DOE/NV/10630-65
UC-702

OPERATIONAL AIR SAMPLING REPORT
July 1 Through December 31, 1992

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April 1993

Work Performed Under
Contract No. DE-AC08-89NV10630

Prepared for the
U.S. Department of Energy
Nevada Operations Office

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Table of Contents

Abstract	ii
List of Figures	iii
List of Tables	iii
Abbreviations	iv
1. INTRODUCTION	1
2. SAMPLING PROGRAMS AND POLICIES	1
3. SAMPLING TECHNIQUES	2
4. G-TUNNEL COMPLEX	3
5. N-TUNNEL COMPLEX	3
6. P-TUNNEL COMPLEX	6
7. T-TUNNEL COMPLEX	9
8. RDA-200 RADON SAMPLING	9
9. TEST SUPPORT COMPOUND	9
10. DECONTAMINATION PAD	9
11. DECONTAMINATION LAUNDRY	12

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Abstract

Nevada Test Site postshot and tunnel events generate beta/gamma fission products. The REECO air sampling program is designed for measurement of these radionuclides at various facilities supporting these events. Monthly radon sampling is done for documentation of working levels in the tunnel complexes, which would be expected to have the highest radon levels for on-site facilities. Out of a total of 628 air samples taken in the tunnel complexes, 24 showed airborne fission products with concentrations well below their respective Derived Air Concentrations (DAC). All of these were related to event reentry or mineback operations. Tritiated water vapor concentrations were very similar to previously reported levels. The 838 air samples taken at the Area-6 decontamination bays and laundry were again well below any DAC calculation standard and negative for any airborne fission products from laboratory analyses.

List of Figures

Figure 1. N-Tunnel Tritium Concentrations	4
Figure 2. N-Tunnel Complex Air Sampling Locations July Through December 31, 1992	5
Figure 3. P-Tunnel Complex Air Sampling Locations July Through December 31, 1992	7
Figure 4. P-Tunnel Tritium Concentrations	8
Figure 5. Decontamination Pad (Building 6-605) Air Sampling Locations	10
Figure 6. Decontamination Pad Exhaust Fans (Building 6-605) Air Sampling Locations	11
Figure 7. Decontamination Pad Laundry (Building 6-607) Air Sampling Locations	15

List of Tables

Table 1. 24 Reentry Operations Air Sample Results	4
Table 2. 05 Cavity Reentry and Recovery Air Sample Results	8
Table 3. Decontamination Pad Air Sample Results	13
Table 4. Decontamination Pad Laundry Air Sample Results	14

Abbreviations

ALARA: as low as reasonably achievable
ASD: Analytical Services Department
cfm: cubic feet per minute
DNA: Defense Nuclear Agency
DCG: Derived Concentration Guide
DAC: Derived Air Concentrations
GZ: ground zero
HPD: Health Protection Department
LPG: liquid petroleum gas
Lpm: liters per minute
μCi/mL: microcuries per milliliter
MESA: Mining Enforcement and Safety Administration
NTS: Nevada Test Site
RPT: Radiation Protection Technicians
RFOS: Radiological Field Operations Section
WL: working level

1. INTRODUCTION

This report summarizes air sampling programs for the Defense Nuclear Agency (DNA) tunnel complexes, Area-12 Test Support Compound, and the Area-6 Decontamination Pad and Laundry. Evaluations are based on the analyses of the Analytical Services Department (ASD) Counting Laboratory and the calculations of Health Protection Department (HPD), Radiological Field Operations Section (RFOS) Radiation Protection Technicians (RPT) or Health Physicists. This report addresses air samples collected from July 1 through December 31, 1992.

Air sampling is one of the more useful ways of assessing the effectiveness of operational radiation safety programs at the Nevada Test Site (NTS). Air sampling programs document NTS airborne radionuclide concentrations in various work locations and environments. These concentrations generally remain well below the Derived Air Concentration (DAC) values prescribed by the Department of Energy in DOE 5480.11, Attachment 1. These concentrations also remain well below the Derived Concentration Guide (DCG) values prescribed by the Department of Energy in DOE 5400.5, Chapter III.

Of the NTS operational air sampling programs in the tunnel complexes, the initial mining and event reentry and recovery operations represent the only real airborne radioactive inhalation potentials to personnel. Monthly filter and scintillation cell samples were taken and counted in RDA-200 radon detectors to document working levels of radon/thoron daughters and picocurie/liter concentrations of radon gas. Weekly Drierite samples for tritium analysis were taken in the active tunnel complexes to document any changes in normal background levels or reentry drifts as they are advanced toward ground zero (GZ) areas. Underground water sources are considered primary transporters of tritium from old event areas.

Although the majority of field operational air sampling programs are conducted primarily for documentation, continuous review of the data and sampling techniques is used to incorporate new programs that generate environmentally representative data for the various facilities. Such an approach is in the best interest of ALARA (as low as reasonably achievable) programs.

2. SAMPLING PROGRAMS AND POLICIES

Fission product beta/gamma emitters are the radionuclides of greatest interest for NTS operations. An air sample is collected in any work area where the potential for airborne contamination may exist. These areas are identified using past air sample results from similar operations or from the type of work performed in the facility. Most air samples collected on a routine basis are analyzed by the ASD Laboratory using gamma spectra analysis to determine radionuclide concentrations. The Drierite

samples taken in the tunnel complexes also are analyzed by the ASD Laboratory. Gross alpha and beta/gamma concentrations are calculated at facilities where routine detailed radionuclide analysis is not required.

It is the policy of the HPD to perform air sampling in active work areas containing contaminated debris or in areas where mining and drilling operations have the potential to encounter radioactive materials in fissures, cavities, or water. The sampling program continues for documentation purposes until the operation is completed. Once activities in a work area have been suspended and personnel are no longer present, air sampling in that area is discontinued unless requested for special operations.

The gamma spectra results for routine air samples are reviewed by REECO HPD/FOS Health Physicists. Any results indicating the presence of fission products are investigated to relate specific operations to the generation of airborne radionuclides. Engineering or administrative controls are evaluated for prevention of routine airborne generation for subsequent operations. Concentrations of the radon/thoron daughters reported are reviewed for trends and potential radon grab sample studies.

3. SAMPLING TECHNIQUES

Routine air samples consist of a Whatman 41 cellulose fiber prefilter and an MSA-activated charcoal cartridge housed in a four-inch diameter sample head. Several types of calibrated pumps with air flow calibrated liquid petroleum gas (LPG) meters are used to determine total air volume sampled. Air sample data are reported in microcuries per milliliter ($\mu\text{Ci/mL}$).

Tritium water vapor samples are drawn from ambient air in areas where elevated tritium levels are suspected or to collect background information for future reference. A 10/20-mesh indicating Drierite housed in a 10.75-inch (27.3-cm) long $\times$ 1.75-inch (4.45-cm) diameter Lucite column is used as the collection system. Samples are drawn through a 0.188-inch (0.476-cm) aperture at flow rates of 3 to 4 liters per minute (lpm) as measured with a calibrated rotameter. Collection times range from 3 to 6 hours to attain an 80 percent saturation level. This data is also reported in $\mu\text{Ci/mL}$.

The RDA-200 radon detector system uses a low-volume (0-5 lpm) Gilian air sample pump to obtain a grab sample. A sampling time of 13 minutes at approximately 4 lpm provides a minimum 50-liter volume to count for thoron (^{220}Rn) daughters and the use of a scintillation cell in the system provides a radon gas concentration. The modified Kusnetz method and the Informational Report 1015/1975 of the Mining Enforcement and Safety Administration (MESA) are used as guidelines for calculating radon/thoron daughter WL.

4. G-TUNNEL COMPLEX

This tunnel complex remained inactive through this reporting period. No low-volume air samples or Drierite samples were taken at any location.

5. N-TUNNEL COMPLEX

Air sampling was conducted for preevent operations in the U12n.24 Bypass Drift at 8+25 and LOS Drift at GZ until the event was conducted in September 1992. Air sample stations were used at various locations in the 24 Bypass and LOS Drifts as reentry and experiment recovery operations proceeded. Air sampling was initiated in the U12n.25 Drift in October 1992 as preevent mining was started. These sampling locations are shown in Figure 2.

A total of 156 work area and 37 ventilation exhaust air samples were collected this period in support of the U12n.24 preevent, reentry and recovery operations. There were 7 samples with positive results for airborne fission or activation products. All concentrations were well below their respective DACs. The results for each radionuclide are summarized in Table 1.

A total of 10 air samples were taken during preevent mining operations of the U12n.25 Drift. No airborne fission products were detected on any sample.

There were 7 tritiated water vapor samples collected in the 24 Bypass Drift at 8+25 to document ambient concentrations for this operation. The average concentration was approximately $3.0\text{E-}10 \mu\text{Ci/mL}$. The results are summarized in Figure 1.

Figure 1. N-Tunnel Tritium Concentrations

Table 1. 24 Reentry Operations Air Sample Results

Nuclide	Number of Samples	Concentration Average	($\mu\text{Ci/mL}$) Maximum	5480.11 DAC
^{182}Ta	3	4.3E-12	7.0E-12	1.0E-07
^{133}Xe	3	1.2E-11	3.0E-11	1.0E-04
^{131}I	2	2.5E-13	4.0E-13	2.0E-08
$^{131\text{M}}\text{Xe}$	1	N/A	1.0E-11	5.0E-04

Figure 2. N-Tunnel Complex Air Sampling Locations July Through December 31, 1992

6. P-TUNNEL COMPLEX

Air samples were taken in support of 04 Reentry and Cavity gas exchange operations. Air sample stations were moved to various locations in support of mining and drilling operations in the 04 Reentry Drift and cross-cuts to the 04 LOS Drift, until operations were completed in late August 1992. These air sample stations appear in Figure 3.

A total of 72 air samples were taken during the 04 Reentry operation. There were 4 samples with positive results for airborne ^{131}I . They were the result of the 05 Cavity gas exchange operation. The average concentration was $2.3\text{E-}13 \mu\text{Ci/ml}$ with a maximum concentration of $3.5\text{E-}13 \mu\text{Ci/ml}$. Both concentrations are well below the DAC guideline of $2\text{E-}08 \mu\text{Ci/ml}$.

Another air sample station was located in the 05 Cavity Reentry drift in support of mineback operations. This station was discontinued in early October 1992 after operations were completed and a bulkhead built to prevent access. An additional air sample was run for the ventline exhaust near the portal and was maintained for the remainder of the mineback operations.

A total of 204 work area and 59 ventline exhaust air samples were taken during the 05 Cavity gas exchange operation. There were 13 samples with positive results for airborne fission products. All concentrations were well below their respective DACs. The results for each radionuclide are summarized in Table 2.

Air sample stations were established in October 1992 in support of the 06 Bypass and Line-Of-Sight (LOS) drifts as preevent mining was initiated. The portal ventline exhaust air sample station results were transferred to this event code for the remainder of the year.

A total of 90 work area and ventline exhaust air samples were taken during the 06 Preevent mining operations. There were no fission products detected on any sample. The results are summarized in the graph that appears in Figure 4.

Three tritiated water vapor sampling stations were used in this period. One was established in the 04 Reentry Drift at 4+80. A total of 21 samples were taken with an average concentration of $2.0\text{E-}9 \mu\text{Ci/ml}$ and a maximum of $3.2\text{E-}8 \mu\text{Ci/ml}$ ($\text{DAC} = 2\text{E-}5 \mu\text{Ci/ml}$). The second sampling station was in the 05 Access Drift before and after the event. A total of 21 samples were collected with an average concentration of $3.2\text{E-}11$ and a maximum of $8.0\text{E-}11$. The results are also summarized in Figure 4.

Figure 3. P-Tunnel Complex Air Sampling Locations July Through December 31, 1992

Table 2. 05 Cavity Reentry and Recovery Air Sample Results

Nuclide	Number of Samples	Concentration Average ($\mu\text{Ci/mL}$)	Maximum ($\mu\text{Ci/mL}$)	5480.11 DAC ($\mu\text{Ci/mL}$)
^{141}Ce	9	3.6E-12	2.5E-11	3.0E-07
^{131}I	7	3.1E-13	8.6E-13	2.0E-08
^{103}Ru	5	5.8E-13	2.1E-12	7.0E-07
^{95}Nb	4	4.5E-13	1.4E-12	5.0E-07
^{137}Cs	3	1.3E-13	2.4E-13	7.0E-08
^{140}Ba	3	1.2E-12	2.6E-12	6.0E-07
^{140}La	3	1.3E-12	2.8E-12	6.0E-07
^{95}Zr	3	4.7E-13	1.1E-12	6.0E-08
^{144}Ce	1	N/A	1.3E-12	1.0E-08
^{91}Y	1	N/A	4.4E-11	7.0E-08

Figure 4. P-Tunnel Tritium Concentrations

7. T-TUNNEL COMPLEX

This tunnel complex remained shut down through this reporting period. A weekly inspection program checked ventilation, water drainage, and electrical maintenance. An RPT was assigned to provide escort for the weekly underground checks of this complex. No underground air samples were taken.

8. RDA-200 RADON SAMPLING

The RDA-200 Radon and Radon/Thoron Daughter Detector sampling technique was not used during this period. The REECO health physicist and RPTs were not available to perform the sampling and the equipment had not been calibrated to continue the program. The program will be resumed after a routine calibration procedure has been developed, the Site-Specific Radiological Control Manual Implementation schedule decreases the requirement for health physicists and RPTs, and the requirements for continued tunnel operations to support the reduced testing program are determined.

9. TEST SUPPORT COMPOUND

The Area-12 Test Support Compound was activated during late August 1992 and operations continued through November 1992. A total of 195 air samples were taken. These included general work area and downdraft table exhaust locations. No analysis results of any sample showed the presence of fission or activation products. All air sampling was discontinued after the experiments had been dismantled, packaged, and shipped from the compound.

10. DECONTAMINATION PAD

There are twelve fixed air sampling locations at the Decontamination Pad. Four sampling stations are located in the large bay and three sampling stations are located in the small bay. One sample is positioned at each exhaust fan vent in the roof (a total of five). These locations appear in Figures 5 and 6. The sampling network uses Whatman 41 cellulose fiber sampling media and operates within the range of two to four cubic feet per minute (cfm). LPG meters record the integrated sample volume. Each sample is collected over a 24-hour period except those run over the weekends and holidays. Each sample is then allowed to decay for a 24-hour period before counting to increase the probability of detection of alpha or beta/gamma emitters other than the radon/thoron daughters collected.

A 1.5-inch (3.81-cm) diameter portion cut out of the center of each 4-inch (10.16-cm) diameter air filter is counted for alpha and beta/gamma activity in the Tennelec Model LB-5100 proportional counter located at the Decontamination Pad. The counting results are then entered on the Air Sample Data form RE-2409 and the DAC fractions for beta-gamma and alpha emitters calculated. The alpha reference nuclide used for

Figure 5. Decontamination Pad (Building 6-605) Air Sampling Locations

Figure 6. Decontamination Pad Exhaust Fans (Building 6-605) Air Sampling Locations

routine operations is Pb-210 (DAC = $1\text{E-}10 \mu\text{Ci/mL}$). This is a beta emitter but it also has the most restrictive DAC of the radon (^{222}Rn) and thoron (^{220}Rn) daughters, which are the alpha emitters routinely detected during counting of the air sample filters. Use of this nuclide for calculating DAC fractions introduces a conservative bias for triggering investigations for possible airborne alpha emitters. The beta reference nuclide for routine operations is Sr-90 (DAC = $8\text{E-}09 \mu\text{Ci/mL}$). The DACs for specific radionuclides will be used for DAC fraction calculations when identified by process knowledge or analysis results.

Selected samples from the bays and laundry facility are sent quarterly to the ASD Laboratory for analysis to assure quality control. Gamma spectra analysis and gross beta and alpha counts are performed on each set of samples.

For the two sets of samples submitted during this reporting period, all gamma spectra analysis results were non-detectable for fission products. All gross alpha and beta count results were at or below the ASD Laboratory's detection limit.

A total of 385 air samples—55 per station—were collected and analyzed for gross alpha and beta/gamma activity this reporting period for the large and small bays. A total of 105 air samples—21 per station—were collected from the exhaust fan sample locations. The maximum results for any station were $2\text{E-}04$ and $4\text{E-}03$ DAC fractions for gross beta/gamma and alpha respectively. The sampling locations appear in Figures 5 and 6. The analysis result summaries for each station are in Table 3.

11. DECONTAMINATION LAUNDRY

One air sampling head is suspended above and slightly forward of each of the washing machines in the laundry. This represents the personnel breathing zone. Samples are drawn through Whatman 41 cellulose fiber sampling media. LPG meters record the integrated sample volumes. This type of sample is collected once a week during non-operational periods and daily during operational periods. The air filters are analyzed using the Decontamination Pad Tennelec as previously described, except that the entire Whatman 41 filter is counted, since it does not exceed 1.5 inches in diameter.

A total of 120 samples—40 per station—were taken during this period. The maximum gross beta/gamma results for any station was $4\text{E-}04$ and for alpha was $5\text{E-}03$ of their respective DAC fractions. The results are summarized in Table 4.

An air sampling system was used to monitor the dryer exhaust effluent. One air sampling head is suspended at the outside exhaust of each dryer compartment. Samples are collected only during dryer operational periods. The Decontamination Laundry air sampling locations are shown in Figure 7.

A total of 228 samples—38 per station—were taken from the dryer exhausts during this period. The maximum gross beta/gamma results for any station was $4\text{E-}04$ and for alpha was $5\text{E-}03$ of their respective DAC fractions. The summarized data is contained in Table 4.

Table 3. Decontamination Pad Air Sample Results

Station	Radionuclide	No. Samples Detectable	% of Total	Avg. DAC Fraction	Max. DAC Fraction
LARGE BAY					
1	Gross β/γ	42	76	2E-5	8E-5
	Gross α	46	84	6E-4	2E-3
2	Gross β/γ	43	78	2E-5	1E-4
	Gross α	45	82	7E-4	3E-3
3	Gross β/γ	42	76	2E-5	1E-4
	Gross α	44	80	6E-4	4E-3
4	Gross β/γ	39	71	2E-5	2E-4
	Gross α	45	82	7E-4	4E-3
SMALL BAY					
5	Gross β/γ	36	65	2E-5	1E-4
	Gross α	43	78	7E-4	4E-3
6	Gross β/γ	40	73	2E-5	1E-4
	Gross α	44	80	7E-4	3E-3
7	Gross β/γ	37	67	2E-5	9E-5
	Gross α	40	73	6E-4	3E-3
Total Samples Per Station = 55					
EXHAUST FANS					
1	Gross β/γ	12	57	1E-5	6E-5
	Gross α	14	67	3E-4	1E-3
2	Gross β/γ	12	57	2E-5	5E-5
	Gross α	14	67	4E-4	1E-3
3	Gross β/γ	15	71	1E-5	7E-5
	Gross α	14	67	4E-4	1E-3
4	Gross β/γ	12	57	2E-5	8E-5
	Gross α	13	62	7E-4	2E-3
5	Gross β/γ	12	57	2E-5	5E-5
	Gross α	15	71	4E-4	1E-3

Total Samples Per Station = 21

Table 4. Decontamination Pad Laundry Air Sample Results

Station	Radionuclide	No. Samples Detectable	% of Total	Avg. DAC Fraction	Max. DAC Fraction
WASHERS					
1	Gross β/γ	30	75	4E-5	2E-4
	Gross α	25	63	1E-3	5E-3
2	Gross β/γ	22	55	3E-5	1E-4
	Gross α	22	55	9E-4	4E-3
3	Gross β/γ	23	58	5E-5	4E-4
	Gross α	20	50	1E-3	5E-3
Total Samples Per Station = 40					
DRYERS					
1	Gross β/γ	16	42	3E-5	9E-5
	Gross α	20	53	8E-4	4E-3
2	Gross β/γ	15	39	4E-5	1E-4
	Gross α	17	45	1E-3	3E-3
3	Gross β/γ	13	34	4E-5	1E-4
	Gross α	13	34	9E-4	3E-3
4	Gross β/γ	14	37	6E-5	4E-4
	Gross α	10	26	7E-4	2E-3
5	Gross β/γ	19	50	5E-5	3E-4
	Gross α	14	37	2E-3	4E-3
6	Gross β/γ	15	29	3E-5	7E-5
	Gross α	12	32	2E-3	5E-3
Total Samples Per Station = 38

Figure 7. Decontamination Pad Laundry (Building 6-607) Air Sampling Locations

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