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Author(s): Michael W. McNaughton, David H. Kraig, and Joseph C. Lochamy

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FORM 836 (10/96)

Siting of Environmental Direct-Penetrating-Radiation Dosimeters

Michael W. McNaughton, David H. Kraig, and Joseph C. Lochamy
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1. INTRODUCTION

This document establishes the criteria for locating environmental direct penetrating radiation (DPR) dosimeters such as thermo-luminescent dosimeters (TLDs) or electret ion chambers (EICs) near Los Alamos National Laboratory (LANL).

Section 2 outlines the objectives and regulations.
Section 3 establishes the criteria.
Section 4 identifies locations for monitors according to criteria from Section 3.
Section 5 discusses the criteria.
Section 6 applies the criteria to each technical area (TA) of LANL.

2. OBJECTIVES

This section describes the objectives of environmental DPR monitoring in the light of DOE regulations, requirements, and guidance. The applicable DOE Orders are 5400.1 and 5400.5 with implementation guidance provided in DOE/EH-0173T.

DOE order 5400.5, chapter II, section 1a specifies that exposure of members of the public to radiation sources as a consequence of all routine DOE activities shall not cause, in a year, an effective dose equivalent greater than 100 mrem. Dose evaluations should reflect realistic exposure conditions. The limit of 100 mrem is the sum of the deep dose equivalent from exposure to radiation sources external to the body during the year plus the committed dose equivalent from radionuclides taken into the body during the year.

Since a person might be exposed to several sources, monitoring should be performed where there is a potential for doses that are a significant fraction of 0.1 rem per year, so DOE order 5400.5 requires notification of 10 mrem/y. Chapter II section 1a(3) states "DOE operators are required to report DOE-related effective dose equivalent contributions [to the public dose] of 10 mrem or more in a year." This is reiterated in chapter II section 7, which states "the responsible DOE Field Office Manager shall notify, in a timely manner, the relevant program office(s) and the Deputy Assistant Secretary for Environment (EH-20) of actual or potential exposures of members of the public that could result in … an effective dose equivalent from DOE sources exceeding 10 mrem in a year."

The Environmental Regulatory Guide, DOE/EH-0173T, recommends monitoring at 5 mrem/y. Table 5-1 states "routine measurements of penetrating radiation should* be performed at those sites that, as determined by site-specific exposure pathway analysis, might result in an annual dose of site origin at the site boundary, if the total exceeds 5 mrem." (The asterisk after "should*" denotes a high-priority element.)

A draft of 10 CFR 834, "Radiation Protection of the Public and the Environment", was published in the Federal Register, vol. 58 No. 56, dated March 25, 1993. This draft regulation does not contain significant requirements for DPR monitoring beyond the existing DOE orders.

Special consideration is given to the air pathway, for which the EPA has established a limit of 10 mrem/y. Activated air from TA-53 is subject to this limit. Locations in the vicinity of East Gate (about 1 km north of the main TA-53 stack) are considered to be continuously occupied. This special situation is discussed in detail in the TA-53 sub-section of section 6.

3. Criteria for Establishing DPR Locations

We have identified the following as the fundamental drivers for determining the locations and numbers of DPR monitors.

I. Monitor sites with the potential for 5 mrem/y at the boundary.
The Environmental Regulatory Guide, DOE/EH-0173T (Table 5-1) states "routine measurements of penetrating radiation should be performed at those sites that, as determined by site-specific exposure pathway analysis, might result in an annual dose of site origin at the site boundary, if the total exceeds 5 mrem."*

Identify locations on site boundaries that have the potential to receive more than 5 mrem/y of DPR dose, and monitor at or near this location. The monitoring may be done closer to the source and a calculation performed to determine the dose at the boundary. Calculated doses (as opposed to measured) should be clearly indicated as such in any reports. An appropriate occupancy factor will be used in the calculations, see section 5.I.a.

II. Evaluate/Quantify DPR exposure from unplanned events.
One of the objectives of environmental monitoring according to DOE/EH-0173T is the detection and quantification of unplanned releases.

A. Monitor Population Centers. Monitor the nearby population centers to determine total dose from unplanned events. Los Alamos, White Rock, Pajarito Acres, San Ildefonso Pueblo, Santa Clara Pueblo, and Santa Fe are the nearest population centers and should be monitored. Because the source (LANL) is distant from the population centers (other than Los Alamos and White Rock which are discussed further in Item B.) below, establish one monitoring location in each in each population center at a location representative of the population center.

B. Monitor at AIRNET locations routinely operated by ESH-17. In the unlikely event of a large, catastrophic release of radioactive material, data from AIRNET and DPR monitors will need to be compared with calculations from models. In general, modeling will be most successful if selected locations have a complete set of data. *Therefore, DPR monitors should continue to be co-located with AIRNET monitors*.

C. Monitor site-boundary locations not adequately covered by AIRNET. Identify DPR sources near the publicly accessible site boundary and determine if these areas are adequately evaluated by a nearby AIRNET station. If not, a DPR monitoring station should be located there.

III. Operational Assessment

One of the objectives of environmental monitoring according to DOE/EH-0173T is to evaluate "the effectiveness of controls".

We interpret this to suggest monitoring around facilities that have the potential for increased DPR at their boundary and that operate in a manner intended to reduce DPR at these boundaries. Monitoring of DPR allows facility managers to assess the efficacy of their DPR-reducing processes. This type of monitoring can be at the request of facility personnel or may be suggested by ESH-17 if we see areas of potential public concern, like Area G, as discussed below.

IV. Public Concern or Legal Action

Even though not explicitly required by DOE orders or guidelines, a facility should be monitored for DPR if a significant public concern is communicated to ESH-17 in writing by a publicly-recognized organization.

Additionally, monitoring may be required as a result of a civil action such as brought on by Concerned Citizens for Nuclear Safety (CCNS).

V. Other

It may be necessary to monitor at other locations for reasons not identified above. In these special cases, the reasons need to be documented and the duration of the monitoring needs to be specified.

VI. Other Drivers

DOE Orders (as implemented through DOE/EH 0173T guidance) specify objectives for monitoring not included explicitly in the six basic criteria above. These include evaluation of : natural background levels; validity of models to predict the concentration of pollutants; and long-term trends.

We believe that monitoring that addresses criteria I-VI will also allow assessment for these additional objectives.

4. Identification of Monitoring Locations

I. Monitoring locations identified under criterion I, with the potential for 5 mrem/y at the boundary, are:

- TA-3-130, near the intersection of Pajarito Road and Diamond Drive;
- TA-18, at Pajarito Road;
- TA-43-1, near the Health Research Lab.;
- TA-53, at State Road 502 north of LANSCE;
- TA-54, at the boundary of area G;

II.A DPR-monitoring locations at AIRNET stations in Los Alamos, White Rock, Pajarito Acres, San Ildefonso, Santa Clara, Espanola, and Santa Fe are sufficient to meet the regulations and guidance. If AIRNET stations are removed from any of these population centers, a DPR monitor should be established in the same or new location to provide the coverage needed under this criterion.

II.B DPR monitors need to be located at all AIRNET locations. The locations should be updated anytime AIRNET stations are removed or new stations are sited.

II.C Site boundaries need to be monitored where DPR monitoring associated with AIRNET stations is inadequate according to the technical basis discussed in section 5. The site boundary DPR monitors identified here are as follows:

- TA-3, State Road 501 near the Wellness Center and University House;
- TA-8 and 16, State Road 501 west of Anchor Site and S Site;
- TA-15, State Road 4 south of DARHT.
- TA-48, at Pajarito Road;
- TA-55, at Pajarito Road.

The northern boundary is monitored at a string of AIRNET stations from the Western Residential Area of Los Alamos to East Gate Industrial Park. These are spaced approximately 1 km apart, which is about the distance from the DPR sources to the boundary. According to Section 5.I.d, this spacing is generally satisfactory. The exceptions are the sources at TA-43-1 and at TA-3. These will be discussed individually in the following sections.

The western boundary is monitored at the existing DPR locations: 18, 21, 76, 77, 78, and 79. These are spaced about 1 km apart, except for locations 78 and 79 which are closer. The major DPR sources are discussed in section 6; they are generally about 1 km from the road, so the existing DPR locations are satisfactory. Coverage of TA-8 might be improved by replacing location 79 with a new location at the closest publicly-accessible point to TA-8-22.

The southern boundary is monitored at the existing locations 15, 25, 80, 81, and 94. These should be augmented by a new location about a mile south-east of the entrance to TA-49 to monitor DARHT.

The eastern boundary is monitored at the AIRNET stations in White Rock and along State Road 4.

IV. Operational Assessment. The following facility has been identified under this criterion:

- TA-54: area G.

Area G is adequately monitored by DPR locations 601-641.

V. The only monitors required under this criterion currently are those specified in the Consent Decree from settlement of the CCNS lawsuit. These include:

- 17 dosimeters at the existing AIRNET stations;
- approximately 11 TLDs around the TA-53 facility, including any of its lagoons containing radioactive material;
- approximately 7 albedo TLDs on the north, east, and south sides of TA-18;
- approximately 16 TLDs around TA-50;
- approximately 33 TLDs around TA-54;
- approximately 7 TLDs around TA-16, S-Site; and
- approximately 15 TLDs around TA-15 firing site

According to the consent decree, these dosimeters will be operated for a period of 5 years from entry of the decree. The decree is dated March 25, 1997. Therefore, these locations must be monitored and the data reported to CCNS through the first quarter of 2002. These stations can be eliminated effective the second quarter of 2002 provided they are not needed to satisfy another criterion.

Additional stations may be needed to satisfy legitimate concerns of other organizations that communicate these concerns to ESH-17, in writing. ESH-17 will retain final authority on where monitors are to be located.

VI. Other

No other DPR monitoring locations have been identified at this time.

Table: the dosimeter locations that meet the siting criteria, I through IV, are summarized in the following table.

Note 1: Locations are marked on the FIMAD plot, ID G105907.
Note 2: the notation "TA-21/53" means the dosimeter is located at TA-21 but is most useful to monitor TA-53.
Note 3: locations that would meet criterion II.C if the AIRNET station were removed are marked "y" in the II.C column.

#	Location	I	II A	II B	II C	III	IV	Comment
1	Espanola			yes				
2	Pojoaque							beyond El Rancho
3	Santa Fe							use #101
4	Fenton Hill							too far from LANL
5	Barranca Sch.		yes	yes				
6	Arkansas Ave.							too far from LANL
7	Cumbres Sch.							too far from LANL
8	48th Street		yes	yes			yes	
9	Airport			yes	y		yes	
10	Bayo Canyon							too far from LANL
11	Shell Station		yes	yes	y		yes	
12	Royal Crest		yes	yes	y		yes	
13	White Rock		yes	yes	y		yes	
14	Estante Drive							too far from LANL
15	Bandelier		yes	yes	y			
16	Ski area							too far from LANL
17	TA-21/53 (NW)				yes			
18	TA-69 (W)				yes			
19	TA-53 (WNW)				yes		yes	
20	TA-72 (S.R. 4)			yes	y		yes	
21	TA-16 (W)				yes		yes	
22	TA-18 (N) PM-1	yes		yes				
23	TA-3 (E)			yes				
24	SR4 and SR502							too far from LANL
25	TA-49 (S)			yes	y			
26	TA-2							facility is closed
27	TA-2							facility is closed
28	TA-18 (E)	yes						
29	TA-35/50 (N)						yes	
30	TA-35/50 (N)						yes	
31	TA-59							no DPR
32	Van de Graaff							facility is closed
33	Anaconda							facility is closed
34	central alarm fac.							no public access

35	W fence of CMR							no public access
36	TA-3 shops							no public access
37	TA-72/53 (SE)						yes	
38	TA-55 (S)				yes			
39	TA-55 (W)				yes			
40	TA-55 (N)							no public access
41	McDonalds		yes	yes	y		yes	
42	S of airport							redundant with 412
43	East Gate							redundant with 401
44	Big Rock Loop							too far from LANL
45	Cheyenne Street							too far from LANL
46	Los Pueblos St.							too far from LANL
47	Urban Park		yes	yes				
48	county landfill			yes	y		yes	
49	Pinon School		yes	yes			yes	
50	Nazarene Ch.		yes	yes	y		yes	
51	Bayo Canyon							too far from LANL
52	Taos							too far from LANL
53	San Ildefonso		yes	yes				
54	Jemez Pueblo							too far from LANL
55	Monte Rey S.		yes	yes	y		yes	
56	East Gate							redundant with 403
57	ESH-17 Kiva							no DPR
58	TA-36/54 (S)			yes	y		yes	
59	TA-43/41canyon			yes	y		yes	
60	Piedra Drive		yes	yes			yes	
61	TA-53 lagoon							replace with L114
62	TA-53 lagoon							replace with L115
63	TA-53 lagoon							replace with L116
64	TA-53 (N)						yes	
65	TA-53 (N)						yes	
66	East Gate	yes		yes			yes	
67	LAMC		yes	yes	y		yes	
68	Trinity Ch.		yes	yes	y		yes	
69	TA-35/50 (N)						yes	
70	TA-35/50 (N)						yes	
71	TA-35/50 (N)						yes	
72	TA-50 (SE)				yes		yes	
73	TA-50 (E)						yes	
74	TA-50 (N)						yes	
75	TA-50 (SW)				yes		yes	
76	WETF			yes			yes	
77	TA-16 (W)				yes		yes	
78	TA-8 (W)				yes		yes	
79	TA-8 (W)						yes	

80	TA-16 (S)				yes		yes	
81	TA-16 (SW)				yes		yes	
82	TA-15						yes	
83	TA-15						yes	
84	TA-15						yes	
85	TA-15						yes	
86	TA-15						yes	
87	TA-15						yes	
88	TA-15			yes			yes	
89	TA-15			yes			yes	
90	TA-15						yes	
91	TA-36			yes			yes	
92	TA-36						yes	
93	TA-36						yes	
94	TA-33			yes				
95	El Rancho			yes				
96	WR Met Station							redundant with #50
97-99	Mortandad							no public access
100	TA-5 Mortandad				yes			
101	Santa Fe		yes	yes				
102	TA15 NEWNET							redundant with #76
103	Santa Clara		yes	yes				
104	TA-53 lagoon						yes	
105	Wellness Center				yes			new
106	University Hse				yes			new
107	TA-5 AIRNET			yes	y			new
108	TA-43-1	yes						new
109	TA-48-1	yes						new
110-3	TA-21 AIRNET			yes				new
114	TA-53 east						yes	new
115	TA-53 NE						yes	new
116	near old L63						yes	new
117	TA-3-130 N	yes						new
118	TA-3-130 E	yes						new
119	TA-3-130 S	yes						new
120	TA-2 AIRNET			yes				new
121	LA Inn			yes				new
122	Research Park			yes				new
201-5	MDA A							no DPR
221-7	MDA AB							no public access
228	TA-49/15 (S)						yes	
229	TA-49/15 (S)						yes	
230	TA-49/15 (S)						yes	
241-53	MDA B							no DPR
254	TA-21			yes			yes	

261-2	TA-50 MDA C						yes	
263-4	TA-50 MDA C							redundant
265	TA-50 MDA C						yes	
266	TA-50 MDA C							redundant
267-70	TA-50 MDA C						yes	
281-4	MDA E							no public access
301-4	MDA F							no public access
321-2	MDA T							no public access
323	MDA T			yes				
324-7	MDA T							no public access
341-4	MDA U							no public access
361	MDA V (N)			yes				
362-4	MDA V							no public access
381-3	MDA W,X							no public access
401	East Gate	yes						
402	East Gate							redundant
403	East Gate	yes					yes	
404	East Gate							redundant
405	East Gate	yes					yes	
406-7	East Gate							redundant
408	East Gate	yes					yes	
409-11	East Gate							redundant
412	East Gate	yes						
461-72	background							redundant
601-8	MDA G (N)	yes		yes		yes	yes	
610-1	MDA G (E)	yes		yes		yes	yes	
613-20	MDA G (S)	yes		yes		yes	yes	
622	MDA G (S)	yes				yes	yes	
623	MDA G (interior)	yes				yes		
624-6	MDA G (S)	yes				yes	yes	
627	MDA G (interior)	yes				yes		
628-30	MDA G (S)	yes				yes	yes	
631	MDA G (interior)	yes				yes		
632-3	MDA G (interior)							redundant
634-5	MDA G (E)	yes		yes		yes	yes	
636-8	MDA G (W)	yes				yes	yes	
639-41	MDA G (E)	yes				yes		
642	MDA G San I E	yes				yes		
643	MDA G San I W	yes				yes		
7 old albedos	TA-18	yes					yes	

Additional comments

Location L2, Pojoaque is beyond El Rancho so potential DPR is better monitored at El Rancho. Similarly, location L3, the old Santa Fe location is beyond Buckman Mesa so potential DPR is better monitored at Buckman Mesa.

The locations at TA-15, TA-35, TA-36, TA-49, TA-50, and TA-53 should be reconsidered when the CCNS Consent Decree expires; see the discussion of these TAs in section 6.

Locations L254 and L361 are both close to AIRNET station #20. L361 is preferred, but L254 is designated for the CCNS Consent Decree. L254 should be discontinued when the Consent Decree expires.

5. Discussion of Criteria

This section discusses the criteria, defines terms, and clarifies the interpretations.

I. Monitoring sites with the potential for 5 mrem/y at the boundary.

a. Annual dose and occupancy factors

DOE/EH-0173T recommends monitoring if the annual dose of site origin exceeds 5 mrem/y. We interpret the "annual dose" to be the dose for the full 24 hours per day and 365 days per year, i.e., without an occupancy factor.

For reports, and to comply with the dose limits of DOE order 5400.5, we apply an occupancy factor. In doing this, we are following the DOE guidance that dose evaluations should reflect realistic exposure conditions.

The NCRP recommends an occupancy factor of 16 for “occasional occupancy” in “outside areas used only for pedestrian or vehicular traffic” (see page 65 of NCRP Report No. 49). In cases of occasional occupancy, the reporting limit of 10 mrem/y to a member of the public corresponds to 10 x 16 = 160 mrem/y on a continuously-installed dosimeter. This is in addition to natural background radiation, which is approximately 140 mrem/y in Los Alamos county. Thus, a dosimeter reading of 160 + 140 = 300 mrem/y would indicate a public dose of 10 mrem/y, assuming public access and occasional occupancy. A reading of 300 mrem/y at a location that is not publicly accessible will be used to calculate the dose to the most exposed individual, and the calculated dose will be reported.

In the vicinity of LANL, a public occupancy factor of 16 is appropriate along Pajarito Road, the section of Diamond Drive within TA-3 and TA-43, East and West Jemez Roads, and State Road 4. The Los Alamos townsite, the Los Alamos Medical Center, White Rock, and East Gate Industrial Park are considered to be continuously occupied, i.e., an occupancy factor of one will be used.

b. Boundary

For the purpose of DPR siting and calculating public dose, the boundary of a LANL technical area (TA) is at the fences, entrances, etc., marked with no-trespassing signs. Within this boundary, monitoring is performed by radiological control technicians for occupational radiation protection as required by 10 CFR 835. Outside this boundary, monitoring is performed by ESH-17 for the protection of the public.

The boundary of LANL is defined by State Road 4 to the south and State Road 501 to the west. The northern boundary generally follows the north rim of Los Alamos and DP Canyons, with exceptions at TA-21, -33, -43, -61, -70, -71, -73, and -74, which will be discussed individually in section 6 of this report. Similarly, the western boundary generally follows State Road 4, with exceptions north of TA-54 and south of TA-5, and at TA-33, -70 and -71.

Pajarito Road and East Jemez Road are owned by the DOE, but (except on rare occasions) they are unrestricted, so these are also considered to be part of the "site boundary". The network of roads that permeate a technical area (such as Mercury Road at TA-3) are not considered to be part of the site boundary for the purpose of environmental monitoring.

c. Sources of DPR

Alpha and beta radiation do not cause DPR, and are not discussed in this report. Gamma and x-ray sources are: radiation-producing devices such as x-ray devices and accelerators, sealed radioactive sources, and other radioactive material. Neutron sources are: special sealed sources such as Cf-252 and PuBe, high-energy accelerators such as LANSCE, reactors and critical assemblies.

Radiation-producing devices are inventoried and surveyed by the x-ray/sealed-source team of ESH-12. Dose rates from this inventory are used to determine if a device might cause 5 mrem/y to a member of the public. For example, see section 6.

Most x-ray devices at LANL are low-power devices, approximately equivalent to the cabinet x-ray devices at airports. These are called "enclosed beam analytical x-ray systems" in ANSI standard N43.2, and "exempt shielded" x-ray systems in ANSI standard N43.3. The dose rates from these systems are limited to 0.5 mrem/h at 2 inches, so they are not capable of causing 5 mrem/y to the public. Devices capable of producing a larger dose rate are called "shielded" and "open" systems in ANSI standard N43.3. These are discussed individually in section 6. Accelerators are also discussed individually in section 6.

Most sealed radioactive sources at LANL produce less than 25 mrem/h at 1 ft. Using the inverse-square law, 25 mrem/h at 1 ft is 2.5 microrem/h at 100 ft. If we assume the source is in use for 2000 hours per year, this corresponds to 5 mrem/y, so these sources are unlikely to cause significant public dose. Sources that produce more than 25 mrem/h at 1

ft are called registrable sources, and are inventoried by the x-ray/sealed-source team of ESH-12.

The gamma dose rate at 30 cm (1 foot) is most simply calculated using the equation: dose rate in R/h = 6CE, where C is the activity in curies and E is the energy, in MeV, emitted per disintegration. For example, cobalt-60 emits 1.17+1.33 MeV per disintegration, so the dose rate at 1 foot from a 1-mCi cobalt-60 source is 15 mR/h.

Neutron dose rates from PuBe, AmBe, PoBe, RaBe, and Cf sources can be estimated as follows. According to the report "Calculated Dose Equivalent Rates from PuBe Source Neutrons" by Erik F. Shores, LA-UR-99-3595, the dose rate is 30 mrem/h at 30 cm from a PuBe source containing 1 Ci of either Pu-238 or Pu-239. According to the Health Physics and Radiological Health Handbook (page 228 of the 1992 edition) the dose rates from 1 Ci of AmBe or PoBe are about the same as from 1 Ci of PuBe. However, the dose rate from 1 Ci of RaBe is 200 mrem/h at 30 cm. Finally, the dose rate from 1 Ci of Cf-252 is 50,000 mrem/h at 30 cm, according to ICRU Report #26.

Alternatively, the calculation can be based on Appendix E of 10 CFR 835; (this appendix is used to define an accountable source and also the requirements for radioactive material posting). The Appendix E values are derived by the method described in detail in a publication by David Lee and Kathleen Shingleton: Radiation Protection Management (ISSN 0740-0640), volume 15, page 23 (1998); (reprints are available from David Lee of ESH-12). The Appendix on page 40 of this publication lists the activity to impart 100 mrem at 1 meter in 1000 hours, for all nuclides capable of producing external dose. Appendix E of 10 CFR 835 uses the same method, except the time used is 4380 hours (6 months). Also, in 10 CFR 835, internal dose is used instead of external dose for some nuclides. This is explained in detail in the publication by Lee and Shingleton.

LANL facilities with large (registrable) radioactive sources are discussed individually in section 6.

A registrable source could cause 5 mrem/y to the public if it were unshielded and close to a publicly accessible location for a long time. In practice, however, registrable sources are locked in well shielded containers for almost all the time. Assurance that these sources are well shielded is provided by the data from personnel dosimeters worn by LANL workers who work much closer to the source. For example, at TA-35, the distance from the sources to the boundary is about 10 times the distance to the workers, so the dose rate to workers is 100 times the dose rate to the public. In this case, a scenario that produces 5 mrem in 8760 hours at the site boundary would cause 114 mrem in 2000 hours to the workers.

Facilities with significant amounts of radioactive material are designated as nuclear facilities. These are discussed individually in section 6.

d. Distance

In general, DPR locations should be near the publicly-accessible point that has the maximum dose rate. Usually, this is the publicly accessible point closest to the source.

If we allow the measured dose rate to be 30% smaller than the maximum possible, it follows (using the inverse-square law and trigonometry) that DPR-monitoring locations should be spaced along the boundary at about the same distance apart as the radiation sources are from the boundary. The maximum public dose may then be calculated from the measured dose using the inverse-square law.

The accuracy is improved if DPR is monitored close to the source. The calculations of public dose then use the inverse-square law combined with estimates of the absorption in air, berms, etc. If the inverse square law is to be used, the monitoring location must be far enough away so the source can be approximated as a point source. According to the Health Physics and Radiological Health Handbook and page 377 of Basic Radiation Protection Technology by Daniel Gollnick, the ratio of the distance from the source to the largest dimension of the source should be greater than 3. For example, locations within a hundred meters of the LANSCE lagoons or the LANSCE "boneyard" are too close for the inverse-square law to be used.

DPR-monitoring locations should not be too close. This is because it is difficult to model the absorption over uneven terrain. For example, it is difficult to use locations at TA-15 to calculate the public dose from DARHT, because absorption in the trees, berms, and the uneven land surfaces cannot be reliably modeled.

e. Procedure to Identify DPR sources

The following procedure is recommended to identify sources of DPR that might cause a public dose of 5 mrem/y.

1. Obtain from ESH-12 the inventory of radiation-producing devices. Obtain surveys for those devices designated as "shielded" or "open" or with an energy greater than 10 MeV. For all facilities that are not already monitored for DPR, calculate the dose rate at the closest publicly-accessible point, taking account of the appropriate occupancy factor.

2. Obtain from ESH-12 the inventory of "registrable" sources (which are sources capable of producing more than 25 mrem/h at 1 ft). For all facilities that are not already monitored for DPR, calculate the dose rate at the closest publicly-accessible point, taking account of the appropriate occupancy factor.

3. Obtain from the NESHAP team of ESH-17 the inventory of radioactive materials and select those capable of producing more than 25 mrem/h deep dose at 1 ft. Based on the calculations described in section c, quantities less than 1 mCi can be ignored. For all facilities that are not already monitored for DPR, calculate the dose rate at the closest publicly-accessible point, taking account of the appropriate occupancy factor.

4. Contact the ESH-1 team leaders to ensure there is no significant DPR source that has been overlooked. If ESH-1 personnel suggest a DPR source that may have been overlooked, consult with the personnel involved with the inventories discussed in steps 1, 2, or 3, as appropriate.

5. Obtain from ESH-12 a list of deep doses for individuals, and use the Laboratory phone directory to identify their work locations. Mark any facilities where an individual received more than 500 mrem/y and which is not already being monitored for DPR, and discuss these cases with the appropriate ESH-1, ESH-4 and ESH-12 team leaders.

6. Use the personnel data obtained in step 5 to eliminate marginal cases. For example, see the discussion of TA-35 in section I.c, above. Thus, if personnel who routinely work much closer to the source have small doses, and this can be used to show that the doses at the publicly accessible points are less than 5 mrem/y, eliminate this case as a significant DPR source.

II. Unplanned events

The most likely event to cause measurable dose at a population center is an airborne release of radioactive material. Therefore, DPR monitors at nearby population centers should be co-located with the AIRNET stations in Los Alamos, White Rock, Pajarito Acres, San Ildefonso Pueblo, Santa Clara Pueblo, and Santa Fe. El Rancho is beyond San Ildefonso and Espanola is beyond Santa Clara, and so do not need to be monitored. There is no credible scenario for a measurable DPR dose at more distant locations such as Jemez Pueblo or Taos.

DPR locations should also be co-located with AIRNET stations on site and near the site boundary.

DPR without an airborne release is possible near large radiation producing devices such as the large radiation-producing devices at TA-8, -15, -16, -18, and -53. These are discussed individually in section 6..

III. Operational Assessment

Additional DPR monitoring locations may be requested by the appropriate facility manager. The final arbiter of such requests will be the ESH-17 group leader.

IV. Public Concern or Legal Action

Additional DPR monitoring locations may be requested by publicly-recognized organizations or mandated by legal actions. The final arbiter of such requests will be the ESH-17 group leader

V. Other reasons

At present, no other reasons for DPR monitoring have been identified. The following sections discuss the technical basis that might weigh in favor of or against DPR monitoring at other locations.

a. Radiation and Contamination

DPR dosimeters monitor for direct penetrating gamma and/or neutron radiation. In contrast to radiation, contamination is best measured by collecting samples and analyzing them in the laboratory. In general, DPR dosimeters are not suitable for monitoring the slow spread of contamination or detecting the possible release of contamination from the material disposal areas discussed in section b.

The DPR dose rate from soil contamination can be calculated from the equation:

$$\text{dose rate (R/h)} = \pi\, C\, D\, E$$

where C is the activity per unit volume in Ci/m^3, D (in meters) is the mean depth from which the gammas of interest emerge (i.e., $D=d/0.693$ where d is the half-value-layer thickness in meters) and E is the gamma energy emitted per disintegration, in MeV. For example: if the density is 1.6 g/cm^3, 1 pCi/g is 1.6 $\mu Ci/m^3$; in the case of ^{137}Cs, d = 0.1 m, so the dose rate is 3.6 mrem/y. This result agrees with the value of 0.12 nGy/h per Bq/kg, published by A. Clouvas et al. in Health Physics, volume 78, pages 295-302 (March 2000).

One of the TLDs at Area-T (i.e., TLD location L323) generally measures about 150 mrem/y above background. According to the sampling results reported in LA-UR-91-962 (page 16-124) this is caused by approximately 50 pCi/g of ^{137}Cs in the soil. Contamination at this level is accurately quantified by soil sampling techniques since it is 1,000 times the detection limit given in Table 5.10 of the Environmental Surveillance Report for 1997 (LA-13487-ENV).

At other locations around the perimeter of Area-T, the Cs-137 contamination is several pCi/g. This contamination is easily measured in soil samples, but cannot be detected by the other 6 TLDs at Area-T.

In addition to ^{137}Cs, LA-UR-91-962 reports several pCi/g of plutonium contamination around the perimeter of Area-T; this contamination is 1,000 times above the minimum detectable activity of alpha spectroscopy, but is about a factor of 100 below the detection limit of the DPR monitors. Thus, DPR monitoring is especially insensitive to plutonium contamination. This is expected, because D and E (in the equation above) are small.

Area-AB at TA-49 is described in LA-11135-MS. It contains the largest quantity of plutonium contamination at LANL, and is monitored both by TLDs and by alpha spectroscopy. Data from the ten DPR locations L221-230) show no activity above background, because the plutonium contamination is a factor of 1,000 below the detection limit for TLDs. However, Table 5-8 and 5-9 of the 1998 ESR clearly identifies

a pattern of contamination, which is 100 times the detection limit for alpha spectroscopy. More detail is also contained in LA-UR-90-3283.

In summary, when compared with TLDs, contamination monitoring is 100 times more sensitive for Cs-137 and 100,000 times more sensitive for plutonium. Therefore, DPR monitoring is not generally appropriate for monitoring contamination.

b. Waste Disposal Areas

Until December 31, 1999, the following waste disposal areas (a.k.a. material disposal areas) were monitored for DPR: areas A, AB, B, C, E, F, G, T, U, V, W, and X. (Area D was not monitored, because the principal radioactive contaminant was ^{210}Po, which has now decayed to near zero. Area K is not monitored, because the principal radionuclide is tritium.)

Environmental surveillance of the waste disposal areas at LANL is discussed in LA-UR-90-3283. Areas A, B, C, D, E, F, G, and T are also discussed in LA-6848-MS. Area B is discussed in LA-11126-MS. Area AB is discussed in LA-11135-MS. Areas T, U, V, and A are discussed in sections 16.5 through 16.8 of LA-UR-91-962. Areas W and X are discussed in LA-UR-75-5016. Other areas are discussed in two reports from the Environmental Restoration Project: the core document for Material Disposal Areas: LA-UR-99-4423, (August 1999); and the core document for Canyons Investigations": LA-UR-96-2083.

The US Geological survey report No. 75-406 (LANL library call number TD898.12.N6 E9, 1975) includes recommendations for monitoring the radioactive waste burial sites at Los Alamos. The main focus is on the water pathway, with a secondary focus on plants. LA-11126-MS focuses on the pathway through plants. DPR monitoring does not have a role in this monitoring.

Only area G and one location at area T show DPR values significantly above background. Underground contamination is present at other waste-disposal areas, but, as discussed in section V.a, this contamination is better monitored by other methods such as soil and sediment sampling. Therefore, DPR monitoring of areas A, AB, B, C, E, F, U, V, W, and X should be discontinued.

In summary, waste areas that have the possibility of slow moving contamination but have no detectable DPR should not be monitored for DPR. Location # 323 at Area T shows significant DPR dose and should continue to be monitored. Area G is an active waste disposal site which is changing on a daily basis, and should continue to be monitored.

c. Continuous, Intermittent, and Pulsed Radiation

Continuous radiation can be measured with instruments such as a pressurized ion chamber (PIC), a Bicron Microrem meter, an Exploranium GR-130, or an Eberline E-600 with SPA-3 (sodium iodide) probe. The E-600 with SPA-3, when operated in "scalar"

mode with a count time of 1 minute, can measure the natural background dose rate with a statistical precision of 1%.

These instruments are normally handheld and read visually by the operator, so they sample the dose rate only while the operator is present. In order to detect anomalous intermittent radiation such as a mishandled radioactive source or a malfunctioning x-ray device, the instrument must either record or integrate the dose rate as a function of time. The detectors connected to the NEWNET system record the dose rate, but the 5 second time constant of this system makes it unsuitable for monitoring the short pulses from flash-x-ray devices or the critical assemblies at TA-18.

TLDs and electrets integrate with respect to time. Thus, they are appropriate for monitoring pulsed or unpredictable intermittent radiation. For example, a radioactive source may be partially shielded when measurements are made with a handheld meter but might be inadvertently left out, unpredictably and intermittently.

In summary, TLDs or electrets are appropriate methods to detect anomalous, intermittent, or pulsed radiation. A system that continuously records the dose rate, such as NEWNET, is an alternative method for some applications, but is not suitable for monitoring pulsed devices, such as flash-x-ray devices used for radiography of explosions or implosions.

d. Neutrons

At some facilities, neutrons are the main DPR concern. This may be the case where there are large radioactive sources that produce neutrons (e.g., Cf-252, PuBe, or AmBe), accelerators with energy greater than 10 MeV (e.g., LANSCE), reactors, or critical assemblies (e.g., at TA-18). Sources of neutrons should be specifically identified during the procedure of section 4e. If neutrons are significant, the ESH-4 albedo dosimeters should be used to measure the dose equivalent.

6. LANL TAs

Within a technical area (TA), dose-rate monitoring is the responsibility of the radiological control technicians (RCTs). The RCTs ensure that general employees (such as clerical workers) who are not Radiological Workers receive less than 100 mrem/y. In most cases, the public dose is less than the general-employee dose because the public is further from the source. In some cases, there is also an occupancy factor.

DPR sources at each active technical areas (TA) will now be considered in detail. These are discussed in the Los Alamos report "Description of Technical Areas and Facilities at Los Alamos National Lab--1997, LA-UR-97-4275. In addition, the inactive TAs are discussed in LA-UR-90-3400. Acid Canyon, Los Alamos Canyon, DP Canyon, and Mortandad Canyon are also discussed at the end of this section.

TA-0

TA-0 is normally considered to be "off site". It consists of publicly owned buildings in Los Alamos and White Rock used for office space and class rooms, and the museum. There are no significant DPR sources in these areas.

Conclusion: there is no need to monitor TA-0 for environmental DPR.

TA-1

TA-1 was the original technical area in the vicinity of Ashley Pond in downtown Los Alamos. It has been cleaned up and is no longer a source of DPR.

Conclusion: there is no need to monitor TA-1 for environmental DPR.

TA-2 (Omega West)

TA-2 was the site of the Omega-West reactor. This is now closed and the fuel has been removed. Radiation was detected from TA-2 during the Aerial Radiological Survey in 1994 (DOE/NV/11718-107, UC-702, 1998). This radiation came from radioactive fuel rods that were being removed from TA-2 during 1994. At present, there are no significant sources of DPR at this area. Furthermore, the area is very isolated, with no public activity nearby. The closest possible public access is to the locked gate, 100 m from the old reactor building. The closest public activity is at the top of the mesa near the west end of TA-21.

TA-2 has been monitored at location L27 with a TLD since 1979. In 1993, this TLD indicated a total annual dose of 201 mrem. However, since the decommissioning in 1994, the dose rates have been consistent with natural background radiation.

Conclusion: there is no need to monitor TA-2 for environmental DPR.

TA-3 (South Mesa Core Area)

TA-3 contains many radioactive sources and radiation producing devices, and several nuclear facilities. The major nuclear facility at TA-3 is the CMR building. Other notable facilities from the DPR perspective are the ESH-4 source-storage and calibration buildings (TA-3-65 and TA-3-130) and the ESH-4 Health-Physics Instrument Calibration Facility (west end of TA-3-40).

The west wing of TA-3-40 and TA-3-1353 contain 150-kV x-ray devices. The Sigma complex (TA-3-66, -35, and -159) and the Uranium shop (TA-3-102) contain radioactive materials, primarily depleted uranium, which is mostly a beta emitter and so is not a significant source of DPR. In the past, TA-3-164 (between TA-3-102 and CMR) was used to store enriched uranium, but this material has now been removed. These are not significant sources of DPR.

The Ion-Beam Facility (TA-3-16) is now closed; it contains residual levels of tritium but is not a source of DPR. The High-Voltage-Test Facility (TA-3-316) is still designated a low-hazard radiation facility, though at present it is rarely used so it may not even reach the threshold for this designation. These two facilities were monitored with TLDs at locations L32 and L33 from 1984-99. Throughout this period, the data were consistent with natural background.

TA-3 has been monitored with TLDs at location L23 since 1980 and at locations L32 through L36 since 1984. The data show that the dose rates at these on-site locations are consistent with natural background.

TA-3 is also monitored by RCTs to ensure that the dose to general employees is less than 100 mrem/y. In almost every case, the sources of radiation are much closer to these general employees than to the network of roads within and around TA-3. The vicinity of TA-3-130 is an exception. Surveys of this location show that the dose rate at the fence near Pajarito Road is 0.4 mrem/h when the Cs-137 source is in use, and is 0.2 mrem/h when the neutron source is in use. These data indicate that this location should be monitored for DPR, including neutrons.

The boundary should be monitored by environmental monitors. For this purpose, two new locations, one near the Wellness Center and one near University House, were installed in January 2000. These locations are far enough from the radiation sources to allow use of the inverse square law for calculations, and close enough to the sources so they will record a higher dose rate than at the residences north of Los Alamos Canyon.

Conclusion: monitor TA-3 for gammas at 3 locations: at the AIRNET station, near the Wellness Center, and near University House; monitor for gammas and neutrons near TA-3-130.

TA-5

TA-5 is east of TA-35 and TA-52, and includes the boundary where Mortandad Canyon enters San Ildefonso land. It includes Airnet station #23, and DPR location L100 at sampling station MCO-13 where Mortandad Canyon enters San Ildefonso land. These two locations should be monitored for DPR as part of the LANL boundary.

Conclusion: continue to monitor at location L100 and add DPR monitor L107 at Airnet station #23.

TA-6 (Two-mile mesa)

TA-6 is isolated from public access, undeveloped, and contains no DPR sources. It includes Material Disposal Area F, which should not be monitored for DPR, as discussed in section 5.V.

Conclusion: there is no need to monitor TA-6 for environmental DPR.

TA-8 (Anchor West)

The Radiographic Testing Facility is a category-2 nuclear facility and consists of TA-8-22, -23, -24, and -70. TA-8-24 (Isotope Building) is about 150 m from the boundary. TA-8-23 is about 400 m from the boundary, and contains a 20 MeV Microtron, which is similar to a cyclotron. TA-8-22 is about 400 m from the boundary, and contains several x-ray devices, up to 450 kV and 10 mA.

Measurements by ESH-12 personnel around TA-8-23 show the dose rates are about 10 mrem/h at the roll-up door. This corresponds to 100 microrem/h at DPR-monitoring location L79, and 10 microrem/h at the boundary.

TA-8 has been monitored at locations L78 and L79 since 1997; these locations are near the closest points of public access. During 1997 and 1998, the dose rate was approximately 160 mrem/y, which is consistent with background. However, considering the varied use of the TA-8 x-ray devices, TA-8 should continue to be monitored along the outer LANL boundary.

Conclusion: continue to monitor at locations L78 and L79.

TA-9, TA-11, and TA-14

These areas are isolated from public access and have no significant DPR sources.

Conclusion: there is no need to monitor these areas for environmental DPR.

TA-15 (R site)

TA-15 is surrounded by restricted areas and is about one mile from the nearest public-access point. Nevertheless, TA-15 attracts public interest because it is the site of the DARHT accelerator, which produces short, intense bursts of high-energy x rays. Because of the distance, there is no likely scenario to produce 5 mrem/y to the public.

TA-15 has been monitored since 1997 with TLDs at locations L82 through L90, and the data indicate dose rates consistent with background radiation. However, DARHT is not yet fully operational. Therefore, these locations should continue to be monitored for the present, as required by the CCNS consent decree. If, as expected, the dose rate to the public remains far below 5 mrem/y, the number of monitoring locations at TA-15 should be phased out, when this is allowed by the agreement with CCNS. At this time, TA-15 should be monitored nearer to the southern boundary of TA-49; see the discussion of TA-49, below.

Conclusion: continue to monitor TA-15 for DPR, and reevaluate in the year 2002.

TA-16 (S site)

Within the boundary of TA-16, there are two category-2 nuclear facilities. One, WETF, involves tritium and so does not result in DPR. The other, TA-16-411, may sometimes contain strategic nuclear material (SNM). It is about a mile from the nearest public access and is not a significant source of DPR.

There are several x-ray devices near the NW corner of TA-16, near DPR location L77. These are about 100 m from the publicly-accessible fence and about half a mile from State Road 501. Measurements by ESH-12 personnel show that, when the device at TA-16-226 is running, the dose rate at the inner fence of TA-16-226 is about 1 mR/h to the north-east and 0.2 mR/h to the north-west. Using the inverse-square law to calculate the dose at the fence around TA-16, at the closest publicly-accessible point the dose rate is about 1 micro-rem/h. If the device operates for 2000 hours per year, the dose rate for continuous occupancy would be 2 mrem/y.

The dose rate from TA-16-260 is about 15 mR/h on the east side of the building, but the west side is better shielded, (refer to the memo from David Lee, ESH-12-FTHP-95-075, dated July 7, 1995). Based on the data in this memo, the dose rate for continuous occupancy at the publicly accessible fence is estimated to be about 1 mrem/y.

TA-16 has been monitored since 1979 at location L21, and since 1997 at locations L76, L77, L80, and L81. The data are consistent with background radiation.

In summary, there are several devices which, in combination, are capable of producing a dose rate of several mrem/y at the fence. A factor of 16 should be applied for occasional occupancy, so the dose rate to the public is likely to be much less than 1 mrem/y.

Conclusion: according to criterion II, the west and south perimeters of TA-16 should continue to be monitored at locations 21, 76, 77, 80, and 81, near the outer boundary of LANL.

TA-18 (Pajarito Lab.)

TA-18, Pajarito Lab., contains the Los Alamos Criticality Experiments Facility, LACEF, which includes several critical assemblies. These are category-2 nuclear facilities, and produce intense pulses of gammas and neutrons. It is adjacent to Pajarito Road, which is publicly accessible for most of the time, though it is closed to the public when doses of more than 1 mrem are expected. The most-exposed individual on Pajarito Road was estimated to receive about 3 mrem in 1998 from TA-18.

About 90% of the dose from TA-18 comes from neutrons. Therefore, in addition to the gamma dosimeters at location L28, TA-18 is monitored by 7 albedo neutron dosimeters. Two of these albedo dosimeters are within the boundaries of TA-36 marked with no-trespassing signs; these two albedo dosimeters should be discontinued when this is allowed by the agreement with CCNS.

Conclusion: TA-18 should continue to be monitored with the existing dosimeters.

TA-21 (DP Site)

DP Site was the plutonium facility before TA-55 was built. At present, it contains the TSTA and TSFF tritium facilities, which are category-2 nuclear facilities. However, tritium does not cause DPR. TA-21 also includes material disposal areas (MDA) A, B, T, U, and V.

TA-21-257, next to MDA T, was once a radioactive-liquid-waste-treatment facility. Several decades ago, environmental releases from this facility and MDA T resulted in a dose rate of about 300 mrem/y at DPR monitoring location L323. However, this is inside the area posted with a no-trespassing sign and a no-public-access sign.

The monitoring of MDAs is discussed in section 5.V. Apart from location L323 at MDA T, the dose rates at the other MDA locations at TA-21 are consistent with background, and so do not need to be monitored for DPR.

TA-21-146 was a category-3 nuclear facility, but has been decontaminated and is awaiting re-classification as a nonhazardous facility. TA-21-5, -150, and -324 contain low levels of contamination that are not significant DPR sources.

DPR monitoring location L17 monitors the west-north-west sector of TA-53; se the discussion of TA-53, below.

Conclusion: monitor at the AIRNET stations and at location L17.

TA-22 and TA-28

These areas are isolated from public access and have no significant DPR sources.

Conclusion: there is no need to monitor TA-22 or TA-28 for environmental DPR.

TA-33 (HP Site)

In the past, TA-33-86 was the site of a high-pressure tritium facility. This is now decommissioned and awaiting reclassification from a category-3 nuclear facility to a nonhazardous category. There are no significant DPR sources at TA-33.

TA-33 has been monitored at locations L94 and L281 through L284 since 1997. The data are consistent with background. As discussed in section 5.V, locations L281 through L284 do not need to be monitored. According to criterion II the Airnet site should continue to be monitored.

Conclusion: continue to monitor at the Airnet station.

TA-35 (Ten Site)

TA-35-2 and TA-35-27 are category-3 nuclear facilities because each contains a radioactive-material-storage vault and about 35 registrable sealed sources. These are located at the east end of TA-35, 500 m from the entrance gate. The Laboratory directory lists 88 workers who work within about 50 m of the sources. If the sources cause 5 mrem in 8760 hours at 500 m, these workers would receive 114 mrem in 2000 hours at 50 m. In fact, the annual doses for 1998 were as follows: at TA-35-2, one individual received 119 mrem; at TA-35-27, one individual received 157 mrem and one received 133 mrem; the remaining 85 workers in these two buildings received less than 100 mrem.

TA-35 has been monitored at locations L29, L30, L381, L382, and L383 since 1976. The data are consistent with background. In summary, the only reason to monitor TA-35 for environmental DPR is to satisfy the CCNS Consent Decree.

Conclusion: reevaluate TA-35 when the CCNS consent decree expires.

TA-36 (Kappa Site)

Kappa Site contains several high-energy radiographic x-ray devices. However, these are isolated, more than half a mile from the closest public-access points. TA-36 has been monitored at locations L91, L92, and L93 since 1997. The data are consistent with background radiation. Location L58 (at the AIRNET station near Pajarito Road) is in TA-36, though it is usually thought of as monitoring the south of TA-54.

There are plans to relocate the ESH-4 calibration facility from TA-3 to TA-36, close to TA-36-1. When this is complete, TA-36-1 should be re-evaluated as a potential DPR monitoring site.

Conclusion: continue to monitor at the existing locations. Reevaluate TA-36 when the CCNS Consent Decree expires or when the calibration facility is relocated.

TA-37 (Magazine Area C)

This area is isolated from public access and has no significant DPR sources.

Conclusion: there is no need to monitor TA-37 for environmental DPR.

TA-39 (Ancho Canyon)

TA-39-56 houses a 450-kVp (150 keV average) x-ray device which produces 224 mR per pulse at a distance of 1 foot. At the entrance gate, 1 mile away, the inverse-square law reduces this by a factor of more than 10 million, and absorption reduces it by a factor of 10,000, so this device is not capable of causing a dose to 5 mrem/y at the boundary.

TA-39-88 and TA-39-57, 1.5 miles from the gate, and TA-39-111, 0.5 miles from the gate, also house x-ray devices. TLD measurements by ESH-12 show the dose rates at nearby locations are too small to measure, and so they are much less than 5 mrem/y at the boundary.

TA-39-69 houses a 150-kVp x-ray device. When it is operating, this device can produce a dose rate of 18 mR/h at one location just outside the east wall of the building. At the public road, 500 m to the south, the calculated dose rate is less than 0.1 mrem/y.

Conclusion: there are no locations at TA-39 that need to be monitored.

TA-40

This area is isolated from public access and has no significant DPR sources.

Conclusion: there is no need to monitor TA-40 for environmental DPR.

TA-41 (W site)

TA-41-1 and TA-41-4 were nuclear facilities (primarily tritium) until 1994 but have been decommissioned. There are no significant DPR sources at TA-41.

Conclusion: there is no need to monitor TA-41 for DPR.

TA-43 (HRL)

The Health Research Lab (HRL) contains 4 large Co-60 and Cs-137 sources in shielded rooms in the basement near the south-west corner of TA-43-1. When gamma irradiation is being conducted in these rooms, the dose rate is 2 mrem/h in the adjacent hallway.

The HRL is on the north perimeter of LANL, about 100 m from the Los Alamos Medical Center and some continuously occupied residential areas. Using the inverse-square law, the dose rate at publicly occupied areas is about 1 microrem/h. Therefore, a public dose rate of 5 mrem/y is unlikely but possible.

Conclusion: TA-43 should be monitored, both at the existing Airnet location (location L67) and at a new location near the south-west corner of TA-43-1.

TA-45

TA-45 was the site of the old liquid waste treatment plant (1951-1964) at the top of Acid Canyon. Acid Canyon is discussed near the end of section 6 (after the discussion of TA-74).

TA-46 (WA site)

There is uranium in the laser-enrichment facility, TA-46-154, 300 m from Pajarito Road, but there are no significant DPR sources at TA-46.

Conclusion: there is no need to monitor TA-46 for environmental DPR.

TA-48 (Radiochemistry)

The radiochemistry laboratory is a category-3 nuclear facility because it contains radioactive material in the hot cells, radiochemistry labs, and room 606, all located toward the north of TA-48-1, and in TA-48-45, 300 m from Pajarito Road. The inventory of radioactive material at TA-48 varies. The dose rate from some samples is about 100 rem/h at a distance of 30 cm, which is 100 microrem/h at 300 m if we assume no shielding. However, the material is generally well shielded by the walls of the hot cells.

The work areas at TA-48-1 are within 100 m of the hot cells. A dose of 5 mrem in 8760 hours at 300 m corresponds to 10 mrem in 2000 hours at 100 m. In 1998, 3 workers at TA-48 received more than 100 mrem, so personnel dosimetry cannot be used to rule out a dose of 5 mrem/y at the boundary. In summary, a dose of 5 mrem/y at the boundary is unlikely but possible.

Conclusion: monitor TA-48 at a new location between TA-48-1 and Pajarito Road.

TA-49 (Frijoles Mesa)

TA-49-113 houses a 150-kVp (50 keV average) pulsed x-ray device that produces 1 mR per pulse at a distance of 2 feet. State Road 4 passes the site half a mile from the buildings; at this distance, the inverse square law reduces the dose by a factor of more than a million, and absorption reduces the dose further by a factor of >100, so this device is not capable of producing 5 mrem/y at the boundary. TA-49 has been monitored at location L25 since 1974, and at locations L221 through L230 since 1991. These data are all consistent with background radiation.

The boundary of TA-49 is the closest publicly accessible point to the TA-15 DARHT facility. TLDs and electrets at some locations at TA-49 are useful to monitor DARHT; see the discussion in the TA-15 section, above.

Conclusion: There are no DPR sources at TA-49 that need to be monitored, but locations at TA-49 should be used to monitor TA-15. As stated in the discussion of TA-15, these should be reevaluated in 2002.

TA-50 (Liquid waste)

TA-50-1 processes radioactive liquid waste received from other LANL TAs. The western part of TA-50, buildings 37 and 69, also have some solid waste facilities. TA-50-1, -37, and -69 are category-2 nuclear facilities.

Because the inventory of radioactive material varies, and because it is close to Pajarito Road, it is difficult to exclude the possibility of 5 mrem/y at boundary. Furthermore, TA-50 is the subject of public interest; monitoring at 16 locations is required by the agreement with CCNS.

Because TA-50 is not a point source, criterion I and section 5.I.d require 2 monitoring locations. Therefore, when the agreement with CCNS expires, the number of locations should be reduced from 16 to 2.

Conclusion: reduce the number of locations from 16 to 2 when the CCNS consent decree expires.

TA-51 (Environmental Research Site)

There are no significant DPR sources at TA-51. An albedo neutron monitor is located at TA-51 because this is a location at which Pajarito Road is blocked when a significant dose is expected from TA-18.

Conclusion: continue to monitor for neutrons from TA-18 at this site.

TA-52 (Reactor Development Site)

TA-52 housed the UHTREX reactor (LA-3556) that has been decommissioned and dismantled (LA-12356). At present, there are no significant DPR sources at TA-52.

Conclusion: there is no need to monitor TA-52 for environmental DPR.

TA-53 (LANSCE)

The Los Alamos Neutron Science Center, LANSCE, contains an 800-MeV, 1-mA accelerator. It is the source of several mrem of radiation at State Road 502 and Eastgate, half a mile to the north. Thus, it meets criterion I. However, LANSCE is unusual in many ways.

The emission from routine operations at LANSCE is primarily activated air, e.g., oxygen-15, nitrogen-13, etc., which cannot be measured by AIRNET. In principle, these radionuclides can be measured with TLDs, but attempts to do so over the past decade have not attained the required accuracy; (the EPA limit is 10 mrem/y for airborne emissions).

TLDs could measure an unplanned release. For this purpose, TLDs should be located with approximately one in each sector from west to north-east. Other directions are less critical because the radioactive half lives are so short that the activity decays before reaching populated areas.

As discussed in Section 5.I.d, the existing TA-53 locations L64 and L65 are too close to the boneyard. At present, they only measure local radiation from the boneyard. Similarly, L61-63 are too close to the old LANSCE lagoons to be effective. Furthermore, the old lagoons have been removed from service. L61-62 should be replaced with new locations, L114-5, about 100 m from the new lagoon. L63 should be replaced with a new location, L116, just outside the fence east of the old lagoon.

Conclusion: monitor at locations: L17, L19, L37, L104, L412, L408, L405, L403, L401, and L66. Replace L61-63 with new locations L114-6. Reevaluate when the CCNS Consent Decree expires.

TA-54 (Solid Waste)

Solid radioactive waste is received, processed, and stored at TA-54. Area G is a category-2 nuclear facility, monitored by TLDs and electrets at about 40 existing locations (L601 through L641), some of which indicate a potential dose rate to the public of 5 mrem/y. Area G is an area of public concern for which 33 dosimeters are required by the CCNS consent decree. According to section 5.I.d, the dosimeters should be located further from the source of radiation and closer to the publicly accessible fences marked with no-trespassing signs.

Conclusion: continue to monitor TA-54 at locations L601-641. Re-assess the number and locations when this is allowed by the consent decree.

TA-55 (Plutonium Facility)

TA-55 is the main plutonium facility at LANL. TA-55-4, also known as PF-4, is a category-2 nuclear facility. In addition, there are several small x-ray devices and several large neutron sources at TA-55. Most of the DPR is low-energy radiation which is shielded by glove boxes and walls, so the dose rates to workers are much larger than to the public on Pajarito Road. In 1998, 17 workers in TA-55-4 received between 1 and 2 rem/y and 161 workers received between 0.1 and 1 rem/y, so it is not possible to use personnel data to rule out a dose of 5 mrem/y at the boundary.

TA-55 has been monitored at locations L38, L39, and L40 since 1983. In 1998, the dose rate at L39 was 183 ± 10 mrem, which indicates a possible dose of more than 5 mrem/y at the boundary.

Location 40 is on site, to the north, and is not in the direction of the nearby site boundary, so it should be discontinued.

Conclusion: continue to monitor TA-55 at locations 38 and 39.

TA-57 (Fenton Hill)

There are no significant DPR sources at TA-57.

Conclusion: there is no need to monitor TA-57 for DPR.

TA-58

This is an undeveloped area west of TA-3. There are no DPR sources at TA-58.

Conclusion: there is no need to monitor TA-58 for DPR.

TA-59 (ESH and EM)

TA-59 has no large radiation producing devices. There are two 50-keV analytical x-ray devices and a 5 mCi Am-241 source, which cannot credibly produce a measurable dose outside the room in which they are used. A preliminary study found three individuals based at TA-59 who received doses >100 mrem/y, but further investigations revealed that two of these individuals received their doses at TA-55-4 and one at TA-18.

TA-59 has been monitored at location L31 since 1984. The data are consistent with background.

Conclusion: TA-59 does not need to be monitored for environmental DPR.

TA-60 (Sigma Mesa)

Sigma Mesa contains several SWMUs. Most of these contain old chemicals such as solvents, oil, and sludge, in addition to old building materials such as wood, steel, asphalt and concrete debris. An abandoned pond contains low levels of radioactive material and is posted as radioactive. The levels of radioactivity are low and the area is isolated.

Conclusion: TA-60 does not need to be monitored for environmental DPR.

TA-61

There are no significant DPR sources at TA-61. However, Royal Crest Trailer Park is an isolated population center in the middle of TA-61. This is monitored at DPR location L12, which coincides with AIRNET station #12.

Conclusion: continue to monitor at the AIRNET station.

TA-62

TA-62 (west of TA-3) is undeveloped except for a water tank. There are no DPR sources at TA-62.

Conclusion: there is no need to monitor these areas for environmental DPR.

TA-63 (Services)

TA-63 is a base for service organizations doing work at other TAs, e.g., JCNNM. A preliminary study found 4 individuals based at TA-63 who received doses >100 mrem/y. However, TA-63 has no radiation producing devices, so they received the doses at other TAs.

Conclusion: TA-63 does not need to be monitored for environmental DPR.

TA-64 through 68

TA-64 is the Central Guard Facility. TA-65 was an undeveloped buffer zone. TA-66 contains offices and conference rooms. TA-67 and -68 are isolated and undeveloped. There are no significant DPR sources at these areas.

Conclusion: TA-64 through 68 do not need to be monitored for environmental DPR.

TA-69

TA-69 is the entrance station to TA-6, TA-8, etc. It is part of the outer boundary of LANL and so should continue to be monitored at location L18.

Conclusion: continue to monitor at location L18.

TA-70 and TA-71

These undeveloped areas are south of Pajarito Acres and east of State Road 4. There are no DPR sources near these areas.

Conclusion: there is no need to monitor these areas for DPR.

TA-72 (PTLA training)

TA-72 contains no DPR sources. However, it is part of the LANL boundary and should continue to be monitored at Airnet station #11 (DPR location L20). Also, location L37, at the PTLA pistol range, monitors the south of TA-53 as part of the CCNS consent decree.

Conclusion: continue to monitor at locations L20 and L37.

TA-73 (Airport)

A preliminary study found one worker based at TA-73 who received a dose >100 mrem/y. There are no DPR sources at TA-73, and at present, there are no individuals at TA-73 with >100 mrem/y. TA-73 includes the Los Alamos Fire Department, and some Fire Department personnel also work at other locations such as TA-55, so it appears the individual in question received the dose at another TA.

Conclusion: TA-73 does not need to be monitored for environmental DPR.

TA-74 (Otowi Tract)

TA-74 is an undeveloped area at the north-east boundary of LANL and contains no DPR sources.

Conclusion: TA-74 does not need to be monitored for environmental DPR.

Acid Canyon (TA-45)

Acid Canyon received discharges of untreated waste until 1951 and from the original liquid waste treatment facility at TA-45 from 1951-1964. As described in LA-8890-ENV, LA-9409-MS, and LA-9831-MS, it has been decontaminated and released for public use. There is no credible scenario that would result in 5 mrem/y to the public from DPR. It is a subject of public interest, but since the dose rates are constant, this interest can be addressed by monitoring with hand held instruments and soil sampling.

Conclusion: Acid Canyon does not need to be monitored for environmental DPR.

Los Alamos and DP Canyons

Historically, Los Alamos and DP Canyons (TA-72 and TA-73) have received discharges of radioactive material from TA-2 and TA-21. The radioactive contamination in these canyons is described in LA-8890-ENV, LA-MS-2038, LA-9409-MS, and LA-9831-MS. According to LA-8890-ENV, the Aerial Radiological Survey (DOE/NV/11718-107, UC-702, 1998), and the 1997 LA Environmental Surveillance Report (LA-13487-ENV page 61) dose rates are about 2 to 3 microrem/h above background. Potential doses to hikers in these canyons are published on page 61 of LA-13487-ENV. Given the low occupancy of these canyons, there is no credible scenario that would result in a dose of 5 mrem/y.

Conclusion: Los Alamos and DP Canyons do not need to be monitored for DPR.

Mortandad Canyon

Mortandad Canyon receives the treated effluent from TA-50-1. Dose rates were reported in the 1997 Environmental Surveillance Report (LA-13487-ENV) on pages 58-60, and in Figure 5-5 on page 210. These dose rates range from zero to 24 mrem/y (3 microrem/h)

for continuous occupancy. Location L100, near the boundary of TA-5 and San Ildefonso land, should continue to be monitored as part of the LANL boundary.

Conclusion: Mortandad Canyon should be monitored for DPR near the San Ildefonso boundary at location L100.

7. Conclusion

From 1997 through 1999, about 240 environmental DPR dosimeters were deployed in and near Los Alamos National Laboratory. None of these indicates a probable dose of >10 mrem/y to a member of the public. The reasons for most of these dosimeters are: to measure the dose from unplanned events, and to respond to public concern. Approximately 140 dosimeters should continue be deployed, mostly around the outer boundary of LANL and along the publicly accessible roads.

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