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**Environmental Radiological Monitoring
of Air, Rain, and Snow on and near the
Hanford Site, 1945-1957**

**Hanford Environmental
Dose Reconstruction Project**

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March 1994**

**Letter Report for the Technical Steering Panel
and the Centers for Disease Control and Prevention
under Contract 200-92-0503(CDC)/18620(BNW)**

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Preface

In 1987, the U.S. Department of Energy (DOE) directed the Pacific Northwest Laboratory, which is operated by Battelle Memorial Institute, to conduct the Hanford Environmental Dose Reconstruction (HEDR) Project. The DOE directive to begin project work followed a 1986 recommendation by the Hanford Health Effects Review Panel (HHERP). The HHERP was formed to consider the potential health implications of past releases of radioactive materials from the Hanford Site near Richland, Washington.

An 18-member Technical Steering Panel (TSP) was selected by the vice presidents for research at major universities in Washington and Oregon to direct the project work. The TSP consists of experts in the various technical fields relevant to HEDR Project work and representatives from the states of Washington, Oregon, and Idaho; Native American Tribes; and the public.

A December 1990 Memorandum of Understanding between the Secretaries of the DOE and the U.S. Department of Health and Human Services (DHHS) transferred responsibility for managing the dose reconstruction and exposure assessment studies to the DHHS. This transfer resulted in the current contract between Battelle, Pacific Northwest Laboratories (BNW), and the Centers for Disease Control and Prevention (CDC), an agency of the DHHS.

The purpose of the HEDR Project is to estimate the radiation dose that individuals could have received as a result of exposure to radionuclide emissions from the Hanford Site since operations began in 1944. A major objective of the HEDR Project is to estimate doses to those individuals who were exposed to radioactive materials (including gaseous iodine-131) released to the environment from Hanford through the inhalation of contaminated air and the consumption of contaminated foodstuffs and/or water.

The HEDR Project work is conducted under several technical and administrative tasks, including the Environmental Monitoring Data Task. The staff on this task assemble, evaluate, and summarize key historical measurements of radionuclide concentrations in the environment around the Hanford Site. This effort included reviewing the available information on the radiological monitoring of air, rain, and snow on and near the Hanford Site. This report is the result of an assessment of the availability and quality of air, rain, and snow data for the period 1945 to 1957.

Summary

This report is a result of the Hanford Environmental Dose Reconstruction (HEDR) Project. The goal of the HEDR Project is to estimate the radiation dose that individuals could have received from emissions since 1944 at the Hanford Site near Richland, Washington. Members of the HEDR Project's Environmental Monitoring Data Task have developed databases of historical environmental measurements of such emissions.

Hanford documents were searched for information on the radiological monitoring of air, rain, and snow at and near the Hanford Site in Richland, Washington. The monitoring information was reviewed and summarized. The end product is a yearly overview of air, rain, and snow samples as well as ambient radiation levels in the air that were measured from 1945 through 1957. The following information is provided in each annual summary: the media sampled, the constituents (radionuclides) measured/reported, the sampling locations, the sampling frequencies, the sampling methods, and the document references. For some years a notes category is included that contains additional useful information. For the years 1948 through 1957, tables summarizing the sampling locations for the various sample media are also included in the appendix.

A large number of documents were reviewed to obtain the information in this report. A reference list is attached to the end of each annual summary. All of the information summarized here was obtained from reports originating at Hanford. These reports are all publicly available and can be found in the Richland Operations Office (RL) public reading room.

The information in this report has been compiled without analysis and should only be used as a guide to the original documents.

Glossary

autoradiograph: image of a radioactive particle recorded on a photographic film or plate

Big Suckers: air sampling devices

"C" chambers: ionization chambers that were used for measuring beta and gamma radiation

cfm: cubic feet per minute

Ci: abbreviation for curie

CI monitor: constant iodine monitor. The CI monitor used a moto-air pump to pull about 20,000 ft³ of air per week through a filter. Activity was monitored by a Geiger-Mueller (GM) detector.

CWS: Chemical Warfare Service; applies to supplies procured through the U.S. Army

detachable chambers: portable ionization chambers that were set up in the field, charged, and read by a minometer. "X" chambers were the largest portable chambers, "M" were medium-sized chambers, and "S" were the smallest portable chambers.

dissolving run: two-step process that took place in the separation plants. First, the aluminum cladding around the fuel element was dissolved with a caustic solution of sodium hydroxide; then the fuel itself was dissolved with nitric acid.

dual-unit air monitoring devices: units that consisted of an air filter, a moto-air pump, a GM tube, a decade scaler, and a recorder. The moto-air pumps were connected to a timer set so that the sample collection period alternated between the two filtering units every few hours. One unit recorded the count rate during sample accumulation while the other recorded the decaying count rate of the filter in the unit that was off. The recorded decay rates were analyzed in the laboratory in an attempt to identify short-lived, naturally occurring progeny of radon and thoron.

EA: Esterline Angus recorder

GM: Geiger-Mueller detector. Glass-walled GM detectors were used in the field. Mica-window detectors were used in the lab.

HI: Health Instruments (Group)

HM: Health Monitor

integron: ionization chamber that measures gamma radiation

Little Suckers: continuously operating moto-air pumps that pulled air through a filter. Activity was monitored by a GM detector and readings were recorded. Radioactive material, impinged on the filter paper, was measured with a glass walled GM tube and counter.

"M" or M-22 chambers: detachable ionization chambers similar to "X", "S", and "C" chambers used to measure dose at locations outside the perimeters of the reactor and separations areas on the Hanford Site.

minometer: small instrument used for reading and recharging ionization chambers and pencil dosimeters

mr: milliroentgen; one thousandth of a roentgen.

mrad: millirad; one thousandth of a rad.

mrep: one thousandth of a rep. In the past, this unit was used in radiation protection work as a measure of the change produced by radiation in living tissue.

MSA: Mine Safety Appliance; a manufacturer of hand pumps

pig: a container (usually lead) used to ship or store radioactive materials. The thick walls protect the person handling the container from radiation.

precipitrons: air sampling devices

Queenie: air sampling device. Also known as the Pfanstiehl Collector, the Queenie consisted of a cylindrical filter paper and holder attached to a Filter Queen vacuum cleaner.

rad: radiation absorbed dose; the traditional unit of absorbed dose that represents 100 ergs of energy absorbed per gram of anything from any kind of ionizing radiation.

rep: roentgen-equivalent-physical; an outdated unit of absorbed dose defined as the amount of energy (90 ergs/gram) deposited in tissue from exposure (in air) to 1 roentgen of x- and/or gamma radiation.

roentgen (r): unit of exposure (in air) to x- and/or gamma radiation

"S" or S-22 chambers: detachable ionization chambers similar to "M," "X," and "C" chambers used to measure dose at locations outside the perimeters of the reactor and separations areas on the Hanford Site.

sodium thiosulfate sampling systems: hand pumps used to measure radioactivity. Glass absorption columns (30 cm long with an inside diameter of 1.5 cm) were filled with glass wool packing and 10 cc of a 1 percent sodium thiosulfate solution was added. Air was pulled through the column with a hand pump. The collected samples were allowed to drip from the chamber through a small capillary tube onto a 1-inch watch glass. This was probably done in the laboratory. Measurements were made on a mica-window GM detector after the fluid had evaporated (HW-3-2894).

VGM: Victoreen GM

Victoreen Integrator: fixed ionization chamber that measured ambient radiation

"X" or X-22 chambers: detachable ionization chambers similar to "M," "S," and "C" chambers used to measure dose at locations outside the perimeters of reactor and separations areas, on the Hanford site.

614 Buildings: small wooden buildings located on and off the Hanford Site that housed air sampling equipment and radiation detection instrumentation.

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Introduction

To support the Hanford Environmental Dose Reconstruction (HEDR) Project's objective of estimating the radiation dose that individuals could have received as a result of emissions from the Hanford Site, HEDR Project staff developed a database of historical environmental measurements. The data from these measurements are made available to the applicable HEDR tasks and the public.

Environmental sampling for radiological contaminants has been conducted at and around the Hanford Site since operations began in the mid-1940s. This report provides information on the measurement of ambient environmental radiation levels in the air and on the collection of air, rain, and snow samples for radiological analysis from 1945 through 1957. The information in this document was compiled to assess the type and amount of data collected during these years. No databases of historical air, rain, and snow concentration and/or measurement data have been created. During the 1940s and early 1950s, the equipment and techniques used for collecting radiological samples and monitoring radiation levels were often inaccurate. This was due to the newness of the nuclear industry and the haste with which the industry (including the facilities and monitoring equipment at the Hanford Site) was developed. The result was that the air monitoring data are insufficient for use in the HEDR Project. Because access to these data may be of interest to the public, however, an overview of the available air monitoring data for 1945-1957 is being published.

Data Quality Objectives

The information in this report has been compiled without analysis. The original purpose was to provide an overview of the data available. Because it was determined that the air monitoring data would not be used in the HEDR Project, no data quality objectives were established nor were the data submitted to a rigorous data quality review. The information presented in this report should only be used as a guide to the original documents. The original documents need to be consulted directly prior to use of any of the data presented in this report.

General Information

For the most part, the data are reported here in the units provided in the original documents. No attempt was made to quantitatively convert the data to currently used units. Radiation exposure was reported in units of milliroentgen (mr) and milliroentgen-equivalent-physical (mrep) through the third quarter of 1953. The roentgen (abbreviated r for old or R for new) is a unit for defining exposure in the air to x- or gamma radiation (ionizing

radiation). Roentgen-equivalent-physical (rep) is an outdated unit of absorbed dose and is a measure of the amount of energy deposited in tissue as a result of exposure (in air) to x- or gamma radiation. Beginning in the fourth quarter of 1953, data were reported in units of millirads (mrad). The rad is the traditional unit of absorbed dose and represents energy absorbed per unit mass of anything from any kind of ionizing radiation. All three of these units are nearly equivalent as the difference in energy deposited in tissue between all three is very small.

Sampling Locations

Radiological monitoring at the Hanford Site has traditionally consisted of sampling in the environment and at or near facilities. Environmental sampling has generally been conducted to monitor contamination levels in the environment on and off the Hanford Site, and sampling in and near facilities has been conducted to assess personnel exposures and to monitor waste controls, effluents, and emissions. Because the focus of the HEDR Project is primarily to assess the doses to people living off-site, this report includes mostly off-site environmental sampling information. However, near-facility sampling and monitoring are also discussed. Information on sampling inside facilities has not been included.

Most of the off-site sampling locations mentioned in this document are easily found on state and local maps and are only generally described here. Many of the on-site sampling locations are identified by road and mile marker (e.g., Rt. 4S, mile 16), building name or number, operating area (200-E, 200-W, etc.), or code number (e.g., PSN 310). Some of these locations are easily identified today. Others, like many of the old military camps, cannot be located without further research.

Sampling Equipment

Some of the equipment discussed in this report are described to help the reader understand what the equipment looked like and how it worked. This information was included only if it was easily obtained or was provided along with other pertinent sampling information. In most cases, this kind of information has not been included, and it will be up to the reader to locate more specific information on equipment design characteristics, component parts, unit sizes, calibrations, etc.

Radiological Monitoring of Air, Rain, and Snow on and near the Hanford Site in 1945

Media Sampled

Exposure rates in air and contamination levels in air, rain, and snow were monitored at locations on and near the Site.

Constituents Measured/Reported

Radiation levels were measured with several kinds of ionization chambers. Results were reported in mrem and mrep per hour or day. All data included natural background activity which was about 0.016 mrep/hour. Beginning in late March, film packets were used to supplement (corroborate) some of the chamber data (HW-7-1228 DEL, HW-7-1115 DEL). The limiting sensitivity of the film packs was approximately 2.0 to 2.5 mrep in 8 hours (HW-7-1228 DEL).

Iodine-131 was sampled with several types of iodine collectors. Most reported data were collected using air filters and results were given in terms of Ci/cc. Only a few values were reported each month from July through November (HW-3-2894).

Radon concentrations on iodine filters collected in the 300 Area in July and August were measured. Some data were reported (HW-3-2894).

Starting in late March, active particles were collected on sticky or oil-coated paper. Counts per minute for beta and alpha were reported a few times during the year (HW-7-1115 DEL).

Rain and snow samples were collected periodically and analyzed for radioiodine. Samples were collected during dissolving runs in the separation plants or when puddled rainwater looked discolored. Some concentrations were reported (HW-7-1115 DEL).

Sampling Locations

Sampling locations were primarily around facilities on the Site. However, some monitoring occurred at outlying on-site locations and in a few communities near the Hanford Site. During the first hot dissolvings in early 1945, radiation measurements south of the Site were restricted to Pasco because of the paucity of sampling equipment (HW-7-1115 DEL).

Integrans (ionization chambers measuring gamma radiation) were apparently set up and operating in Pasco and in the 100 Areas by January 1945. However, as of the first of January, no significant reading had ever been found on such meters (HW-7-1115 DEL). By late March, 29 Integrans had been placed outside of plant buildings (HW-7-1115 DEL) and in "outlying areas" (HW-7-1228 DEL). From March through the end of the year, average Integrans readings were reported for the 100 and 200 Areas (HW-7-1115 DEL, HW-7-1228 DEL) and for the outlying locations of Riverland, Hanford, Richland, Pasco, Kennewick, Benton City, and the 300 Area (HW-7-1228 DEL).

"C" type ionization chambers (measured beta and gamma) were located in the 614 Buildings. Average 24 hour dose values (mrep) were reported for 100-B, 100-D, 100-F, 200-E, and 200-W from mid-September through the end of the year (HW-7-1115 DEL).

"X," "S," and "M" type detachable ionization chambers were used at various locations around the Site. Readings from scattered locations were given for the first half of the year (HW-7-1115 DEL). Beginning in late June, a listing of sampling locations and average dose rates (mrep/hour) for those locations were included in the weekly reports (HW-7-1115 DEL). Similar information was also included in the monthly reports for September and October (HW-7-1228 DEL).

Airborne radioiodine and radon data began to be reported in July following the installation of continuous iodine monitors (filter units). Data were reported for samplers located in the 300 Area in July, August, and September; near the T Plant stack in November; the southeast corner of the 200-E Area during October and November; and at the Integrans monitoring station southwest of the B Plant stack in December (HW-3-2894, HW-7-1115 DEL). An additional unit was set up in Benton City in December but no data were given (HW-7-1115 DEL).

Snow and rain samples were collected at various locations on the Site and in the nearby communities of Kennewick and Richland (HW-7-1115 DEL).

Sampling Frequencies

Integrans and "C" chambers operated continuously. The readings from these instruments were retrieved every two to three days and accumulated dose readings were tabulated by 8-hour intervals (HW-1228 DEL). Results were reported weekly.

Rain was apparently not sampled routinely. Samples were collected during or after dissolvings or at other times when it was known or suspected that

atmospheric iodine levels were elevated. Following the first dissolvings at T Plant in early April, some rainwater puddles near the 221 Building (200-W Area analytical facilities) were brown in color (HW-7-1115 DEL).

Data for detachable chambers were reported weekly during most of the year. Sampling frequencies were not discussed.

Monitoring for atmospheric radioiodine was sporadic during most of the year because of imperfect sampling techniques. With the development and placement of the constant iodine monitors during the latter part of the year, sampling at a few locations was done at least weekly.

Air samplers for collecting airborne particles were not operated regularly during the year.

Sampling Methods

Several types of monitors for airborne radioiodine were used in 1945. Most of the reported data were collected with "constant iodine monitors." Initially these units consisted of a paper filter (8 square inches) supported by a screen around a thin walled glass Geiger-Mueller (GM) counter. Air was pulled through the filter by a moto-air pump and active material deposited on the filter was monitored by the GM counter. Readings were recorded on a Esterline Angus (EA) recorder. The first samples were collected on dry filter paper. Collection efficiency was assumed to be 20%. The next samples were collected on filter paper moistened with a mixture of glycerine and water because it was thought that a wet filter would improve collection efficiency. Collection efficiencies for the wet filters were not given, and the moisture content of the filters used for the remainder of the year was not expressed. However, the collection efficiency for samples collected in the 200-E Area during October and November was given as 50%. Constant iodine monitors were generally run between the hours of 8 p.m. and 6 a.m. because most metal dissolvings also occurred during this time period (HW-3-2894).

Other techniques used for monitoring airborne radioiodine included GM detectors, a system that collected iodine in a sodium thiosulfate solution when air was drawn through it, and a unit that condensed and froze iodine out of air drawn through a chamber containing dry ice (HW-7-2604). Sodium thiosulfate sampling systems were made by filling glass absorption columns (30 cm long with an inside diameter of 1.5 cm) with glass wool packing and adding 10 cc of a 1% sodium thiosulfate solution. Air was pulled through the column with a hand pump. The collected samples were allowed to drip from the chamber through a small capillary tube onto a 1-in. watch glass (probably done in the laboratory). Measurements were made on a mica-window counter after the fluid had evaporated (HW-3-2894). Problems with the third technique (condensing and freezing iodine) developed when too much condensation took place in the intake

tube ahead of the sampling chamber. When a Whatman #50 paper filter was placed in-line, ahead of the ice, the filter picked up 10% to 15% of the total radioiodine sampled (HW-3-2894, HW-1228 DEL).

Airborne radioiodine was also monitored by counting the activity collected on air-conditioning filters from units located in buildings on the Site and in Richland (HW-3-2894, HW-7-1115 DEL) and by using portable air samplers at on-site locations (HW-7-1115 DEL). Data were reported only occasionally.

Integron ionization chambers were unreliable. The units needed frequent repairs, did not ink (print) at all times, and calibrations were off (high) by as much as 30% to 60% (HW-1228 DEL, HW-7-1115 DEL). These units were installed to measure radiation quantitatively. If functioning properly, a full scale reading was caused by exposure to an 8-hour "tolerance dosage" (HW-7-2271, p. 1). However, most of the chambers were showing a full scale deflection with considerably less than an 8-hour exposure. It was decided that the signal amplifier and the chamber were not complementary and that the amplifier electronics needed some modification (HW-7-2271). Also, film packets (badge films) and/or detachable ionization chambers were located at Integron monitoring locations beginning in late March to supplement or verify integron readings (HW-7-1115 DEL). Integron chambers were modified in mid-September. Paper ice cream cartons, similar to those used in the "C" type chambers, replaced whatever chamber material they were using previously (HW-7-1115 DEL).

"C" type detachable ionization chambers were located near Integron chambers in the operating areas. The chambers in these units were made from standard ice cream cartons. The advantage to this type of chamber was the cost of replacement if they became contaminated or malfunctioned. The sensitivity of these units was comparable to that of the "M"-22 type chamber (detachable condenser type chambers for gamma measurements). The wall of the "C" chamber transmitted approximately 33% of the iodine beta radiation (HW-7-1115 DEL).

"M" (or M-22), "S" (or S-22), and "X" (or X-22) type detachable ionization chambers were similar to "C" chambers and were used to measure dose at locations outside the operating areas. The aluminum exterior of chamber of these units was apparently susceptible to damage from the abrasive action of blowing sand, so a system of supports was constructed for some of the chambers and installed during March. Chamber monitoring stations were continually moved farther and farther from the stacks. In May and July it was thought that most positive chamber readings were due to the influence of deposited ground contamination rather than atmospheric radiation (HW-7-1115 DEL). Exceptions occurred when high readings were found after stack gases were seen to be "looping" toward ground level under certain meteorological conditions.

As stated before, most rain samples were collected when atmospheric activity was known or believed to be elevated. Usually this was during the dissolving periods at night, but some looping also occurred during daylight hours. On at least one occasion, dissolving at the B Plant was interrupted and not restarted until the rain had more or less stopped falling (HW-7-1115 DEL).

Notes

Queenies, Little Suckers, Big Suckers, and Precipitrons were other air sampling devices. The Queenie, also known as the Pfanstiehl Collector, consisted of a cylindrical filter paper and holder attached to a Filter Queen vacuum cleaner.

Temperature tests were run on neon-ethyl ether and neon-amyl acetate, thin window glass GMs to determine effects. The neon-amyl acetate tube was greatly affected by temperature changes. The neon-ethyl ether tube was not affected and seemed to be the tube of choice for use outdoors (HW-3-2894).

The first and second batch of dissolvings at the T Plant began the second week of April. Fumes looped to the ground during three of the first five dissolvings (HW-7-1115 DEL). Concentrations 100 times the permissible limit could occur near the ground for brief periods at these times. The tolerance concentration for I-131 in the atmosphere on the Site was $\sim 1.0E-13$ Ci/cc (HW-7-2604).

Off-gas monitoring for radioiodine was done routinely until June. Periodic checks were done after that date (HW-7-2604).

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Radiological Monitoring of Air, Rain, and Snow on and near the Hanford Site in 1946

Media Sampled

Exposure rates in air and contamination levels in air, rain, and snow were monitored at locations on and near the Site.

Constituents Measured/Reported

Radiation levels were measured with several kinds of ionization chambers and film packs. Weekly and monthly chamber results were reported in mr and mrep per hour or day. The limiting sensitivity of Integrator readings was probably no better than 2 mr/24 hours. All data included natural background activity which was about 0.3 mr/24 hours (HW-7-3517). Film pack results were used to corroborate high Integrator readings and were rarely reported. Starting in March, Integrator readings began to be reported in mrep rather than mr because of the installation of thin windows in the Integrator units to allow measurement of beta radiation in addition to gamma (HW-7-3694). By September, almost all Integrator samplers had been converted to thin windows.

Iodine-131 was sampled with constant iodine monitors (filtering units) and with small portable hand pumps (thiosulfate scrubbers). For the most part, data from one to three locations were reported weekly and/or monthly. Results were given in units of Ci/cc or $\mu\text{Ci/L}$.

Rain samples were collected periodically at random locations during spring and summer months and in the 200 Area during dissolving runs (HW-7-4312). A few results were reported. In October, new rain sampling equipment was installed at 20 locations (HW-7-5301). Sampling during the last quarter of the year was greatly increased and maximum and average values for several sample sites were reported monthly. Snow was also collected and analyzed during November (HW-7-5428). Results were reported in terms of $\mu\text{Ci/L}$.

Sampling Locations

The majority of the sampling locations in 1946 were on-site near the operating facilities and in some of the outlying areas of the Site, including Riverland and the 300 and 700 Areas. Some samples and measurements were also reported for locations in Richland, Benton City, Kennewick, and Pasco.

Sampling Frequencies

Integrans and "C" chambers operated continuously. Readings from these instruments were retrieved every two to three days and accumulated dose readings from the Integrans were tabulated by 8-hour intervals.

Rain was apparently not sampled routinely during the first nine months of the year. Samples were collected during or after dissolvings or at other times when it was known or suspected that atmospheric radioiodine levels were elevated. However, following the installation of new rain collection stations in October, samples were collected weekly (if it rained) (HW-7-5301).

Data for detachable chambers were reported weekly for most of the year. Sampling frequencies were not discussed.

Data for constant iodine monitors were reported weekly and monthly but a specific sampling schedule was not given. Hand pumps were used occasionally throughout the year, probably at times and locations where elevated radioiodine levels were expected.

Film packets at Integrans stations were collected weekly (HW-7-5605).

Sampling Methods

Two types of airborne radioiodine samplers were used in 1946. Most of the reported data were collected with "constant iodine monitors." These used a moto-air pump to pull air through a filter (type unknown). Active material impinged on the filter was monitored by a GM counter and readings were recorded. If asbestos filters were being used, the collection efficiency for I-131 was determined to be 70% (HW-3-3383). Sodium thiosulfate sampling systems (hand pumps) were made by filling glass absorption columns (30 cm long with an inside diameter of 1.5 cm ID) with glass wool packing and adding 10 cc of a 1% sodium thiosulfate solution. Air was pulled through the column with a hand pump. The collected samples were allowed to drip from the chamber through a small capillary tube onto a 1-in. watch glass (probably done in the laboratory). Counts were made on a mica-window counter after the fluid had evaporated (HW-3-2894).

Victoreen Integrans were installed to measure radiation quantitatively. If functioning properly, a full scale reading was caused by exposure to a tolerance dosage. As with "C" type units, standard ice cream cartons were used for chambers.

"C" type detachable ionization chambers were located near Integrans chambers in the operating areas. The chambers in these units were made from standard ice

cream cartons. The advantage to this type of chamber was the cost of replacement if they became contaminated or malfunctioned. The sensitivity of these units was comparable to that of the "M"-22 type chamber. The transmission of radiation from an I-131 source through the wall of one of the "C" chambers was measured with a mica-window GM. About 85% of the radiation was absorbed by the chamber walls leaving a transmission of about 15% (HW-3-3539).

"M," "S," and "X" type detachable ionization chambers were similar to "C" chambers and were used to measure dose at locations outside the operating areas. The aluminum exterior or chamber of these units was apparently susceptible to damage from the abrasive action of blowing sand, so some of the chambers were elevated on stands.

Rain collection methods were not discussed.

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Radiological Monitoring of Air, Rain, and Snow on and near the Hanford Site in 1947

Media Sampled

Exposure rates in air and contamination levels in air, rain, and snow were monitored at locations on and near the Site.

Constituents Measured/Reported

Radiation levels were measured with Integrations, "C," "M," and "S" type ionization chambers, and film packs. Results (mrep/hour or mrep/24 hours) for all routine sampling locations were tabulated and presented in the monthly HI Environs Reports (HW-8243, HW-8486, HW-8027, HW-7831, HW-7608) and HI Section Reports (HW-7844, HW-7046). Quarterly dose rate averages (mrep/24 hours) were reported for detachable chambers in quarterly reports (HW-9496 DEL, HW-3-5511, HW-8549 DEL, HW-7317). Film pack results were used to corroborate high Integrations readings and were rarely reported.

Airborne radiiodine was sampled with constant iodine (CI) monitors (filtering units) at four or five locations and with small portable hand pumps (thiosulfate scrubbers) at random locations. Results for the CI monitors were reported (monthly 8-hour period maximum in $\mu\text{Ci/L}$) in tables in the monthly HI Environs Reports. A few values were also reported in the HI Section Monthly Reports. Data collected with portable hand pumps were reported infrequently (HW-3-5511).

Airborne particles were collected on small paper filters with air filtering devices and the filter was counted in the laboratory for beta radioactivity. Some of these devices were used in conjunction with the CI monitors. Tabulated data were reported ($\mu\text{Ci/L}$ average) in the monthly HI Environs Reports. Quarterly results were presented graphically in quarterly reports.

Rain data were tabulated and reported monthly in the HI Environs Reports. Results were reported for five sampling zones in terms of $\mu\text{Ci/L}$, beta. Some monthly information was also reported in the HI Section Reports. Results were reported quarterly, but much of the data were presented graphically rather than in tables (HW-9496 DEL, HW-8549 DEL).

Sampling Locations

Monitoring was conducted both on and off the Site. Locations were primarily on the Site near operating facilities and along area roadways. Additional

on-site monitoring was conducted at outlying areas, including the 300 and 700 Areas, Gable Mountain, Benson's Ranch, the old Hanford townsite, and Riverland. Monitoring was also conducted in Benton City, Richland, Pasco, and Kennewick.

Sampling Frequencies

Integrations and "C" chambers operated continuously. Readings from these instruments were retrieved every two to three days and accumulated dose readings were tabulated at 24 hour intervals.

Rain data were reported monthly when it rained. Sampling frequencies were not discussed, but rain gauges were probably checked weekly when it rained.

Data for detachable chambers were reported weekly for most of the year. Sampling frequencies were not discussed.

Data for constant iodine monitors were reported weekly and monthly but a specific sampling schedule was not given. Hand pumps were used occasionally throughout the year, probably at times and locations where elevated radioiodine levels were expected.

Film packets at Integrator locations were collected weekly (HW-7-5605).

Sampling Methods

Two types of airborne radioiodine samplers were used this year. Most of the reported data were collected with CI monitors. These were continuously operating motor-air pumps (also referred to as Little Suckers) that pulled air through a 1.75 in. filter (type unknown) at a flow rate of 2 cubic feet per minute (cfm). Activity was monitored by a GM counter and readings were recorded. Radioactive material impinged on the filter paper was measured with a thin mica-window counter. Corrections were made on filter counts for decay and geometry based on the assumption that all beta activity came from 8-day radioiodine (HW-8549). Sodium thiosulfate sampling systems were made by filling glass absorption columns (30 cm long with an inside diameter of 1.5 cm) with glass wool packing and adding 10 cc of a 1% sodium thiosulfate solution. Air was pulled through the column with a 3-liter hand pump. The collected samples were allowed to drip from the chamber through a small capillary tube onto a 1-inch watch glass (probably in the laboratory). Counts were made on a mica window counter after the fluid had evaporated (HW-3-2894).

Victoreen Integrations were installed to measure radiation quantitatively. If functioning properly, a full scale reading resulted from exposure to a

tolerance dosage. As with "C" type units, standard ice cream cartons were used for chambers.

"C" type detachable ionization chambers were located near Integrator chambers in the operating areas. The chambers in these units were made from standard ice cream cartons, described as heavy, semi-waterproof cardboard (HW-8549). The advantage to this type of chamber was the cost of replacement if they became contaminated or malfunctioned. The sensitivity of these units was comparable to that of the "M"-22 type chamber. The transmission of radiation from an I-131 source through the wall of one of these carton chambers was measured with a mica-window GM. About 85% of the radiation was absorbed by the chamber wall (HW-3-3383).

"M" and "S" type detachable ionization chambers were similar in function to "C" chambers and were used, in pairs, to measure dose at locations outside the operating areas. The cylindrical aluminum chambers of these units were apparently susceptible to damage from the abrasive action of blowing sand, therefore, some of the chambers were elevated on stands. Portable minometers were used to read and recharge these instruments at regular intervals (HW-8549).

Rain samples were collected in open vessels. Sample size was variable, depending on the amount of rainfall during the sampling period. Collected samples were treated with sodium thiosulfate (to prevent volatilization of the I-131), evaporated, and counted directly on a thin mica-window counter. It was assumed that all activity was due to I-131. Rain samples collected in 1947 were not filtered, but studies had shown that filtering the rain samples removed most of the activity. A study of the filter papers indicated the presence of small active particles with relatively long half-lives. The source of these particles was not known (HW-8549).

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Radiological Monitoring of Air, Rain, and Snow on and near the Hanford Site in 1948

Media Sampled

Exposure rates in air and contamination levels in air, rain, and snow were monitored at locations on and near the Site.

Constituents Measured/Reported

Ambient radiation was measured with Victoreen Integrators, "C," "M," and "S" type detachable ionization chambers, and film packs. Data tables listing monthly averages (mrep per 24 hours) for all chamber sampling locations were published in the monthly HI Environs Reports. Monthly and quarterly averages (mrep per 24 hours) for detachable chambers were reported in quarterly reports (HW-13743 DEL, HW-11333 DEL, HW-12677 DEL, HW-10242 DEL). Data for film packs were not reported.

Atmospheric radioiodine was measured at a few locations with constant iodine (CI) monitors. The monthly maximum 8-hour concentration was reported ($\mu\text{Ci/L}$) for each sampling site (HI Environs Monthly Reports).

Radioactive particles were sampled with air filtering units and were monitored for total beta activity. Monthly averages ($\mu\text{Ci/L}$) were reported in the HI Environs Monthly Reports and quarterly averages ($\mu\text{Ci/L}$) were reported in the quarterly reports (HW-13743 DEL, HW-11333 DEL, HW-12677 DEL, HW-10242 DEL). In March, a few of these filters were exposed to x-ray film (K-type) for periods from 72 to 115 hours. The number of dark spots on the exposed film was an indication of the number of active particles on the filter. Decay studies indicated that most filter activity decayed with a half-life of greater than eight days (HW-9103). However, during the second quarter of the year, it was assumed that all filter activity was from 8-day iodine and calculations neglected the long-lived material (HW-11333 DEL). The same thing was said for filter data presented in a report summarizing data for the years 1945 through 1948 (HW-9871). By April, all routine air sampling filters were being autoradiographed (115 hour exposures initially, 168 hour exposures later in the year) (HW-9730, HW-12677 DEL). Throughout the year, most particle activity was seen in or near the 200 Areas (up to 200 particles/filter) but some were also found on filters collected in nearby communities (HW-13743 DEL, HW-12677 DEL) and on a filter collected at Mullens Pass, Idaho, in December. Chemical analysis of the Idaho filter showed that 20% of the activity was due to strontium, 60% to 70% was due to rare earths and 4% was due to ruthenium (HW-12131). Particle count data were included in the HI monthly reports from October through December. These data were collected with air filtering units

that were set up specially to monitor air particle concentrations and should not be confused with the moto-air samples collected routinely throughout the year (HW-13743 DEL). In July, very high beta activity levels were found on filters collected at locations in the 300 Area. Analyses found uranium on the filters (HW-10730). High uranium levels were found on 300 Area filters through the remainder of the year and the source was assumed to be the 314 Building stack (the Melt Plant) (HW-10998). Levels were always less than the current tolerable concentration of uranium in air (HW-11534). Numbers of filterable alpha emitters remained low at other locations (HW-11534, HW-10730, HW-11264) but numbers of filterable beta emitters were frequently high on filters collected in and near the 200 Areas. A study of the efficiency of the filter paper found that only 3% to 4% of the atmospheric (gaseous) I-131 was being captured by the filters. Using a thicker filter increased efficiency to 12% to 20%. It was decided that activity on the filters should be regarded as mostly long-lived material from the stacks (HW-10427, HW-12677 DEL). Decay curves generated from filter paper activity showed that the long-lived activity was composed of materials with half-lives of 30 to 60 days (60% to 80%), 275 to 300 days (30% to 40%) and a small amount of very long lived components (1% to 2%) (HW-10758).

Routinely collected rain and snow samples were analyzed for beta activity. Monthly maximum and average values for sampling areas ($\mu\text{Ci/L}$) were reported in the HI Environs Monthly Reports. Quarterly averages for each sampling area were reported in quarterly reports (HW-13743 DEL, HW-11333 DEL, HW-12677 DEL, HW-10242 DEL). Radioactivity in samples generally decreased as the distance between the collection point and the separations area stacks increased (HW-10242 DEL, HW-12677 DEL). One rain sample collected during the first quarter of the year was filtered, then counted. All of the activity was found on the filter and the half-life was greater than expected for 8-day radioiodine (HW-10242 DEL). Many of the samples collected toward the end of the year were autoradiographed. About 100 particles per sample were found in samples collected in and near the 200 Areas but activities in samples collected five to ten miles from the operations areas were near background (HW-12131). Dust, collected in rain samplers following a major dust storm in September, was autoradiographed. The low number of radioactive particles observed indicated that the active particles were associated with rainfall and were not due to resuspension of contaminated soil by wind (HW-11264).

Sampling Locations

Most sampling and monitoring for filterable beta emitters, ionizing radiation, airborne radioactive particulates, gaseous I-131, and rain were conducted near operating facilities and along roadways on the Site. Sampling and monitoring were also conducted at on-site locations in outlying areas, and in the nearby

communities of Pasco, Richland, Kennewick, and Benton City. The specific locations are listed in Table A.1 in the appendix.

Sampling Frequencies

Integrators and "C" chambers operated continuously. These instruments were checked every two to three days and accumulated dose readings were tabulated at 24 hour intervals.

Rain samples were collected weekly when it rained (HW-7-5301).

Data for detachable chambers were reported weekly for most of the year. Sampling frequencies were not discussed.

Data for constant iodine monitors were reported monthly but a specific sampling schedule was not reported.

Air filters used for collecting airborne particles for analysis of beta emitters were monitored weekly at most locations (HW-11333 DEL) or after five days (HW-10730). Filters for determining particle concentrations were collected every seven days (HW-13743 DEL).

Film packets at Integrator stations were collected weekly (HW-7-5605).

Sampling Methods

Atmospheric radioiodine was collected with filtering units referred to as CI monitors. These used a motor-air pump to pull about 20,000 ft³ of air per week through a 1.5 inch CWS #5 filter (HW-10730, HW-13743 DEL, HW-10998). Activity was monitored by a GM counter and readings were recorded (HW-11333-DEL). These units were situated outdoors, with filters exposed directly to the atmosphere (HW-13743 DEL).

Particle activity was measured on the CI monitor filters as well as on filters collected with other air filtering units (HW-11333 DEL). According to HW-13743, these other units were located under a protective cupola type roof in the 614 Buildings, which housed the Integrators and micromax recorders of the air monitoring program. The particles detected on these filters were drawn through the vents of the cupola (HW-13743 DEL). In the laboratory, samples were counted on standard 1-inch diameter thin mica-window counters contained in lead pigs with 1.5-inch walls. Counting was done on the first shelf located about 1/8 inch below the counter face. Filters were mounted on counting cards and covered with cellophane. Counting rates were measured over varying intervals depending on sample type and length of time the sample had

been decaying. Results were corrected for backscatter from the counting plate, absorption in the counter window, and geometry, but not for self absorption (HW-10758). Analyses for uranium (alpha) included the ether extraction method and the fluorophotometric method (HW-12677 DEL).

Victoreen Integrators were installed to measure radiation quantitatively. If functioning properly, a full scale reading resulted from exposure to a tolerance dosage.

"C" type detachable ionization chambers were located near Integrator chambers in the operating areas. The chambers in these units were made from heavy, semi-waterproof cardboard. The advantage to this type of chamber was the cost of replacement if they became contaminated or malfunctioned. The sensitivity of these units was comparable to that of the "M"-22 type chamber. About 25% of the beta radiation emitted by 8-day radioiodine penetrated the chamber wall (HW-11333-DEL, HW-9871).

Cylindrical "M" and "S" type detachable ionization chambers were similar to "C" chambers and were used to measure dose at locations outside the operating areas. These units were usually placed in pairs. Units were read and charged with a Victoreen minometer (HW-9871). At least 50% of the chamber wall in these units was made from 1.0 mm aluminum foil (HW-9871).

Rain samples were collected in 500 ml containers. Sample size was dependent on total rainfall and varied from 0 to 500 mls. Rain collection gauges were located in at least 30 locations, including some nearby communities, and in all major on-site construction zones (HW-11333 DEL).

Notes

During the first and second quarters of 1948, statistical analyses were done on concentrations of airborne beta emitters measured at various routinely sampled locations (HW-11333 DEL, HW-10142 DEL).

The background level for detachable chambers was 0.3 to 0.5 mrep/24 hours (HW-13743 DEL).

$1 \mu\text{Ci} = 3.7 \times 10^4$ disintegrations/sec (HW-9871).

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Radiological Monitoring of Air, Rain, and Snow on and near the Hanford Site in 1949

Media Sampled

Air, rain, and snow were sampled at locations on and off the Site. Increased sampling occurred in early December when one ton of green uranium (cooled for 16 days) was dissolved (HW-17003). This dissolving has been referred to as the "Green Run."

Constituents Measured/Reported

Airborne contamination was measured using air filtering devices (Little Suckers) which collected filterable beta emitters and particles on paper filters. These filters were counted with thin mica-window counters then exposed to K-type x-ray film for 168 hours to detect the presence of radioactive particles discharged from stacks (HW-14243 DEL, HW-17003 DEL). Concentrations of particles were estimated by visually counting the dark spots on the exposed x-ray film (HW-14234 DEL, HW-17434 DEL). Filterable beta emitters were reported in units of $\mu\text{Ci/L}$ of air (HW-14243 DEL, HW-17434 DEL). Data were presented as maximum weekly averages (HW-17434 DEL), monthly averages (HW-18615, HW-17003 DEL) and quarterly averages (HW-14243 DEL, HW-17434 DEL, HW-18615).

Gaseous I-131 concentrations in air were monitored by adding a radioiodine scrubber behind the air filtering system on some of the samplers. These scrubbers were tested during the first quarter of 1949 (HW-14243 DEL) and sampled officially for the first time in April, 1949 (HW-17434 DEL). In the first quarter report, it was thought that all but about 3.5% of gaseous I-131 passed through the filters and was trapped in the scrubbers (HW-14243 DEL). This was changed to between 5% and 10% in the second and third quarter reports (HW-17434 DEL, HW-18615). Additional scrubbers were installed to monitor I-131 during the Green Run. These scrubbers operated without air filtering systems. Even though readings included some filterable radioactive particles, it was assumed that essentially all activity was from I-131 (HW-17003 DEL). Iodine concentrations were presented in units of $\mu\text{Ci/L}$ and were reported as maximum weekly averages (HW-17434 DEL), monthly averages (HW-18615, HW-17003 DEL) and quarterly averages (HW-17434 DEL, HW-18615).

Ambient radiation levels (average dose rates) were measured with several types of ionization chambers located on- and off-site (HW-14243 DEL, HW-17434 DEL). Data were reported in units of mrep/24 hours and background levels were not subtracted (HW-14243 DEL, HW-17434 DEL, HW-18615, HW-17003 DEL). Readings were corroborated with film studies and portable instrument surveys (HW-17434

DEL). Data were reported as monthly and quarterly averages (HW-14243 DEL, HW-17434 DEL, HW-18615, HW-17003 DEL).

The responsibility of monitoring for airborne radioactive particles was transferred to the Site Survey Group of the HI Division in June, 1949 (HW-17434 DEL). Particle monitoring was increased in 1949 during the third and fourth quarters of the year and additional filters were installed both on- and off-site during early December to help monitor Green Run activities (HW-18615, HW-17003 DEL). Increased particle concentrations noticed during the third quarter of the year were associated with an unknown off-site source (HW-18615, HW-17003 DEL). A radiochemical analysis of radioactive particles collected in September indicated a composition of 23% strontium, 12% barium, 7% cerium, and 3% zirconium. Eleven percent of the radioactivity remained with the insoluble residue and a trace of alpha activity was noted when several hundred particles were composited and examined (HW-18615). Within the exclusion areas (200 Areas), particle deposition was more of a problem within the laboratory buildings than outside of them (HW-17434 DEL, HW-17003 DEL). An overall decrease in active particles during the first quarter of the year may have been due to the installation of water scrubbers and sand filters in front of the main ventilation stacks (HW-14243 DEL). In the second quarter report for 1949, data were presented in units of particles/m³ and particles/ft³. In the 1949 third and fourth quarter reports, data were presented in terms of particles/m³ only (HW-18615, HW-17003 DEL). Reported data included monthly averages (HW-18615, HW-17003 DEL) and quarterly averages (HW-17434 DEL, HW-18615, HW-17003 DEL).

Beta radioactivity in rain samples was monitored each quarter. Quarterly averages were reported as mμCi/L (milli micro curie/liter) of water. Snow samples were also collected following the December Green Run (HW-17003 DEL). Some of the rain samples collected following the Green Run were autoradiographed to determine particle content. Radioactive particles were not detected but there was evidence of I-131 contamination (HW-17003 DEL).

Sampling Locations

On-site and community sampling and monitoring locations for filterable beta emitters, ionizing radiation, airborne radioactive particles, I-131, and rain are listed in Table A.2 in the appendix. The Hanford Site map (Figure 1) helps to identify locations of some of the sampling sites.

Ionization chambers, used for measuring dose, were located both on and off the Site. "C" type chambers were used to measure average dose within the production areas (HW-14243 DEL). "M" and "S" type chambers measured doses at random locations throughout the Site and in local communities (HW-14243 DEL, HW-17434 DEL, HW-18615). The smaller "S" type chambers predominated at on-site

locations where construction personnel were working (HW-14243 DEL). Several units were situated at distant locations for evaluation of background radioactivity (HW-18615). Generally, two chambers were used at each location (HW-18615). These three chamber types ("C," "M," "S") were considered detachable and were supported on 5-foot high wooden stands (HW-17434 DEL, HW-17003). Beginning in April 1949, data for fixed chambers were reported. These chambers were referred to as Victoreen Integrators and were located at permanent monitoring stations called 614 Buildings. Several stations were located within each operating area (along the perimeter fences) and individual units were placed in the vicinity of nearby populated areas (HW-17434 DEL, HW-17003 DEL).

From March 1949 through October 1949, scrubber samples were collected from the 200-W Area gate, Benton City, 200 ESE, the 300 Area, and Richland. In November, a sixth station was added in the new 100-H Area (HW-17003 DEL). For the December 3 Green Run, 14 special units were placed in the separations areas and 13 were located in the vicinity of the 100 Areas. Green Run off-site scrubber locations included Benton City, Spokane, and Richland, Washington; Boise, Idaho; and Klamath Falls, Oregon (HW-17003 DEL). Filter samples (for airborne beta emitters) were also collected on-site and in nearby communities.

Rain samplers were located at 28 locations on and adjacent to the Site for most of the year. During the Green Run, rain samplers were added at an additional 6 locations.

Off-site particle sample collection sites included Richland, Benton City, Pasco, Spokane, Stampede Pass, and Walla Walla, Washington; Lewiston and Boise, Idaho; Klamath Falls and Meacham, Oregon; and Great Falls, Montana.

Sampling Frequencies

Detachable ionization chambers were read in pairs at intervals ranging from 1 to 5 days, depending on chamber capacity and the historic radiation level at the monitoring location (HW-14243 DEL, HW-18615). Normally, each chamber was read about 3 times per week (HW-17434 DEL, HW-17003 DEL). According to the 1949 second quarter report, results for Victoreen Integrators were tabulated as dose per 8-hour interval (HW-17434 DEL).

Routine filter and scrubber samples were collected once each week (HW-17434 DEL). Special samples from scrubbers operating in the separations areas during the Green Run were collected at various intervals between December 2 and December 8. Scrubbers at Boise, Idaho; Spokane, Washington; and Klamath Falls, Oregon ran continuously through December 7. Benton City units ran from December 3 to December 7 (HW-17003 DEL).

Routine particulate samples were collected weekly (HW-17434 DEL). Green Run filters were also collected after one week (HW-17003 DEL).

Sampling Methods

Filter samples were collected by drawing 2 cfm of air through a 1.5 in. diameter paper filter for a period of one week (HW-17434 DEL). Filters were sent to the laboratory for beta counting.

Scrubber samples were obtained by passing filtered air through a 1-liter solution composed of 50% 0.1N (normal) sodium carbonate (Na_2CO_3) and 50% 0.1N sodium hydroxide (NaOH). A small amount of sodium iodide was also added to act as a carrier for the I-131 (HW-14234 DEL). During hot summer months some samples were lost because the solution evaporated before the sample was collected.

Samples for particle counting were collected by filtering 2 to 10 cfm of air through a 26 in² filter paper. After one week, these filters were removed and exposed to K-type x-ray film for 168 hours. Normally, filters from on-site sampling locations were exposed to film within one week of removal. Off-site samples were exposed to film about 2 weeks after removal (HW-18615). In addition to particle filters, other particle sampling methods mentioned in the monthly reports for 1949 included particle traps (pans of water or sticky paper) and large particle frames. These were not discussed in the quarterly reports and results were not reported.

Rain was collected in 500 ml vessels (HW-17434 DEL). A metal funnel was inserted in the bottle and held in place by a standard laboratory ring stand and clamp.^(a)

(a) Communication Log (HEDR Project Document No. 10930239), "Information on Rain Sampling During the Early Years of Hanford's Operations," telephone conversation between R.W. Hanf, BNW, and J.K. Soldat, BNW, July 20, 1993.

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HW-17434. 1950. Paas, H. J., and W. Singlevich. *Radioactive Contamination in the Environs of the Hanford Works for the Period April, May, June, 1949.* General Electric Company, Hanford Works, Richland, Washington.

HW-18615. 1950. Paas, H. J., and W. Singlevich. *Radioactive Contamination in the Environs of the Hanford Works for the Period July, August, September, 1949.* General Electric Company, Hanford Works, Richland, Washington.

Radiological Monitoring of Air, Rain, and Snow on and near the Hanford Site in 1950

Media Sampled

Air, rain, and snow were sampled at locations on- and off-site. Increased sampling occurred during the last quarter of 1950 after the installation of the first silver reactor on the off-gas line of the dissolver unit in the 200-E Area (HW-21566). The dissolving schedule of irradiated uranium was also increased this year (HW-20700). Monitoring equipment was concentrated in the more heavily populated regions on and off the Site (HW-19454).

Constituents Measured/Reported

Airborne particles were collected on small paper filters and counted for beta radioactivity (HW-18446). Maximum concentrations were seen immediately downwind of the separations areas (HW-21566). Data were usually reported as monthly and quarterly averages for each sampling location (HW-18446, HW-19454, HW-20700, HW-21566). The maximum weekly activity at each location for the quarter was also reported in 1950 in the second, third, and fourth quarter reports (HW-19454, HW-20700, HW-21566). Concentrations were expressed in units of $\mu\text{Ci/cc}$ (HW-20700, HW-21566, HW-19454) and $\mu\text{Ci/L}$ (HW-18446).

Routine samples of airborne I-131 were collected at some of the particle sampler locations by a caustic scrubber unit installed downstream of the filters (HW-18446). Additional samples were collected with portable and hand operated scrubber units during dissolving periods in the third and fourth quarters of the year. These values were compared to Victoreen GM (VGM) readings taken at the same time and location (HW-20700, HW-21566). Results for routine sampling during the first quarter of 1950 were given as monthly and quarterly averages only (HW-18446). The other quarterly reports for 1950 also reported the maximum weekly values observed at each sampling location during the quarter (HW-19454, HW-20700, HW-21566). Concentrations were expressed in units of $\mu\text{Ci/cc}$ (HW-19454, HW-20700, HW-21566) and $\mu\text{Ci/L}$ (HW-18446). Results for non-routine samples were not tabulated but some values were provided in the text (HW-20700, HW-21566). VGM data were not provided.

Ionizing radiation levels were measured with several different types of recording chambers located both on and off the Site (HW-18446). Background levels were determined by operating small detachable ionization chambers at remote locations (HW-18446, HW-19454). With the exception of Victoreen Integrators, chambers were usually placed in pairs and the minimum reading from the two units was used to compute dose rates (HW-21566, HW-20700). Background

was not subtracted and some "M" and "S" chamber readings may have been influenced by activity from materials deposited on the ground around the units (HW-20700). Monthly and quarterly values for each sampling location were reported in units of mrep/24 hours. The number of Integrators used at each location was also noted (HW-18446, HW-19454, HW-20700, HW-21566).

The number of airborne radioactive particles collected on routine filters and supplementary special particle filters were determined by exposing the filters to x-ray film and examining the resulting autoradiographs (HW-18446). Particle problems seemed to be restricted to the immediate vicinity of the 200 Areas exclusion areas (HW-20700). Maximum particle concentrations were seen inside the 222 Building laboratories located in the 200-W Area (HW-21566, HW-19454). Samples were collected both on- and off-site. Monthly and quarterly averages for each sample location were reported (particles/m³) for all particulate filters collected. The total air volume sampled at each location was also reported (HW-18446, HW-19454, HW-20700, HW-21566).

All rain samples were counted for total beta activity. Some were checked for alpha activity and those samples with high beta levels were autoradiographed to determine radioactive particle concentrations (HW-21566). Samples were analyzed according to standard procedures and techniques used for drinking and river water (HW-21566). Data reported included maximum and average quarterly values for each sample location and the number of samples collected at each Site (HW-19454). Concentrations were given in terms of $\mu\text{Ci/L}$ in the 1950 first quarter report (HW-18446) and in $\mu\text{Ci/cc}$ in the other quarterly reports for 1950 (HW-19454, HW-20700, HW-21566).

Sampling Locations

On-site and off-site sampling and monitoring locations for filterable beta emitters, ionizing radiation, airborne radioactive particles, I-131, and rain are listed in Table A.3 in the appendix.

Distant particle-sampling sites included Boise and Lewiston, Idaho; Klamath Falls and Meacham, Oregon; Stampede Pass, Walla Walla, and Spokane, Washington; and Great Falls, Montana (HW-18446, HW-20700, HW-19454, HW-21566). Particle samples were also collected in Annette, Alaska, during part of this sample year, but no data were given.

"M" and "S" type detachable ionization chambers were used at field stations located between the operating areas (HW-18446). "C" type detachable chambers were located on-site, inside the 614 Buildings near the fixed Victoreen Integrator chambers (HW-20700). As many as 2 or 3 Victoreen units were situated along the perimeter fences in each operating area. Single units were operated at locations close to nearby communities (HW-19454).

In addition to routine scrubber samples, large portable scrubbers and small hand operated units were used at locations downwind of the separations areas during certain meteorological conditions seen in the third and fourth quarters of 1950. Locations were selected to be representative of maximum air concentrations of stack gas during dissolvings (HW-20700, HW-21566).

Sampling Frequencies

Routine samples of filterable beta emitters were collected weekly (HW-18446, HW-19454).

Routine scrubber samples were also collected weekly.

"Control sampling" occurred daily during the last four months of the year in the 200-E (Tower #16) Area. Scrubber samples were collected over a 16-hour period from 4 p.m. to 8 a.m. the next day. This represented the bulk of the dissolving period on any given day. Additional samples were collected in November and December when the silver reactors were both operational and non-operational (HW-21566).

Portable scrubbers were used during dissolving periods in October and November to evaluate peak I-131 concentrations in air. Sampling frequency was not reported (HW-21566).

The results for Victoreen Integrators were reported for 8-hour intervals (HW-19454, HW-21566).

"M," "S," and "C" chambers were read at least 2 and sometimes 3 times per week (HW-19454).

Particle filters used for monitoring airborne beta emitters and for measuring the air concentrations of radioactive particles were collected weekly (HW-19454, HW-21566).

Rain samplers were monitored weekly at most locations. The sampler located at the 200 Area Meteorology Station was collected after every rainfall (HW-19454). The number of samples collected at a single location depended on the amount of precipitation and ranged from 0 to as many as 41.

Sampling Methods

Samples of filterable beta emitters were collected by drawing about 20,000 ft³ of air through a 1.8 in² CWS #6 filter paper over a period of one week. The volume of air passing through the filter was measured with a running time

meter used in conjunction with a precalibrated 1/4 horsepower moto-air pump (HW-21566, HW-20700). The running time meter was attached to the primary power line of each sampling motor. When motors or pumps failed during a sampling period, volume determinations were based upon the number of hours accumulated on the meter prior to the failure (HW-20700). When removed, filters were held for two or three days before counting to allow any thorium or radon progeny present to decay (HW-19454, HW-20700). Counts were made with a thin mica-window counter. Window thickness varied from 3 to 5 mg/cm² (HW-21566). All collected filters were also exposed to K-type x-ray film for 168 hours. The number of radioactive particles collected was determined by visually counting the dark spots on the exposed film (HW-18446).

Non-filterable I-131 was trapped in about 2 liters of solution containing 4 g of sodium hydroxide and 10.6 g of sodium carbonate. A small amount of sodium iodide was also added as a carrier (HW-18446). This solution was usually located downstream of the air filter (HW-19454). Some scrubber samples were collected with a small Mine Safety Appliance (MSA) hand pump. Iodine-131 was collected by pushing 10 liters of air through a solution volume of less than 50 mls (HW-21566). Large portable scrubbers were used downwind of the separations areas and were operated in a manner similar to the way routine scrubbers were used.

Ionization chambers were of two types; fixed and detachable. The fixed units were Victoreen Integrans. The detachable units were "M," "S," and "C" chambers. These units were set out in pairs supported by 5 ft high wooden stands. Radiation levels were evaluated by using the minimum reading from one of the two chambers (HW-20700). Background values were not subtracted (HW-21566). "C" type chambers were located primarily in the 614 Buildings to verify Victoreen Integrator readings (HW-19454).

Particles were collected on small 1.8-in² filters in the method described under filterable beta emitters above, and on larger 26-in² (HW-18446) or 4 in. x 7 in. (HW-21566) CWS #6 filters through which 2 to 10 ft³/min of air was drawn by a moto-air pump (HW-18446). Samples collected on-site were usually autoradiographed within one week. Samples collected from distant locations were generally exposed within two weeks (HW-18446). Blank samples usually accompanied each set of film exposures (HW-20700). A sheet of polythene, 0.002 in. thick, was used as a shield between the filter and the film. The sensitivity of this method was determined by soaking small resin particles in an activated solution (HW-21566) and calibrating them with a mica-window counter (HW-20700). Resin particle activity was on the order of 5 disintegrations/minute/particle. Concentrations were calculated using particle counts and total air flow as determined from the hour meter on the pump (HW-21566).

Rain was collected in 500 ml collection vessels mounted under metal funnels (HW-18446).

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HW-20700. 1951. Paas, H. J., and W. Singlevich. *Radioactive Contamination in the Environs of the Hanford Works for the Period July, August, September, 1950.* General Electric Company, Hanford Works, Richland, Washington.

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Radiological Monitoring of Air, Rain, and Snow on and near the Hanford Site in 1951

Media Sampled

Exposure rates in air and contamination levels in air and rain were monitored both on and off the Site. Installation of the silver reactors was completed during the first quarter of 1951 (HW-21214).

Constituents Measured/Reported

Average dose rates (including background activity) inside the operating areas and in the vicinity of nearby communities were measured with Victoreen Integrations (HW-21214). These readings were supported by "C" chamber measurements at the same locations and by "M" and "S" chamber readings at locations between the operating areas (HW-21214). "C" chambers were located inside the small wooden building containing the Integron equipment (HW-24203). Two "C" chambers were used at each location (HW-21214). Chamber readings were generally lower during the first quarter of 1951 because of the installation of the silver reactors. Dose was evaluated by using the minimum reading from the two chambers. Natural background activity was 0.3 to 0.5 mrep/24 hours (HW-24203). Erroneous readings were deleted from the data (HW-21214). Monthly and quarterly averages for each sampling location were reported in units of mrep/24 hours (HW-21214, HW-22313, HW-23133, HW-24203).

Radioactivity from airborne beta and alpha emitters was measured by counting material collected on small paper filters. Results of beta counting for each sampling location were reported as monthly and quarterly averages and maximum weekly values for the quarter in units of $\mu\text{Ci/cc}$ (HW-21214, HW-22313, HW-23133, HW-24203). Only hourly maximum and average beta measurements were reported for special samples collected February 9, 1951 (HW-21214). Alpha measurements on small air filters were first reported during the second quarter of the year. Counts were made with standard alpha counters. Counting corrections included 52% for counter geometry and a 50% efficiency factor to correct for losses from self-absorption of alpha particles in the filter material. Monthly averages, maximum values, and number of samples were reported for each collection site (HW-22313, HW-23133, HW-24203) in units of $\mu\text{Ci/cc}$.

Iodine-131 concentrations in air were monitored with caustic scrubbers located downstream of the filter samples. Maximum concentrations were found directly downwind of the separations area stacks (HW-21214). Increased activity was seen in May and early June when the silver reactors failed and were not operating (HW-22313). Results for each sampling location were reported as

monthly and quarterly averages and maximum weekly values for the quarter. Concentrations were expressed in units of $\mu\text{Ci/cc}$ (HW-21214, HW-22313, HW-23133, HW-24203).

Particle concentrations in air were determined by autoradiographing all of the small filter samples plus some larger filters that were used solely for the sampling of airborne particulates. High particle concentrations seen in February, March, June, July, October, and November were related to nuclear tests in Nevada (HW-24203, HW-21214). Radioactive fallout from these tests was usually detected in the Pacific Northwest 2 to 5 days after the detonation, depending on wind speed and direction (HW-24203). Readings at sampling locations distant from Hanford were also elevated for these time periods (HW-24203, HW-21214). A particle increase prior to the late-October Nevada bomb test was attributed to a foreign source (HW-24203). High particle counts in May were related to the failure of the silver reactor in the 200-W Area (HW-21214). Maximum particle concentrations were seen inside the 222 labs, located in the 200 Areas (HW-21214). Results were primarily reported as monthly and quarterly averages for each sampling location in units of particles/ m^3 (HW-21214, HW-22313, HW-23133, HW-24203). However, weekly averages were reported for special samples collected in February and the first week of March (HW-21214). The total air volume sampled at each location for each sampling period was also reported.

Rain samples were routinely analyzed for total beta. Reported results for each sampling location included monthly averages and maximum weekly values for the quarter. Decay studies on rainwater samples with high activities showed I-131 to be approximately 80% of the total activity in all cases and as much as 95% in one case. The longer-lived components were not identified (HW-23133). A program was initiated in the first quarter of 1951 to study alpha activity in large volumes of rainwater. The roofs of several site buildings were eaved and large containers were installed to collect the run-off water (HW-22313). Results for the first samples were inconclusive (HW-21214), so similar determinations were discontinued in April 1951 pending improvements in analytical methods and techniques (HW-22313). Alpha monitoring was done on small volume (<100 ml) rainwater samples during the third and fourth quarters of 1951 but radioactivity levels were below detection limits (HW-23133, HW-24203). A few fourth-quarter samples were also checked for particle activity (HW-24203). Rainwater analyses were done at the environmental monitoring analysis laboratory (222-U laboratory) (HW-22313).

Sampling Locations

On-site and off-site sampling and monitoring locations for airborne filterable beta and alpha emitters (including dual unit air monitors), ionizing radiation (chambers), airborne radioactive particles, I-131 (scrubbers), and rain are listed in Table A.4 in the appendix.

Remote locations routinely sampled for airborne radioactive particles included Boise and Lewiston, Idaho; Klamath Falls and Meacham, Oregon; Stampede Pass, Walla Walla, and Spokane, Washington; and Great Falls, Montana (HW-21214, HW-22313, HW-23133, HW-24203). Beginning in October, samples were also collected in Yakima, Washington (HW-24203). Additional remote sampling was done as part of a joint fallout study with the Atomic Energy Commission between late January and early February in New Mexico, Utah, Idaho, and Washington. However, results were not reported in the reviewed document (HW-21214).

Sampling of airborne particles with the dual-unit air monitoring devices was initiated during the second quarter of 1951. Samples were exposed one week at locations in and near the 200 Areas and the Meteorology Tower (HW-22313).

Fixed Victoreen Integrators were located along perimeter fences within the operational areas on the Site and in the vicinity of nearby communities. The units were housed in the 614 Buildings.

A pair of detachable "C" type chambers was located near the Integrators, in both on- and off-site 614 Buildings (HW-21214).

Detachable "M" and "S" type chambers were exposed at portable monitoring stations between the operating areas and in residential areas (HW-21214, HW-22313).

In addition to routine scrubber samples, large portable scrubbers and small hand-operated units were used at locations downwind of the separations areas when various meteorological conditions caused stack gases to loop toward the ground (HW-21214, HW-22313, HW-23133, HW-24203). Sampling was usually confined to an area within a 3-mile radius of the 200 Area stacks (HW-22313).

Sampling Frequencies

Routine samples of filterable beta emitters were collected weekly (HW-21214).

Routine I-131 samples were also collected weekly. Special samples were collected with portable and hand-operated units when visual observation indicated that stack gases were looping close to ground level near the 200 Areas

(HW-21214). During periods of peak emissions, some of these non-routine samples were obtained over 15 to 30 minute (HW-24203, HW-21214), one hour (HW-23133, HW-22313), or two hour periods (HW-22313).

Results from Victoreen Integrators were reported for 8-hour intervals HW-21214, HW-22313). "C," "M," and "S" chambers were measured 2 or 3 times per week (HW-21214).

Generally, particle samples were obtained weekly (HW-23133, HW-21214). Daily monitoring occurred at 8 locations during the fourth quarter of 1951 to determine the exact date of maximum particle concentrations from Nevada nuclear tests (HW-24203).

Rain samples were collected at the Hanford Meteorology Station (near the 200 Areas) following each rainfall. Samples at other locations were collected weekly (HW-22313).

Sampling Methods

Weekly samples of filterable beta emitters were collected by drawing about 20,000 ft³ of air through a 1.8 in² CWS #6 filter paper. The volume of air passing through the filter was measured with a running-time meter used in conjunction with a precalibrated 1/4 horsepower moto-air pump (HW-21566, HW-20700, HW-24203). The running-time meter was attached to the primary power line of each sampling motor. When motors or pumps failed during a sampling period, volume determinations were based upon the number of hours accumulated on the meter prior to the failure (HW-20700). When removed, filters were held for two or three days before counting to allow any thorium or radon progeny present to decay (HW-22313, HW-19454, HW-20700). Beta counts were made with a thin mica-window counter. Window thickness varied from 3 to 5 mg/cm² (HW-21566). All collected filters were also exposed to K-type x-ray film for 168 hours. Contamination control (background) was monitored weekly by exposing unused filter paper to film in the same dark-room used for sample preparation. The detection limit was set at two particles per filter (HW-22072). Radioactive particle concentrations were determined by visually counting the dark spots on the exposed film (HW-18446).

Collected particles were prepared for decay and absorption studies by digesting the filter in nitric acid, removing any organic material by heating in a muffle furnace at 500°C, dissolving the salts in nitric acid, removing insoluble material with centrifugation and drying the supernate on a 1-inch stainless steel disk. It should be noted that this procedure would remove most of the I-131 and Ru-106 from the particles. The dried salts were then counted with a thin mica-window GM tube connected to a Higinbotham scaler. Samples were positioned 0.33 cm from the face of the tube and counted 30

minutes. Corrections were made for backscatter, self absorption, and window and air absorption (HW-22072).

Filters from dual-unit air monitors were collected weekly during most of the year. These filters supplemented the filters routinely collected for assessing the concentration of airborne beta emitters and were processed in the same manner (HW-22313, HW-23133, HW-24203).

Non-filterable I-131 was trapped in about 2 liters of solution containing 4 g of sodium hydroxide (NaOH) and 10.6 g (HW-18446) or 1.6 g (HW-21891) of sodium carbonate. A small amount of sodium iodide was also added as a carrier (HW-18446). This solution was usually located downstream of the air filter (HW-19454). Some I-131 samples were collected with a small MSA hand pump by pushing 10 liters of air through a caustic solution volume of less than 50 ml (HW-21566). The large radioiodine samplers used downwind of the separations areas were operated in a manner similar to that used for routine radioiodine samplers.

Ionization chambers were of two types; Victoreen Integrans (fixed) and "M," "S," and "C" (detachable). The detachable chambers were set out in pairs, supported on 5 ft high wooden stands. Radiation levels were evaluated by using the minimum reading obtained from the two chambers (HW-20700). Background values were not subtracted (HW-21566). "C" type chambers were used primarily in the 614 Buildings to verify the Victoreen Integrans readings (HW-19454).

Airborne particles were collected on the small 1.8-in² filters using the method described in the section discussing filterable beta emitters above, and on larger 6.3-in² and 23.5-in² CWS #6 filters at an air flow rate of 2 or 10 ft³/min, respectively. (HW-21214). Higher flow rates were used at distant locations to increase measurement sensitivity (HW-24203). Samples collected on-site were usually autoradiographed within one week. Samples collected from distant locations were generally exposed to x-ray film within two weeks (HW-24203). Concentrations were calculated using particle counts and total air flow as determined from the running-time meter on the pump (HW-21566).

Rain was collected in 500 ml collection vessels mounted below metal funnels (HW-18446).

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Radiological Monitoring of Air, Rain, and Snow on and near the Hanford Site in 1952

Media Sampled

Exposure rates in air and contamination levels in air and rain were monitored at locations on and off the Site.

Constituents Measured/Reported

A variety of air samples were analyzed for filterable beta and alpha emitters, non-filterable I-131, and airborne radioactive particles. Ambient radiation levels were also measured. Rain was primarily monitored for gross beta activity but was occasionally autoradiographed to check concentrations of radioactive particles (HW-25866, HW-26493, HW-27510, HW-27641, HW-28300).

Filterable beta and alpha emitters were sampled by drawing air through small paper filters using either of two types of samplers. Information reported for each sampling location included monthly and quarterly averages. Concentrations were given in units of $\mu\text{Ci/cc}$ (HW-25866, HW-26493, HW-27510, HW-27641).

A few sample filters that exhibited high gross beta or alpha counting rates were analyzed for specific contaminants. Concentrations of uranium, plutonium, and ruthenium were obtained from filters removed from a sampling station near the Redox Area and analytical results were reported (HW-27510).

Airborne I-131 was collected with caustic scrubbers. Collections from permanent sampling locations were supplemented with samples obtained with large portable scrubbers and small hand operated units. Values in the fourth quarter of 1952 were the lowest seen since I-131 sampling with scrubbers was started (HW-27641). Monthly and quarterly averages were reported for each sampling location along with the maximum weekly values for the quarter. Concentrations were expressed in units of $\mu\text{Ci/cc}$ (HW-25866, HW-26493, HW-27510, HW-27641).

Ambient radiation levels were measured with several types of ionization chambers. These included Victoreen Integrators and "C," "M," and "S" type units. Average monthly and quarterly concentrations (mrep/24 hours) were given for each sampling site. The number of Integrators used at each location was also reported (HW-25866, HW-26493, HW-27510, HW-27641).

Atmospheric concentrations of radioactive particles were monitored by autoradiographing both the filters collected for beta and alpha counts and

other larger filters that were used solely for atmospheric particle measurements. Daily and weekly values for the period October 1952 through the first week of January 1953 were given in a special report discussing increased atmospheric particle concentrations due to Nevada nuclear tests (HW-28300). The highest particle counts seen since the inception of the Hanford particle monitoring program were seen in May and June following another nuclear test in Nevada. Maximum values were seen in Boise, Idaho, and Great Falls, Montana (HW-26493). Results were reported for routine samples collected at each location and included monthly and quarterly averages and the volume of air sampled. All results were reported in units of particles/m³ (HW-25866, HW-26493, HW-27510, HW-27641, HW-28300).

Results reported for rain samples collected during 1952 were given as quarterly averages and maximum weekly values for the quarter. The number of samples obtained at each sample site were also included. Concentrations of beta and alpha emitters were reported in units of $\mu\text{Ci/cc}$ (HW-25866, HW-26493, HW-27510, HW-27641). Analytical procedures and calculation correction factors were the same as those used for other water samples (HW-25866). Some samples were autoradiographed during the third and fourth quarters of the year. Concentrations of airborne radioactive particles in third quarter samples were negligible (HW-27510) but particle concentrations in fourth quarter samples were very high (HW-27641).

Sampling Locations

Routine on-site and off-site sampling and monitoring locations for airborne filterable beta and alpha emitters (including samples collected with dual unit air monitors), ionizing radiation (chambers), airborne radioactive particles, gaseous I-131 (scrubbers), and rain are listed in Table A.5 in the appendix.

Airborne particles were routinely sampled at the following remote locations: Boise and Lewiston, Idaho; Klamath Falls and Meacham, Oregon; Stampede Pass, Walla Walla, Yakima, and Spokane Washington; and Great Falls, Montana (HW-25866, HW-26493, HW-27510, HW-27641). Particle samples were also collected from these locations during a special study done between October 1952 and early January 1953 (HW-28300).

Dual-unit air monitors were used to supplement data collected from routine air filter samples. Sample filters were changed at weekly intervals at locations in the 200 Areas, near the Hanford Meteorology Tower, and in Richland (HW-25866, HW-26493, HW-27510, HW-27641).

Victoreen Integrators were located along perimeter fences within the operational areas, and in the vicinity of nearby communities. The units were housed inside the 614 Buildings (HW-26493, HW-25866).

Pairs of detachable "C" type chambers were located in the 614 Buildings with the Integrans, both on and off the Site (HW-26493, HW-27510). Radiation was apparently measured within the building in which the units were housed (HW-26493).

Pairs of detachable "M" and "S" type chambers were exposed at locations in nearby communities, between the operating areas and in various military and construction camps located on the Site (HW-25866).

In addition to routine I-131 samplers (scrubbers), large portable scrubbers and small hand-operated units were used at locations downwind of the separations areas when meteorological conditions caused stack gases to loop toward the ground (HW-25866, HW-27510).

Sampling Frequencies

Routine filter samples were collected weekly (HW-26493).

Routine I-131 samples were collected daily or weekly (HW-25866, HW-26493, HW-27510). Special samples were collected with portable and hand-operated units when visual observation indicated that stack gases were looping close to ground level near the 200 Areas (HW-27510, HW-25866).

Victoreen Integrans readings were tabulated for 8-hour intervals (HW-27510, HW-25866). "C," "M," and "S" chambers were monitored 2 or 3 times per week (HW-21214).

Airborne particle samples were generally obtained weekly (HW-25866, HW-21214). However, some daily sampling occurred in May and June and between November 1952 and the first week of January 1953, when radioactive material from nuclear tests in Nevada passed over the region (HW-28300, HW-27641, HW-26493).

Rain collection frequencies were not discussed. In the past, samples were collected weekly at most locations (HW-22313).

Sampling Methods

Airborne beta emitters were collected by drawing about 20,000 ft³ of air per week through a CWS #6 paper filter that had a surface area of 1.8 in². The volume of air passing through the filter was determined from a running-time meter used in conjunction with a precalibrated 1/4 horsepower moto-air pump (HW-25866, HW-20700, HW-24203). The running-time meter was attached to the primary power line of each sampling motor. When motors or pumps failed during a sampling period, volume determinations were based upon the number of hours

accumulated on the meter prior to the failure (HW-20700). When removed, filters were held for two or three days before counting to allow any thorium or radon progeny present on the filter to decay (HW-22313, HW-19454, HW-20700). Beta counts were made with a thin mica-window counter. Window thickness varied from 3 to 5 mg/cm² (HW-21566). Collected filters were also exposed to K-type x-ray film for 168 hours to measure the number of radioactive particles on the filter. The sensitivity of this measurement was on the order of 3 disintegrations/minute/particle based on carbon-14 and strontium-90 standards (HW-26493). Over 1000 filters were autoradiographed during the second quarter of 1952 and approximately 20% were obtained from remote locations in Washington, Oregon, Idaho, and Montana (HW-26493).

Dual unit air monitors were operated for most of the year. The filters collected with these units supplemented the filters routinely collected for assessing the concentration of airborne beta emitters and were processed in the same manner (HW-26493, HW-27510, HW-25866).

Non-filterable I-131 was trapped in about 2 liters of solution containing 4 g of sodium hydroxide (NaOH) and 10.6 g (HW-18446) or 1.6 g (HW-21891) of sodium carbonate. A small amount of sodium iodide was also added as a carrier for the I-131 (HW-18446). This solution was usually located downstream of the air filter (HW-19454). Small MSA hand pumps were also used to collect airborne I-131. Samples were collected by pushing 10 liters of air through a caustic solution volume of less than 50 mls (HW-21566). The large portable scrubbers used downwind of the separations areas were operated in a manner similar to that used for routine radioiodine samplers. Sample counting rates obtained in the laboratory were corrected for geometry, yield efficiency, and volume (HW-25866).

Ionization chambers were of two types: Victoreen Integrans (fixed) and "M," "S," and "C" chambers (detachable). The detachable units were set out in pairs, supported by 5 ft high wooden stands. Radiation levels were evaluated by using the minimum discharge reading from the two chambers (HW-27510). Battery powered minometers were used to simultaneously charge and measure the discharge of these units (HW-27641). Background values (0.3 to 0.5 mrep/24 hours) were not subtracted (HW-21566, HW-25866). The results from the "C" type chambers were used to verify the Victoreen Integrans readings (HW-19454).

Airborne particles were collected on small filters as described in the paragraph above discussing airborne beta emitters, and on larger CWS #6 filters by drawing 2 to 10 ft³ of air per minute through the filters using a pre-calibrated moto-air pump (HW-21214, HW-25866, HW-28300). Higher volume air flows were used in samplers at distant locations to increase measurement sensitivity (HW-24203). Samples collected on-site were usually autoradiographed within one week following collection. Samples obtained from distant locations were generally autoradiographed within two weeks of collection

(HW-25866). Concentrations were calculated using particle counts and total air flow as determined from the running-time meter on the pump (HW-21566).

During the period of increased sampling in the fourth quarter of 1952, particles were collected on filters with surfaces of 28 in² using flow rates greater than 5 ft³/min and on filters with surfaces of 9 in² with flow rates below 5 ft³/min. Air was drawn through the filters with 1/4 or 1/2 horsepower moto-air pumps. On-site filters were autoradiographed the day after removal. Remote samples were exposed to film 2 to 5 days after removal. Normal film exposure was 168 hours. However, during periods of high particle concentrations, shorter preliminary exposures were also used. Total volume of air sampled was based on the accumulated hours of operation of a precalibrated pump as determined from the running-time meter installed on each motor. Autoradiograph sensitivity was 3 disintegrations/minute for an energy spectrum with maximum beta energies ranging from approximately 0.16 MeV to approximately 3.5 MeV. Sensitivity was determined by impregnating Dowex resin with solutions of Sr-90, Ru-106, and S-35, drying the resin on a piece of filter paper and exposing the particle to the film after determining its count rate with a standard beta counter (HW-28300).

Rain was collected in 500 ml collection vessels (HW-18446).

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Radiological Monitoring of Air, Rain, and Snow on and near the Hanford Site in 1953

Media Sampled

Ambient radiation levels were measured and samples of air and rain were collected both on and off the Site. In 1953, the emphasis of the monitoring program was shifted from the immediate environs to perimeter residential areas and remote locations (HW-29514).

Constituents Measured/Reported

Air samples were analyzed for filterable beta and alpha emitters, non-filterable I-131, and airborne radioactive particles. Rain was monitored primarily for gross beta activity but some samples were occasionally autoradiographed to determine the concentration of radioactive particulates. Ambient environmental radiation levels were also measured (HW-28009, HW-29514, HW-30174, HW-30744, HW-28925).

Filterable beta and alpha emitters were collected on filters using two types of samplers. Information reported for each sampling location included monthly and quarterly average concentrations, and the maximum weekly average concentration for the quarter. Concentrations of beta emitters were determined radiochemically (HW-30174) and were reported in units of $\mu\text{Ci/cc}$ (HW-28009, HW-29514, HW-30174, HW-30744). A portable, large-volume sampling unit was operated for nine hours on March 12 when Redox stack gas concentrations near the ground appeared high. Results of the filter analyses showed the presence of total beta activity, zirconium, ruthenium, and rare earth nuclides. Results were given (HW-28009, HW-28925). Routine samples collected between May 30, 1953, and June 6, 1953, indicated elevated levels of beta emitters due to fallout from Nevada nuclear weapons tests (HW-29514). Two special air filter samples were taken of smoke from a fire in the 300 Area burning pit on May 29, 1953. Data on concentrations of alpha emitters were reported (HW-29514).

Airborne I-131 was collected with caustic scrubbers. Collections from permanent sampling locations were supplemented with samples obtained with large portable scrubbers and small hand operated units during periods of low atmospheric dilution ratios ($<500:1$) at locations downwind of the 202-S stack (HW-29514, HW-30174). Samples were analyzed by radiochemical analyses (HW-30174) and monthly and quarterly average concentrations were reported for each sampling location, along with the maximum weekly values for the quarter. Concentrations were expressed in units of $\mu\text{Ci/cc}$ (HW-28009, HW-29514, HW-30174, HW-30744). Increased I-131 concentrations were seen in both the

first and third quarters of 1953 following the failure of the silver reactors at Redox and 222-S Plant (HW-28009, HW-30174).

Ambient radiation levels were measured with several types of ionization chambers. These included Victoreen Integrators and "C," "M," and "S" units. Average monthly and quarterly concentrations (mrep/24 hours for the first three quarters of 1953 and mrad/24 hours for the fourth quarter of 1953) were reported for each sampling site (HW-28009, HW-29514, HW-30174, HW-30744). Elevated dose rates in early June were attributed to fallout from nuclear weapons tests in Nevada (HW-29514).

Atmospheric concentrations of radioactive particles were monitored by autoradiographing the small filters routinely used for measuring concentrations of airborne beta and alpha emitters and the larger filters collected solely for measuring atmospheric particle concentrations. Disintegration rates as low as 3 to 5 disintegrations/minute were detected by this method (HW-30174). Results were reported for routine samples collected at each location and included monthly and quarterly average concentrations. All results were reported in units of particles/m³ of air (HW-28009, HW-29514, HW-30174, HW-30744). Because of nuclear weapons tests in Nevada in 1953, increased particle concentrations were seen in late May, late August, and mid-September (HW-30174, HW-29514). Increased particle concentrations were also seen in July, but the reason for the increase was not known (HW-30174).

Special particle sampling took place between March 3 and June 6, 1953, to monitor the fallout from nuclear weapons tests in Nevada. Samples were collected daily from two on-site and five off-site locations including: Walla Walla and Spokane, Washington; Lewiston and Boise, Idaho; and Klamath Falls, Oregon. Collected filters were autoradiographed for 168 hours and daily counts of radioactive particles were provided for all sites sampled in units of particles/m³. Additional twice-daily sampling (weekends excepted) was conducted in the 300 Area in an attempt to collect particle samples for electron microscope examinations. Studies had shown that nuclear explosions tended to produce spherical atmospheric particles. It was hoped that this diagnostic technique would make it possible to identify differences in fallout materials (HW-28925). No correlation was seen between peaks of high concentrations of spheres and individual tests. It was not possible to tell if peaks were from fallout from the most recent detonation or from the reappearance of a cloud from a preceding test (HW-28925).

Ambient gamma radiation was also measured continuously between March and June, 1953. Experimental equipment was set up outside the 329 Building, in the 300 Area (HW-28925).

Results reported for rain samples collected during 1953 included quarterly average concentrations and weekly maximum concentrations for the quarter. The

number of samples obtained at each sample site were also reported. Concentrations of beta and alpha emitters were reported in units of $\mu\text{Ci/cc}$ of rain (HW-28009, HW-29514, HW-30174, HW-30744). Some samples were autoradiographed to determine concentrations of radioactive particles (HW-28009, HW-29514). High concentrations of beta emitters were found in samples collected in late May. Counts were from 10 to 1000 times above normal levels during this period and the rain monitoring program was temporarily expanded to include a larger sampling area (see Table A.7 in the appendix). Concentrations at remote locations were similar to those found in the immediate environs of Hanford, indicating that the source of the particles was probably nuclear testing in Nevada (HW-29514). Mud samples were also collected at this time both on and off the Site. These samples were analyzed for beta and alpha activity. Results indicated that off-site beta levels were several hundred times higher than levels at Hanford while off-site alpha activity was comparable to normal Hanford levels (HW-29514). Concentrations of radioactive particles in third quarter rain samples were also elevated because of the influx of materials from off-site sources (HW-30174). A radiochemical analysis for fission products was conducted on a rain sample collected in the 300 Area on May 26, 1953. Decay, absorption, and gamma-ray spectrometer studies were done on other rain samples collected at about the same time (HW-28925).

Sampling Locations

Routine on-site and off-site sampling and monitoring locations for filterable beta emitters (including dual unit air monitors), ionizing radiation (chambers), airborne radioactive particles, I-131 (scrubbers), and rain are listed in Table A.6 in the appendix.

Sampling of particles at remote locations in 1953 was done routinely at Boise and Lewiston, Idaho; Klamath Falls and Meacham, Oregon; Stampede Pass, Walla Walla, Yakima, and Spokane, Washington; and Great Falls, Montana (HW-28009, HW-29514, HW-30174, HW-30744).

Dual-unit air monitors were used to supplement routine filter samples. Samplers were exposed one week at locations in the 200 Areas, near the Hanford meteorology tower, and in Richland (HW-28009, HW-29514, HW-30174, HW-30744).

Victoreen Integrators were operated in the 614 Buildings located along perimeter fences within the operational areas on Site and in the vicinity of nearby communities (HW-28009, HW-29514, HW-30174, HW-30744).

Pairs of detachable "C" type chambers were also located in the 614 Buildings around the perimeters of the operating areas (HW-28009, HW-30744).

Pairs of detachable "M" and "S" type chambers were located in nearby communities, between the operating areas, and in various military and construction camps located on the Site (HW-28009, HW-30744).

In addition to routine I-131 samplers, large portable scrubbers and small hand operated units were used at locations downwind of the separations areas when various meteorological conditions caused stack gases to loop toward the ground (HW-29514).

Sampling Frequencies

Routine filter samples for beta and alpha emitters were collected daily and weekly (HW-30744, HW-29514). Special samples were collected during a period of heavy fallout in late May and early June at half-hour and one-hour intervals (HW-29514).

Routine I-131 samples were collected daily or weekly (HW-25866, HW-26493, HW-27510). Special samples were collected with portable and hand operated units when visual observation indicated that stack gases were looping close to ground level near the 200 Areas (HW-30174, HW-29514).

Results from Victoreen Integrators were tabulated for 8-hour intervals HW-28009, HW-30744). "C," "M," and "S" chambers were monitored 1 to 3 times per week, depending on chamber capacity and historic dose levels at each location (HW-30174, HW-30744).

Particle samples were generally obtained daily and weekly (HW-30174, HW-30744).

The rain collection gauge located at the Hanford meteorology station was monitored after every measurable rainfall (HW-30744). Collection frequencies for other rain sampling stations were not discussed, but in the past, samplers had been monitored weekly, if it rained.

Sampling Methods

Filter samples were collected by drawing 2.0 to 2.5 ft³/min of air through a 1.8 in² CWS #6 filter paper (HW-30744). The volume of air passing through the filter was determined with a running-time meter used in conjunction with a precalibrated 1/4 horsepower moto-air pump (HW-25866, HW-20700, HW-24203). When removed, filters were held for two or three days before counting to allow any thorium or radon progeny present on the filters to decay away (HW-30744, HW-28009). All collected filters were also exposed to K-type x-ray film for 168 hours to determine the number of radioactive particles collected. The

sensitivity of this measurement was on the order of 3 to 5 disintegrations/minute/particle based on carbon-14 and strontium-90 standards (HW-30744).

Mobile, large-volume air samplers operated daily between March and June to sample filterable material in fallout originating off-site. Collections were made daily between 8:00 a.m and 4:00 p.m. at flows of 120 cfm. These filters were autoradiographed to determine concentrations of radioactive particles, then analyzed radiochemically to measure gross beta activity.

Dual-air monitors were used throughout the year. Filters from these samplers supplemented the air filters used for monitoring levels of beta and alpha emitters and were processed in the same manner (HW-28009, HW-29514, HW-30174, HW-30744). Units at each location were operated alternately, with each unit representing 50% of a month's sample (HW-28009).

Non-filterable I-131 was trapped in approximately 2 liters of a scrubber solution containing about 4 g of sodium hydroxide (NaOH) and 10.6 g (HW-18446) or 1.6 g (HW-21891) of sodium carbonate. A small amount of sodium iodide was also added as a carrier (HW-18446). This solution was usually located downstream of the air filter (HW-19454). When small MSA hand pumps were used, I-131 was collected by pushing 10 liters of air through a caustic solution volume of less than 50 ml (HW-21566). The large portable scrubbers that were used downwind of the separations areas were operated in a manner similar to the routinely used scrubbers. Counts were corrected for geometry, yield efficiency, and volume (HW-25866).

Ionization chambers were of two types: Victoreen Integrans (fixed) and "M," "S," and "C" chambers (detachable). These units were set out in pairs, and were supported by wooden stands that were about 5 feet tall. Radiation levels were evaluated using the minimum discharge reading from the two chambers (HW-29514, HW-28009). Battery powered Minometers were used to charge and measure the discharge of these units (HW-28009). Background values (0.3 to 0.5 mrep/24 hours) were not subtracted (HW-21566, HW-25866). "C" type chambers were used to verify the Victoreen Integrans readings (HW-19454). "Film packets" were also used for recording radiation dose at some chamber stations. Readings obtained from these packets were used to corroborate chamber readings (HW-30174).

Airborne radioactive particles were collected on the small filters as described above, and on larger CWS #6 filters by drawing 2 to 10 ft³/min of air through the filters with a pre-calibrated moto-air pump (HW-21214, HW-25866, HW-30174). Larger air sample volumes were used at distant locations to increase measurement sensitivity (HW-24203). Filter samples collected on-site were usually autoradiographed within one week. Filter samples collected from distant locations were generally radioautographed within two

weeks (HW-25866). Concentrations were calculated using particle counts and the computed sample volume (HW-21566).

Rain was sampled from rain collection gauges when it rained (HW-30174).

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Radiological Monitoring of Air, Rain, and Snow on and near the Hanford Site in 1954

Media Sampled

Exposure rates in air and contamination levels in air, rain, and snow were monitored at locations on and near the Site.

Constituents Measured/Reported

Air samples were analyzed for filterable beta and alpha emitters, non-filterable I-131, and atmospheric particles. Ambient radiation levels were also measured. Rain was primarily monitored for gross beta activity but was occasionally autoradiographed to measure particle concentrations (HW-31818, HW-33896, HW-36504, HW-36505).

Filterable beta and alpha emitters were sampled by drawing air through small paper filters with two types of samplers. Information reported for each sampling location included monthly and quarterly average concentrations and the maximum weekly average concentration for the quarter. Beta concentrations were given in units of $\mu\text{Ci/cc}$ (HW-33754, HW-33896) or $\mu\text{Ci/ml}$ (HW-36504, HW-36505). The increased concentrations of beta emitters observed in May may have been related to a series of nuclear detonations in the South Pacific. Radiochemical analyses and decay studies of the filters revealed the presence of material typical of fallout debris (HW-33896). Higher readings in November were also related to nuclear activities at remote off-site locations (HW-36505).

Iodine-131 concentrations in air were monitored with caustic scrubbers that were located downstream of the filters used for collecting alpha and beta emitters. Samples were analyzed by radiochemical analyses (HW-31818) and monthly and quarterly average concentrations were reported for each sampling location along with the maximum weekly values for the quarter. Concentrations were expressed in units of $\mu\text{Ci/cc}$ (HW-31818, HW-33896) or $\mu\text{Ci/ml}$ (HW-30174, HW-30744). Increased I-131 concentrations were noted during March. Between March 13 and March 15, 11 curies of I-131 were released daily from the Separations Areas (HW-31818).

Ambient radiation levels were monitored with several types of ionization chambers. These included Victoreen Integrators and "C," "M," and "S" units. Average monthly and quarterly concentrations (mrad/24 hours) were reported for each sampling site (HW-31818, HW-33896, HW-36504, HW-36505). Elevated dose rates recorded within a 5-mile radius of the Separations Areas early in the first quarter of 1954 were related to a release of more than 300 Ci of

ruthenium from Redox in January (HW-33754). Continued high ruthenium ground contamination resulted in increased readings at the Redox and 200-W Integron stations during the second quarter of 1954 (HW-33896).

Radioactive particle concentrations in air were monitored by autoradiographing the filters collected for determining the concentrations of beta and alpha emitters in air and other, larger, filters that were used solely for counting airborne radioactive particles. This "filming" technique had a sensitivity of 5 disintegrations/minute/particle based on ruthenium, sulfur-35 and carbon-14 standards (HW-31818). Results were reported for routine samples collected at each location and included monthly and quarterly average concentrations and the volume of air sampled. All results were reported in units of particles/m³ (HW-31818, HW-33896, HW-36504, HW-36505). Particle concentrations at nearly all Hanford Area and remote sampling locations were above average during the second, third and fourth quarters of 1954. Deposition dates and radiochemical analyses of particle filters indicated that the particles were from sources other than Hanford (HW-36504, HW-33896, HW-36505).

Results reported for rain samples collected during 1954 were given as quarterly average concentrations and maximum weekly values for the quarter. The number of samples obtained at each sample site was also reported. Concentrations of beta emitters were reported in units of $\mu\text{Ci/cc}$ (HW-31818, HW-33896) or $\mu\text{Ci/ml}$ (HW-36504, HW-36505). Several evaporated rain samples collected at perimeter locations during the first quarter of 1954 were autoradiographed to determine particle concentrations (HW-31818). Selected samples were also radiochemically analyzed for alpha emitters and test results were reported (HW-31818, HW-33896). Several snow samples were collected in and near the 200-W Area during the month of January. These samples were analyzed radiochemically and some analytical results were reported (HW-31818).

Several large releases of radioactive ruthenium from the Redox stacks in the 200-W Area occurred in 1954. Much of the area around the Redox facility was contaminated, as were some off-site areas on Wahluke Slope and areas near (but not in) Richland. Unplanned releases of particles contaminated with radioactive ruthenium had been a problem at Redox since 1952. Ammonium nitrate crystals apparently formed on the interior walls of the Redox stack and then became contaminated with ruthenium. The crystals eventually flaked off the wall, were carried out the stack, and were deposited in the surrounding environs. Some of these particles were up to several inches in diameter. However, due to their fragile crystalline structure and chemical makeup, most particles, apparently, were not visible by the following day (HW-32437).

Sampling Locations

On-site and off-site sampling and monitoring locations for filterable alpha and beta emitters, ambient radiation levels, airborne radioactive particles, I-131 (scrubbers), and rain that were used routinely in 1954 are listed in Table A.8 in the appendix.

Remote locations routinely sampled for radioactive particles included Boise and Lewiston, Idaho; Klamath Falls and Meacham, Oregon; Seattle, Walla Walla, Yakima, and Spokane, Washington; and Great Falls, Montana (HW-31818, HW-33896, HW-36504, HW-36505).

Filters from dual-unit air monitors were used to supplement filter samples collected for analysis of beta emitters. Dual unit filters were exposed for one week periods at locations in the 200-W and 200-E Areas and in Richland (HW-31818, HW-33896, HW-36504, HW-36505).

Victoreen Integrators were housed in the 614 Buildings located along perimeter fences within the operational areas on the Site, and in the vicinity of nearby communities (HW-31818, HW-33896, HW-36504, HW-36505).

Pairs of detachable "C" type chambers were located around the perimeters of the manufacturing areas (HW-31818, HW-33896, HW-36504, HW-36505).

Pairs of detachable "M" and "S" type chambers were located in nearby communities, between the operating areas, and in various military and construction camps located on the Site (HW-31818, HW-33896, HW-36054, HW-36505). These chambers were also used for obtaining supplemental measurements at monitoring stations where confirming data was desirable (HW-31818).

Sampling Frequencies

Routine samples of filterable beta and alpha emitters were collected daily and weekly (HW-31818, HW-33896).

Routine I-131 samples were collected daily or weekly (HW-33896, HW-31818).

Results of Victoreen Integrator measurements were tabulated at 8-hour intervals (HW-33896, HW-36505). "C," "M," and "S" ionization chambers were read daily or weekly (HW-36504, HW-33896, HW-36505) or one to three times weekly (HW-31818).

Airborne radioactive particle samples were generally obtained daily and weekly (HW-30174, HW-30744).

The rain collection gauge located at the Hanford Meteorology Station was monitored after every measurable rainfall (HW-33896, HW-36504). Collection frequencies for other rain sampling stations were not discussed, but in the past samplers had been monitored weekly when it rained.

Sampling Methods

Filterable beta samples were collected by drawing 2.0 to 2.5 ft³ of air (HW-31818) through a small filter paper (HW-30744). The volume of air passing through the filter was determined with a running-time meter used in conjunction with a precalibrated 1/4 horsepower moto-air pump (HW-25866, HW-20700, HW-24203). Volume determinations were based upon the number of hours accumulated on the meter (HW-20700). When removed, filters were held for two or three days before counting to allow any thorium or radon progeny to decay (HW-31818, HW-33896). All collected filters were also exposed to K-type x-ray film for 168 hours to measure the number of radioactive particles. The sensitivity of this measurement was on the order of 5 disintegrations/minute/particle based on ruthenium, carbon-14 and sulfur-35 standards (HW-31818).

Filters from dual-unit air monitors were collected throughout the year. These filters supplemented the routine air filter samples and were processed in the same manner (HW-31818, HW-33896, HW-36504).

Non-filterable I-131 was trapped in approximately 2 liters of scrubber solution containing 4 g of sodium hydroxide and 10.6 g (HW-18446) or 1.6 g (HW-21891) of sodium carbonate. A small amount of sodium iodide was also added as a carrier for the I-131 (HW-18446). This scrubber was usually located downstream of the air filter (HW-19454). Samples were analyzed radiochemically (HW-33896).

Ionization chambers were of two types: Victoreen Integrans (fixed) and "M," "S," and "C" chambers (detachable). These detachable units were set out in pairs and were supported by wooden stands that were about 5 ft tall. Radiation levels were evaluated by using the minimum discharge reading from the two chambers (HW-31818, HW-33896). Battery powered minometers were used to charge and measure the discharge of these units (HW-28009). Background values were not subtracted (HW-21566, HW-25866). "C" type chambers were used to verify Victoreen Integrans measurements (HW-19454).

Particles were collected on the small filters in the method described earlier, and on larger CWS #6 filters by drawing 2 to 10 ft³/min of air through the filters using a pre-calibrated moto-air pump (HW-31818, HW-33896, HW-30174). Higher volume air samplers were used at distant locations to increase measurement sensitivity (HW-24203). Samples collected on-site were usually autoradiographed within one week. Samples collected from distant locations

were generally exposed to x-ray film within two weeks (HW-25866). Concentrations were calculated using particle counts and total air flow as determined from the running-time meter on the pump (HW-21566).

Rain was sampled from collection gauges (HW-30174).

Notes

Two special studies on the ruthenium particle problem were issued during 1954. The first (HW-32473) was authored by D. P. Ebright and was titled A History of the Redox Ruthenium Problem. The second was written by H. M. Parker and was called Status of Ground Contamination Problem.

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Radiological Monitoring of Air, Rain, and Snow on and near the Hanford Site in 1955

Media Sampled

Ambient radiation levels were measured and samples of air, snow, and rain were collected both on and off the Site.

Constituents Measured/Reported

Ambient radiation levels were measured and air samples were analyzed for filterable beta and alpha emitters, non-filterable I-131, and radioactive atmospheric particles. Rain was primarily monitored for gross beta activity but was occasionally autoradiographed to measure concentrations of radioactive particles (HW-36506, HW-38566, HW-39429, HW-40671).

Filterable beta and alpha emitters were sampled by drawing air through small paper filters using two types of samplers. Information reported for each sampling location included monthly and quarterly averages for 1955, and the maximum weekly average for each quarter of the year. Concentrations of beta emitters were reported in units of $\mu\text{Ci/ml}$ (HW-36506, HW-38566, HW-39429, HW-40871). The number of beta emitters measured during the second quarter of 1955 was higher at remote locations than at sampling sites at or near the Hanford Project. These increased beta concentrations were attributed to radioactive materials originating from sources other than Hanford (HW-38566, HW-39429).

Atmospheric I-131 was collected with caustic scrubbers. Samples were analyzed by radiochemical analyses (HW-36506, HW-38566) and monthly and quarterly averages for 1955 were reported for each sampling location along with the maximum weekly values for each quarter. Concentrations were expressed in units of $\mu\text{Ci/ml}$ (HW-36506, HW-38566, HW-39429, HW-40871). A significant increase in atmospheric I-131 was observed at sampling locations on the Site in March. This increase coincided with abnormal emissions from the reprocessing plant stacks during this period. Readings at sampling sites located near neighboring communities reflected normal levels (HW-36506).

Ambient radiation levels were monitored with several types of ionization chambers. These included Victoreen Integrators and "C," "M," and "S" type units. Average monthly and quarterly concentrations (mrad/24 hours) were reported for each sampling site (HW-36506, HW-38566, HW-39429, HW-40871).

Concentrations of radioactive particles in the atmosphere were monitored by autoradiographing the filters collected for beta and alpha counts as well as

other, larger, filters that were used solely for atmospheric particle measurements. Results were reported for routine samples collected at each location and included monthly and quarterly averages and the volume of air sampled. All results were reported in units of particles/m³ (HW-36506, HW-38566, HW-39429, HW-40871). During the second and fourth quarters of 1955, particle concentrations at all locations were elevated. These increases were attributed to contamination from sources other than Hanford (HW-38566, HW-40871).

Results reported for rain samples collected during 1955 were given as quarterly averages and maximum weekly values for the quarter. The number of samples obtained at each sample site were also included. Concentrations of beta emitters were reported in units of $\mu\text{Ci/ml}$ (HW-36506, HW-38566, HW-39429, HW-40871).

Sampling Locations

Routine on-site and off-site sampling and monitoring locations for filterable beta and alpha emitters (including dual unit air monitors), ionizing radiation (chambers), airborne radioactive particles, I-131 (scrubbers), and rain are listed in Table A.9 in the appendix.

"The pending closure of the North Richland area to civilians prompted the moving of two air sampling stations (filterable beta) from that vicinity." (HW-36506, p.35)

Routine remote particle sampling locations included Boise and Lewiston, Idaho; Klamath Falls and Meacham, Oregon; Seattle, Walla Walla, Yakima, and Spokane, Washington; and Great Falls, Montana (HW-36506, HW-38566, HW-39429, HW-40871).

Dual-unit air monitors were used to supplement collections of filterable beta emitters. Samples were exposed for one-week periods at locations in the 200-E Area and in Richland (HW-36506, HW-38566, HW-39429, HW-40871).

Fixed Victoreen Integrators were located in the 614 Buildings along perimeter fences within the operational areas on the Site and in the vicinity of nearby communities (HW-36506, HW-38566, HW-39429, HW-40871).

Pairs of detachable "C" type chambers were located around the perimeters of the operating areas (HW-36506, HW-38566, HW-39429, HW-40871).

Pairs of detachable "M" and "S" type chambers were located in nearby communities, between the operating areas, and in various military and construction camps located on the Site (HW-36506, HW-38566, HW-39429, HW-40871).

Sampling Frequencies

Routine samples of filterable beta and alpha emitters were collected daily and weekly (HW-36506, HW-39429).

Routine I-131 (scrubber) samples were collected daily or weekly (HW-36506, HW-38566).

Victoreen Integrators were operated continually and the results tabulated as doses per 8-hour interval (HW-40871, HW-39429). "C," "M," and "S" chambers were read daily or weekly (HW-36506, HW-38566).

Samples of airborne radioactive particles were generally obtained daily or weekly (HW-39429, HW-38566).

Collection frequencies for rain were not discussed, but in the past, the sampler located near the Hanford Meteorology Station was monitored following each rainfall and the samplers located at other sites were monitored weekly.

Sampling Methods

Samples of filterable beta emitters were collected by drawing 2.0 to 2.5 ft³/min of air (HW-36506) through small paper filters (HW-30744). The volume of air passing through each filter was determined with a running-time meter used in conjunction with a precalibrated 1/4 horsepower moto-air pump (HW-25866, HW-20700, HW-24203). The running-time meter was attached to the primary power line of each sampling motor. Sample volume determinations were based upon the number of hours accumulated on the meter (HW-20700). After the samples were collected, filters were held for seven days (HW-36506) or "several" days (HW-38566) before counting to allow any thorium or radon progeny present to decay. All collected filters were also exposed to K-type x-ray film for 168 hours to determine the number of radioactive particles present (HW-36506).

Filters from dual unit air monitors were collected throughout the year. These filters supplemented the air filters routinely collected for measuring the concentrations of airborne beta and alpha emitters (HW-39429, HW-40871).

Non-filterable I-131 was trapped in scrubbers containing about 2 liters of a caustic solution that included 4 g of sodium hydroxide and 10.6 g (HW-18446) or 1.6 g (HW-21891) of sodium carbonate. A small amount of sodium iodide was also added as a carrier for the I-131 (HW-18446). This solution was usually located downstream of the air filter (HW-19454). Samples were analyzed radiochemically (HW-38566).

Ionization chambers were of two types: Victoreen Integrans (fixed) and "M," "S," and "C" chambers (detachable). The detachable units were set out in pairs and were supported by wooden stands that were about 5 ft tall. Radiation levels were evaluated by using the minimum discharge reading from the two chambers (HW-39429, HW-36506). Battery powered minometers were used to charge and measure the discharge of these units (HW-28009). "C" type chambers were used to verify Victoreen Integrans readings (HW-19454).

Airborne radioactive particles were collected on the small filters in the method described under filterable beta emitters above, and on larger CWS #6 filters by drawing 2 to 10 ft³/min (HW-36506) through the filters using a pre-calibrated moto-air pump (HW-31818, HW-30174). Higher air flows were used at distant locations to increase measurement sensitivity (HW-24203). Samples collected on-site were usually autoradiographed within one week. Samples collected from distant locations were generally exposed to x-ray film within two weeks (HW-25866). Particle concentrations were calculated using particle counts and total air flow as determined from the running-time meter on the pump (HW-21566).

Rain was sampled from collection gauges (HW-30174).

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Radiological Monitoring of Air, Rain, and Snow on and near the Hanford Site in 1956

Media Sampled

Ambient radiation levels were measured, and samples of air, snow, and rain were collected both on and off the Site.

Constituents Measured/Reported

Air samples were analyzed for filterable beta and alpha emitters, non-filterable I-131, and atmospheric radioactive particles. Ambient environmental radiation levels were also measured (HW-43012, HW-44215, HW-46726, HW-48374). Rain was primarily monitored for gross beta activity but was occasionally autoradiographed to determine concentrations of radioactive particles (HW-43012, HW-44215).

Filterable beta and alpha emitters in air were sampled by drawing air through small paper filters using two different types of samplers. Information reported for each sampling location included monthly and quarterly average concentrations, and the maximum weekly average concentration for the quarter. Beta activity concentrations were reported in units of $\mu\text{Ci/ml}$ (HW-43012, HW-44215, HW-46726, HW-48374). Increased concentrations of beta emitters were seen during the first quarter of 1956 due to nuclear weapons tests and to the burial of contaminated solid wastes and equipment on-site in February (HW-43012). Levels of airborne beta emitters were even higher from April through October when fallout from off-site nuclear bomb testing increased (HW-44215, HW-46726). More normal levels returned in November and December (HW-48374).

Atmospheric I-131 was collected with caustic scrubbers. Samples were analyzed by radiochemical analyses (HW-43012, HW-44215) and monthly and quarterly average concentrations were reported for each sampling location along with the maximum weekly concentration for the quarter. Concentrations were expressed in units of $\mu\text{Ci/ml}$ (HW-43012, HW-44215, HW-46726, HW-48374). Activity levels during the first and fourth quarters of 1956 were normal (HW-43012, HW-48374). Elevated levels during the second quarter were due to increased emissions from the separations plants in April and May and to weapons test fallout. During this period, concentrations in residential areas bordering the Site were at or slightly above the detection limit (HW-44215). Third quarter increases were related only to nuclear fallout (HW-46726).

Ambient radiation levels were routinely monitored with several types of ionization chambers. These included Victoreen Integrators and "M" and "S" type

units. "C" type chambers were not discussed in the 1956 quarterly reports but HM chambers were mentioned in the fourth quarter report. Average monthly and quarterly concentrations (mrad/24 hours) were given for each sampling site. Data collected with the HM-type chambers were not reported (HW-43012, HW-44215, HW-46726, HW-48374). Higher than normal radiation readings seen in the fourth quarter of 1956 were attributed to fallout from nuclear weapons tests and to instrument problems (HW-48374).

Atmospheric concentrations of radioactive particles were monitored by autoradiographing the filters collected routinely for beta and alpha counting and other, larger, filters that were used solely for atmospheric particle measurements. Results were reported for routine samples collected at each location and included monthly and quarterly average concentrations and the volume of air sampled. All results were reported in units of particles/m³ (HW-43012, HW-44215, HW-46726, HW-48374). Elevated particle counts were common for most of 1956 as a result of the increase in nuclear test fallout. Burial of contaminated solid waste and equipment during February also contributed to first quarter activities (HW-43012).

Results of rain and snow sampling were only reported for samples collected during the first two quarters of 1956. Quarterly average concentrations and maximum weekly values for the quarter were reported. The number of samples obtained at each sample site was also included. Beta activity concentrations were reported in units of $\mu\text{Ci/ml}$. Elevated beta activity was seen in both the first and second quarters of 1956 (HW-43012, HW-44215).

Sampling Locations

Routine on-site and off-site sampling and monitoring locations for filterable beta and alpha emitters (including dual unit air monitors), ionizing radiation (chambers), airborne radioactive particles, nonfilterable I-131 (scrubbers), and rain are listed in Table A.10 in the appendix.

Routine remote particle-sampling locations included Boise and Lewiston, Idaho; Klamath Falls and Meacham, Oregon; Seattle, Walla Walla, Yakima, and Spokane, Washington; and Great Falls, Montana (HW-43012, HW-44215, HW-46726, HW-48374).

Dual unit air monitors were used to supplement collections of filterable beta emitters during the first three quarters of 1956. Sample filters were exposed for periods of one week at locations in the 200-E Area and in Richland (HW-43012, HW-44215, HW-46726).

Victoreen Integrators were located in the 614 Buildings along perimeter fences within the operational areas on the Site, and in the vicinity of nearby communities (HW-43012, HW-44215, HW-46726, HW-48374).

Pairs of detachable "M" and "S" type chambers were located in nearby communities, between the operating areas, and in various military and construction camps located on the Site (HW-43012, HW-44215, HW-46726, HW-48374).

Information on the locations of HM chambers was not provided (HW-48374).

Sampling Frequencies

Routine filter samples used for measuring concentrations of airborne beta and alpha emitters were collected daily and weekly (HW-43012, HW-44215).

Routine I-131 (scrubber) samples were collected daily or weekly (HW-43012, HW-44215).

Victoreen Integrators were operated continually and the results were tabulated as the accumulated dose over 8-hour intervals (HW-43012, HW-44215). "M" and "S" chambers were read daily or weekly (HW-44215, HW-46726). No information was located on HM chamber sampling frequencies.

Samples of airborne radioactive particles were generally obtained daily or weekly (HW-43012, HW-44215).

Collection frequencies for rain were not discussed, but in the past, the sampler located near the Hanford Meteorology Station was collected following each rainfall and the samplers located at other sites were checked weekly.

Sampling Methods

Samples of airborne filterable beta emitters were collected by drawing 2.0 to 2.5 ft³/min of air (HW-43012) through small CWS #6 filter papers (HW-30744). The volume of air passing through the filter was determined from a running-time meter used in conjunction with a precalibrated 1/4 horsepower moto-air pump (HW-25866, HW-20700, HW-24203). The running time meter was attached to the primary power line of each sampling motor. Volume determinations were based upon the number of hours accumulated on the meter (HW-20700). After removal, filters were held for several days (HW-46726) before counting to allow any thorium or radon progeny present to decay. All collected filters were also exposed to K-type x-ray film for 168 hours to determine the number of radioactive particles present (HW-43012).

Filters from dual-unit air monitors were collected weekly from January through September. The results from these filter samples supplemented those from the routine air filters (HW-43012, HW-44215).

Non-filterable I-131 was trapped in about 2 liters of caustic scrubber solution containing 4 g of sodium hydroxide and 10.6 g (HW-18446) or 1.6 g (HW-21891) of sodium carbonate. A small amount of sodium iodide was also added as a carrier for the I-131 (HW-18446). The scrubber solution was usually located downstream of the air filter (HW-19454). Samples were analyzed radiochemically (HW-43012).

Ionization chambers were generally of two types: Victoreen Integrators (fixed) and "M" and "S" chambers (detachable). However, HM type chambers were also used. The detachable units were set out in pairs and were supported on wooden stands about 5 ft tall. Radiation levels were evaluated by using the minimum discharge reading from the chambers (HW-43012, HW-44215). Battery powered minometers were used to charge and measure the discharge of these units (HW-28009). Operation of the HM type chambers was not discussed.

Airborne radioactive particles were collected on the small filters in the method described above, and on larger CWS #6 filters by drawing 2 to 10 ft³/min (HW-43012) through the filters using a pre-calibrated moto-air pump (HW-31818, HW-30174). Higher air flow rates were used at distant locations to increase measurement sensitivity (HW-24203). Samples collected on-site were usually autoradiographed within one week. Samples collected from distant locations were generally exposed to x-ray film within two weeks (HW-25866). Particle concentrations were calculated using particle counts and total air flow as determined from the running-time meter on the pump (HW-21566).

Rain was sampled from collection gauges (HW-30174).

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Radiological Monitoring of Air, Rain, and Snow on and near the
Hanford Site in 1957

Media Sampled

Ambient radiation levels were measured and air samples were collected both on and off the Site.

Constituents Measured/Reported

Air samples were analyzed for filterable beta emitters, non-filterable I-131, and airborne radioactive particles. Ambient environmental radiation levels were also measured (HW-51009, HW-52803, HW-54841, HW-54842). Filterable beta (and alpha) activity concentrations in air and beta activity concentrations in rain and snow were not reported in the 1957 quarterly reports.

Atmospheric I-131 was collected with caustic scrubbers. Samples were analyzed radiochemically and monthly and quarterly average concentrations were reported along with the maximum weekly concentration for the quarter. Specific sampling locations were not listed. Composite values were given for general areas in and near the Site. Concentrations were expressed in units of $\mu\text{Ci/cc}$ (HW-54842, HW-54841, HW-51009, HW-52803).

Ambient radiation levels were routinely measured with several types of ionization chambers. These included Victoreen Integrators and HM, "M," and "S" type units. Average quarterly concentrations (mrad/day) were reported for sampling areas listed in the quarterly Hanford Environs Reports (HW-54842, HW-54841, HW-51009, HW-52803). Data collected with the HM type samplers were reported as part of the Integrator summaries (HW-54842, HW-54841, HW-51009, HW-52803).

Concentrations of airborne radioactive particles were monitored by autoradiographing the filters collected for beta and alpha counting and other, larger filters that were used solely for atmospheric particle measurements. In the quarterly Hanford Environs Reports, results were reported for routine samples collected at each remote location and for general areas within and near the Site. All results were reported in units of particles/ m^3 (HW-54842, HW-54841, HW-51009, HW-52803).

Sampling Locations

Routine on-site and off-site sampling and monitoring locations for ionizing radiation (chambers) and airborne particulates are listed in Table A.11 in the appendix.

Routine remote particle-sampling locations included Boise and Lewiston, Idaho; Klamath Falls and Meacham, Oregon; Seattle, Walla Walla, Yakima, and Spokane, Washington; and Great Falls, Montana (HW-54842, HW-54841, HW-51009, HW-52803).

Victoreen Integrans and HM chambers were located in small air monitoring buildings called 614 Buildings scattered throughout the Hanford Site and in the nearby communities of Richland, Kennewick, Pasco, and Benton City (HW-52038). According to HW-52038, they were located so as to monitor each 'area' and each section of an 'area' where differing environmental radiation sources and/or meteorological conditions might have produced distinct exposure patterns (HW-52038).

Pairs of detachable "M" and "S" type chambers were located in nearby communities, between the operating areas and in various military and construction camps located on the Site.

Sampling Frequencies

Samples of routine filterable beta and alpha emitters were collected weekly (HW-52038).

Routine I-131 (scrubber) samples were collected weekly (HW-89066, HW-52038)).

Victoreen Integrans and HM chambers were read weekly. Accumulated dose readings were tabulated by 8-hour intervals (HW-40871, HW-52038). "M" and "S" chambers were read daily or weekly (HW-44215, HW-46726).

Samples of airborne radioactive particles were generally obtained weekly (HW-43012, HW-44215).

Sampling Methods

Non-filterable I-131 was trapped in scrubbers containing about 2 liters of a caustic solution consisting of 4 g of sodium hydroxide and 10.6 g (HW-18446) or 1.6 g (HW-21891) of sodium carbonate. A small amount of sodium iodide was also added as a carrier for the I-131 (HW-18446). The scrubber was usually located downstream of the air filter (HW-19454). Weekly monitoring of these samplers was made possible through the use of automatic water feeders which

kept the liquid in the scrubber at the desired level (HW-52038). Samples were analyzed radiochemically (HW-43012).

Total environmental external radiation exposure was measured by several methods. Portable ionization chambers, similar in operation to standard pencil type personnel dosimeters, were operated in locations where no electric power was available. Semi-weekly readings of these chambers was necessary to avoid complete discharge between visits. Locations monitored included Army Camps and well-traveled roads where exposure to personnel traveling on the project was of interest (HW-52038).

Another type of external radiation dose measurement was made by HM chambers and Integrans. These devices measured dose rate and accumulated total 8-hour dose, respectively, providing continuous records on strip charts (HW-52038).

Film badges, located in each 614 building, were another means of recording external radiation. These badges were used as an inexpensive backup to HM chambers and Integrans, in the event of a power failure (HW-52038).

Airborne radioactive particles were collected on 2 in. x 4 in. HV-70 asbestos filter paper through which $2.0 \text{ ft}^3/\text{min}$ of air was drawn by an electrically driven pump. These filters were counted in the lab for gross beta and alpha emitters and then autoradiographed for one week on K-type x-ray film to determine the number of radioactive particles per unit volume of air sampled. Particle concentrations were calculated using particle counts and total air flow as determined from the running-time meter on the pump (HW-21566).

Monitoring of the time of arrival of airborne radioactive particulates and identification of short-lived natural activity was accomplished through the operation of continuously monitored filter samplers. These 1.5 in. diameter HV-70 filter papers were mounted over a glass-walled GM tube which in turn was connected to a Decade type scaler and a recorder (HW-52038).

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APPENDIX

Sampling Locations, 1948-1957

TABLE A-1. Routine Sampling Locations for Victoreen Integrators, "C" Type Ionization Chambers, "M" and "S" Type Detachable Ionization Chambers, Air Filtering Units, Constant Iodine Monitors, and Rain in 1948

<u>Sampling Locations</u>	<u>Integron</u>	<u>"M"&"S"</u>	<u>"C"</u>	<u>Filters</u>	<u>I-131</u>	<u>Rain</u>
Rt 10, mile 1		X				
mile 3		X				
Rt 1, mile 8		X				
Intersection Rt 1 & Rt 4N		X				
Rt 4S, mile 10		X				
mile 6		X				X
mile 4						X
mile 16		X				
mile 22		X				X
300 Area	X		X	X,P		X
Rt 3, 622 Bldg.						X
mile 1		X				
Meteorology Tower, 200'		X				
Junction Rt 6 and 11-A						X
Rt 11-A, mile 6		X				
mile 1		X				
mile 10		X				
mile 5		X				
Rt 2-S, mile 4		X				
100-B	X		X			X
100-D	X		X	X,P		X
100-F	X		X			X
100 Areas						X
200-E	X		X	P		X
200 ESE				X	X	
200-E Area, Tower #18				X,P		
200-W	X		X	P		X
200-W Gatehouse				X	X	
200-W TX Area		X		P		X
200-W Tower #4				X	X	
105 DR Area		X		X,P		X
234-235 Area (200-W)			X			
White Bluffs		X		X,P		X
Gable Mountain				X,P	X	X
Intermediate Zone						X
Outlying Areas						X
Riverland	X	X				X
Hanford	X	X		X,P	X	
Hanford 101 Building		X		X,P		X
Benson's Ranch						X

TABLE A-1. (contd)

<u>Sampling Locations</u>	<u>Integron</u>	<u>"M"&"S"</u>	<u>"C"</u>	<u>Filters</u>	<u>I-131</u>	<u>Rain</u>
Richland		X		X,P	X	
Benton City	X	X		X,P		X
Kennewick	X					
Pasco	X			X,P		X
Pasco H & R Depot						X
700 Area	X	X				X

X = indicates sampling location.

P = particle sampling location.

Rain = includes snow sampling locations.

TABLE A-2. On-site and Off-site Collection Locations for Filterable Beta Emitters, Ionizing Radiation, Airborne Particles, Iodine-131, and Rain in 1949

<u>Sampling Locations</u>	<u>Filters</u>	<u>I-131</u>	<u>Chamber Type</u>	<u>Rain</u>
<u>100 Areas and Environs</u>				
100-B Area	P		V C	R
100-F Area	P		V C	
100-D Area	B P		V C	
Rt. 1, mile 8			"M"	
Rt. 2N, mile 10			"M"	
mile 5			"M"	
At White Bluffs	B P		"M"	
Rt. 11A, mile 1			"S"	
At Hanford 614 bldg.	B		V "S"	
At Hanford 101 bldg.	B		"M"	
At 100-H Area	B	I	V "M" C	
105 DR construction zone	B			
Intersection Rt. 1 & Rt. 4N			"M"	
Hanford		P		
Along Rt. 2 at Hanford				R
<u>Within 5 Miles of 200-E Area</u>				
Rt. 4S, mile 6			"S"	
Rt. 11A, mile 6			"S"	
Rt. 3, mile 1			"S"	
Meteorology 200'			"S"	
234-235 Area			"S"	
Gable Mountain	B P			
200-E, Tower #16	B			
200-ESE	B	I		
Batch Plant			"M"	
<u>Within 10 Miles of 200-E Area</u>				
Rt. 4S, mile 10			"S"	
Rt. 10, mile 1			"S"	
mile 3			"S"	
Rt. 2S, mile 4			"S"	
700 Area			V	
<u>Near the 300 Area</u>				
300 Area	B P	I	V C	
Rt. 4S, mile 16			"S"	
mile 22			"S"	
3000 Area North	B		V "S"	
South			V "S"	

TABLE A-2. (contd)

<u>Sampling Locations</u>	<u>Filters</u>	<u>I-131</u>	<u>Chamber Type</u>	<u>Rain</u>
<u>Outlying Zones</u>				
Richland	B P	I	"S"	
Benton City	B P	I	V "S"	
Riverland			V	R
Pasco	B P		V	R
North Richland	P			
Hiway - Toppenish to Goldendale				R
Washtucna, WA.				R
Hiway - Walla Walla to Pendleton				R
Hiway - Ritzville to Davenport				R
Hiway - Arlington to Pendleton				R
<u>200-E and Vicinity</u>				
200-E Area	B P		"S" C	
2701 bldg. (in and outside)	P			
2704 bldg. (in and outside)	P			
222-B Hall	P			
222-B Gate (outside)	P			
222-B laboratory	P			
B-Gate	P			
BY-SE (outside)	P			
BY-NE (outside)	P			
221-B (outside gallery)	P			
HI Garden	P			
<u>200-W and Vicinity</u>				
200-W Area	P	I	V	C
200-W, Tower #4	B			
200-W, Tower #15	B			
200-W gatehouse	B			
"T" Gate (outside)	P			
222 Maintenance (inside)	P			
South guard tower (outside)	P			
"U" Gate (outside)	P			
West guard tower (outside)	P			
231 (outside)	P			
2722 (outside and inside)	P			
222 "T" (outside and inside)	P			
2701 (outside and inside)	P			

TABLE A-2. (contd)

<u>Sampling Locations</u>	<u>Filters</u>	<u>I-131</u>	<u>Chamber Type</u>	<u>Rain</u>
<u>Meterology Tower</u>				
3'	P			
50'	P			
100'	P			
150'	P			
200'	P			
250'	P			
300'	P			
350'	P			
400'	P			

V = Victoreen Intergrons.
 "C", "M", and "S" = Chamber types.
 B = beta Filters.
 I = iodine scrubbers.
 P = particles.
 R = rain.

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TABLE A-3. On-site and Off-site Collection Locations for Filterable Beta Emitters, Ionizing Radiation, Airborne Particles, Iodine-131, and Rain in 1950

<u>Sampling Locations</u>	<u>Filters</u>	<u>1-131</u>	<u>Chamber Type</u>	<u>Rain</u>
100-B Area	P		"C" V	R
100-F Area	P		"C" V	R
100-D Area	B P		"C" V	R
200-E Area			"C" V	
200-W Area			"C" V	
200-W, Tower #4	B			
200-W, Tower #15	B			
300 Area	B P	S	"C" V	R
200-W gatehouse	B	S		
200-N Area				R
200-W Area 250' E of stack				R
200-W Area 2000' E of stack				R
200-W Area 3500' SE of stack				R
200-W Area 750' SE of stack				R
200-E Area 1000' E of stack				R
200-E Area 7000' E of stack				R
200-E Area 4900' E of stack				R
200-E Area 8000' SE of stack				R
200-W Redox Area	B			
<u>100 Areas and Environs</u>				
Rt. 1, mile 8			"M"	
Rt. 2N, mile 10			"M"	
Rt. 2N, mile 5			"M"	
Hanford				R
Benson Ranch				R
At White Bluffs	B P		"M"	
Rt. 11A, mile 1			"S"	
At Hanford 614 bldg.	B		V "S"	
At Hanford 101 bldg.	B			R
Hanford 101 Area			"M"	
P-11 Area			"M"	
100-DR waterworks			"M"	R
At 100-H Area	B	S	"C" V "M"	R
Intersection of Rt. 1 and Rt. 4N			"M"	
<u>Within 5 Miles of 200-E Area</u>				
Rt. 4S, mile 6			"S"	R
Rt 4S, mile 2.5			"S"	

TABLE A-3. (contd)

<u>Sampling Locations</u>	<u>Filters</u>	<u>1-131</u>	<u>Chamber Type</u>	<u>Rain</u>		
Rt. 11A, mile 6			"S"			
Redox Area			"S"			
Rt. 3, mile 1			"S"			
Meteorology 200'			"S"			
Meteorology Building				R		
Gable Mountain	B	S		R		
200-E, Tower #16	B	S				
200-ESE	B	S				
Batch Plant			"S"			
<u>Within 10 Miles of 200-E Area</u>						
Rt. 4S, mile 10			"S"			
Rt. 10, mile 1			"S"			
Rt. 10, mile 3			"S"			
Rt. 2S, mile 4			"S"			
700 Area			V			
<u>Near the 300 Area</u>						
Rt. 4S, mile 16			"S"			
Rt, 4S, mile 22			"S"			
3000 Area North	B	S	V	"S"		
3000 Area South			V	"S"		
<u>Outlying Zones</u>						
Richland	B	P	S	"S"	R	
Benton City	B	P		V	"S"	R
Riverland	B			V		R
Pasco H & R Depot						R
Pasco	B	P		V		R
North Richland (South)						R
North Richland (North)			S			R
<u>200-E and Vicinity</u>						
2701 bldg. (outside and inside)		P				
2704 bldg. (outside and inside)		P				
222-B Hall		P				
222-B (outside)		P				
222-B laboratory		P				
B-Gate		P				
BY-SE		P	S			

TABLE A-3. (contd)

<u>Sampling Locations</u>	<u>Filters</u>	<u>1-131</u>	<u>Chamber Type</u>	<u>Rain</u>
BY-NE	P			
221-B	P			
HI Garden	P			
<u>200-W and Vicinity</u>				
"T" Gate	P			
South guard tower	P			
"U" Gate	P			
West guard tower	P			
231	P			
2722	P			
222-T Hall	P			
222-T Laboratory	P			
222 "T" (outside)	P			
2701 (outside and inside)	P			
272	P			
<u>Meteorology Tower</u>				
3'	P			
50'	P			
100'	P			
150'	P			
200'	P			
250'	P			
300'	P			
350'	P			
400'	P			

P = particle collection location.

B = beta filter collection location.

V = Victoreen Integrator collection location.

"M", "S", and "C" = Chamber collection locations.

R = rain sampling location.

S = iodine-131 sampling location.

TABLE A-4. On-site and Off-site Collection Locations for Filterable Beta Emitters, Ionizing Radiation, Airborne Particles, Iodine-131, and Rain in 1951

<u>Sampling Locations</u>	<u>Filters</u>	<u>I-131</u>	<u>Chamber Type</u>	<u>Rain</u>
100-B SE			"M"	
100-B NE			"M"	
100-B Area	P		V "C"	R
100-F Area	P		V "C"	R
100-D Area	B P		V "C"	R
200-E Area			V "C"	
200-W Area			V "C"	
200-W, Tower #4	B P			
200-W, Tower #15	B P			
200-W #2	B			
300 Area	P	S	V "S"	
200-W gatehouse	B	S		
200-N Area				
200-N 614 building				R
200-W Area 250' E of stack				
200-W Area 1000' E of stack				R
200-W Area 7000' E of stack				R
200-W Area 8000' SE of stack				R
200-W Area 4900' SE of stack				R
200-W Area 2000' E of stack				
200-W Area 3500' SE of stack				
200-W Area 750' SE of stack				
200-E Area 250' E of stack				R
200-E Area 750' SE of stack				R
200-E Area 1000' E of stack				
200-E Area 3500' SE of stack				R
200-E Area 7000' E of stack				
200-E Area 4900' E of stack				
200-E Area 8000' SE of stack				
200-W Redox Area	B			R
Foster's Ranch	P			
622 building				R
<u>100 Areas and Environs</u>				
Rt. 1, mile 8			"M"	
Rt. 2N, mile 10			"M"	
Rt. 2N, mile 5			"M"	
Hanford			V	
Benson Ranch				

TABLE A-4. (contd)

<u>Sampling Locations</u>	<u>Filters</u>	<u>I-131</u>	<u>Chamber Type</u>	<u>Rain</u>
At White Bluffs	B P		"M"	R
Rt. 11A, mile 1			"S"	
At Hanford 614 bldg.	B P		"S"	R
At Hanford 101 bldg.	B P			R
Hanford 101 Area	P		"M"	
P-11 Area			"M"	
100-DR waterworks				
At 100-H Area	B P	S	"M"	R
Intersection of Rt. 1 and Rt. 4N			"M"	
<u>Within 5 Miles of 200-E Area</u>				
Rt. 4S, mile 6			"S"	R
Rt. 4S, mile 2.5			"S"	
Rt. 4S, mile 4.5			"S"	
Rt. 11A, mile 6			"S"	
Redox Area		S	V	"S"
Rt. 3, mile 1			"S"	
Meteorology 200'			"S"	
Meteorology Building			"S"	
Semi-Process Construct. #1			"S"	
Semi-Process Construct. #2			"S"	
200-E Semi-Works	B			
Gable Mountain	B P	S		R
200-E, Tower #16	B P	S		
200-ESE	B	S		
Batch Plant			"M"	R
200-E PSN 300			"S"	
PSN 310			"S"	
PSN 320			"S"	
PSN 330			"M"	
PSN 330			"S"	
<u>Within 10 Miles of 200-E Area</u>				
Rt. 4S, mile 10			"S"	
Rt. 10, mile 1			"S"	
Rt. 10, mile 3			"S"	
Rt. 2S, mile 4			"S"	
700 Area	P		V	
Military Camp, PSN Charlie			"S"	
<u>Near the 300 Area</u>				
Rt. 4S, mile 16			"S"	

TABLE A-4. (contd)

<u>Sampling Locations</u>	<u>Filters</u>	<u>I-131</u>	<u>Chamber Type</u>	<u>Rain</u>
Rt, 4S, mile 22			"S"	
3000 Area North	P		"S"	R
3000 Area South			"S"	
300 Area 614 Building	B			R
300 Area Decade	P			
<u>Outlying Zones</u>				
Richland	B P	S	V	"S" R
Benton City	B P	S	V	"S" R
Riverland	B P		V	R
Pasco H & R Depot				R
Pasco	B P	S	V	"S"
North Richland (South)			V	
North Richland (North)	B P	S	V	R
Kennewick	B P	S	V	"S"
<u>Dual Units</u>				
200 WEC #1	B			
200 WEC #2	B			
200 ESE #1	B			
200 ESE #2	B			
200-W 2707 EA Building #1	B P			
200-W 2707 EA Building #2	B P			
200 EEC #1	B P			
200 EEC #2	B P			
Met Tower				
Ground level	B			
200' level	B			
400' level	B			
EEC Dual Monitor #1		P		
EEC Dual Monitor #2		P		
Richland #1	B			
Richland #2	B			
<u>200-E and Vicinity</u>				
2701 bldg. (outside and inside)	P			
2704 bldg. (outside and inside)	P			
222-B Hall	P			
222-B (outside)	P			
222-B laboratory	P			
B-Gate	P			
BY-SE	P			

TABLE A-4. (contd)

<u>Sampling Locations</u>	<u>Filters</u>	<u>I-131</u>	<u>Chamber Type</u>	<u>Rain</u>
BY-NE	P			
221-B	P			
HI Garden	P			
200-E Tower #15	P			
200-ESE Decade filter	P			
200 ESE Twin #1	P			
200 ESE Twin #2	P			
<u>200-W and Vicinity</u>				
"T" Gate	P			
South guard tower	P			
"U" Gate	P			
West guard tower	P			
231 Area	P			
2722	P			
222-T Hall	P			
222-T Laboratory	P			
222 "T" (outside)	P			
2701 (outside and inside)	P			
272 Building	P			
200-W WEC #1	P			
200-W WEC #2	P			
<u>Meteorology Tower</u>				
3'	B	P		
50'		P		
100'		P		
150'		P		
200'	B	P		
250'		P		
300'		P		
350'		P		
400'	B	P		

P = particle collection location.

B = beta filter collection location.

V = Victoreen Integrator collection location.

"M," "S," and "C" = chamber collection locations.

R = rain sampling location.

S = iodine-131 sampling location.

TABLE A-5. On-site and Off-site Collection Locations for Filterable Beta and Alpha Emitters, Ionizing Radiation, Airborne Particles, Iodine-131, and Rain in 1952

<u>Sampling Locations</u>	<u>Filters</u>	<u>I-131</u>	<u>Chamber Type</u>	<u>Rain</u>
100-B SE			"M"	R
100-B NE			"M"	R
100-B Area	P		V "C"	
100-F Area	P		V "C"	
100-F SW				R
100-D Area	B P		V "C"	
200-E Area			V "C"	
200-W Area			V "C"	
200-W, Tower #4	B	S		
200-W Tower #14	B			
200-W, Tower #15	B			
300 Area	B P	S	V "S"	
200-W Gatehouse	B	S		
200-N 614 Building				R
200-W Area 1000' E of Stack				R
200-W Area 7000' E of Stack				R
200-W Area 8000' SE of Stack				R
200-W Area 4900' SE of Stack				R
200-E Area 250' E of Stack				R
200-E Area 750' SE of Stack				R
200-E Area 2000' E of Stack				R
200-E Area 3500' SE of Stack				R
200-W Redox Area	B			
622 Building				R
<u>100 Areas and Environs</u>				
Rt. 1, mile 8			"M"	
Rt. 2N, mile 10			"M"	
Rt. 2N, mile 5			"M"	
Hanford			V	
Benson Ranch				
At White Bluffs	B P		"M"	R
Rt. 11A, mile 1			"S"	
At Hanford 614 Bldg.	B		"S"	R
At Hanford 101 Bldg.	B			R
Hanford 101 Area	P		"M"	
P-11 Area			"M"	
At 100-H Area	B	S	V "M"	R
Intersection of Rt. 1 and Rt. 4N			"M"	

TABLE A-5. (contd)

<u>Sampling Locations</u>	<u>Filters</u>	<u>I-131</u>	<u>Chamber Type</u>	<u>Rain</u>
<u>Within 5 Miles of 200-E Area</u>				
Rt. 4S, mile 6			"S"	R
Rt. 4S, mile 2.5			"S"	
Rt. 4S, mile 4.5			"S"	
Rt. 11A, mile 6			"S"	
Redox Area	P	S	V	R
Redox (outside)			"M"	
Rt. 3, mile 1			"S"	
Meteorology 200'			"S"	
Meteorology Building				R
Semi-Process Construct. #1			"S"	
Semi-Process Construct. #2			"S"	
200-E Semi-Works	B			
Gable Mountain	B	S		R
200-E, Tower #16	B	S		
200-ESE	B	S		
Batch Plant			"M"	R
200-E PSN 300			"S"	
PSN 310			"S"	
PSN 320	B		"S"	
PSN 330			"S"	
<u>Within 10 Miles of 200-E Area</u>				
Rt. 4S, mile 10			"S"	
Rt. 10, mile 1			"S"	
Rt. 10, mile 3			"S"	
Rt. 2S, mile 4			"S"	
<u>Near the 300 Area</u>				
Rt. 4S, mile 16			"S"	
Rt. 4S, mile 22			"S"	
300 Area 614 Building	B			R
<u>Outlying Zones</u>				
Richland	B P	S	V	R
Benton City	B P	S	V	R
Riverland	B		V	R
Pasco H & R Depot				R
Pasco	B P	S	V	"S"

TABLE A-5. (contd)

<u>Sampling Locations</u>	<u>Filters</u>	<u>I-131</u>	<u>Chamber Type</u>	<u>Rain</u>
North Richland (South)			V	"S"
North Richland (North)	B	S	V	"S" R
Kennewick	B	S	V	"S"
<u>Dual Units</u>				
200 West East Center #1	B			
200 WEC #2	B			
200 ESE #1	B			
200 ESE #2	B			
200 East Center #1	B			
200 EEC #2	B			
Met Tower				
Ground level	B			
200' level	B			
400' level	B			
Richland #1	B			
Richland #2	B			
<u>200-E and Vicinity</u>				
2701 Bldg. (outside and inside)	P			
2704 Bldg. (outside and inside)	P			
222-B Hall	P			
222-B (outside)	P			
222-B Laboratory	P			
B-Gate	P			
BY-SE	P			
BY-NE	P			
221-B	P			
HI Garden	P			
200-E Tower #15	P			
<u>200-W and Vicinity</u>				
"T" Gate	P			
South Guard Tower	P			
"U" Gate	P			
West Guard Tower	P			
231 Area	P			
2722	P			
222-U Lab	P			
222-T Hall	P			
222-T Laboratory	P			

TABLE A-5. (contd)

<u>Sampling Locations</u>	<u>Filters</u>	<u>I-131</u>	<u>Chamber Type</u>	<u>Rain</u>
222 "T" (outside)	P			
2701 (outside and inside)	P			
272 Building	P			
291-S (inside)	P			
<u>Meteorology Tower</u>				
3'	P			
50'	P			
100'	P			
150'	P			
200'	P			
250'	P			
300'	P			
350'	P			
400'	P			

P = particle collection location.

B = beta and/or alpha filter collection location.

V = Victoreen Integrator collection location.

"M," "S," and "C" = chamber collection locations.

R = rain sampling location.

S = I-131 sampling location.

TABLE A-6. On-site and Off-site Collection and Measurement Locations for Filterable Beta and Alpha Emitters, Ionizing Radiation, Airborne Particles, Iodine-131, and Rain in 1953

<u>Sampling Locations</u>	<u>Filters</u>	<u>I-131</u>	<u>Chamber Type</u>	<u>Rain</u>
<u>100 Areas and Environs</u>				
100-B SE Construction			"M"	R
100-B NE Construction			"M"	
100-B Area	P		V "C"	
100-F Area	P		V "C"	
100-F SW				R
100-D Area	AB P		V "C"	
100-D SW				R
Rt. 1, mile 0				R
Rt. 1, mile 5				R
Rt. 1, mile 8			"M"	
Rt. 1, mile 9				R
Rt. 2N, mile 10			"M"	R
Rt. 2N, mile 5			"M"	
Hanford	A		V	
At White Bluffs	AB P		"M"	R
Rt. 11A, mile 1			"S"	
At Hanford 614 Bldg.	AB		"S"	R
At Hanford 101 Bldg.	AB		"M"	R
Hanford 101 Area	P		"M"	
P-11 Area			"M"	
At 100-H Area	AB	S	V "C" "M"	
100-H SW				R
Intersection of Rt. 1 and Rt. 4N			"M"	
<u>Within 5 Miles of 200-E Area</u>				
200-N 614 Building				R
Rt. 4S, mile 0				R
Rt. 4S, mile 6			"S"	R
Rt. 4S, mile 2.5			"S"	
Rt. 4S, mile 4.5			"S"	
Rt. 11A, mile 0				R
Rt. 11A, mile 6			"S"	
Rt. 11A, mile 10				R
Redox Area	P	S	V	R
Redox (outside)			"M"	
Rt. 3, mile 1			"S"	
Meteorology 200'			"S"	

TABLE A-6. (contd)

<u>Sampling Locations</u>	<u>Filters</u>	<u>I-131</u>	<u>Chamber Type</u>	<u>Rain</u>
622 Meteorology Building				R
Semi-Process Construct. #1			"S"	
Semi-Process Construct. #2			"S"	
200-E Semi-Works	AB	S	V "C"	"S"
Gable Mountain	AB	S		R
200-E, Tower #16		S		
200-ESE		S		
Batch Plant			"M"	R
200-E PSN 300 (Military camp)			"S"	
PSN 310 (Military camp)			"S"	
PSN 320 (Military camp)	AB		"S"	
PSN 330 (Military camp)			"S"	
<u>Within 10 Miles of 200-E Area</u>				
Rt. 4S, mile 10			"S"	
Rt. 10, mile 1			"S"	
Rt. 10, mile 3			"S"	
Rt. 2S, mile 4			"S"	
Rt. 2S, mile 5				R
Rt. 11A, mile 15				R
<u>Near the 300 Area</u>				
Rt. 4S, mile 16			"S"	
Rt. 4S, mile 17				R
Rt. 4S, mile 22			"S"	
300 Area	A	P	S	V
300 Area 614 Building	B			
<u>Outlying Zones</u>				
Richland		P	S	V
Benton City	AB	P	S	V
Riverland	AB			V
Pasco H & R Depot				
Pasco	AB	P	S	V
North Richland (South)				V
North Richland (North)	AB		S	V
Kennewick		P		V
Pasco-Kennewick				
700-A 614				

TABLE A-6. (contd)

<u>Sampling Locations</u>	<u>Filters</u>	<u>I-131</u>	<u>Chamber Type</u>	<u>Rain</u>
<u>Dual Units</u>				
200 West East Center #1	AB			
200 WEC #2	AB			
200 ESE #1	AB			
200 ESE #2	AB			
Richland #1	AB			
Richland #2	AB			
200-W Area	B			
200-E Area	B			
<u>200-E and Vicinity</u>				
200-E Area 250' E of Stack				R
200-E Area 750' SE of Stack				R
200-E Area 2000' E of Stack				R
200-E Area 3500' SE of Stack				R
200-E Area			V "C"	
2701 Bldg. (outside and inside)	P			
2704 Bldg. (outside and inside)	P			
B-Gate	P			
BY-SE	P			
BY-NE	P			
221-B	P			
200-E Tower #15	AB			
<u>200-W and Vicinity</u>				
200-W Area 1000' E of Stack				R
200-W Area 7000' E of Stack				R
200-W Area 8000' SE of Stack				R
200-W Area 4900' SE of Stack				R
200-W Gatehouse		S		
200-W Area			V "C"	
200-W Redox Area	AB			
200-W, Tower #4	AB	S		
"T" Gate	P			
"U" Gate	P			
West Guard Tower	P			
231 Area	P			
2722	P			
222-U Lab	P			
222-T Hall	P			
222-T Laboratory	P			

TABLE A-6. (contd)

<u>Sampling Locations</u>	<u>Filters</u>	<u>I-131</u>	<u>Chamber Type</u>	<u>Rain</u>
222 "T" (outside)	P			
2701 (outside and inside)	P			
272 Building	P			
291-S (inside)	P			
<u>Meteorology Tower</u>				
3'	P			
50'	P			
100'	P			
150'	P			
200'	P			
250'	P			
300'	P			
350'	P			
400'	P			

P = particle collection location.

B = beta filter collection location.

A = alpha filter collection location.

V = Victoreen Integron collection location.

"M," "S," and "C" = chamber collection locations.

R = rain sampling location.

S = iodine-131 sampling location.

TABLE A-7. Off-site Rain Sampling Locations for Collections Made on May 26, 1953, in Eastern Washington, Northern Oregon and Eastern Idaho (HW-29514)

Location

300 Area to Kennewick
Mile 0
5
10
15
Benton City to Prosser
Mile 0
5
10
Prosser to Paterson
Mile 5
10
15
20
Near Paterson, Washington
Plymouth, Washington
McNary Dam
Union Gap to Sunnyside, Mile 25
Sunnyside North
Sunnyside to Prosser, Mile 5
Prosser (3 sites)
Union Gap, Washington
Ellensburg, Washington
5 Miles East of Vantage, Washington
Ritzville, Washington
North Sprague, Washington
West Spokane, Washington
Pasco to Connell, Washington, Mile 5
Lewiston, Idaho
6 Miles West of Oregon State Line on US # 395
Walla Walla, Washington Railroad Station
Walla Walla River
Junction of Highways # 395 and 730
5 Miles South of the Junction of Highways # 730 and 395
26 Miles South of the Junction of Highways # 730 and 395
Creek Water from Cold Creek
Pendleton, Oregon
Pendleton, Oregon to Loudon, Washington, Mile 15
Pendleton, Oregon to Loudon, Washington, Mile 20
Creek Water at Mile 25, Pendleton, Oregon to Loudon, Washington
Pendleton to Loudon, Mile 35
Loudon, Washington

TABLE A-8. Routine On-site and Off-site Collection and Measurement Locations for Filterable Beta and Alpha Emitters, Ionizing Radiation, Radioactive Airborne Particles, Iodine-131, and Rain in 1954

<u>Sampling Locations</u>	<u>Filters</u>	<u>I-131</u>	<u>Chamber Type</u>	<u>Rain</u>
<u>100 Areas and Environs</u>				
100-B SE Construction				R
100-B Area	P		V "C"	
100-F Area	P		V "C"	
100-F SW				R
100-D Area	AB P		V "C"	
100-D SW				R
Rt. 1, mile 8			"M"	
Rt. 2N, mile 10			"M"	
Rt. 2N, mile 5			"M"	
Hanford			V	
At White Bluffs	AB P		"M"	R
Rt. 11A, mile 1			"S"	
At Hanford 614 Bldg.	AB		"S"	R
At Hanford 101 Bldg.			"M"	
F-11 Area			"M"	
At 100-H Area	AB	S	V "C"	
100-H SE				R
Intersection of Rt. 1 and Rt. 4N			"M"	
<u>Within 5 Miles of 200-E Area</u>				
200-N 614 Building				R
Rt. 4S, mile 6			"S"	R
Rt. 4S, mile 2.5			"S"	
Rt. 4S, mile 4.5			"S"	
Rt. 11A, mile 6			"S"	
Redox Area	P	S	V	"S"
Redox (outside)			"M"	
Redox Experimental Unit	AB			
Rt. 3, mile 1			"S"	
622 Meteorology Building				R
200-E Semi-Works	AB	S	V "C"	
Gable Mountain	AB	S		R
200-E, Tower #16		S		
200-ESE		S		

TABLE A-8. (contd)

<u>Sampling Locations</u>	<u>Filters</u>	<u>I-131</u>	<u>Chamber Type</u>	<u>Rain</u>
Batch Plant			"M"	R
200-E PSN 300 (Military camp)			"S"	
PSN 310 (Military camp)			"S"	
PSN 320 (Military camp)	AB		"S"	
PSN 330 (Military camp)			"S"	
PSN 329 (Military camp)	B			
PSN 40 (Military camp)			"S"	
PSN 50 (Military camp)	AB		"S"	
PSN 51 (Military camp)			"S"	
PSN 61 (Military camp)			"S"	
<u>Within 10 Miles of 200-E Area</u>				
Rt. 4S, mile 10			"S"	
Rt. 10, mile 1			"S"	
Rt. 10, mile 3			"S"	
Rt. 2S, mile 4			"S"	
<u>Near the 300 Area</u>				
Rt. 4S, mile 16			"S"	
Rt. 4S, mile 22			"S"	
300 Area	A	P	S	V
300 Area 614 Building				
			"S"	R
<u>Outlying Zones</u>				
Richland		P	S	V
Benton City	AB	P	S	V
Riverland	AB			V
Pasco H & R Depot				
Pasco	AB	P	S	V
North Richland (North)	AB		S	V
Kennewick		P		V
700-A 614				
			"S"	R
<u>Dual Units</u>				
200 West East Center #1	AB			
200 WEC #2	AB			
200 ESE #1	AB			
200 ESE #2	AB			
Richland #1	AB			
Richland #2	AB			

TABLE A-8. (contd)

<u>Sampling Locations</u>	<u>Filters</u>	<u>I-131</u>	<u>Chamber Type</u>	<u>Rain</u>
<u>200-E and Vicinity</u>				
200-E Area 250' E of Stack				R
200-E Area 2000' E of Stack				R
200-E Area 3500' SE of Stack				R
200-E Area			V "C"	
2704 Bldg. (outside and inside)	P			
"B"-Gate	P			
BY-SE	P			
BY-NE	P			
2-EWC 614 Building	P			
<u>200-W and Vicinity</u>				
200-W Area 1000' E of Stack				R
200-W Area 7000' E of Stack				R
200-W Area 8000' SE of Stack				R
200-W Area 4900' SE of Stack				R
200-W Gatehouse		S		
200-W Area			V "C"	
200-W West Center	AB	S		
200-W Scrubber		S		
200-W EC 614 Building	P			
200-W Redox Area	AB			
200-W, Tower #4	AB	S		
"T" Gate	P			
"U" Gate	P			
West Guard Tower	P			
231 Area	P			
2722	P			
222-U Lab	P			
222-T Hall	P			
222-T Laboratory	P			
222 "T" (outside)	P			
2701 (outside and inside)	P			
272 Building	P			
SX Tank Farm	P			

TABLE A-8. (contd)

<u>Sampling Locations</u>	<u>Filters</u>	<u>I-131</u>	<u>Chamber Type</u>	<u>Rain</u>
<u>Meteorology Tower</u>				
3'	P			
50'	P			
100'	P			
150'	P			
200'	P			
250'	P			
300'	P			
350'	P			
400'	P			

P = particle collection location.

B = beta filter collection location.

A = alpha filter collection location.

V = Victoreen Integrator measurement location.

"M," "S," and "C" = chamber measurement locations.

R = rain sampling location.

S = I-131 sampling location.

TABLE A-9. Routine On-site and Off-site Sampling and Measurement Locations for Filterable Beta and Alpha Emitters, Ionizing Radiation, Radioactive Airborne Particles, Iodine-131, and Rain in 1955

<u>Sampling Locations</u>	<u>Filters</u>	<u>I-131</u>	<u>Chamber Type</u>	<u>Rain</u>
<u>100 Areas and Environs</u>				
100-B SE Construction				R
100-B Area	P		V	
100-F Area	P		V	
100-F SW				R
100-D Area	AB P		V	
100-D SW				R
100-K Area			V	
100-K #1	AB			
100-K #2	AB			
100-K #3	AB P	S		
Rt. 1, mile 8				"M"
Rt. 2N, mile 5				"M"
Rt. 4N				"M" (?)
Hanford	AB		V	R
At White Bluffs	AB P	S	V	R
Rt. 11A, mile 1				"S"
At 100-H Area	AB	S	V	
100-H SE				R
Intersection of Rt. 1 and Rt. 4N				"M"
PSN 3 (Military camp)				"S"
PSN 21 (Military camp)				"S"
<u>Within 5 Miles of 200-E Area</u>				
200-N 614 Building				R
Rt. 4S, mile 6				"S" R
Rt. 4S, mile 2.5				"S"
Rt. 4S, mile 4.5				"S"
Rt. 11A, mile 6				"S"
Redox Area	A P	S	V	R
Rt. 3, mile 1				"S"
622 Meteorology Building				R
200-E Semi-Works	AB	S	V	
Gable Mountain	AB	S		R
200-ESE	AB	S		
200 ESE 614 Building		P		
Batch Plant				R
PSN 50 (Military camp)	AB			"S"

TABLE A-9. (contd)

<u>Sampling Locations</u>	<u>Filters</u>	<u>I-131</u>	<u>Chamber Type</u>	<u>Rain</u>
PSN 51 (Military camp)			"S"	
PSN 61 (Military camp)			"S"	
PSN 42 (Military camp)			"S"	
<u>Within 10 Miles of 200-E Area</u>				
Rt. 4S, mile 10			"S"	
Rt. 10, mile 1			"S"	
Rt. 2S, mile 4			"S"	
PSN 70 (Military camp)			"S"	
<u>Near the 300 Area</u>				
Rt. 4S, mile 16			"S"	
Rt. 4S, mile 22			"S"	
300 Area	B P	S	V	R
PSN 60 (Military camp)			"S"	
<u>Outlying Zones</u>				
Richland	AB P	S	V	R
Benton City	AB P	S	V	R
Riverland	AB		V	R
Pasco	AB P	S	V	R
Kennewick	P		V	
1100 Area	AB	S	V	R
<u>Dual Units</u>				
200 ESE #1	AB			
200 ESE #2	AB			
Richland #1	AB			
Richland #2	AB			
<u>200-E and Vicinity</u>				
200-E Area 250' E of Stack				R
200-E Area 2000' E of Stack				R
200-E Area 3500' SE of Stack				R
200-E Area			V	
2704 Bldg. (outside and inside)	P			
"B"-Gate	P			
BY-SE	P			
2-EWC 614 Building	P			
2701 Building (inside and outside)	P			

TABLE A-9. (contd)

<u>Sampling Locations</u>	<u>Filters</u>	<u>I-131</u>	<u>Chamber Type</u>	<u>Rain</u>
<u>200-W and Vicinity</u>				
200-W Area 1000' E of Stack				R
200-W Area 7000' E of Stack				R
200-W Area 8000' SE of Stack				R
200-W Area 4900' SE of Stack				R
200-W Area			V	
200-W West Center	AB	P	S	
200-W EC 614 Building	AB		S	
200-W Redox Area	B			
"T" Gate		P		
"U" Gate		P		
231 Area		P		
2722		P		
222-U Lab (inside)		P		
222 "T" (outside)		P		
2701 (outside and inside)		P		
272 Building		P		
<u>Meteorology Tower</u>				
3'		P		
50'		P		
100'		P		
150'		P		
200'		P		
250'		P		
300'		P		
350'		P		
400'		P		

P = particle collection location.
 B = beta filter collection location.
 A = alpha filter collection location.
 V = Victoreen Integratron measurement location.
 "M" and "S" = chamber measurement locations.
 R = rain sampling location (data reported for first and second quarters of 1956 only).
 S = iodine-131 sampling location.
 "C" chamber data were not located.

TABLE A-10. Routine On-site and Off-site Sampling and Measurement Locations for Filterable Beta and Alpha Emitters, Ionizing Radiation, Radioactive Airborne Particles, Iodine-131, and Rain in 1956

<u>Sampling Locations</u>	<u>Filters</u>	<u>I-131</u>	<u>Chamber Type</u>	<u>Rain</u>
<u>100 Areas and Environs</u>				
100-B SE Construction				R
100-B Area	P		V	
100-F Area	P		V	
100-F SW				R
100-D Area	AB P		V	
100-D SW				R
100-K Area			V	
100-K #1	AB			
100-K #2	AB			
100-K #3	AB P	S		
Rt. 1, mile 8				"M"
Rt. 2N, mile 5				"M"
Rt. 4N				"M" (?)
Hanford	AB		V	R
At White Bluffs	AB P	S	V	R
Rt. 11A, mile 1				"S"
At 100-H Area	AB	S	V	
100-H SE				R
Intersection of Rt. 1 and Rt. 4N				"M"
PSN 3 (Military camp)				"S"
PSN 21 (Military camp)				"S"
<u>Within 5 Miles of 200-E Area</u>				
200-N 614 Building				R
Rt. 4S, mile 6				"S" R
Rt. 4S, mile 2.5				"S"
Rt. 4S, mile 4.5				"S"
Rt. 11A, mile 6				"S"
Redox Area	A P	S	V	R
Rt. 3, mile 1				"S"
622 Meteorology Building				R
200-E Semi-Works	AB	S	V	
Gable Mountain	AB	S		R
200-ESE	AB	S		
200 ESE 614 Building	P			
Batch Plant				R
PSN 50 (Military camp)	AB			"S"

TABLE A-10. (contd)

<u>Sampling Locations</u>	<u>Filters</u>	<u>I-131</u>	<u>Chamber Type</u>	<u>Rain</u>
PSN 51 (Military camp)			"S"	
PSN 61 (Military camp)			"S"	
PSN 42 (Military camp)			"S"	
<u>Within 10 Miles of 200-E Area</u>				
Rt. 4S, mile 10			"S"	
Rt. 10, mile 1			"S"	
Rt. 2S, mile 4			"S"	
PSN 70 (Military camp)			"S"	
<u>Near the 300 Area</u>				
Rt. 4S, mile 16			"S"	
Rt. 4S, mile 22			"S"	
300 Area	B P	S	V	R
PSN 60 (Military camp)			"S"	
<u>Outlying Zones</u>				
Richland	AB P	S	V	R
Benton City	AB P	S	V	R
Riverland	AB		V	R
Pasco	AB P	S	V	R
Kennewick	P		V	
1100 Area	AB	S	V	R
<u>Dual Units</u>				
200 ESE #1	AB			
200 ESE #2	AB			
Richland #1	AB			
Richland #2	AB			
<u>200-E and Vicinity</u>				
200-E Area 250' E of Stack				R
200-E Area 2000' E of Stack				R
200-E Area 3500' SE of Stack				R
200-E Area			V	
2704 Bldg. (outside and inside)	P			
"B"-Gate	P			
BY-SE	P			
2-EWC 614 Building	P			
2701 Building (inside and outside)	P			

TABLE A-10. (contd)

<u>Sampling Locations</u>	<u>Filters</u>	<u>I-131</u>	<u>Chamber Type</u>	<u>Rain</u>
<u>200-W and Vicinity</u>				
200-W Area 1000' E of Stack				R
200-W Area 7000' E of Stack				R
200-W Area 8000' SE of Stack				R
200-W Area 4900' SE of Stack				R
200-W Area			V	
200-W West Center	AB P	S		
200-W EC 614 Building	AB	S		
200-W Redox Area	B			
"T" Gate	P			
"U" Gate	P			
231 Area	P			
2722	P			
222-U Lab (inside)	P			
222 "T" (outside)	P			
2701 (outside and inside)	P			
272 Building	P			
<u>Meteorology Tower</u>				
3'	P			
50'	P			
100'	P			
150'	P			
200'	P			
250'	P			
300'	P			
350'	P			
400'	P			

P = particle collection location.

B = beta filter collection location.

A = alpha filter collection location.

V = Victoreen Integron measurement location.

"M" and "S" = chamber measurement locations.

R = rain sampling location (data reported for first and second quarters of 1956 only).

S = iodine-131 sampling location.

"C" chamber data were not located.

TABLE A-11. Routine On-site and Off-site Sampling and Measurement Locations for Ionizing Radiation and Airborne Radioactive Particles in 1957

<u>Sampling Locations</u>	<u>Filters</u>	<u>I-131</u>	<u>Chamber Type</u>	<u>Rain</u>
<u>100 Areas and Environs</u>				
100-B Area	P		V	
100-F Area	P		V	
100-D Area	P		V	
100-K Area			V	
100-K #3	P			
Rt. 1, mile 8				"M"
Rt. 2N, mile 5				"M"
Hanford			V	
At White Bluffs	P		V	
Rt. 11A, mile 1				"S"
At 100-H Area			V	
Intersection of Rt. 1 and Rt. 4N				"M"
PSN 3 (Military camp)				"S"
PSN 21 (Military camp)				"S"
<u>Within 5 Miles of 200-E Area</u>				
Rt. 4S, mile 6				"S"
Rt. 4S, mile 2.5				"S"
Rt. 11A, mile 6				"S"
Redox Area	P		V	"M" (?)
Rt. 3, mile 1				"S"
200-ESE	P			"S" (?)
PSN 50 (Military camp)				"S"
PSN 51 (Military camp)				"S"
PSN 61 (Military camp)				"S"
PSN 42 (Military camp)				"S"
<u>Within 10 Miles of 200-E Area</u>				
Rt. 4S, mile 10				"S"
Rt. 10, mile 1				"S"
Rt. 2S, mile 4				"S"
PSN 70 (Military camp)				"S"
<u>Near the 300 Area</u>				
Rt. 4S, mile 16				"S"
Rt. 4S, mile 22				"S"
300 Area	P		V	
PSN 60 (Military camp)				"S"

TABLE A-11. (contd)

<u>Sampling Locations</u>	<u>Filters</u>	<u>I-131</u>	<u>Chamber Type</u>	<u>Rain</u>
<u>Outlying Zones</u>				
Richland	P		V	
Benton City	P		V	
Riverland			V	
Pasco	P		V	
Kennewick	P		V	"S"
1100 Area			V	
<u>200-E and Vicinity</u>				
200-E Area			V	
2704 Bldg. (outside and inside)	P			
BY-SE	P			
2-EWC 614 Building	P			
200 EEC	P			
241 BC Tank Farm	P			
2701 Building (inside and outside)	P			
<u>200-W and Vicinity</u>				
200-W Area			V	
200-W West Center	P			
200-W EC 614 Building				"S" (?)
"T" Gate	P			
"U" Gate	P			
7-Plant Gate	P			
231 Pit	P			
2722	P			
222-U Lab (inside)	P			
222 "T" (outside)	P			
2701 (outside and inside)	P			
272 Building	P			

TABLE A-11. (contd)

<u>Sampling Locations</u>	<u>Filters</u>	<u>I-131</u>	<u>Chamber Type</u>	<u>Rain</u>
<u>Meteorology Tower</u>				
3'	P			
50'	P			
100'	P			
150'	P			
200'	P			
250'	P			
300'	P			
350'	P			
400'	P			

P = particle collection location.

V = Victoreen Integron measurement location.

"M" and "S" = chamber measurement locations.

(?) = there could have been either an "M" or an "S" chamber at this location.

Data for filterable beta and alpha emitters, rain, and "C" chambers were not reported in the reviewed documents.

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