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ROLLER COASTER

PROJECT OFFICERS REPORT—PROJECT 2.8

OFF-SITE SURVEY

Partial Copy Only

J. S. Coogan, Project Officer

U.S. Public Health Service
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Las Vegas, Nevada 89101

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ABSTRACT

Operation Roller Coaster was a joint United States and United Kingdom experiment to determine plutonium hazards from accidents with plutonium bearing weapons. Four chemical detonations involved such weapons. The U. S. Public Health Service, through a Memorandum of Understanding with the U. S. Atomic Energy Commission and in conjunction with Project Roller Coaster, provided off-site radiological health surveillance. Detectable quantities of plutonium were released to off-site locations, but contamination levels did not present a significant hazard. Sampling methods are described and discussed with recommendations. The biological significance of plutonium is related to hazard evaluation. Certain recommendations are discussed for emergency procedures in the event of an accident.

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CHAPTER I

INTRODUCTION

Operation Roller Coaster was a joint US/UK series of four non-nuclear detonations of plutonium bearing weapons. The project was designed to supply empirical information concerning the nature and extent of the resultant alpha contamination and to help establish criteria for the transport and storage of such weapons. Studies of a similar nature were conducted as part of Operation Plumbob (Test Group 57) in 1957.

The four events in this series and their firing dates were:

Double Tracks	0255 May 15, 1963
Clean Slate I	0417 May 25, 1963
Clean Slate II	0347 May 31, 1963
Clean Slate III	0330 June 9, 1963

Three of the events, Double Tracks and Clean Slate I and III, released plutonium to off-site areas in detectable quantities.

Under a Memorandum of Understanding between the U. S. Atomic Energy Commission (AEC) and the U. S. Public Health Service (PHS) an Off-Site Radiological Safety Organization was established in 1954 to conduct radiological surveillance of the area within a 300-mile radius surrounding the Commission's Nevada Test Site. The Off-Site Radiological Safety Program conducts radiological monitoring and environmental sampling in the off-site areas surrounding the restricted area enclosed within the Nevada Test Site and the Nellis Air Force Range. This overall complex of the Nevada Test Site (NTS)

and the Nellis Air Force Range (NAFR) includes the Nuclear Rocket Development Station (NRDS) and the Tonopah Test Range (TTR) and for simplicity will be called the test range complex throughout this report. For Operation Roller Coaster, the facilities of Sandia Corporation's Tonopah Test Range were utilized. Although routine sampling and monitoring is conducted around the test range complex, surveillance may be extended as necessary to provide more detailed coverage.

A vast number of experiments with very detailed analysis were conducted as part of the Project.[7] This report is not an evaluation of these experiments but is a presentation of the radiation environment in public areas surrounding the test range complex based on the analysis of samples gathered by the U. S. Public Health Service. Some of these samples were investigated at the Southwestern Radiological Health Laboratory while others entered the general sample handling machinery of the Project.

To insure parallel objectives and paths, a referee team was chosen by the scientific director of operations for Roller Coaster to provide recommendations to the functions of the Project. The team arranged for cross laboratory checks with blanks, blind duplicates, spikes, and standards. Several specific recommendations for radiochemistry were given:

1. Yield in analysis should be determined by ^{236}Pu tracer.
2. Yields should not be less than 60%.
3. All samples should be completely dissolved for any radiochemistry.

CHAPTER 2

PROCEDURES

The Off-Site Radiological Safety Program maintains a network of air sampling and dosimetry stations in the off-site area and samples milk and water on a routine schedule. The extent and frequency of monitoring was increased greatly during Operation Roller Coaster, and new techniques were initiated to adequately measure alpha contamination.

2.1 GROUND MONITORING

Prior to Operation Roller Coaster, selected roads in the general vicinity were posted with marking stakes to be used as references for ground monitoring and sampling locations. Figures 2.1 and 2.2 illustrate the numbering systems used.

Ground monitors used Eberline PAC-3G proportional alpha counters, PAC-1S scintillation alpha counters, and Victoreen Thyac Geiger-Mueller detectors. The latter instruments were available for any unforeseen emergency; no β-γ readings above background were observed.

The PAC-3G has three scale ranges, x1, x10, x100, with a maximum capability of 100,000 cpm. The total window area is about 61 cm^2, but the sensitive area is only 55 cm^2. The sensitive volume contains propane gas and has an aluminized mylar window about 1 mg/cm^2 thick. This instrument has an auxiliary probe cover which decreases the efficiency by a factor of 20 and allows the range to extend to 2,000,000 cpm. The PAC-1S has four ranges, x1, x10, x100, x1000, with a direct readout to

2,000,000 cpm over 60 cm^2 probe area. The probe face is aluminized mylar backed with thin layers of dutch leaf to prevent light leaks to the ZnS phosphor present in a thin layer. A prism/lens concentrates and directs the light pulses to the photocathode of the photomultiplier tube located in the probe handle.

Both types of instruments were calibrated to indicate 1 cpm for every 2 dpm of the plutonium calibration standards.

Due to the intricacies of alpha monitoring, all PHS monitors active in Operation Roller Coaster participated in a refresher training program which included field exercises in plutonium alpha monitoring. If an indication of less than 50 cpm was encountered in monitoring, earphones were used and the number of clicks was counted for one minute. Whenever higher readings were encountered, a paper shield was placed over the probe to ensure the PAC-3G's were not beta sensitive. Light sensitivity of the PAC-1S probes was frequently checked by turning the probes toward the sun and observing any instrument deflection.

Rough quantitative estimates of deposition can be made on the basis of the conversion table in Figure 2.3 (published by NRDL) and the curve in Figure 2.4 from Test Group 57 Interim Test Reports.

2.2 FALLOUT COLLECTORS

Two types of fallout collectors were used to represent an ideal surface to catch particles dropping during cloud passage. The first was a 12 by 12-inch cellophane surface called a film collector, and the second a 50 mm by 75 mm glass microscope slide. Both were coated with canada balsam to fix particulate to the surface. These collectors were placed at various reference stakes on platforms three feet above the ground.

The film collectors were analyzed primarily for plutonium activity and were the subject of radiochemical analysis described later in this section. The glass slides were submitted for special particulate analysis including phosphor autoradiography, nuclear track autoradiography, and optical and electron microscopy.

Table 2.1 shows the number of film collectors and glass slide samples selected for analysis.

(See Table 2.1)

Four laboratories processed the film collectors: Eberline Instrument Company, Tracerlab, Hazelton-Nuclear Science Corporation, and Isotopes Incorporated, with the latter performing the special particulate analysis of U. S. Public Health Service samples.

2.3 COLLECTOR RADIOCHEMISTRY

The four laboratories providing this service did have some variations in their individual radioanalytical procedures, but their objective and the overall standardization requirements were the same for all.

The samples were dissolved completely including any organic material or silicates; ^{236}Pu was added as a tracer for yielding or percentage recovery information, and the solutions passed through ion exchange columns. The plutonium was eluted from the column and the plutonium electroplated from the resultant solution.

The equipment used for alpha particle energy spectra varied among the laboratories; however, the peaks of primary interest were observed by all; they included: ^{238}Pu (5.49 Mev), ^{239}Pu (5.15 Mev), ^{240}Pu (5.12 and 5.15 Mev) and the tracer, ^{236}Pu (5.76 Mev). Calculations were based upon the 5.15 Mev peak common to ^{239}Pu and ^{240}Pu.

ISOTOPES, INC. SPECIAL PARTICULATE ANALYSIS

Sixteen of the glass deposition slides from the off-site array were selected for special particulate analysis by Isotopes, Inc. The three methods used were phosphor intensification autoradiography, nuclear emulsion alpha track autoradiography with optical microscopy, and electron microscopy with nuclear track autoradiography. Detailed information of procedures may be found in WT 2507.[15]

2.4 AIR SAMPLING

Air samples were taken with Staplex and General Metal Works high volume air samplers using Gelman type E glass fiber filters. Flow rates ranged from 40 to 60 cfm as measured with rotameters. The average flow rate over the sampling period was used to determine total air sampled. Nineteen air sampling stations were located in public areas, and five were in the test range complex. Figures 2.1 and 2.2 show air sampling locations. Some sampling locations changed during the series, as shown in the sample results.

The glass fiber filters contain a small amount of organic fiber for strength and were later discovered to contain 1.8 to 5.06μgm U_3O_8 per filter.[10] The efficiency of the filter at optimum flow rates is 99.6% for particles larger than 0.25μ and greater than 98% for

particles as small as 0.05μ.[6] Efficiency tests for this filter showed 0.03% penetration using 0.3μ DOP aerosol.

Each filter was first gross alpha counted on a Nuclear Chicago Model 193A Ultrascaler using an Eberline Instrument Co. large area probe with an effective area of 49.98in.^{2} . The instruments were calibrated with low and high count rate standards; mapping various segments of the chamber resulted in an average observed efficiency of 24%. The ratio of the probe area to sample area was 0.79. Thus the approximate conversion of alpha monitor cpm to actual dpm was approximately $\frac{1}{.24} \times \frac{1}{.79} \cong 5.3$ (see Appendix D).

Filters showing alpha activity above background were sent to Tracerlab for radiochamical analysis for $^{239,240}Pu$ and for uranium fluorimetry. A Jarrell-Ash fluorometer was used.