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FRCM CHAPTER 4 RADIOACTIVE MATERIALS

Revision History

| Author | Description of Change | Revision Date |
|---------------------------------|--|----------------|
| M. Wolter and J. D. Cossairt | <ul style="list-style-type: none"> • Changes to Articles 412.3, 423.4d, and 423.4.f to clarify existing practices and remove obsolete/incorrect lists of instruments used for certain purposes. See iTrack Review # 48609. • Addition of Article 423.6 to cover on-site transfers with significant risk. | July 2018 |
| J. D. Cossairt | <ul style="list-style-type: none"> • Editorial change to Article 441 to add Figure 4-1 to incorporate a flowchart that illustrates Fermilab's waste handling procedures | September 2017 |
| J. D. Cossairt | <ul style="list-style-type: none"> • Reformulated Radiological Control Organization due to Fermilab-wide reconfiguration of ESH&Q personnel. • Article 415 amended to provide a specific provision pertaining to SURF, delete provisions for custodians of Radioactive Materials Areas, and clarify requirements for outdoor storage of radioactive materials • Article 423 amended to clarify the responsibilities for transporting Fermilab rad material Class 3 or higher. | November 2016 |
| J. D. Cossairt | <ul style="list-style-type: none"> • Reflect new Sealed Source Program requirements intended to better address institutional risks (Part 3). • New Article 424 to describe current metals recycling practices and update Articles 413 & 422 to be consistent with new Article 424. • Update incorrect organizational information. | July 2015 |
| J. D. Cossairt | <ul style="list-style-type: none"> • Add link to forms in Article 441.4 | February 2013 |
| J. D. Cossairt | <ul style="list-style-type: none"> • Updated Articles 412.4 and 412.5 to address the DOE suspension of recycling of radioactive materials originating from Radiological Areas. • Incorporated suggestion of DOE-FSO in Article 412.8 • Amend Article 423.2b to incorporate clarifications from the Radiation Safety Subcommittee. | November 2012 |

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CHAPTER 4 RADIOACTIVE MATERIALS

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50 **PART 1 RADIOACTIVE MATERIAL IDENTIFICATION, STORAGE AND**
 51 **CONTROL**

52
 53 **411 Definitions**

54
 55 Any material, equipment or system component which has been exposed to particle beams or
 56 contaminated by contact with accelerator activated material or with naturally occurring
 57 radioactive material is considered suspect radioactive material. Furthermore, items located in
 58 known or suspected Contamination, High Contamination or Airborne Radioactivity Areas and
 59 having the potential to become contaminated are considered suspect radioactive material.
 60 Radioactive material includes sealed and unsealed sources. Controls for sealed sources are
 61 described in Part 3 of this Chapter. Appendix E of 10 CFR 835 defines quantities of radioactive
 62 materials that are considered "accountable" under 10 CFR 835.

63
 64 **Radioactive Material:** Fermilab has established a practical release criterion for materials,
 65 equipment, and waste based on the use of field survey instruments. Materials, equipment,
 66 system components, waste items, or waste containers are considered to be radioactive if:

- 67
 68 • On a contact survey the gross count rate with any surface is greater than twice
 69 the mean background count rate as measured in a low background (<2000 cpm)
 70 with a standard Bicon Analyst™ gamma scintillation probe.
 71 or
 72 • On a contact survey the net count rate above mean background with any surface
 73 is greater than 2000 cpm as measured in a moderate background (≥2000 cpm but
 74 <3000 cpm) with a standard Bicon Analyst™ gamma scintillation probe.
 75 or
 76 • On a contact survey the net count rate above mean background with any surface
 77 is greater than 50 cpm above mean background on an Eberline E140N or Ludlum
 78 177-4 Frisker Geiger-Mueller survey instrument.
 79 or
 80 • Concentrations of any radionuclides contained within the material matrix equal
 81 or exceed those specified in applicable federal, DOE, state, or local regulations.
 82 or
 83 • They have removable or fixed surface radioactivity which equals or exceeds the
 84 limits established in Table 2-2.

85
 86 If any of these conditions are satisfied, then the material is radioactive by definition.

87
 88 The technique using the Frisker Geiger-Mueller tube instrument is permitted because of its
 89 simplicity and in situations where static magnetic fields are present that will preclude proper
 90 operations of the photomultiplier tube inherent in the Bicon Analyst™. See further
 91 requirements in Part 2 of this chapter. Training in the use of this instrument comprises a part of
 92 Radiological Worker Training.
 93

94 The use of the Bicron Analyst™ is the preferred methodology for screening items for potential
 95 offsite transport.

96

97 **412 Requirements**

98

99 1. Materials which have been in areas where activation is possible shall be considered
 100 radioactive material until surveyed. Materials in Contamination, High Contamination or
 101 Airborne Radioactivity Areas shall also be considered suspect radioactive material until
 102 surveyed, unless the area is an Airborne Radioactivity Area where only gaseous, short-
 103 lived (half-life of 1 hour or less) activation products are present (such as represented by
 104 the typical accelerator-produced airborne radionuclides — ^{11}C , ^{13}N , ^{15}O , and ^{41}Ar —
 105 at Fermilab). Surveys must assess the applicability of the criteria in Article 411, unless
 106 process knowledge is available. This includes materials moved from “Controlled” to
 107 “Uncontrolled” areas (see Articles 421.1 and 422.1).

108

109 a. As materials are removed from beamline enclosures where activation is
 110 possible (as designated by members of the Radiological Control
 111 Organization), the items shall be surveyed and labeled appropriately.

112

113 b. Materials or system components which are processed in such a way as to
 114 remove all or part of the gamma emitting radionuclides they may contain are
 115 specifically exempt from the definition set forth in article 411. The specific
 116 activities of exclusive beta emitting radionuclides can no longer be
 117 accurately correlated with those of the gamma emitting radionuclides in such
 118 cases. Laboratory analysis must be used to ascertain the radioactive status if
 119 process knowledge is insufficient.

120

121 c. Known or suspected alpha emitters must be surveyed with an “alpha meter”
 122 obtainable from and used by members of the Radiological Control
 123 Organization. Materials known to be or suspected of being contaminated
 124 with low energy beta emitters (e.g., ^3H or ^{63}Ni) also require special survey
 125 techniques. In such cases, the assigned RSO should be contacted.

126

127 2. If an item is found to be radioactive and it is to remain on site, surveys shall be performed
 128 promptly with a dose rate meter with appropriate scales to determine which Class label
 129 should be applied. The label should be filled out completely.

130

131 3. Any material, equipment, system component, waste item, or waste container with
 132 removable contamination levels equaling or exceeding the levels specified in Table 2-2
 133 are considered radioactively contaminated. If they can be decontaminated to levels
 134 below those specified in Table 2-2 and are not otherwise radioactive then they may be
 135 reclassified as non-radioactive material.

136

- 137 4. Material determined to be non-radioactive may be disposed of as waste or taken off site
138 without restriction as to its radioactivity provided it did not originate from a posted
139 Radiological Area. The Glossary shall be referenced for the precise definition of
140 “radiological area”. All radioactive labels should be removed from the material when it
141 is determined not to be radioactive (see Article 413.10).
142
- 143 5. In July 2000, DOE imposed a suspension on the recycling of metals originating from
144 inside a Radiological Areas as defined by 10 CFR 835 (see Glossary to the Manual).
145 This action was in addition to a moratorium in recycling actual radioactive materials
146 issued in January 2000. This moratorium and its subsequent suspension remain in effect.
147
- 148 a. This provision applies to recycling of metals and does not apply to reuse of
149 materials by Fermilab or other DOE facilities.
150
- 151 b. The assigned Radiation Safety officer (RSO) shall be consulted concerning
152 special procedures instituted to meet the requirements of this suspension.
153
- 154 c. Arrangements for recycling of metals are made through the Facility Engineering
155 Services Section Logistics and Property Control (FESS - LPC) Office with
156 coordination from the ESH&Q Section in consultation with DOE-FSO as
157 necessary.
158
- 159 d. See Article 424 of this chapter for more information about metals recycling.
160
- 161 6. A piece of equipment should be broken down into the smallest number of components
162 that is practical and the radioactivity of each item determined individually. This helps
163 ensure that the amount of radioactive waste generated is minimized.
164
- 165 7. If a group of individual items, which by themselves would not be classified as
166 radioactive, are placed together collectively in such a manner that the aggregate meets
167 the definition of a radioactive material found in Article 411, then the aggregate must be
168 considered radioactive.
169
- 170 8. In cases where materials are brought on site containing naturally occurring radioactive
171 material (NORM) such as thoriated tungsten welding rods or blasting grit, the
172 background to be used in determining the radioactive status of residues should be the
173 radiation field produced by a non-activated or contaminated sample in the same counting
174 geometry as the sample being analyzed. In most cases, this background will be
175 significantly higher than the ambient background.
176
- 177 9. While radioactive items at Fermilab are mostly volume-activated, there are occasionally
178 instances of “fixed contamination”. Fixed contamination is radioactive material on the
179 surface of an item maintained in place by means of a bonding agent such as adhesive,
180 paint, or epoxy. Such items should be routinely monitored to assure continued integrity.

181

 182 **413 Radioactive Material Labeling and Handling**

183

 184 1. Fermilab has implemented a system of labeling radioactive materials outside beam
 185 enclosures which assigns classes to them based upon exposure rates. In addition, Table
 186 4-1 lists general labeling requirements for radioactive materials. All radioactive material
 187 outside radiological areas shall be labeled in accordance with Tables 4-1 and 4-2.

188

 189 2. Radioactive material may be capable of generating a Radiation Area, High Radiation
 190 Area, or Very High Radiation Area. These areas shall have special controls in
 191 accordance with Article 333 and be posted/designated in accordance with Article 234.

192

 193 3. The Laboratory has developed response and notification requirements associated with a
 194 loss of radioactive material, including searches, internal investigations, documentation
 195 and reporting. The Radiological Control Organization and the Senior Radiation Safety
 196 Officer is to be notified in the event of a loss or theft of radioactive material. This
 197 includes radioactive sources.

198

 199 ***Table 4-1 General Labeling Requirements for Radioactive Materials***

200

| | REQUIRED LABELING |
|---|---|
| Equipment, components and other items that are radioactive | “CAUTION, RADIOACTIVE MATERIAL” (but use Table 4-2 for radioactive label classes) |
| Sealed and unsealed radioactive sources or associated storage containers | “CAUTION, RADIOACTIVE MATERIAL” and/or standard radiation symbol |
| Equipment, components and other items with actual or potential internal contamination | “CAUTION, CONTAMINATED MATERIALS” or “CAUTION, POTENTIAL INTERNAL CONTAMINATION HAZARD” |
| Components, equipment or other items with fixed contamination (see Article 221) | “CAUTION, FIXED CONTAMINATION” |

201

202

203
 204

Table 4-2 Radioactivity Class Labels

| Label | Exposure Rate (mR/hr @ 1 ft) | | |
|--|--|-----|--------------------------|
| | At Least | but | Less Than |
| CAUTION RADIOACTIVE MATERIAL Class 1 | Satisfies definition in Article 411 | | 1 mR/hr |
| CAUTION RADIOACTIVE MATERIAL Class 2 | 1 | | 10 mR/hr |
| CAUTION RADIOACTIVE MATERIAL Class 3 | 10 | | 100 mR/hr |
| DANGER RADIOACTIVE MATERIAL Class 4 | 100 | | 1000 mR/hr (= 1 R/hr) |
| DANGER: HIGHLY RADIOACTIVE MATERIAL Class 5 | 1 R/hr | | ---- |

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4. The following are not subject to item labeling requirements as set forth in Table 4-1:
- a. Radioactive material located in areas posted in accordance with the requirements of Articles 234-236.
 - b. Radioactive material or containers packaged and labeled for off site shipment in accordance with Department of Transportation Regulations.
 - c. Equipment or installed system components undergoing maintenance covered by a Radiological Work Permit.
 - d. Installed system components located within an area, inaccessible to individuals.
 - e. Items located within areas posted in accordance Article 233 when it is impractical to label all items. Such items shall be properly surveyed and labeled when they are removed from such areas.
 - f. Short-lived (half-life of 1 hour or less) radioactive material generated during an irradiation (i.e., research samples while an experiment is being conducted, etc.) that is immediately used.
 - g. Installed in process equipment such as piping or tanks if the posting is of no value for controlling exposures during repairs and maintenance as determined by the assigned RSO.

- 230
231 5. The following are not subject to labeling requirements if they are Class 2 or less and if
232 they are not significantly ($\geq 10X$ general background) more radioactive than ambient
233 radiation fields where they are stored:
234
235 a. Radiological control samples such as air, process and soil samples or swipes that
236 are in the custody of personnel properly trained in the handling, packaging and
237 transport of these samples.
238
239 b. Portable tools and equipment with fixed contamination permanently marked
240 with yellow or magenta and maintained in a labeled contaminated tool crib or
241 storage and distribution area.
242
243 c. Personal Protective Equipment and clothing.
244
245 6. Labels shall have a yellow background with a magenta or black standard radiation
246 warning trefoil. Lettering shall be magenta or black.
247
248 7. Labels shall include the maximum dose rate at 30 cm (1 foot) (see Tables 4-1 and 4-2),
249 removable surface contamination levels, if any (specified as alpha or beta-gamma),
250 dates surveyed, and surveyor's initials or preferably the surveyor's Fermilab ID number.
251 For items determined to be Class 1 the dose rate need not be included.
252
253 8. Packaged radioactive material should have the label visible through the package or
254 affixed to the outside.
255
256 9. When certain radionuclides (some alpha sources, tritium, etc.) are packaged so that no
257 radiation is detectable outside the container, a Caution, Radioactive Material label shall
258 be used. Additional information, such as the radionuclide present, specific activity, etc.,
259 shall be affixed to the container.
260
261 10. Non-radioactive materials should not carry radioactivity Class labels. Good practice is
262 to check items whenever practical, reclassify items which need a new label, and remove
263 all labels if the item is no longer radioactive.
264
265 11. Hand tools and equipment stored in radiological areas may be marked with yellow or
266 magenta paint to denote that they are radioactive. Outside these areas, they must be
267 marked with the appropriate radioactivity Class labels.
268
269 12. Material and equipment exceeding the removable surface contamination values
270 specified in Table 2-2 of the Manual may be conditionally released for movement on-
271 site from one radiological area for immediate placement in another radiological area
272 only if appropriate monitoring is performed and appropriate controls for the movement
273 are established and exercised under authorization of the assigned RSO.

274

275

414 Radioactive Material Packaging

276

277

1. Material that is outside Contamination, High Contamination or Airborne Radioactivity Areas and is confirmed or suspected of having removable radioactive contamination levels greater than Table 2-2 values, shall be securely wrapped in plastic or placed in a container such that any potential contamination from that material will be completely contained.

282

283

2. Contaminated material with sharp edges or projections should be taped or additionally protected to ensure package integrity.

284

285

286

3. Contaminated material with removable contamination levels in excess of 100 times Table 2-2 values should have additional packaging controls such as double-wrapping or the use of plastic bags inside containers.

288

289

290

4. Yellow plastic wrapping material should be used in packaging radioactive material for storage, transportation, or shipment. Yellow plastic sheets or bags should not be used for non-radiological purposes.

291

292

293

5. The amount of combustible material used in packaging should be minimized and selected in accord with Fermilab ES&H Manual fire protection policies.

295

296

297

415 Radioactive Material Storage

298

299

1. Areas where radioactive material is stored should be appropriately posted as set forth in Part 3 of Chapter 2.

300

301

302

2. Long-term (more than 1 year) storage of radioactive material should be in areas specifically designated for the storage of radioactive material. Portions of the Railhead currently constitute Fermilab's major long-term storage area (see Subpart 13 below).

303

304

305

3. Radioactive materials shall not be stored off site (including buildings rented or leased by the Laboratory) or at certain specified on-site locations including the following:

307

308

309

- a. On site housing (dorms, etc.)
- b. Established eating and drinking areas (lunch rooms, vending areas, etc.)
- c. In Wilson Hall unless the provisions of Chapter 9 Part 1 are followed.

310

311

312

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314

315

4. The acquisition, use, and associated transportation of radioactive materials including sealed sources and nuclear materials at the Sanford Underground Research Facility (SURF) in areas leased or managed by FRA/Fermilab shall be approved by the SRSO.

316

317

- 318 These materials shall be managed in accordance with requirements applicable to the
319 particular space within the SURF facility.
320
- 321 5. Decontamination or disposal of radioactive material is the preferred alternative to long-
322 term storage except for equipment of significant value. For purposes of this Article,
323 “value” may be either defined in terms of financial considerations or in terms of the
324 difficulty of replacing the materials or equipment in question.
325
- 326 6. Article 242 specifies documentation requirements for facilities containing radioactive
327 materials. Proposals for additions to and deletions from this list shall be approved by the
328 assigned RSO.
329
- 330 7. The Radiological Control Organization shall conduct periodic walkthroughs of areas
331 where radioactive material is stored or used to check for adherence to Laboratory
332 policies, especially with respect to the minimization of material accumulation, proper
333 labeling, and container integrity.
334
- 335 8. Storage of non-radioactive material in any radiological area should be minimized.
336
- 337 9. Outdoor storage of radioactive material is discouraged.
338
- 339 a. Any new outdoor storage locations that will be used more than 30 days shall be
340 approved by the SRSO.
341
- 342 b. The use of shielding blocks for storing radioactive materials outdoors with
343 limited protection against the outdoor weather environment and as the dominant
344 structural element is strongly discouraged.
345
- 346 c. Outdoor storage locations that will be used for periods of less than 30 days may
347 be approved by the assigned RSO.
348
- 349 d. In cases where outdoor storage is necessary and where removable radioactivity
350 is present, containers of high integrity shall be chosen to prevent degradation
351 from weathering and the resultant release of radioactive material.
352
- 353 e. Radioactive items and associated pieces of equipment shall be stored in a
354 structurally sound manner that provides the long term ability to safely retrieve
355 the items from both a material handling and radiation safety perspective.
356
- 357 10. Radioactive material should be stored in a manner that reduces combustible loading.
358 The use of cardboard containers for storage is discouraged.
359
- 360 11. Flammable or combustible materials should not be stored adjacent to areas where
361 radioactive material is stored or used.

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12. Fire protection measures, such as smoke detectors, water sprinklers and fire extinguishers, should be considered when establishing areas for the storage and usage of radioactive materials.
 13. Specific locations in the Railhead area of the Laboratory are designated for general storage of radioactive material. Limited indoor storage, built from shielding blocks, is available in the Lundy Barn. However, the building is not heated, air conditioned or completely waterproof, so some deterioration due to the physical conditions should be expected. The procedures for using this storage area are given below.
 - a. General
 - (1) Radioactive material storage at the Railhead is under the direct control of FESS – LPC as the landlord. Contact them for storage arrangements.
 - (2) All portable items (items weighing less than 200 lbs.) must be stored in a secure area, e.g., either inside a building or in a fenced and locked area outside. If stored outside, provision should be made to prevent any environmental contamination or theft.
 - (3) All items must be surveyed, labeled with the exposure rate, date of survey, and contamination level, if any, on a Material Move Request (MMR) Form. It is the responsibility of the division/section requesting the storage to arrange for appropriate radiation surveys.
 - b. Limits
 - (1) Exposure Rate Limits

Any Class 4 or higher item shall be stored with enough shielding to reduce the radiation exposure rate outside the shield to below 100 mR/hr.
 - (2) Contamination Limits
 - (i) When practical, all surfaces of all items shall be decontaminated to levels less than those specified in Table 2-2.
 - (ii) Items which cannot be decontaminated must be covered with a waterproof barrier (e.g., Herculite™) and put inside a container which will provide weather protection for the duration of storage. Class 4 and 5 radioactive items which are subject to corrosion shall be covered with a waterproof barrier. Other unusual

405 situations such as those which may involve radioactive liquid,
406 powder, etc., will be handled on a case-by-case basis.

407

408 **PART 2 RELEASE AND TRANSPORTATION OF RADIOACTIVE MATERIAL**

409

410 **421 Release to Controlled Areas**

411

412 1. Materials released from radiological areas to Controlled Areas should be promptly
413 categorized as radioactive or non-radioactive based on the definition found in Article
414 411 or the process knowledge of the individuals releasing the material.

415

416 2. A wipe survey shall be performed on radioactive material in Contamination, High
417 Contamination or Airborne Radioactivity Areas unless a frisker survey can demonstrate
418 that the removable contamination levels are below those specified in Table 2-2 and no
419 alpha or low-energy beta emitting radionuclides are present. Unpackaged radioactive
420 material to be released to Controlled Areas shall be demonstrated to have removable
421 contamination levels less than Table 2-2 values.

422

423 3. Materials may be released from Contamination Areas for use in Controlled Areas
424 provided that measurements of accessible surfaces show that removable contamination
425 levels are below those in Table 2-2 and contamination levels on inaccessible surfaces
426 are unlikely to exceed those levels. These items shall be routinely monitored and
427 controlled in accordance with administrative procedures in Article 221. Controls shall
428 be established to ensure that no unmonitored individual is likely to exceed a dose that
429 would require monitoring in keeping with Articles 511 or 521. See also Article 413.12.

430

431 4. Radioactive material with removable contamination levels greater than Table 2-2 values
432 which cannot be decontaminated shall be packaged prior to release to Controlled Areas.
433 These items shall be routinely monitored and controlled in accordance with
434 administrative procedures. Controls shall be established to ensure no unmonitored
435 individual is likely to exceed a dose that would require monitoring in accordance with
436 Articles 511 or 521.

437

438 5. Material not immediately removed from Contamination, High Contamination, or
439 Airborne Radioactivity Areas after survey shall be controlled to prevent contamination
440 while awaiting release. Potentially activated material not immediately released after
441 survey shall be controlled to prevent activation while awaiting release.

442

443 6. Records for release of potentially contaminated materials shall describe the property,
444 date of last survey, identity (either initials or a Fermilab ID number) of the person who
445 performed the survey, type and identification number of the survey instruments used,
446 and survey results demonstrating the contamination levels are below those of Table 2-
447 2. Otherwise, item 4 above applies.

448

449 7. Radioactive material, equipment, or items released from radiological areas to Controlled
450 Areas which are to be declared as waste shall be characterized as to the prominent
451 radionuclide concentrations found in the material. This should be done before its release,
452 if possible; otherwise as soon as practical after its release.
453

454 8. Materials released to Controlled Areas shall be labeled in accordance with Article 413.
455

456 **422 Release to Uncontrolled Areas**

457

458 1. Material in Controlled Areas or Radioactive Material Areas shall be categorized as
459 radioactive or non-radioactive based on the definitions found in Article 411.1 or the
460 process knowledge of the individuals releasing the material prior to release to
461 uncontrolled areas. (Note that special precautions apply to the use of radioactive
462 materials in Wilson Hall as specified in Chapter 9.)
463

464 2. Fermilab removable surface activity criteria for releasing radioactive material to
465 uncontrolled areas are consistent with regulatory requirements. Radioactive material
466 being released shall also be evaluated for contamination under any coatings if “fixed”
467 contamination is present. Such materials must have removable contamination levels less
468 than those of Table 2-2 and no fixed contamination for such release to be permitted.
469

470 3. Material not immediately released after survey shall be controlled to prevent activation
471 or contamination while awaiting release.
472

473 4. Labels shall be removed or defaced prior to release for unrestricted use of materials that
474 are found to be no longer radioactive. Labels shall be disposed of as radioactive waste.
475

476 5. Radioactive materials on or within material, equipment, or real property which is
477 approved for release when the radiological conditions of the material, equipment, or real
478 property have been documented to comply with the criteria of release set forth in a DOE-
479 approved authorized limit are subject to the provisions associated with that limit that
480 were reviewed in the process of securing the required DOE authorization. Such
481 authorization limits are approved according to the requirements of DOE Order 458.1.
482

483 **423 Transportation of Radioactive Material**

484

485 1. General Requirements for shipments

486 a. Table 2-2 removable contamination values shall be used as controlling limits for
487 on site transportation when using a DOE conveyance (i.e., government vehicle).
488 When a radioactive material shipment is received from or shipped to an off-site
489 destination, the requirements of 49 CFR173 Subpart I shall apply.

490 The DOT removable contamination limits stated in 49 CFR
491 173.443, as applied to Fermilab, are as follows:

492

493 Beta-gamma emitting radionuclides & low toxicity alpha emitters:
494 24,000 dpm/100 cm² (10 nCi/100 cm²)

495 All other alpha emitting radionuclides: 2400 dpm/100 cm² (1 nCi/100
496 cm²)
497

498 b. 49 CFR 171 through 180 describe requirements for inspecting and surveying
499 packages, containers and transport conveyances prior to off-site transport.

500 c. Transport conveyances should be visually inspected prior to loading to ensure
501 the trailers are acceptable for the intended use.

502 d. Drivers of motor vehicles in which radioactive material is transported shall have
503 a copy of all documentation required by applicable rules and regulations.

504

505 2. Shipment of Radioactive Material

506 a. All material to be shipped off site which has been in beamline areas or is
507 otherwise suspected of being radioactive must be categorized as either
508 radioactive or non-radioactive based upon the definition in Article 411 or upon
509 process knowledge:

510 (1) If a survey is required to determine if the item is radioactive, it shall be
511 made by an appropriately trained individual having current Material
512 Move Request (MMR) survey training. Material Move Request surveys
513 are based most commonly on the use of the Bicon AnalystTM survey
514 instrument (see Article 411). The Authorized Surveyor list can be
515 obtained from the ESH&Q Section through the TRAIN database.

516 (2) Items which are not radioactive (see Article 411), provided they are free
517 of labels or other indications that the item may have once been designated
518 as radioactive, may be shipped without restrictions as to its radioactive
519 content unless the provisions of the DOE-imposed metals recycling
520 suspension apply (see Articles 412 and 424). This includes shipments
521 going through the Receiving Warehouse Site 38 or delivery directly to a
522 vendor's vehicle at the site location. An online Material Move Request
523 must still be completed and signed attesting to the non-radioactive
524 classification of the material.

- 525 b. All off-site shipments of radioactive material shall be coordinated through the
526 Hazard Control Technology Team (HCTT) of the ESH&Q Section. Upon receipt
527 of items, HCTT will complete packaging, labeling, and shipping requirements.
528 The HCTT then makes the proper shipping arrangements through FESS - LPC.
529 The MMR shall accompany all off-site shipments of radioactive material.
530
- 531 c. Off-site shipments of radioactive material, including subcontractors' handling of
532 off-site shipments, shall be controlled and conducted in accordance with this
533 Manual and applicable Federal, state and local regulations.
534
- 535 d. Before shipment, a visual inspection of packages shall be performed to ensure
536 that packages are not damaged. The inspection should identify dents, flaking
537 paint, debris, package orientation and any indication of leakage.
538 e. Before shipment, a comparison of package count to the shipping manifest shall
539 be made to ensure accountability.
- 540 f. Transport conveyances should be carefully radiologically surveyed before
541 loading a vehicle consigned as exclusive use or when using a commercial carrier
542 specializing in radioactive material transport.
- 543 g. Transport of large volumes of radioactive material by non-DOE motor vehicles
544 should be "exclusive use" to prevent commingling of DOE and other commercial
545 shipments.
- 546 3. Receipt of Radioactive Material
- 547 a. Receipt of radioactive material shall be arranged through, and approved by, the
548 ESH&Q Section. If packages containing quantities of radioactive material in
549 excess of a Type A quantity as defined in 10CFR71.4 are expected, arrangements
550 shall be made to either:
- 551 (1) Take possession of the package when the carrier offers it for delivery; or
- 552 (2) Receive notification of its arrival at the carrier's terminal and to take
553 possession of the package as soon as possible thereafter.
- 554 b. Upon receipt of a radioactive material shipment, a visual inspection of packages
555 shall be performed to ensure that packages are not compromised. In addition, a
556 comparison of the package count to the shipping manifest shall be made to
557 ensure accountability.
- 558 c. External surfaces of packages known to contain radioactive material shall be
559 monitored for both radiation and contamination levels if:

- 560 (1) A Radioactive White I, Yellow II, or Yellow III label (as specified at
561 49CFR172.403 and 172.436-440) is present; or
- 562 (2) Has been transported as low specific activity material (as defined at
563 10CFR71.4) on an exclusive use vehicle (as defined at 10CFR71.4); or
- 564 (3) Has evidence of degradation, such as packages that are crushed, wet, or
565 damaged.
- 566 d. Monitoring shall be completed as soon as practicable following the receipt of the
567 package, but not later than 8 hours after the beginning of the working day
568 following the receipt. Until the monitoring can be performed, the packages
569 should be segregated and temporarily placed in a posted Radioactive Material
570 Area. Exceptions are noted below:
- 571 (1) No measurements of removable contamination need to be made when the
572 package contains only special form (as defined in 10CFR71.4) or
573 gaseous radioactive material; or
- 574 (2) No measurements of radiation levels are required when the package
575 contains less than a Type B quantity (as defined in 10CFR71.4) of
576 radioactive material.
- 577 (3) Monitoring is not required for packages transported on the Fermilab site
578 under the continuous observation and control of a DOE or Fermilab
579 employee who is knowledgeable of and implements required exposure
580 control measures.
- 581 4. Requirements for On Site Transfers
- 582 The division/section heads are responsible for providing safe and environmentally
583 responsible on site transfer of radioactive materials during work conducted by their
584 personnel. The responsibility for proper transfer and transport shall, at a minimum,
585 address the following:
- 586 a. Providing appropriate labels which specify Class of radioactivity according to
587 the provisions of this Chapter. NOTE: additional provisions apply to the
588 transportation of materials that are Class 3 or higher.
- 589 b. Meeting radiation safety handling, packaging, and shipping requirements. This
590 may require special instructions from, or supervision by, radiation safety
591 personnel.

- 592 c. Ascertaining that destinations are appropriate for receiving the material, and
593 have controls in accordance with Article 233 and be posted in accordance with
594 Article 234.
- 595 d. Arranging appropriate transportation. Such transfers are restricted to
596 government vehicles with the exception of sealed check sources on field
597 instruments maintained by the ESH&Q Section which are allowed to be
598 transported on site in personal vehicles that shall not be taken off site during such
599 transfers.
- 600 e. The vehicle should be driven directly to its destination with no unnecessary stops
601 along the way. No "side trips" off site are allowed. No "side trips" to facilities
602 frequented by the public on site are allowed (e.g., the recreation facilities, village
603 residential units, and/or Wilson Hall unless the latter is the destination (see
604 Chapter 9 Part 1 of this Manual).
- 605 f. Radioactive materials are not permitted in on site housing (e.g., dorms) or in
606 established eating and drinking areas (e.g., lunchrooms and vending areas)
607 unless specifically approved by the assigned RSO on a case-by-case basis. Such
608 approvals should not be given for areas accessible to members of the public.
- 609 g. Special restrictions apply to radioactive materials in Wilson Hall (see Chapter 9
610 Part 1).
- 611 h. The Fermilab Comprehensive Emergency Response Plan describes appropriate
612 responses for potential on site radioactive material transportation accidents.
- 613 i. All on-site transfers of radioactive materials made using the services provided
614 by FESS – LPC (Shipping and Receiving), and otherwise between divisions and
615 sections, shall require a completed and approved Material Move Request.
- 616 5. Requirements for transporting materials that are determined to be Class 3 or higher.
617
- 618 a. A completed and approved MMR and survey must accompany all materials that
619 have been determined to be Class 3 or higher during transportation.
- 620 b. Before transport, the vehicle shall be surveyed to verify that prior contamination
621 does not exist. After transport is complete, the vehicle shall be surveyed again
622 to check for contamination. Radiological Control Organization (RCO) personnel
623 performing these surveys should be aware that potential contamination may
624 consist of activated material fragments (see Article 345). In this situation, wipe
625 surveys are not sufficient, hence, a direct survey of the vehicle itself must be
626 performed by members of the RCO.
- 627 c. Prior to transport, the material shall be wrapped. This is in addition to any
628 protective covering or housing that already exists for shielding purposes. If this

- 629 is not feasible, the vehicle must be protected in a manner such that any potential
630 removable contamination will be completely contained (see Article 335).
- 631 d. The ESH&Q Section shall keep a log that tracks which Fermilab vehicle was
632 used for each transport of Radioactive Material Class 3 or higher items. This log
633 shall provide information regarding the initial location of the material being
634 transported, destination, date of transport and transportation route. Radiation
635 surveys of the material being transported shall also be documented in these logs.
- 636 e. The approval of the SRSO will be needed for the transport of Class 3 items on-
637 site for which the dose rate outside of shielding is estimated to exceed 1 R/h.
- 638 6. On-site transfers of significant risk to surrounding personnel of accumulating dose shall
639 require review by the SRSO and approval by the CSO. The assigned RSO shall
640 participate in planning for such transports.
- 641 a. These include one or more of the following characteristics:
- 642 (1) Identified need for slow speed transport with load not tied down (i.e.
643 “strapped down”) from ALARA considerations.
- 644 (2) Identified need to forego “wrapping” of the transport items as otherwise
645 required by Article 423.5 from ALARA considerations.
- 646 (3) Unstrapped and unwrapped loads may be transported in this manner only
647 if the speed of the transport of < 10 mph and suitable weather conditions,
648 subject to the discretion of the assigned RSO are present.
- 649 (4) Other departures from full compliance with U. S. Department of
650 Transportation Regulations.
- 651 (5) Determination by the assigned RSO of the need to close the affected
652 roadways and escort the transport using Fermilab Site Security personnel
653 and equipment as escorts to keep unauthorized personnel excluded from
654 planned route and proximity to the activated item and its transporting
655 vehicle.
- 656 b. These transfers require participation by the Fermilab Site Security Department
657 to close affected roadways and render them cleared of non-essential vehicles,
658 pedestrians, and bicyclists at all times during the transport from initiation at the
659 point of origin to receipt at the destination as specified on the MMR.
- 660 c. These transfers require participation by the Fermilab Fire Department to assure
661 understanding of road blockages that may require detours in the event of an
662 emergency response such as a fire or ambulance run. For emergency situations

663 the Fire Department will be afforded the opportunity to breach the transport route
664 with a dose of < 1 mrem per firefighter.

665 d. Documentation of communication with the Fermilab Site Security and Fire
666 Departments and notification of the Office of Communication shall be included
667 in the request submitted to the SRSO and CSO for review and approval prior to
668 the transport.

669

670 **424 Recycling of Metals**

671

672 As stated in Article 412, the July 2000 DOE suspension of metals removed from Radiological
673 Areas as defined by 10 CFR 835 and this Manual remains in force. Metals to be recycled from
674 Fermilab therefore must meet the following set of criteria:

675

676 1. The metals shall not originate from a currently posted radiological area (that is a
677 Radiation Area, High Radiation Area, Very High Radiation Area, Contamination Area,
678 or Airborne Radioactivity Area).

679

680 2. Work to be performed by subcontractors that may involve potential metals recycling
681 shall be reviewed by the assigned RSO and the SRSO prior to the awarding of bid
682 packages. This can be done in the normal course of review of projects. The results of
683 this process shall be incorporated into the Terms and Conditions of the relevant
684 subcontracts as incorporated by the Fermilab Legal Office.

685

686 3. Fermilab internal or time and material (T&M) tasks that may generate metals for
687 potential recycling shall be reviewed by the assigned RSO and incorporated into
688 designated recycling packages that are approved by the SRSO.

689

690 4. Clearly stated and documented process knowledge may be used to permit recycling of
691 metals that clearly cannot contain radioactivity.

692

693 5. All metals released for recycling shall be carefully surveyed by hand using the Bicon
694 Analyst™ survey meter in accordance with Article 411 and must proceed through the
695 “Bicon truck scanner” located at Site 38 without detection of radioactive materials.

696

697 **PART 3 RADIOACTIVE SOURCE CONTROLS**

698

699 **431 Radioactive Source Controls**

700

701 At a minimum, Fermilab’s Sealed Source Control and Accountability Program will address
702 sources meeting the criterion in Appendix E of 10CFR835, but has been expanded to include
703 all sealed sources on the site except for those installed on smoke detectors as commercial
704 devices used for fire protection. Fermilab is also bound by the requirements of DOE O231.1B.
705 These requirements have been incorporated into the Program document referenced above.

- 706
707 1. All uses of sealed sources at Fermilab shall be approved by the ESH&Q Section under
708 the authority of the Chief Safety Officer as delegated to the SRSO.
709
- 710 2. Radioactive source procurement and use at Fermilab is limited to sealed radioactive
711 sources that have been produced by facilities that are licensed to manufacture such
712 sources by the U.S. Nuclear Regulatory Commission (NRC), NRC agreement states,
713 or in some cases, non-US companies demonstrated to follow licensing requirements
714 equivalent to those of the NRC.
715
- 716 3. The ESH&Q Section shall maintain, or cause to be maintained, accountability records
717 for sealed radioactive sources.
718
- 719 4. The ESH&Q Source Physicist shall be a member of the Radiological Control
720 Organization assigned to maintain radioactive source controls. At Fermilab, procedures
721 for radioactive source control and accountability are documented in the Source Control
722 and Accountability Program that contains the details of Fermilab's program for sealed
723 radioactive source management.
724
- 725 5. Radioactive source users shall notify the ESH&Q Section Source Physicist (or designee)
726 of changes in use, storage, transfer, disposal, return or loss of a sealed source.
727
- 728 6. Except for sealed radioactive sources consisting solely of gaseous radioactive material
729 or liquid radioactive material such as tritium, each accountable sealed source shall be
730 leak tested under the following conditions and frequency:
731
- 732 a. Upon receipt (see item 8).
733
- 734 b. Sealed radioactive sources on loan by the ESH&Q Section are leak-tested
735 (wiped) monthly, except for sources located in areas that are unsafe for human
736 entry or otherwise inaccessible (e.g. sources installed in detectors). This program
includes verification of the sealed radioactive source inventory.
- 737 c. Sealed radioactive sources in the inventory of the ESH&Q Section are leak-
738 tested (wiped) every 6 months, unless they have been removed from service or
739 placed into storage. The time interval to conduct the leak tests may be extended
740 by a period not to exceed 30 days to accommodate scheduling needs. Sources
741 removed from service or placed in storage, including sources mounted on
742 radiation safety instruments, are not subject to periodic leak testing. Such
743 sources shall be stored in a controlled location and shall be leak tested prior to
744 being returned to service. This program includes verification of the sealed
745 radioactive source inventory.

- 746 d. Whenever damage is suspected. Sealed radioactive sources found to be leaking
747 shall be controlled in a manner that minimizes the spread of contamination and
748 removed from service.
- 749 e. Sealed radioactive source leak tests shall be capable of detecting radioactive
750 material leakage equal to or exceeding 0.005 microCurie.
- 751 7. Labels used to identify sealed radioactive sources shall also identify the radionuclide,
752 date of assay, and source inventory number. These labels, sometimes small in size, are
753 excepted from the specifications on color normally used for radiological postings. A
754 permissible example at Fermilab is the engraved brass tags commonly used on these
755 sources. The current list of source users is maintained in a database which associates
756 them with the sources by inventory number.
- 757
- 758 8. Procurement of radioactive sources shall be coordinated with the ESH&Q Section (see
759 Article 432).
- 760
- 761 9. Receipt surveys of source shipments shall be performed by the ESH&Q Section. These
762 sources shall be leak-tested (see above) within 30 days of receipt.
- 763
- 764 10. Sources, including radiography sources (see Article 362), shall not be brought on site
765 without the prior approval of the SRSO or designee.
- 766
- 767 11. Source monitors are designated for each source box/cabinet. Source monitors are
768 responsible for the control of the source box/cabinet lock key issued to them by the
769 ESH&Q Section, locking and unlocking source boxes, logging sources in and out on the
770 source access log sheet and verifying source training of the user requesting the source.
- 771
- 772 12. Source box/cabinet lock keys shall not be duplicated.
- 773
- 774 13. Source box/cabinet lock keys may not be transferred to persons who are not qualified
775 (by training) to use sealed radioactive sources.
- 776
- 777 14. When a person is no longer designated a source monitor, he/she shall return the source
778 box/cabinet lock key to the ESH&Q Section.
- 779
- 780 15. Source monitors shall notify the ESH&Q Section Source Physicist (or designee) if a
781 source box/cabinet lock key is discovered missing, lost, or found.
- 782

783 **432 Procurement of Sealed Radioactive Sources at Fermilab**

784

785 The ESH&Q Section maintains an inventory of frequently used sources which are available for
786 loan to Fermilab employees and visiting experimenters. These sources are safely packaged and
787 are available in different geometries to meet a variety of needs. Sources can be packaged in

788 special holders to meet specific needs. A listing of some types of sealed radioactive sources
789 available is given in Table 4-3.

790

791 Sealed radioactive sources not available in the inventory can be procured through arrangement
792 with the ESH&Q Section Source Physicist (or designee) for loan to individuals requesting them.
793 The procedures for procurements are as follows.

794

795 1. After discussion of requirements, the purchase requisition must be routed through the
796 ESH&Q Section and must be approved (signed) both by the Division/Section Head (or
797 designee) who supervises the work being done and by the SRSO.

798

799 2. An individual will be required to read, sign, and date a Radioactive Source Loan Form
800 (R.P. Form # 12). The responsibilities of persons using radioactive sources at Fermilab
801 are listed on the back of this form as well as in Article 433.

802

803 3. Both Radioactive Source training (course #FN000048) and Radiological Worker
804 training (course #s FN000470 and FN000471) shall be provided to the employee or
805 experimenter prior to source use. Training is documented on the Training Record and
806 Information Network.

807

808 4. Shipment of sources from other institutions shall be first discussed with the ESH&Q
809 Section Source Physicist (or designee) in consultation with the assigned RSO. Sources
810 purchased from outside vendors or shipped to Fermilab from other institutions are
811 shipped directly to the ESH&Q Section through FESS – LPC.

812

813 5. The purchase requisition must include the following specifications pertinent to the
814 shipment of radioactive sources to Fermilab:

815

816 a. Removable activity must be less than one nanoCurie.

817

818 b. The Purchase Order should be marked “Prime DOE Contractor. No License
819 Required.”

820

821 c. The outside of the package must be marked “Contains radioactive material. Do
822 not open at Receiving. Contact Hazard Control Technology Team on arrival.”

823

824
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 826

Table 4-3 Typical Sources in Inventory

| Nuclide | Half-life | Principal Radiations | γ Energy, or Maximum β Energy, MeV | General Range of Activities |
|-------------------|-----------|---|---|--|
| ^{55}Fe | 2.7 yr. | γ | 0.006 (Mn X-ray) | 2 μCi to 200 μCi |
| ^{60}Co | 5.27 yr. | γ | 1.17, 1.33 | 0.1 μCi to 2 mCi |
| ^{137}Cs | 30.2 yr. | γ | 0.662 | 4 μCi to 700 μCi |
| ^{90}Sr | 29 yr. | β^- , no γ | 0.546 β , 2.27 β (from daughter ^{90}Y) | 19 μCi to 4 mCi |
| ^{106}Ru | 368 days | β^- , γ | 3.54 β (from daughter ^{106}Rh) | 0.001 μCi to 120 μCi |
| ^{207}Bi | 38 yr. | γ , Internal Conversion Electron | 0.570, 1.0648 γ ; 0.976, 0.482 ICE | 0.03 μCi to 10 μCi |
| ^{241}Am | 432 yr. | α , γ | 5.48 α ; 0.026, 0.060 γ ; numerous Np X-rays | 0.1 μCi to 10 mCi |

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433 Responsibilities of Persons Using Radioactive Sources at Fermilab

1. The user shall not tamper with, disassemble, or modify a source or its holder in any way, nor remove any source from its holder or housing. Requests for source installation or new or modified source holders or housing must be discussed with ESH&Q Section personnel.
2. If a user purchases a radioactive source, purchase requisitions must be routed through the ESH&Q Section Source Physicist (or designee) for proper approval and signatures.
3. Radioactive sources shall not be brought to or taken from Fermilab unless approved in advance by Fermilab's Senior Radiation Safety Officer (SRSO) or designee.
4. Radioactive sources shall be kept in a locked box/cabinet when not in use. The storage box/cabinet shall bear sign(s) "Caution Radioactive Material". Tool boxes and other portable containers are not acceptable source storage containers.
5. Sources and source boxes/cabinets shall be accessible to ESH&Q Section personnel for monthly inventory and leak testing.

- 847
- 848 6. Dosimetry badges shall be worn and a “Caution Radiation Area” sign shall be displayed
- 849 when the potential exists for an individual to receive a dose of ≥ 5 mR in 1 hour at a
- 850 distance of 30 cm (1 foot) from the source. As deemed necessary, the ESH&Q Section
- 851 Source Physicist (or designee) or the assigned RSO may require written work
- 852 authorization such as a Radiological Work Permit (RWP).
- 853
- 854 7. A “Caution Radioactive Material” sign shall be displayed near the source during use. If
- 855 a source is contained within detection equipment, a “Caution Radioactive Material”
- 856 label with the source I.D. clearly stated must be attached to the outside of the equipment.
- 857
- 858 8. The user shall not leave sources unattended. Radioactive sources should be under
- 859 constant surveillance or they should be secured. The ESH&Q Section Source Physicist
- 860 (or designee) shall be notified if a source needs to be used for an extended period of time
- 861 (days or weeks) without returning it to its designated storage location. Special
- 862 arrangements shall be made to ensure adequate radioactive source control.
- 863
- 864 9. The user shall not detach the "Caution Radioactive Material" tag/label or the source I.D.
- 865 label from the source.
- 866
- 867 10. The ESH&Q Section Source Physicist (or designee) and assigned RSO shall be
- 868 contacted to arrange for source transfers. Under most circumstances, ESH&Q Section
- 869 personnel will transport the source to the new location. Likewise, when a source is
- 870 issued, ESH&Q Section personnel will deliver the source to the storage location
- 871 designated on the source loan form. After consultation with the ESH&Q Section Source
- 872 Physicist (or designee), division/section personnel may transport sources on site in
- 873 government vehicles provided that the source is returned to its assigned storage location
- 874 at the end of the workday. The user shall not transport sources in private vehicles.
- 875 11. The transfers described above are restricted to government vehicles with the exception
- 876 of sealed check sources on field instruments maintained by the ESH&Q Section.
- 877 12. The user shall notify the ESH&Q Section Source Physicist (or designee) when the
- 878 source is no longer needed. ESH&Q Section personnel will pick up the source and return
- 879 it to ESH&Q Section storage.
- 880
- 881 13. The user shall promptly notify the ESH&Q Section Source Physicist (or designee) if a
- 882 source is discovered missing, lost or found.
- 883
- 884 14. If a user suspects that a source is broken or causing contamination, the user shall call or
- 885 have someone call x3131 immediately. The source should not be removed from its
- 886 storage location or current location if in use. Others should be kept away from the
- 887 source.
- 888

- 889 15. The user shall contact the ESH&Q Section Source Physicist (or designee) to obtain a
890 source that is not currently located in a source storage box. The ESH&Q Section Source
891 Physicist (or designee) shall complete the Radioactive Source Loan Form (R.P. Form
892 #12) and the user shall sign and date the form.
893
- 894 17. Exceptions to any of the above rules shall be approved in advance in writing by the
895 SRSO. Departures from these rules may result in confiscation of the source(s). Severe
896 or repeated violations may result in loss of radioactive source privileges at Fermilab.
897

898 **PART 4 RADIOACTIVE WASTE MANAGEMENT**

899 **441 Requirements**

900 All radioactive material that is not needed for present or probable future use should be disposed
901 of as radioactive waste. In addition, any signs, tags, or labels used to indicate the presence of
902 radiation and/or radioactive material must be destroyed beyond recognition or disposed of as
903 radioactive waste. Compactable radioactive waste such as disposable protective clothing, rags,
904 and compressible items shall be placed in yellow radioactive waste bags. Normally, non-
905 compactable solid and liquid radioactive waste must be placed in approved containers provided
906 by the ESH&Q Section. Large items which are suitable for direct burial in accordance with
907 current disposal site provisions may be disposed of without containment. Where applicable,
908 these items are to be placed on pallets, or in the case of pipes, banded in bundles. Compactable
909 and non-compactable waste must be kept separate to allow maximum efficiency in the
910 radioactive waste disposal program. [FESHM Chapter 8021](#) further specifies Fermilab's
911 radioactive waste disposal program.
912
913

914 Specific procedures for disposal of radioactive waste can be found in the Low-Level Waste
915 Certification Program (LLWCP). Radiological operations generating radioactive waste should
916 be designed and developed to permit segregation, monitoring, storage and disposal. The
917 ESH&Q Section should be contacted if questions or problems arise.
918
919

920 1. Procurement, Delivery, and Storage of Radioactive Waste Containers

921 a. The ESH&Q Section is responsible for ordering, inspecting, and issuing
922 radioactive waste containers. The containers available are:

- 923 (1) Yellow 55 gal. steel drums, UN1A2. The loaded weight shall not exceed
924 948 lbs (430 kg). Yellow 55-gallon drums are to be used for radioactive
925 waste only.
926
927 (2) 8 mil. yellow poly bags.
928
929 (3) 4' X 3.5' X 4' steel boxes. These boxes are intended for approved contact
930 burial items only, and must contain no glass, dirt, sand, sweeping
931
932

933 compound, or wet material. They hold up to 50 ft³ of items and must not
934 exceed 3000 lbs. gross weight.

935 b. Delivery of empty containers to individual areas on non-pickup days should be
936 coordinated through the ESH&Q Section. Recipients should place drums
937 indoors, where practical, within 24 hours after delivery. In any case, lids must
938 remain on drums.

940 2. Location and Use of Waste Containers

941 a. Drums must remain indoors or in an area protected from the weather while in
942 use. Boxes may be used outdoors at locations designated by area supervisors or
943 Radiological Control Organization personnel.

944 b. “Portable” radioactive waste items weighing less than 200 lbs. must be placed
945 in approved waste containers or kept in a secure area (e.g., either inside a
946 building or in a fenced and locked area outside).

948 3. Radioactive Waste Packaging Requirements

949 a. Solid Non-compactable Waste and Liquid Waste

950 55 gal. radioactive waste drums and steel boxes are the only approved containers
951 for solid radioactive waste. Special 55 gal. liquid waste drums must be used for
952 most liquid radioactive wastes. Small volume liquid waste streams will be
953 handled on a case-by-case basis. Contact the ESH&Q Section for packaging
954 instructions. Radioactive waste identification labels will be affixed to containers
955 by the ESH&Q Section prior to delivery to specific areas. When containers are
956 full, lids must be secured on them. If items are too large for containers, the
957 ESH&Q Section should be contacted to determine the proper method of disposal.

961 b. Compactable Waste

962 All compactable waste must be put into large yellow polyethylene bags that are
963 designated for this purpose. The bags must not contain the following:

- 964 • Metal or wood
- 965 • Glass in any form
- 966 • Cable over 12” long
- 967 • Dirt, sand, sweeping compound or wet material

968 c. Specific procedures for waste generators and other waste packaging
969 requirements are documented in the Fermilab Low-Level Waste Certification
970 Program (LLWCP) which is maintained by the ESH&Q Section.

971
972
973

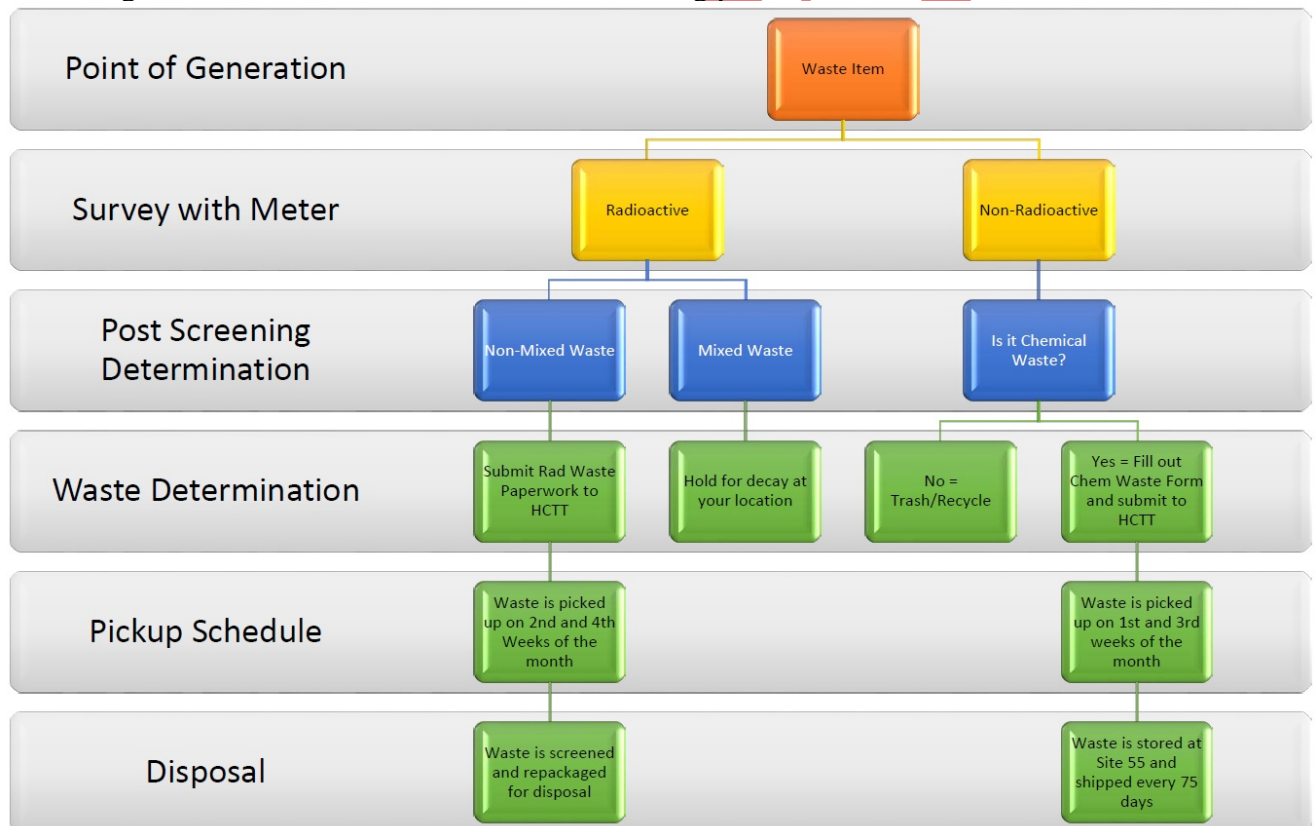
974 d. As with all such offsite transportation of radioactive materials, all such
 975 regulations shall conform to the requirements of the U. S. Department of
 976 Transportation as well as those of the receiving radioactive waste disposal site.
 977

978 4. Radioactive Waste Pickup

979

980 Radioactive waste pickups are performed periodically. Waste generators should request
 981 that waste be picked up by submitting a completed “[Radioactive Waste Certification](#)
 982 [and Pickup Request Form](#)” to the ESH&Q Section Hazard Control Technology Team.
 983 The same form may be used to request empty container delivery. This requires the
 984 tracking of items as they are added to the containers.
 985

986 6. Figure 4-1 illustrates Fermilab’s waste handling procedures.



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992

Note: NOTE: All steps in the process are performed by the person generating the waste item up until the item is picked up by the Hazard Control Technology Team (HCTT). Individuals **MUST** have the proper training for surveying an item as well, when appropriate, being a Chemical Waste Generator. For the Radioactive or Chemical Waste Forms, click [HERE](#). For any questions during this process, contact HCTT.

Figure 4-1 Flowchart illustrating Fermilab’s waste handling procedures.

993 442 Waste Minimization

994

995 A radioactive waste minimization program is in effect to reduce the generation of radioactive
996 waste and spread of contamination from Contamination, High Contamination or Airborne
997 Radioactivity Areas. This plan is a part of the Laboratory's general waste minimization plan
998 which is stated in Fermilab ES&H Manual Chapter 8022. The following practices should be
999 instituted to support minimization of radioactive wastes:

1000

1001 1. Limit the quantities of material entering beamline enclosures or radiological areas to
1002 those needed for performance of work.

1003

1004 2. Restrict quantities of hazardous materials, such as paints, solvents, chemicals, cleaners
1005 and fuels, entering beamline enclosures and other radiological areas and take measures
1006 to prevent inadvertent radioactive contamination of these materials.

1007

1008 3. Use recyclable items and reuse equipment when practical and consistent with other
1009 measures necessary to protect worker safety and health and the environment and with
1010 other articles of this manual.

1011

1012 4. Reserve an assortment of tools primarily for use in Contamination, High Contamination
1013 or Airborne Radioactivity Areas as appropriate.

1014

1015 5. Segregate known nonradioactive and/or uncontaminated materials from potentially
1016 activated and/or contaminated waste.

1017

1018 6. Segregate reusable items, such as respirators and tools.

1019

1020 7. Optimize the number and size of areas where radioactive material is stored or used.

1021

1022 8. Emphasize training in waste reduction philosophies, techniques and improved methods.

1023

1024 443 Mixed Waste

1025

1026 Requirements specified in the Resource Conservation and Recovery Act (RCRA) and Toxic
1027 Substances Control Act (TSCA) apply to waste that contains both radioactive and hazardous
1028 materials. Certain features of the recipient state regulations also apply to these wastes and are
1029 stated in the LLWCP and in Fermilab's RCRA Part B Permit (issued to cover the operations of
1030 the Site 55 Hazardous Waste Storage Facility).

1031

1032 1. Article 442 describes how mixed waste generation should be minimized.

1033

1034 2. Technical and administrative controls should be established to minimize the volume of
1035 mixed waste generated and the amount of radioactivity in such waste. Volume reduction

1036 methods include process optimization, materials substitution and new technology
1037 development.

1038
1039 3. Materials suspected of being mixed waste should be identified and segregated as soon
1040 as practical in the generating process to avoid combining mixed waste with other waste.

1041
1042 3. Materials identified as being mixed waste must be characterized as to their hazardous
1043 and radioactive material content in accordance with all applicable regulations.

1044

1045 **PART 5 CONTROL OF RADIOACTIVE LIQUIDS AND AIRBORNE** 1046 **RADIOACTIVITY**

1047

1048 **451 Minimization and Control of Radioactive Liquid Wastes**

1049

1050 1. A water management program is in place (see Article 346) to identify, trend and
1051 eliminate unnecessary sources of radioactive liquid waste. This program should include
1052 measures to identify and repair leaks.

1053

1054 2. Activities that produce radioactive liquid waste shall be suspended unless sufficient
1055 processing, collection and storage capacity is available to accommodate the waste.

1056

1057 3. Radioactive liquid waste discharge requirements are addressed elsewhere in this
1058 manual.

1059

1060 4. Radioactive liquid waste discharges should be characterized and releases terminated
1061 before exceeding predetermined limits. Discharges of radioactivated water is described
1062 in Article 346.

1063

1064 5. Radioactive liquid waste that cannot be discharged shall be solidified/absorbed and
1065 disposed of as solid radioactive waste.

1066

1067 **452 Control of Airborne Radioactivity**

1068

1069 1. Processes and activities with the potential for producing significant airborne
1070 radioactivity shall include engineering controls to limit releases or properly monitor
1071 them. Controls pertinent to beamline operations are covered in more detail in Chapters
1072 10 and 11.

1073

1074 2. The assigned RSO shall be notified when engineering controls that prevent exposure
1075 of individuals to airborne radioactivity, such as barriers, gloveboxes and glovebags, are
1076 compromised. An evaluation should be made of continuing operations with
1077 compromised engineering controls. The use of respiratory protection to continue is
1078 discouraged. Implementation of short-term engineering modifications that provide a
1079 commensurate level of protection of individuals is the preferred alternative.

- 1080
1081 4. Preventive maintenance and surveillance procedures should be established to ensure
1082 equipment controls are maintained in an operable condition for containment of airborne
1083 radioactivity.
1084
1085 5. Procedures for evaluation and monitoring of airborne radioactivity at Fermilab can be
1086 found in the Fermilab ESH&Q Section publication [Airborne Radionuclide Emissions](#)
1087 [Monitoring Program Procedures Manual](#).
1088

1089 **PART 6 SUPPORT ACTIVITIES**

1090 **461 Personal Protective Equipment**

- 1091
1092
1093 1. Protective clothing designated for radiological control use should be specifically
1094 identified by color, symbol or appropriate labeling.
1095
1096 2. Protective clothing used for radiological control use shall not be used for non-
1097 radiological work.
1098
1099 3. Personal Protective Equipment and clothing used for radiological work shall not be
1100 stored with personal street clothing.
1101
1102 4. Cleaned Personal Protective Equipment (i.e., face shields and respirators) that comes
1103 into contact with the wearer's face and Fermilab-issued non-personal protective clothing
1104 shall be surveyed after use in Contamination, High Contamination, or Airborne
1105 Radioactivity Areas. Contamination levels should be below total contamination values
1106 in Table 2-2 prior to reuse. The use of statistically representative sampling is acceptable.
1107
1108 5. Use of any type of protective clothing other than the disposable type must be approved
1109 by appropriately designated Radiological Control Organization personnel.
1110

1111 **462 Decontamination**

- 1112
1113 1. Radiological Work Permits or technical work documents shall include provisions, as
1114 appropriate, to control contamination at the source to minimize the amount of
1115 decontamination needed.
1116
1117 2. Work planning shall include appropriate consideration of the handling, temporary
1118 storage and decontamination of materials, tools and equipment. More detail concerning
1119 work involving contaminated materials or areas can be found in Chapter 3.
1120
1121 3. Decontamination activities shall be controlled to prevent the spread of contamination or
1122 damage to the environment.
1123

- 1124 4. Water and/or steam are the preferred decontamination agents. Other cleaning agents
1125 should be selected based upon their effectiveness, hazardous properties, amount of
1126 waste generated and ease of disposal.
1127
- 1128 5. Decontamination methods should be used to reduce the number of contaminated areas.
1129
- 1130 6. Reasonable efforts should be made to reduce the level of contamination and the number
1131 and size of contaminated areas that cannot be eliminated.
1132

1133 **463 Vacuum Cleaners and Portable Air-Handling Equipment**

1134

1135 Improper use of vacuum cleaners and portable air-handling equipment may result in the
1136 generation of airborne radioactivity or loose surface contamination areas.
1137

- 1138 1. Vacuum cleaners and portable air-handling equipment used in Contamination, High
1139 Contamination, Airborne Radioactivity, and areas where radioactive material is used or
1140 stored (where the potential for contamination exists) shall be equipped with
1141 High-Efficiency Particulate Air (HEPA) filters and be appropriately labeled. If the
1142 material to be vacuumed is wet enough to preclude resuspension, then HEPA filters are
1143 not necessary.
1144
- 1145 2. HEPA filters used in vacuum cleaners and portable air-handling equipment shall meet
1146 the efficiency and construction requirements for HEPA filters in MIL-F-51068. The
1147 maximum flow rate for the device shall not exceed the flow rate at which the HEPA
1148 filter was efficiency tested. In addition, the device shall be leak tested by the ESH&Q
1149 Section prior to initial use, when units have been opened, and annually. Leak tests are
1150 conducted by injecting Emery 3004 (poly-alpha olefin, CAS No. 68649-12-7) or
1151 equivalent aerosols into the inlet of the device and measuring the Emery 3004
1152 concentrations at the inlet and outlet of the device.
1153
- 1154 3. Vacuum cleaners used for radiological work shall be:
1155
- 1156 a. Uniquely marked and labeled
 - 1157
 - 1158 b. Controlled to prevent unauthorized use
 - 1159
 - 1160 c. Designed to ensure HEPA filter integrity under conditions of use
 - 1161
 - 1162 d. Designed to prevent unauthorized or accidental access to the inner surfaces of
1163 the vacuum.
1164
- 1165 4. Radiation and contamination surveys shall be performed periodically for vacuum
1166 cleaners used in areas where the potential for significant contamination (exceeding
1167 values in Table 2-2) or measurable dose rate (≥ 0.5 mR/hr) exist. The frequency of
1168 radiation surveys should depend on the specific use of the vacuum cleaner.
1169

- 1170 5. Airborne radioactivity levels should be monitored when a vacuum cleaner is used in
1171 High Contamination Areas or Airborne Radioactivity Areas.
1172
- 1173 6. Contamination on the external surface of HEPA-filtered vacuums and any attachments
1174 must be below the levels of Table 2-2 prior to being returned to the ESH&Q Section.
1175 The intake port of the vacuum must be plugged or otherwise sealed to prevent release
1176 of the radioactive material.

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