ¹¹	N ¹³	O ¹⁵	F ¹⁸	Na ²²	Cu ⁶⁴	Ga ⁶⁸	Br ⁷⁶	Zr ⁸⁹	I ¹²⁴
Half-Life	20 min	10 min	2 min	110 min	2.6 y	12.7 hr	68 min	16.2 hr	3.3 d	4.2 d
E _{b+max} (keV)	960 (100%)	1200 (100%)	1730 (100%)	630 (97%)	545 (90%)	653 (18%) b ⁺ 578 (37%) b ⁻	1900 (88%)	4460 (26%)	902 (23%)	1532 (11%) 2135 (11%)
E _{γmax} (keV)	511 (200%)	511 (200%)	511 (200%)	511 (193%)	511 (180%) 1,274 (100%)	511 (36%) 1346 (0.5%)	511 (178%)	511 (109%) 559 (74%)	909 (99%) 511 (46%) 15 (41%) 16.7 (7%)	511 (46%) 603 (61%) 1691 (11%)
γ dose-rate (Γ _D) @ 10 cm (mrem h ⁻¹ mCi-1)	70	70	74	72	133	13	65	97	98	75
Skin dose-rate (mrem h ⁻¹ μCi. cm ⁻²)	7215	7030	7400	7215	6216	3700	6697	3610	1750	1924
Select Nuclear Medicine Nuclides (Non- PET)										
Nuclide	Ga ⁶⁷	Tc ^{99m}	In ¹¹¹	I ¹²³	I ¹²⁵	I ¹³¹	Xe ¹³³	Gd ¹⁵³	Lu ¹⁷⁷	Tl ²⁰¹
Half-Life	3.3 d	6 hr	2.8 d	13.1 hr	60 d	8 d	5.2 d	242 d	6.7 d	3.0 d
E _{b-max} (keV)	-	-	2.7 (100%) 145 (8%) 219 (5%)	-	22.7 (20%)	606 (89%)	346 (99%)	-	498 (79%) 385 (9%) 176 (12%)	-
E _{γmax} (keV)	93 (26%) 185 (20%) 300 (16%) 394 (5%)	141 (89%)	171 (90%) 245 (94%)	159 (83%) 27 (70%) 31 (16%)	35.5 (7%) 27.2 (39%) x-ray 27.5 (73%) x-ray 31 (25%) x-ray	362 (81%)	31 (25%) 35 (9%) 81 (37%)	41 (36%) 42 (65%) 47 (25%)	113 (6%) 208 (11%)	69 (27%) 71 (46%) 80 (21%)
γ dose-rate (Γ _D) @ 10 cm (mrem h ⁻¹ mCi-1)	11	12	50	28	28	28	10	17	2.8	8.8
Skin dose-rate (mrem h ⁻¹ μCi. cm ⁻²)	1299	910	1399	1399	78	5994	-	113	4590	999.0

* Assumed contaminant of Br⁷⁶

