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RADIOLOGICAL EFFLUENTS RELEASED FROM NUCLEAR ROCKET AND RAMJET ENGINE TESTS AT THE NEVADA TEST SITE 1959 THROUGH 1969

FACT BOOK

Prepared for the
UNITED STATES DEPARTMENT OF ENERGY
NEVADA OPERATIONS OFFICE
LAS VEGAS, NEVADA

Prepared by
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Las Vegas, Nevada 89193-5487

Work Performed Under Contract No. DE-AC08-91NV10833

DISCLAIMER

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ABBREVIATIONS AND ACRONYMS

AEC	Atomic Energy Commission
EG&G	Edgerton, Germeshausen, and Grier, Inc.
EP	Experimental Plan. A detailed chronological plan of action prepared prior to each test run of rocket and ramjet engines.
EPA	Environmental Protection Agency
EST	Engine Systems Test
ETS	Engine Test Stand
LANL	Los Alamos National Laboratory
LASL	Los Alamos Scientific Laboratory, now LANL
LLNL	Lawrence Livermore National Laboratory
LRL	Lawrence Radiation Laboratory, now LLNL
MW	Megawatt, Million Watt
NASA	National Aeronautics and Space Administration
NERVA	Nuclear Engine for Rocket Vehicle Application
NRDA	Nevada Research and Development Area
NRDS	Nuclear Rocket Development Station, now NRDA
NRX	Nuclear Rocket, Experimental
NTS	Nevada Test Site
PHS	Public Health Service
PLUTO	Program name for the nuclear ramjet engine project
PST	Pacific Standard Time
ROVER	Program name for the nuclear rocket engine project
SNPO	Space Nuclear Propulsion Office; program terminated
SNSO	Space Nuclear Systems Office; program terminated
TLD	Thermoluminescent Dosimeter
TRC	Test Range Complex, which includes the government-controlled areas of the Nevada Test Site, the Nellis Air Force Range, and the Tonopah Test Range
TTR	Tonopah Test Range
WANL	Westinghouse Astronuclear Laboratory
XE	Experimental Engine

IDENTIFICATION OF RADIONUCLIDES FOUND IN EFFLUENT CLOUDS FROM NUCLEAR ROCKET AND RAMJET ENGINE TESTS

Symbol	Name	Half-Life	
Ni-57	Nickel-57		
Kr-85m[1]	Krypton-85m	4.5	hr
Kr-87	Krypton-87	76	min
Kr-88	Krypton-88	2.8	hr
Sr-89	Strontium-89	50.5	day
Sr-90	Strontium-90	29	yr
Sr-91	Strontium-91	9.5	hr
Sr-92	Strontium-92	2.7	hr
Yr-93	Yttrium-93	10	hr
Zr-95	Zirconium-95	64	day
Nb-95	Niobium-95	3.5	day
Zr-97	Zirconium-97	17	hr
Mo-99	Molybdenum-99	2.75	day
Ru-103	Ruthenium-103	40	day
Ru-105	Ruthenium-105	4.4	hr
Te-129	Tellurium-129	70	min
Te-131	Tellurium-131	24	min
I-131	Iodine-131	8	day
Te-132	Tellurium-132	3.25	day
I-132	Iodine-132	2.3	hr
Te-133m	Tellurium-133m	55	min
I-133	Iodine-133	21	hr
Xe-133	Xenon-133	5.2	day
I-134	Iodine-134	53	min
I-135	Iodine-135	6.6	hr
Xe-135	Xenon-135	9	hr
Cs-138	Cesium-138	32	min
Ba-139	Barium-139	1.4	hr
Ba-140	Barium-140	13	day
Ce-141	Cerium-141	32	day
La-142	Lanthanum-142	1.5	hr
Ce-143	Cerium-143	34	hr
Nd-147	Neodymium-147	11	day
U-234	Uranium-234	244,000	yr
Np-249	Neptunium-249	2.3	day

[1] "m": some radionuclides of the same mass exist in two different states; one of the states is called an "isomeric transition" and is designated by the small letter m (stands for metastable) after the mass number.

SECTION 1. BRIEF HISTORY OF NUCLEAR ROCKET ENGINE TESTS

Nuclear rocket and ramjet engine tests were conducted on the Nevada Test Site (NTS) in Area 25 and Area 26, about 80 miles northwest of Las Vegas, Nevada, from July 1959 through September 1969. Figure 1 shows the location of the NTS within Nevada. Figure 2 shows numbers assigned to areas of the NTS and the location of the NRDS within the NTS. As shown in Figure 3, the NRDS (now called the Nevada Research and Development Area, NRDA) is located in the southwest corner of the NTS in Area 25. The nearest populated location during the period of testing was Lathrop Wells (now called Amargosa Valley), about 15 miles south of the NRDS support facilities. These 1970 figures portray the area as it was during the testing period.

Development of the nuclear rocket engine began in 1955 under joint sponsorship of the Air Force and the Atomic Energy Commission (AEC). The Los Alamos Scientific Laboratory (LASL, now the Los Alamos National Laboratory, LANL) was responsible for developing reactor technology for the nuclear rocket engine (Project ROVER) while the Air Force was responsible for the nonnuclear portion of the project. In 1960, the AEC and the National Aeronautics and Space Administration (NASA) formed the Space Nuclear Propulsion Office (SNPO, changed later to the Space Nuclear Systems Office, SNSO) to administer development of an operational nuclear rocket (NERVA, Nuclear Engine for Rocket Vehicle Application). Such a nuclear-powered rocket was visualized for use in space travel, given that the crew could be adequately protected from radiation produced by the operating engine.

In a somewhat parallel program (Project PLUTO), the Lawrence Radiation Laboratory (LRL, now the Lawrence Livermore National Laboratory, LLNL) in 1957 began development of a nuclear ramjet engine. Because this was designed as an air-breathing engine, it was visualized as being restricted to relatively low altitudes.

Table 1 provides a summary of nuclear reactor development for rocket and ramjet engines. No engine tests were conducted during 1970 and 1971. The final related reactor test was of a "nuclear furnace" with a replaceable core in a reusable test bed designed to provide an inexpensive approach to testing advanced fuels in full-scale reactor environments. The nuclear furnace was successfully tested in June and July 1972. All nuclear rocket engines and systems tests were terminated in January 1973.

FIGURE 1. Location of the Nevada Test Site in relation to population centers of neighboring western states.

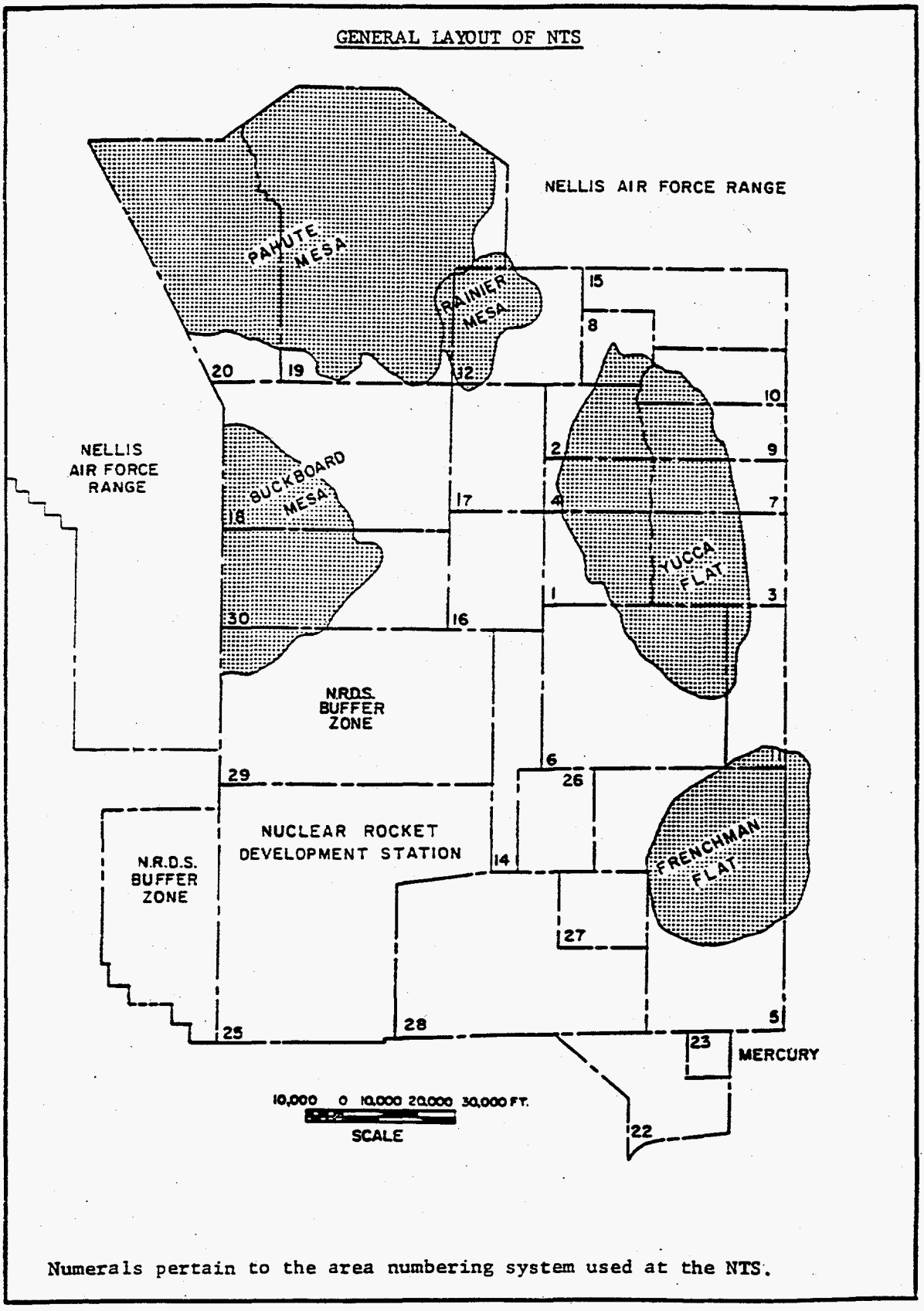

FIGURE 2. Nevada Test Site (showing the location of Areas 25 and 26 in the southwest corner of the NTS).

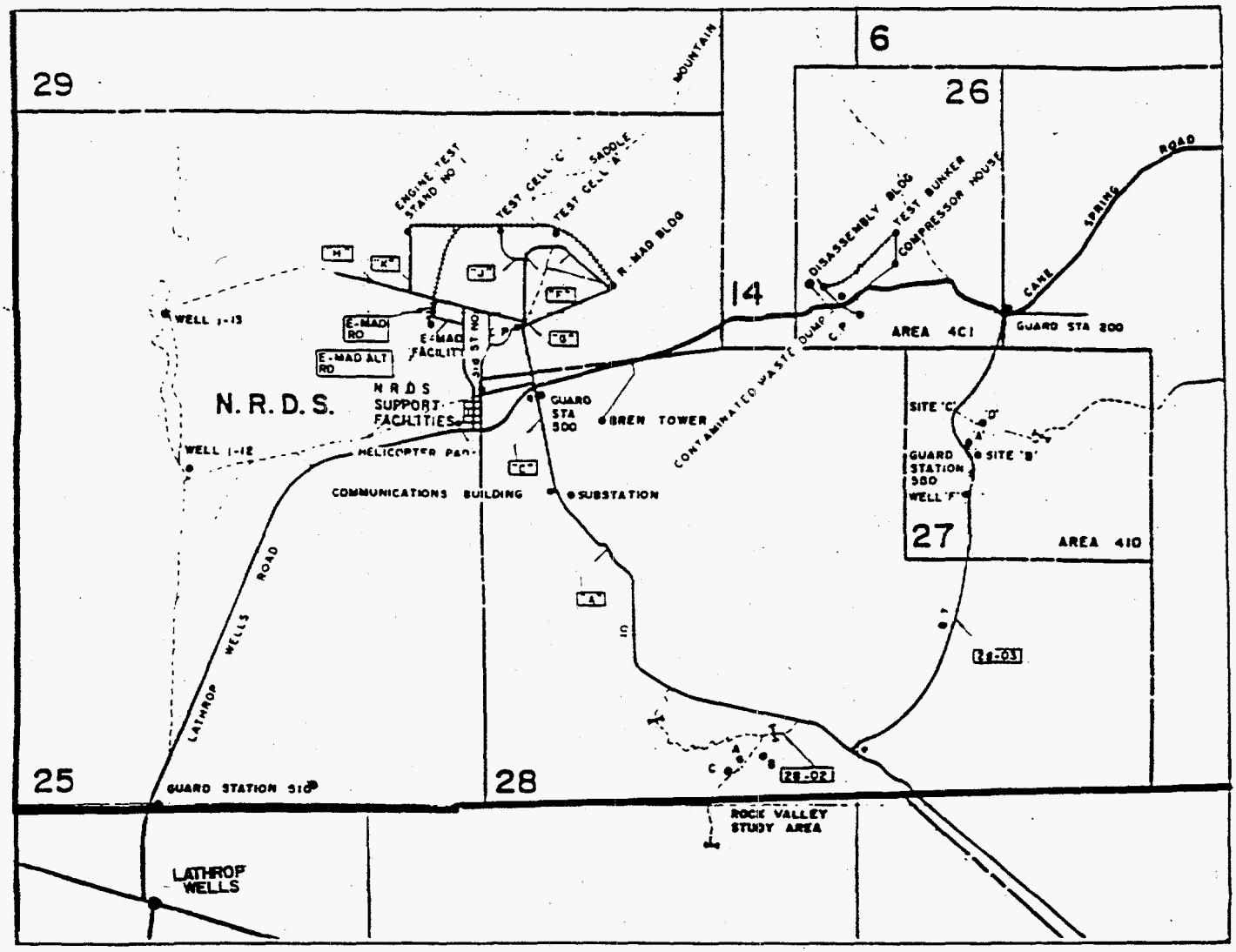

FIGURE 3. Enlargement of Areas 25 and 26 on the NTS.

TABLE 1. SUMMARY OF ROCKET AND RAMJET DEVELOPMENT

Year	Comments and Observations
1955-1961	Period of research, development, and initial testing of nuclear reactors by LASL. Initial reactors KIWI A, KIWI A PRIME, KIWI A-3, and KIWI B-1A, operating on gaseous hydrogen as both coolant and propellant, sustained duration of testing from 30 seconds to 6 minutes and ranged in power output from 70 to 300 megawatts (MW). Power output was limited by cooling capabilities.
1959	KIWI A (July) was the first full power reactor. The fuel was composed of micrometer-sized uranium oxide particles in a carbon matrix-plate geometry.
1960	TORY II-A was the first reactor designed for operation in a nuclear-powered ramjet engine. It was designed for operation at 160 MW at a core temperature of 2,250°F. Fuel elements were a homogeneous mixture of beryllia and uranium oxide extruded and shaped into hollow (to allow for interior flow of coolant) hexagonal cylinders. The last of four power runs exceeded design operating conditions without apparent malfunction.
1962	KIWI B-1B (September) was the first reactor to use liquid hydrogen as the coolant/propellant. The internal core structure failed. Reactors KIWI B-1B and KIWI B-4A demonstrated the ability to use liquid hydrogen as coolant with acceptable power output. Redesign was necessary due to core damage by flow vibration.
1963	Cold flow versions of KIWI B-4A, named KIWI B-4A(CF), KIWI B-2A, and KIWI B-4B, were operated to test design changes required to eliminate core damage resulting from flow vibrations of liquid hydrogen coolant.
1964	NRX-A1 cold flow reactor was successfully tested to probe design concepts for NERVA development. Reactors KIWI B-4D and KIWI B-4E were operated and restarted at full power and temperature for periods up to 8 minutes. NRX-A2 (September, first NERVA reactor) was operated and restarted from low to full power (1100 MW) for periods up to 5 minutes and demonstrated flow control features. KIWI B-4E (August) was the first reactor fueled by uranium carbide beads and had a redesigned core support structure.
1964	TORY II-C was the second reactor designed for operation in a nuclear-powered ramjet engine. It was designed for operation at 500 MW at a core temperature of 2,500°F.
1965	A ROVER flight safety experiment (KIWI TNT, January 1965) was conducted to gather data from a reactor deliberately destroyed by maximum excursion to determine the effects of a launch accident involving a nuclear rocket stage. NRX-A3 was operated and restarted twice at varying power outputs for a total duration of 45 minutes. PHOEBUS 1A was tested (June 1965) at full power and temperature for a duration of 10.5 minutes. During shutdown from full power, the liquid hydrogen coolant was all consumed (a gauge failed; operators were misinformed) resulting in under cooling and severe core damage.

1966 NRX-A4/EST (Engine Systems Test) was the first experiment with breadboard design* and first bootstrap (self starting) startup to power. This system demonstrated that a nuclear-powered rocket could start and operate on its own power and over a wide range of conditions. Operated 29.5 minutes at full power; total operating time was 1 hour 50 minutes. The NRX-A5 was operated (June) and restarted for a total of 30 minutes at full power (1,100 MW).

1967 NRX-A6 operated (January) at design power (1,100 MW) for 1 hour. PHOEBUS 1B was operated (February) for 45 minutes of which 30 minutes were at designed power output of 1,500 MW.

1968 The PHOEBUS 2A reactor, the most powerful nuclear rocket reactor ever built (4,000 MW), was operated at intermediate (20 minutes) and full power (12 minutes). The power density in the reactor exceeded that necessary for the 75,000-pound thrust NERVA nuclear rocket.

1968 The PEWEE 1 reactor (a scaled-down KIWI-type reactor) was developed principally to test and develop fuel elements and support hardware. The reactor was operated and restarted at significant power levels (greater than 500 MW) for a total duration of 1 hour 30 minutes. Exterior surfaces of all fuel elements were coated to retard erosion due to high temperatures and high velocity of coolant/propellant.

1969 The XE PRIME engine reactor began with low-level (100 MW) output for calibration purposes and slightly higher levels for determining restart capability. First test of a NERVA reactor in a flight-type configuration. Reactor was in down-firing position with components clustered in a semi-flight configuration.

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* A breadboard engine contains the principal components of a flight-test system with the components arranged for test convenience rather than for flight.

REFERENCES: CIC # 19569, 41693, LA-12785-MS

The first reactors of the program were called KIWIs after the flightless Kiwi bird of New Zealand. The NRX designation stood for Nuclear Rocket, Experimental. PHOEBUS can mean Apollo, the god of the sun (from Greek mythology); no explanation was found for this name selection. The PEWEE was designed as a small test-bed reactor to operate at maximum power-density and temperature. The XE designation was for Experimental Engine. This engine exhausted downward in a flight configuration whereas earlier rocket engines exhausted straight up (ramjet exhaust nozzles were angled up at 45 degrees). LASL developed the KIWI, PHOEBUS, and PEWEE reactors; working closely with LASL, Westinghouse Astronuclear Laboratory (WANL) developed the NRX and XE reactors.

The original land withdrawal was divided into the ROVER area (Area 25, also called Area 400) and the PLUTO area (Area 26, also called Area 401). LASL and WANL used the

ROVER area for rocket engine testing. LRL used the PLUTO area for research and testing of the nuclear-powered ramjet engines.

Table 2 provides a summary of the nuclear rocket and ramjet engine tests which generated radioactivity detected off site. (Many other tests of engine components and procedures preceded each power-generating run. Appendix 1 lists most test runs leading up to actually generating power for each of the devices tested.) The "time of day" shown provides a general idea of when during the day the test was conducted, but the source documents differ as to the meaning of the stated times (total interval of power generation, interval of peak power production, start and stop times of test run, etc.). For example, the TORY IIA run of May 14, 1961, which was not detected off site, recorded the following times (selected from 5 pages of notes):

0700 - start prerun checklist
1106 - begin approach to nuclear reaction
1215 - reactor critical
1402 - reached desired core temperature (2,250°C)
1404 - held peak power 45 seconds
1407 - decreased reactor power
1408 - nuclear reactions halted

Power was generated from 1215 to 1408, but peak power was held for only 45 seconds during this interval of almost two hours. Run times reported for most power runs refer to the minutes at peak power rather than the total interval of effluent generation; the exact situation is not always clear in summary statements.

The effluent from a nuclear reactor power run differed significantly from the effluent generated by a nuclear explosion. In an explosion, hundreds of different radionuclides are produced almost instantly—some of them in large quantities—and atomic interactions with the medium surrounding the detonation point increased the number and size of radioactive particulates which, in the case of an atmospheric test, were usually spread over a large area. In a reactor run, initially small quantities of radioactive effluents were generated with the amount increasing as the power was increased. The hydrogen coolant/propellant exited the exhaust nozzle (straight up) at high temperature and was then burned; the effluent cloud was composed of noncombustible gasses and particles.

The very hot effluent rose to thousands of feet above ground surface (sometimes 6 to 10 thousand feet—the hotter, the higher—depending on weather conditions). The effluent was composed of water vapor and gasses liberated by fission from the solid metal fuel elements. Some solid particles of nuclear fuel were also liberated by erosion caused by the high temperatures and high flow rates of the coolant/propellant; heavy particles dropped out of the effluent within few thousands of feet of the test cell.

TABLE 2. SUMMARY OF TESTS OF NUCLEAR-POWERED ROCKET AND RAMJET ENGINES WHICH GENERATED RADIOACTIVE EFFLUENT DETECTED OFF SITE

TEST NAME	EXPERI-MENTAL PLAN	DATE	TIME OF DAY (PST)	MAX. CHAMBER TEMP.(°F)	INTEGRATED POWER (MW-sec)	CURIES[1] RELEASE[2]
KIWI A	16	7/01/59	0900-0905	4,500	21,000	840
KIWI A PRIME	7-116-B	7/08/60			60,000	2,500
KIWI A-3	7-216-B	10/19/60			60,000	2,500
TORY IIA	3	10/06/61	1254		31,300	635
KIWI B-1A	6/A	12/07/61	1415-1417		30,000	1,300
KIWI B-1B	4	9/01/62	1130		10,000	420
KIWI B-4A	6	11/30/62	1207		40,000	1,700
TORY IIC	Intermed.	5/12/64	1215			256
KIWI B-4D	4	5/13/64	0945	4,280	110,000	4,600
TORY IIC	Full	5/20/64	1250			741
KIWI B-4E	5-301	8/28/64	1139-1147	4,240	500,000	21,000
KIWI B-4E	6-301	9/10/64	1055-1057	4,000	180,000	7,600
NRX-A2	4	9/24/64	0955-1005	3,600	300,000	1,100
NRX-A2	5	10/15/64	1110-1130		300,000	1,100
KIWI	TNT	1/12/65	1058		9,000	15,000
NRX-A3	4	4/23/65	1254-1258	4,900	320,000	530
NRX-A3	5	5/20/65	0932-0946	3,940	840,000	2,400
NRX-A3	6	5/28/65	0930-1000		500,000	1,200
PHOEBUS 1A	4	6/25/65	1215-1226	4,370	740,000	22,000
NRX-A4/EST	2B	2/03/66	1116-1123[3]	2,576	390,000	12
NRX-A4/EST	3	3/03/66	1310-1316[3]	4,100	880,000	100
NRX-A4/EST	4	3/16/66	1004-1020	4,000	1,000,000	27,000
NRX-A4/EST	4A	3/25/66	0933-0948	4,150	1,100,000	28,000
NRX-A5	3	6/08/66	1302-1318	4,000	1,200,000	1,200
NRX-A5	4	6/23/66	0935-0950	4,100	1,000,000	80,000
PHOEBUS 1B	3	2/10/67	1130-	2,900	140,000	34,000
PHOEBUS 1B	4	2/23/67	1400-1430	4,500	2,600,000	240,000
NRX-A6	3A	12/15/67	1059-1159	4,150	4,500,000	53,000
PHOEBUS 2A	3	6/08/68	1014-1025	2,680	643,000	7,100
PHOEBUS 2A	4	6/26/68	1137-1209	4,060	4,500,000	51,000
PHOEBUS 2A	5A	7/18/68	1210-1222	3,900	660,000	[4]
PHOEBUS 2A	5B	7/18/68	1350-1408		2,000,000	2,100
PEWEE 1	3	12/04/68	1332-1435	4,600	1,530,000	230,000
XE PRIME	5C	6/11/69	0942-0953	4,100	425,000	820
XE PRIME	9A	8/28/69	1518-1551	4,200	338,000	530

[1] These calculated values are precise within 20 percent **(HICKS, 1981)**. Total releases by all rocket and ramjet engine tests amounted to about 843,000 curies. A nuclear explosion generates approximately 30,300,000 curies of fission products (measured 12 hours after the detonation) per kiloton yield; thus, these tests represent about 3 percent of a one-kiloton explosion, or about 30 tons TNT energy equivalent release.

[2] As calculated for 12 hours after the time of release (R+12 hr). Short-lived radionuclides have decayed to stable forms by this time.

[3] Additional run times for NRX-A4: 2B, 1459-1510; 3, 1550-1605.

[4] Results for A&B runs are combined and shown under B run.

In summary, a reactor run generated a plume (due to the high wind speed during NRX-A4/EST, the plume was measured at 60 miles long by 35 miles wide) of water vapor and radioactive gaseous and particulate effluent which stabilized (with regard to altitude) at a substantial altitude above ground. The effluent cooled as it rose and was dispersed by turbulent mixing and winds, and total radioactivity was reduced by decay of short-lived nuclides.

NUCLEAR FURNACE

Test Cell C on the NRDS was also used in 1972 to test a nuclear furnace. The reactor was designed to operate at a full power of 44 MW for the purpose of testing fuel elements at the high temperatures and velocities of larger reactors and to test the operation of an effluent clean-up system designed to remove radioiodine and all low-vapor-pressure radionuclides. Seven reactor runs were conducted, the longest running nearly two hours at design power on July 27, 1972. No airborne radioactivity from any of the test runs was detected off the Test Range Complex by mobile monitors or the routine surveillance networks operated by the Environmental Protection Agency (EPA). Appendix 2 is a copy of the EPA's preliminary report of aerial monitoring and sampling for the seventh run (EP5). This report is representative of source documents used in compiling the information presented for nuclear rocket and ramjet engine tests. The level of detail varied somewhat during the years of nuclear engine tests; but aside from improvements in instruments for detection of radioactivity at low levels, the procedures, formats, and types of results remained fairly constant from 1959 through 1972. Monitoring results for the nuclear furnace tests are presented here because they do not warrant a separate report.

SECTION 2. OFF-SITE RADIOLOGICAL MONITORING

The TORY IIA tests have been reported in the past as generating radioactive materials detected "off site." However, "off site" meant beyond the borders of the then-smaller NTS as it was defined in 1961. Figure 4 shows the rectangular shape of the NTS with the Las Vegas Bombing and Gunnery Range (now the Nellis Air Force Range) bordering on three sides. For tests conducted since then, "off site" is defined as beyond the borders of the Test Range Complex (TRC), which includes the government-controlled areas of the Nevada Test Site, the Nellis Air Force Range, and the Tonopah Test Range (TTR). By the latter definition, only the fourth TORY IIA test, conducted on October 6, 1961, would be categorized as detected "off site."

Under a memorandum of understanding between the AEC and the Public Health Service (PHS, later part of the EPA), the PHS Off-Site Radiological Safety Organization provided radiation detection services during and after all rocket and ramjet engine tests in which the generation of radioactive effluent was anticipated. In the early years, these services typically included air sampling for the collection of airborne particulates for the detection of beta- and gamma-emitting isotopes and field monitoring for gamma radioactivity by mobile monitoring teams and automatic continuous recorders. Other services were investigated and added to the program in later years. PHS monitors were equipped with state-of-the-art instruments for radiation detection throughout the engine testing period, but new equipment and procedures were added as they became available. By the end of nuclear rocket testing in 1969, PHS monitors were equipped with the latest radiation survey instruments, gamma-rate recorders, thermoluminescent dosimeters (TLDs), portable air samplers, and supplies for collecting environmental samples. Also, instrumented aircraft were used for aerial monitoring, for definition of the boundaries of any radioactive effluent clouds, and for cloud sampling. Data from the aircraft were used in directing the placement of ground monitors and their equipment to intercept the cloud trajectory downwind from the NRDS. Following cloud passage, monitors obtained radiation readings in the affected areas and collected samples of native vegetation, milk, cow feed, and water. Filters and charcoal cartridges from air-sampling stations were collected for immediate analysis.

Figures 5 through 13, dispersed among the test descriptions on following pages, show the approximate centerline trajectory of effluent clouds detected off site. (Some test runs produced effluent detected in more than one direction off site; these are shown by dashed trajectory lines.) For all tests prior to the XE series, the effluent was exhausted upward. In many instances, the effluent rose thousands of feet, and subsequent monitoring at ground level detected only dispersed gaseous components in air.

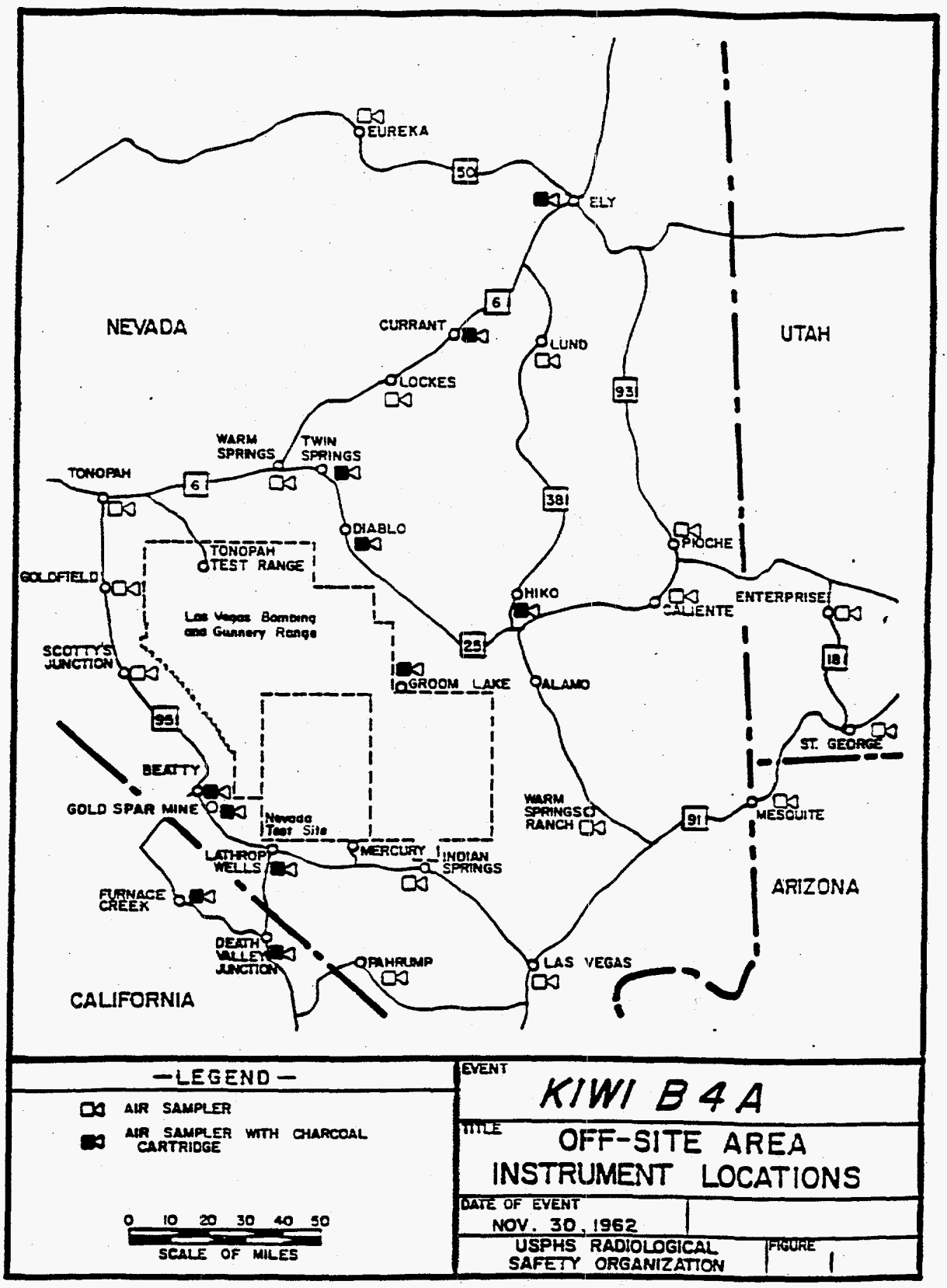


FIGURE 4. The "off site" area in the early 1960s was beyond the rectangular block shown as the Nevada Test Site.

Aircraft monitoring and tracking of effluent clouds was performed by the Public Health Service, by Edgerton, Germeshausen, & Grier, Inc. (EG&G), and sometimes by the Air Force. In addition to directing monitors on the ground, the PHS flew around and through the effluent cloud to estimate cloud size, to obtain air samples for identification of radionuclides present, and for determination of the radionuclide inventory. The PHS aircraft usually performed one or two spiral ascents or descents through the cloud to find the altitude of the highest measured radioactivity; the air-sampling pass through the cloud would be made at this altitude. EG&G aircraft were used primarily for tracking purposes with minimal penetrations into the cloud while tracking the effluent by flying in the vicinity of its outer edges. Clouds were generally tracked as long as they could be detected by instruments in the aircraft, unless the tracking mission was stopped by bad weather or dangerous terrain. Flights were conducted during daylight hours and at night as needed. On one occasion, effluent was tracked out over the Pacific Ocean as far as 200 miles.

Effluent clouds were sampled for isotope identification and for generation of estimates of radionuclide inventory. Cloud location, length, width, and thickness were determined by monitors in the various tracking aircraft (estimates of cloud thickness were sometimes provided by Weather Bureau staff). The PHS aircraft flew through the defined cloud to obtain samples of air containing effluents. The volume of the effluent cloud was calculated, and an average effluent value based on the air samples was assigned to the entire cloud. Radionuclide inventories derived by this procedure differed significantly (up to several orders of magnitude, usually on the high side) from estimates derived from other calculations. Radionuclide inventories reported are as reported in PHS final reports of off-site monitoring.

SECTION 3. DESCRIPTIONS OF TESTS

The following pages report the results of radiation monitoring and sampling efforts associated with rocket and ramjet engine tests. Only positive results are mentioned and summarized. For example, if ground monitoring did not detect any radioactive effluent, no entry appears for ground monitoring; the same holds for other categories of data reported.

Information for each test includes the CIC number for referenced documents. These numbers are the accession number assigned to the document by the Coordination and Information Center, an archive and research facility operated by Reynolds Electrical and Engineering Co., Inc. for the Department of Energy in Las Vegas, Nevada. The purpose of the CIC is to provide the public, the news media, governmental units, and other interested groups and individuals with data and documents on off-site radioactive fallout from nuclear weapons tests and other selected subjects. To this end, about 270,000 documents have been collected and are available for public access.

DEVICE: **KIWI A**

EXPERIMENTAL PLAN (EP): 16

SPONSOR: LASL

DATE: 7/1/59

TIME (PST): 0900-0905

LOCATION: Area 25

TEST CELL: "A"

NOMINAL POWER (MW): 70

INTEG. POWER (MW-sec): 21,000

RELEASE: OFF SITE

CLOUD DIRECTION: N (10°)

REFERENCES: CIC # 38222, 78434

MONITORING RESULTS

AIR SAMPLING: One air sample, from Diablo Maintenance Station, showed a very slight increase compared to the previous day.

MAXIMUM ACTIVITY DETECTED IN AIR OFF SITE: 4.45×10^{-4} $\mu Ci/m^3$ gross beta activity at Diablo Maintenance Station.

MAXIMUM GAMMA EXPOSURE RATE DETECTED OFF SITE: None detected.

DEVICE: **KIWI A PRIME**

EXPERIMENTAL PLAN (EP): 7-116-B

SPONSOR: LASL

DATE: 7/8/60

TIME (PST):

LOCATION: Area 25

TEST CELL: "A"

NOMINAL POWER (MW): 85

INTEG. POWER (MW-sec): 60,000

RELEASE: OFF SITE

CLOUD DIRECTION: NNE (15°)

REFERENCES: CIC # 38223

MONITORING RESULTS

AIR SAMPLING: One positive result at Diablo Maintenance Station.

MAXIMUM ACTIVITY DETECTED IN AIR OFF SITE: 1.1 pCi/m^3 at Diablo Maintenance Station.

MAXIMUM GAMMA EXPOSURE RATE DETECTED OFF SITE: None detected.

DEVICE: **KIWI A3**

EXPERIMENTAL PLAN (EP): 7-216-B

SPONSOR: LASL

DATE: 10/19/60

TIME (PST):

LOCATION: Area 25

TEST CELL: "A"

NOMINAL POWER (MW): 100

INTEG. POWER (MW-sec): 60,000

RELEASE: OFF SITE

CLOUD DIRECTION: NNE (40°)

REFERENCES: CIC # 38223

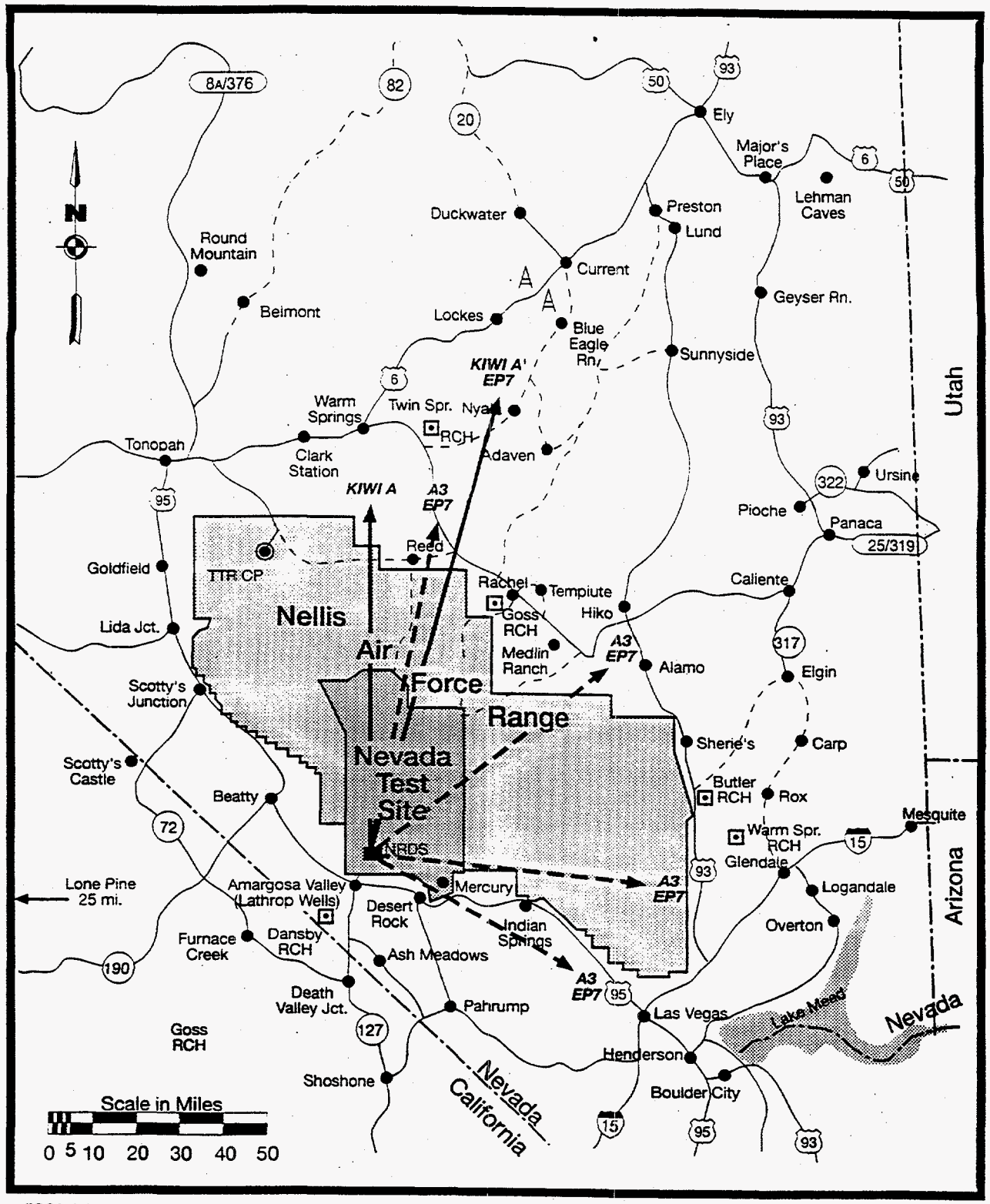
MONITORING RESULTS

AIR SAMPLING: Gross beta activity above background was detected at Alamo, Diablo, Lathrop Wells (now Amargosa Valley), and Warm Springs Ranch. Gamma emitters were detected at Lathrop Wells, Diablo, and Alamo.

ENVIRONMENTAL SAMPLES: An experimental study was conducted to determine whether animals could be used as biological samplers. Animals from several locations were sacrificed in conjunction with the Animal Investigation Program, and their thyroids were analyzed. Slightly elevated levels of I-131 were noted in animals from St. George, Utah, and from the Knoll Creek herd north of Wells, Nevada.

MAXIMUM ACTIVITY DETECTED IN AIR OFF SITE: 8.65×10^{-5} $\mu Ci/m^3$ (assumed to be gross beta activity) at Alamo on October 19.

MAXIMUM GAMMA EXPOSURE RATE DETECTED OFF SITE: None detected.



RDS853.A.5

FIGURE 5. Cloud drift directions following KIWI A Experiment 16, KIWI A Prime (A') Experiment 7 (EP7), and KIWI A3 Experiment 7 (EP7).

DEVICE: **TORY IIA**

EXPERIMENTAL PLAN (EP): 1

SPONSOR: LRL

DATE: 5/14/61

TIME (PST): 1249-1307

LOCATION: Area 26 (401)

TEST CELL: "B" (Test Bunker)

NOMINAL POWER (MW): 46

INTEG. POWER (MW-sec): 18,000

RELEASE: ON SITE* ONLY

CLOUD DIRECTION: NNE (30°)

SAMP. ALT. (MSL, ft): None

DISTANCE CLOUD TRACKED (mi): 30
(First experimental use of aircraft for cloud tracking.)

REFERENCES: CIC # 20319; UCRL 7249

DEVICE: **TORY IIA**

EXPERIMENTAL PLAN (EP): 2

SPONSOR: LRL

DATE: 9/28/61

TIME (PST): 1304-?

LOCATION: Area 26 (401)

TEST CELL: "B" (Test Bunker)

NOMINAL POWER (MW): 144

INTEG. POWER (MW-sec): 16,100

RELEASE: ON SITE* ONLY

CLOUD DIRECTION: NNE (30°)

SAMP. ALT. (MSL, ft): None

DISTANCE CLOUD TRACKED (mi): 30

REFERENCES: CIC # 20319; UCRL 7249

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* Previously reported as being detected off site. In 1961, off site meant off the (smaller then) Nevada Test Site; since about 1962, off site has meant off the Test Range Complex.

DEVICE: **TORY IIA**

EXPERIMENTAL PLAN (EP): 3

SPONSOR: LRL

DATE: 10/5/61

TIME (PST): 1135-?

LOCATION: Area 26 (401)

TEST CELL: "B" (Test Bunker)

NOMINAL POWER (MW): 166

INTEG. POWER (MW-sec): 20,900

RELEASE: ON SITE* ONLY

CLOUD DIRECTION: NNE (30°)

SAMP. ALT. (MSL, ft): None

DISTANCE CLOUD TRACKED (mi): 30

REFERENCES: CIC # 20319; UCRL 7249

DEVICE: **TORY IIA**

EXPERIMENTAL PLAN (EP): 3

SPONSOR: LRL

DATE: 10/6/61

TIME (PST): 1254-?

LOCATION: Area 26 (401)

TEST CELL: "B" (Test Bunker)

NOMINAL POWER (MW): 162

INTEG. POWER (MW-sec): --

RELEASE: OFF SITE

CLOUD DIRECTION: NNE (30°)

SAMP. ALT. (MSL, ft): None

DISTANCE CLOUD TRACKED (mi): 80

REFERENCES: CIC # 20319

MONITORING RESULTS

AIR SAMPLING: Measurable activity was collected in air sampling charcoal cartridges at Alamo and Diablo; activity was detected but unmeasurable at Hiko.

MAXIMUM ACTIVITY DETECTED IN AIR OFF SITE: 0.21 pCi/m^3 I-131 at Alamo and Diablo.

MAXIMUM GAMMA EXPOSURE RATE DETECTED OFF SITE: None detected.

* Previously reported as being detected off site. In 1961, off site meant off the (smaller then) Nevada Test Site; since about 1962, off site has meant off the Test Range Complex.

DEVICE: **KIWI B-1A**

EXPERIMENTAL PLAN (EP): 6/A

SPONSOR: LASL

DATE: 12/7/61

TIME (PST): 1415-1417

LOCATION: Area 25

TEST CELL: "A"

NOMINAL POWER (MW): 300

INTEG. POWER (MW-sec): 30,000

RELEASE: OFF SITE

CLOUD DIRECTION: ENE (55°)

SAMP. ALT. (MSL, ft): None

DISTANCE CLOUD TRACKED (mi): 18

REFERENCES: CIC # 38231

MONITORING RESULTS

AIR SAMPLING: Traces of activity detected at Indian Springs on December 8. Slightly elevated levels of gross beta activity detected at Ash Meadows, Bettle's Ranch, Death Valley Junction, and Lathrop Wells could not be positively associated with the KIWI B-IA test. Traces of gamma-emitter activity were detected in air samples from Ash Meadows, Beatty, Cactus Springs, Death Valley Junction, Indian Springs, and Lathrop Wells.

FALLOUT TRAYS: Gross beta activity was detected in fallout trays distributed along Highway 95 between the Mercury Highway and Lathrop Wells.

MAXIMUM ACTIVITY DETECTED IN AIR OFF SITE: 48 pCi/m^3 (at time of count) at Lathrop Wells.

MAXIMUM GAMMA EXPOSURE RATE DETECTED OFF SITE: None detected.

DEVICE: **KIWI B-1B**

EXPERIMENTAL PLAN (EP): 4

SPONSOR: LASL

DATE: 9/1/62

TIME (PST): 1130

LOCATION: Area 25

TEST CELL: "A"

NOMINAL POWER (MW): 800

INTEG. POWER (MW-sec): 10,000

RELEASE: OFF SITE

CLOUD DIRECTION: S

SAMP. ALT. (MSL, ft): None

DISTANCE CLOUD TRACKED (mi): 15

REFERENCES: CIC # 16226

MONITORING RESULTS

GROUND MONITORING: Positive readings at populated locations were obtained at Lathrop Wells and Ash Meadows.

AIR SAMPLING: Gross beta activity above background was detected at Lathrop Wells and Ash Meadows in Nevada and at Death Valley Junction and Shoshone in California.

FALLOUT TRAYS: One fallout tray located in Lathrop Wells showed low levels of activity above background.

ENVIRONMENTAL SAMPLES: One soil sample from Lathrop Wells showed fresh fission product activity with the highest value being I-133 at 66 pCi/g of soil. Soil samples collected from unpopulated locations around Lathrop Wells (two samples) and Ash Meadows (two samples) contained up to five times the value reported at Lathrop Wells.

MAXIMUM ACTIVITY DETECTED IN AIR OFF SITE: 19,500 pCi/m^3 gross beta activity at Ash Meadows.

MAXIMUM GAMMA EXPOSURE RATE DETECTED OFF SITE: 0.28 mr/hr at a location 2.25 miles east of Lathrop Wells.

DEVICE: **KIWI B-4A**

EXPERIMENTAL PLAN (EP): 6

SPONSOR: LASL

DATE: 11/30/62

TIME (PST): 1207

LOCATION: Area 25

TEST CELL: "A"

NOMINAL POWER (MW): 500

INTEG. POWER (MW-sec): 40,000

RELEASE: OFF SITE

CLOUD DIRECTION: WSW (about 250°)

SAMP. ALT. (MSL, ft): None

DISTANCE CLOUD TRACKED (mi): 30

REFERENCES: CIC # 16226

MONITORING RESULTS

GROUND MONITORING: Readings above background were obtained only at the Goldspar Mine.

AIR SAMPLING: Low levels of activity were detected at Goldspar Mine, Furnace Creek, and Beatty; results could have been due to fallout from a recent Russian nuclear test.

MAXIMUM ACTIVITY DETECTED IN AIR OFF SITE: 4.8 pCi/m^3 Zr-95/Nb-95 on glass fiber filter at Goldspar Mine.

MAXIMUM GAMMA EXPOSURE RATE DETECTED OFF SITE: 0.01 mr/hr at Goldspar Mine.

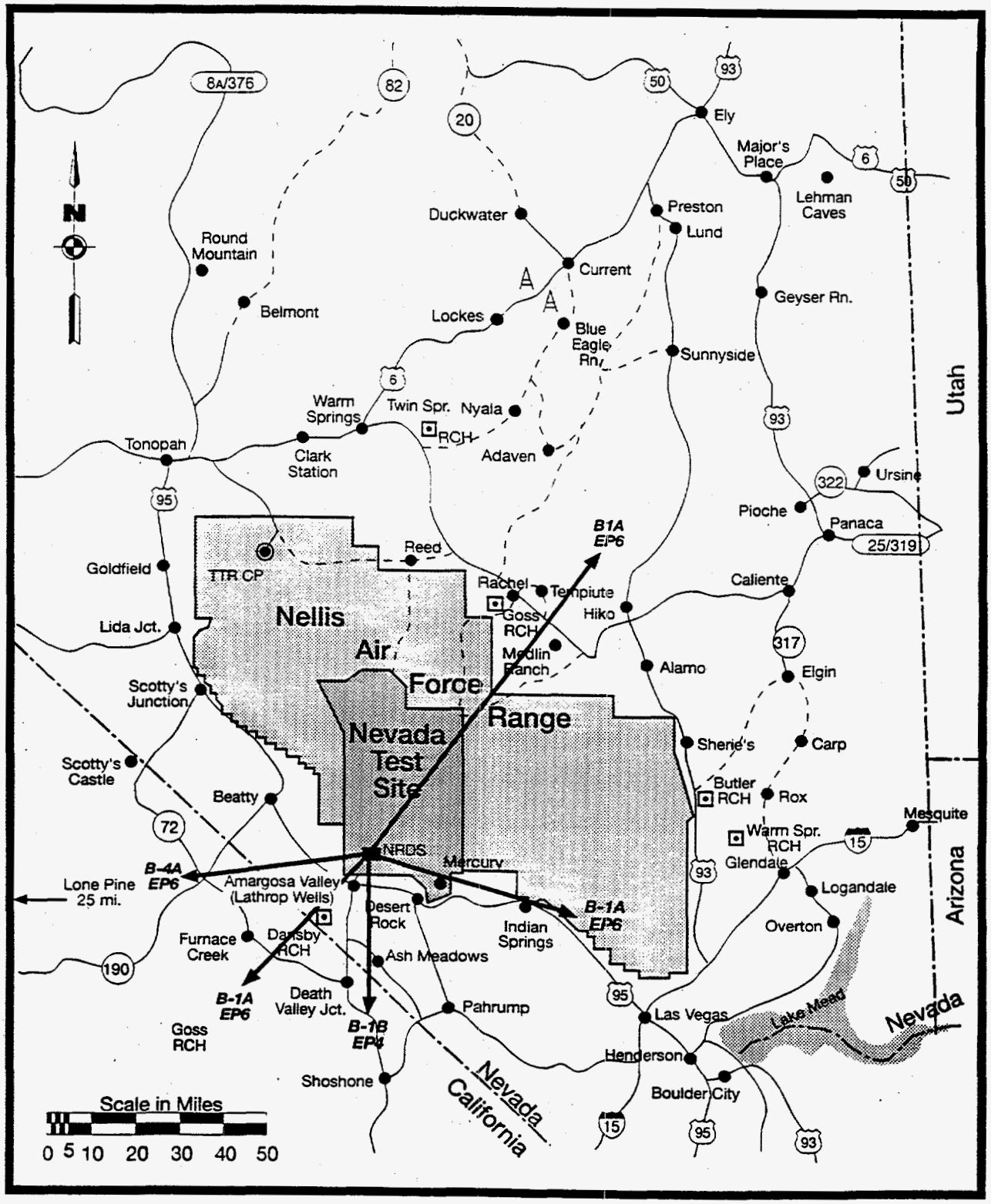


FIGURE 6. Cloud drift directions following KIWI B-1A Experiment 6/A (EP6), KIWI B-1B Experiment 4 (EP4), and KIWI B-4A Experiment 6 (EP6).

DEVICE: **KIWI B-4D**

EXPERIMENTAL PLAN (EP): 3-202

SPONSOR: LASL

DATE: 5/8/64

TIME (PST): 1225

LOCATION: Area 25

TEST CELL: "C"

NOMINAL POWER (MW):

INTEG. POWER (MW-sec): Low

RELEASE: ON SITE ONLY

CLOUD DIRECTION: NNE

SAMP. ALT. (MSL, ft): 6,500

DISTANCE CLOUD TRACKED (mi):

REFERENCES: CIC # 15011, 105317

CLOUD SAMPLING RESULTS

GROSS BETA INVENTORY IN CLOUD (at midtime of sampling): 50 Ci at 1226 PST.

RADIONUCLIDES IDENTIFIED IN THE EFFLUENT CLOUD (at 1226 PST):
Xe-135: 45 Ci. Gamma activity insufficient for isotopic identification.

DEVICE: **TORY IIC**

EXPERIMENTAL PLAN (EP): Intermed.

SPONSOR: LRL

DATE: 5/12/64

TIME (PST): 1215-1228

LOCATION: Area 26 (401)

TEST CELL: "B" Test Bunker

NOMINAL POWER (MW): 324

INTEG. POWER (MW-sec): --

RELEASE: OFF SITE

CLOUD DIRECTION: NNE (25°)

SAMP. ALT. (MSL, ft): 8,000

DISTANCE CLOUD TRACKED (mi): 90

REFERENCES: CIC # 17282, 105316

CLOUD SAMPLING RESULTS

GROSS BETA INVENTORY IN CLOUD (at midtime of sampling): 70,000 Ci at 1250 PST.

RADIONUCLIDES IDENTIFIED IN THE EFFLUENT CLOUD (at 1250 PST):

I-133: 13 Ci Xe-135: 17 Ci Ba-140: 12 Ci

MONITORING RESULTS

GROUND MONITORING: Activity detected at the junction of Valley Road and State Highway 25.

MAXIMUM ACTIVITY DETECTED IN AIR OFF SITE: None detected.

MAXIMUM GAMMA EXPOSURE RATE DETECTED OFF SITE: 0.02 mr/hr net gamma at the junction of Valley Road and State Highway 25.

DEVICE: **KIWI B-4D**

EXPERIMENTAL PLAN (EP): 4-202

SPONSOR: LASL

DATE: 5/13/64

TIME (PST): 0945-0946

LOCATION: Area 25

TEST CELL: "C"

NOMINAL POWER (MW): 915

INTEG. POWER (MW-sec): 110,000

RELEASE: OFF SITE

CLOUD DIRECTION: N (5°)

SAMP. ALT. (MSL, ft): Not given

DISTANCE CLOUD TRACKED (mi): 160

REFERENCES: CIC # 15011, 105317

CLOUD SAMPLING RESULTS

GROSS BETA INVENTORY IN CLOUD (at midtime of sampling): 20,000 Ci at 1520 PST.

RADIONUCLIDES IDENTIFIED IN THE EFFLUENT CLOUD (at 1520 PST):

Zr-95/Nb-95:	<3 Ci	Te-132:	230 Ci	I-131:	44 Ci
I-133:	1,400 Ci	I-135:	220 Ci	Ba-140:	44 Ci
Ce-141:	31 Ci	Mo-99:	<20 Ci	Sr-91:	320 Ci

MONITORING RESULTS

GROUND MONITORING: Activity was detected at Diablo, Queen City Summit, and at a point 8 miles southwest of Nyala.

CONTINUOUS RECORDERS: Activity was detected at Diablo and Lund.

AIR SAMPLING: Activity was detected in air samples from Currant, Diablo, and Queen City Summit.

ENVIRONMENTAL SAMPLES: Radioiodines were detected in milk samples from Alamo, Nyala, Casey's Ranch, Blue Eagle Ranch, Halstead Ranch, Dickinson Ranch, Henroid Ranch, and Tex Gates Ranch; largest value (140 pCi/l I-131) was obtained from the Casey's Ranch sample.

MAXIMUM ACTIVITY DETECTED IN AIR OFF SITE: 1,500 pCi/m^3 gross beta on prefilter from Diablo.

MAXIMUM GAMMA EXPOSURE RATE DETECTED OFF SITE: 0.43 mr/hr net peak dose rate at Diablo.

DEVICE: **TORY IIC**

EXPERIMENTAL PLAN (EP): Full power

SPONSOR: LRL

DATE: 5/20/64

TIME (PST): 1250-?

LOCATION: Area 26 (401)

TEST CELL: Test Bunker

NOMINAL POWER (MW): --

INTEG. POWER (MW-sec): --

RELEASE: OFF SITE

CLOUD DIRECTION: NNE (14°)

SAMP. ALT. (MSL, ft): Not given

DISTANCE CLOUD TRACKED (mi): 125

REFERENCES: CIC # 17282, 105316

CLOUD SAMPLING RESULTS

GROSS BETA INVENTORY IN CLOUD (at midtime of sampling): 4,500 Ci at 1415 PST.

RADIONUCLIDES IDENTIFIED IN THE EFFLUENT CLOUD (at 1415 PST):

Ni-57:	60 Ci	Te-132:	60 Ci	I-133:	60 Ci
I-134:	530 Ci	Ba-139:	1200 Ci		

MONITORING RESULTS

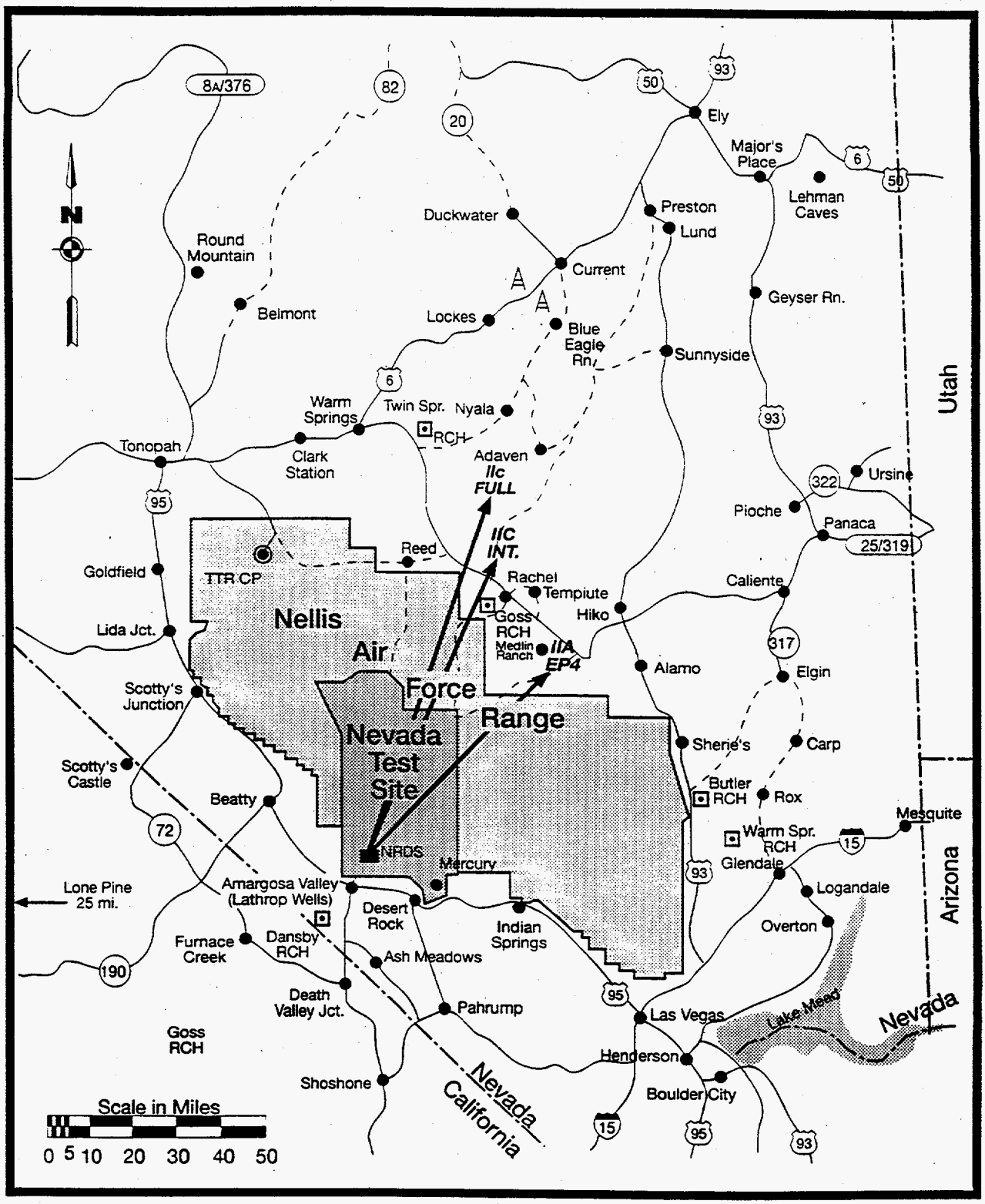
GROUND MONITORING: Activity detected at Goss Ranch and Queen City Summit.

AIR SAMPLING: Fresh fission products were detected in samples collected at Goss Ranch, Adaven, and Sunnyside. The only isotope detected was I-133.

ENVIRONMENTAL SAMPLES: Milk sampling was begun following the KIWI B-4D test on May 13 and continued until some time after the TORY test. The PHS concluded that the TORY test contribution of I-131 to milk was indistinguishable from the contribution from the KIWI test.

MAXIMUM ACTIVITY DETECTED IN AIR OFF SITE: 1,000 pCi/m^3 gross beta on prefilter from Goss Ranch.

MAXIMUM GAMMA EXPOSURE RATE DETECTED OFF SITE: 0.05 mr/hr net peak dose rate at Goss Ranch.



RDS853.A.7

FIGURE 7. Cloud drift directions following TORY IIA Experiment 4 (EP4), TORY IIC Experiments Intermediate (INT.) and Full Power (FULL).

DEVICE: **KIWI B-4E**

EXPERIMENTAL PLAN (EP): 5-301 | SPONSOR: LASL

DATE: 8/28/64 | TIME (PST): 1139-1147

LOCATION: Area 25 | TEST CELL: "C"

NOMINAL POWER (MW): 914 | INTEG. POWER (MW-sec): 500,000

RELEASE: OFF SITE | CLOUD DIRECTION: NNE (28°)

SAMP. ALT. (MSL, ft): 6,400 | DISTANCE CLOUD TRACKED (mi): 110

REFERENCES: CIC # 14746, 105315, 16763

CLOUD SAMPLING RESULTS

GROSS BETA INVENTORY IN CLOUD (at midtime of sampling): 15,500 Ci at 1210 PST (while cloud was over the NTS 8 miles from the test cell).

RADIONUCLIDES IDENTIFIED IN THE EFFLUENT CLOUD (at 1210 PST):

Te-132: 332 Ci	I-133: 288 Ci	I-134: 11,000 Ci
Xe-135: 328 Ci	Ba-139: 3,600 Ci	

MONITORING RESULTS

GROUND MONITORING: Gamma dose rates above background were detected at Coyote Summit and the Goss Ranch.

AIR SAMPLING: Air samples containing fresh fission products were collected at the Goss Ranch, Pioche, Hiko, and the Blue Jay Maintenance Station.

ENVIRONMENTAL SAMPLES: Milk samples from 21 ranches and 4 dairies did not contain detectable activity. A milk sample from the Donahue Ranch (25 miles north of Ursine) contained I-131 at the threshold of detectability (20 pCi/l). Vegetation samples showing the presence of fresh fission products were obtained in or near Nyala, Currant, Ely, Ursine, Caliente, and Hiko. Vegetation samples from 17 other locations in Nevada and Utah contained no detectable activity. A water sample from Fillmore, Utah, contained I-131 at the limit of detectability.

MAXIMUM ACTIVITY DETECTED IN AIR OFF SITE: 22 pCi/m^3 gross beta at the Goss Ranch.

MAXIMUM GAMMA EXPOSURE RATE DETECTED OFF SITE: 0.18 mr/hr at the Goss Ranch.

DEVICE: **KIWI B-4E**

EXPERIMENTAL PLAN (EP): 6-301

SPONSOR: LASL

DATE: 9/10/64

TIME (PST): 1055-1057

LOCATION: Area 25

TEST CELL: "C"

NOMINAL POWER (MW): 882

INTEG. POWER (MW-sec): 180,000

RELEASE: OFF SITE

CLOUD DIRECTION: NE (45°)

SAMP. ALT. (MSL, ft): 6,500

DISTANCE CLOUD TRACKED (mi): 100

REFERENCES: CIC # 14746, 16762, 105315

CLOUD SAMPLING RESULTS

GROSS BETA INVENTORY IN CLOUD (at midtime of sampling): 40,000 Ci at 1134 PST.

RADIONUCLIDES IDENTIFIED IN THE EFFLUENT CLOUD (at 1134 PST):

Te-132:	47 Ci	I-131:	11 Ci	I-133:	80 Ci
I-134:	2,100 Ci	I-135:	120 Ci	Ba-139:	820 Ci
Xe-135:	92 Ci				

MONITORING RESULTS

AIR SAMPLING: Samples containing fresh fission products were collected at the Goss Ranch, Hiko, and Caliente.

ENVIRONMENTAL SAMPLES: Milk samples only from the Schofield Dairy at Hiko contained fresh fission products.

MAXIMUM ACTIVITY DETECTED IN AIR OFF SITE: 445 pCi/m^3 gross beta at Goss Ranch.

MAXIMUM GAMMA EXPOSURE RATE DETECTED OFF SITE: None detected.

DEVICE: **NRX-A2**

EXPERIMENTAL PLAN (EP): 4

SPONSOR: WANL

DATE: 9/24/64

TIME (PST): 0955-1005

LOCATION: Area 25

TEST CELL: "A"

NOMINAL POWER (MW): 1,100

INTEG. POWER (MW-sec): 300,000

RELEASE: OFF SITE

CLOUD DIRECTION: SSW (220°)

SAMP. ALT. (MSL, ft): 7,000

DISTANCE CLOUD TRACKED (mi): 75

REFERENCES: CIC # 4942, 105314, 16764

CLOUD SAMPLING RESULTS

GROSS BETA INVENTORY IN CLOUD (at midtime of sampling): 1,200 Ci at 1240 PST.

RADIONUCLIDES IDENTIFIED IN THE EFFLUENT CLOUD (at 1240 PST):

Zr-97+Nb-97:	6.8 Ci	Te-132:	15 Ci	I-133:	43 Ci
I-134:	410 Ci	Ba-139:	410 Ci		

MONITORING RESULTS

GROUND MONITORING: Gamma dose rates above background were detected near Lathrop Wells, on Highway 95 northwest of Lathrop Wells, and at Dansby Ranch, 10 miles southwest of Lathrop Wells.

CONTINUOUS RECORDERS: The recorder at Lathrop Wells detected reactor effluent with a net peak dose rate of 0.18 mr/hr.

AIR SAMPLING: Fresh fission products were detected on prefilters and cartridges collected from Lathrop Wells and Dansby Ranch in Nevada and from Death Valley Junction, Stovepipe Wells, and Furnace Creek in California.

ENVIRONMENTAL SAMPLES: Milk samples collected at Dansby Ranch indicated low levels of I-133; other fresh fission products were not detectable. Water samples collected at locations under the effluent trajectory did not show detectable levels of radioactivity.

MAXIMUM ACTIVITY DETECTED IN AIR OFF SITE: 450 pCi/m^3 gross beta at Lathrop Wells (84 pCi/m^3 I-135).

MAXIMUM GAMMA EXPOSURE RATE DETECTED OFF SITE: 0.43 mr/hr net peak dose rate at Lathrop Wells.

DEVICE: **NRX-A2**

EXPERIMENTAL PLAN (EP): 5

SPONSOR: WANL

DATE: 10/15/64

TIME (PST): 1110-1130

LOCATION: Area 25

TEST CELL: "A"

NOMINAL POWER (MW): --

INTEG. POWER (MW-sec): 300,000

RELEASE: OFF SITE

CLOUD DIRECTION: NE (about 40°)

SAMP. ALT. (MSL, ft): 6,000

DISTANCE CLOUD TRACKED (mi): 50

REFERENCES: CIC # 4942, 105314, 169859

CLOUD SAMPLING RESULTS

GROSS BETA INVENTORY IN CLOUD: No estimate.

RADIONUCLIDES IDENTIFIED IN THE EFFLUENT CLOUD: No fresh fission products detected.

MONITORING RESULTS

GROUND MONITORING: Due to the low dose rates encountered by aerial monitors, no ground monitors were positioned off the test range complex.

AIR SAMPLING: Only the air sample collected at Indian Springs contained detectable fresh fission products; this was assumed to be the result of southward air drainage from the effluent which passed to the north of this location.

ENVIRONMENTAL SAMPLES: Collected milk samples did not contain detectable fresh fission products. A water sample collected at Goss Ranch contained 75 pCi/l I-133. Vegetation samples collected at Goss Ranch and Hiko contained low levels of fresh fission products.

MAXIMUM ACTIVITY DETECTED IN AIR OFF SITE: 150 total pCi I-131 at Indian Springs; rate could not be determined due to motor failure.

MAXIMUM GAMMA EXPOSURE RATE DETECTED OFF SITE: None detected.

DEVICE: **KIWI**

EXPERIMENTAL PLAN (EP): TNT*

SPONSOR: LASL

DATE: 1/12/65

TIME (PST): 1058

LOCATION: Area 25

TEST CELL: "C" (650 ft NW)

NOMINAL POWER (MW): --

INTEG. POWER (MW-sec): 9,400

RELEASE: OFF SITE

CLOUD DIRECTION: SW (about 210°)

SAMP. ALT. (MSL, ft):

DISTANCE CLOUD TRACKED (mi): 250

REFERENCES: CIC # 4310, 36794

*Transient Nuclear Test--a nuclear safety experiment (to determine the maximum effect of a launch accident) involving intentional explosive destruction of a reactor, similar to the KIWI B-4, by very rapidly inserting an abnormal amount of reactivity into the core with the reactor's control drums. A very sudden increase in fissions, planned or otherwise, is referred to as an "excursion" or a "transient."

CLOUD SAMPLING RESULTS

GROSS BETA INVENTORY IN CLOUD (at midtime of sampling): 1,600,000 Ci at 1220 PST. Cloud was tracked on test day to a location 100 miles SSW of NTS before mission was terminated by darkness. Cloud was found the next day over the ocean from Los Angeles to Santa Barbara.

RADIONUCLIDES IDENTIFIED IN THE EFFLUENT CLOUD (at 1220 PST):

Kr-85M:	5,400 Ci	Kr-87:	14,000 Ci	Kr-88:	23,000 Ci
Sr-89:	33 Ci	Sr-90:	0.4 Ci	Sr-91:	13,000 Ci
Sr-92:	56,000 Ci	Zr-95+Nb-95:	230 Ci	Zr-97:	28,000 Ci
Mo-99:	6,900 Ci	Ru-103:	160 Ci	Te-132:	1,500 Ci
I-131:	540 Ci	I-133:	6,300 Ci	I-134:	28,000 Ci
I-135:	12,000 Ci	Xe-135:	1,100 Ci	Cs-138:	68,000 Ci
Ba-139:	4,200 Ci	Ba-140:	210 Ci	Ce-141:	140 Ci
Ce-143:	5,900 Ci	Nd-147:	210 Ci	Np-249:	130 Ci
U-234:	9.1 Ci				

MONITORING RESULTS

GROUND MONITORING: Activity above background was detected off site at Lathrop Wells and Dansby Ranch in Nevada, at Death Valley Junction in California, and at several highway locations between these points.

CONTINUOUS RECORDERS: Activity was recorded at the locations named above; the highest recorded dose rate was 0.86 mr/hr net peak gamma at Dansby Ranch.

AIR SAMPLING: Air samples from twelve stations in the Amargosa Valley area south of the NRDS contained fresh fission products.

ENVIRONMENTAL SAMPLES: Milk was sampled at 16 locations as far south as Brawley and as far west as San Luis Obispo, California, during the week following the TNT test. None of the 74 milk samples contained detectable quantities of fresh fission products because of the low source term.

MAXIMUM ACTIVITY DETECTED IN AIR OFF SITE: 210,000 pCi/m^3 gross beta on Highway 95, 1.5 miles west of Lathrop Wells.

MAXIMUM GAMMA EXPOSURE RATE DETECTED OFF SITE: 70 mr/hr gamma dose rate 1.5 miles west of Lathrop Wells (2 mr/hr in Lathrop Wells).

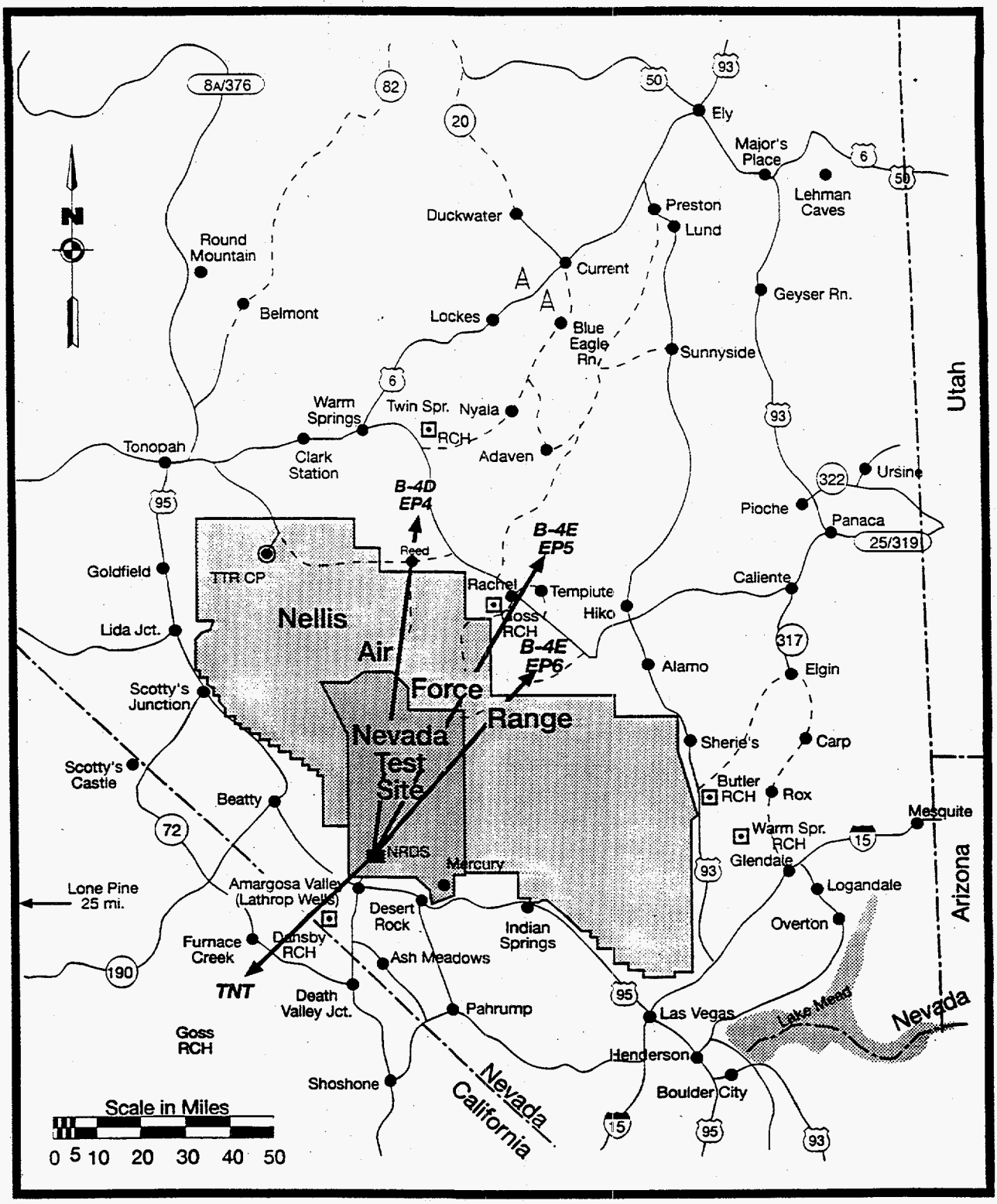


FIGURE 8. Cloud drift directions following KIWI B-4D Experiment 4 (EP4), KIWI B-4E Experiments 5 (EP5) and 6 (EP6), and KIWI TNT.

DEVICE: **NRX-A3**

EXPERIMENTAL PLAN (EP): 4

SPONSOR: WANL

DATE: 4/23/65

TIME (PST): 1254-1258

LOCATION: Area 25

TEST CELL: "A"

NOMINAL POWER (MW): 1,110

INTEG. POWER (MW-sec): 320,000

RELEASE: OFF SITE

CLOUD DIRECTION: SSE (160°)

SAMP. ALT (MSL, ft): Not given

DISTANCE CLOUD TRACKED (mi): 100

REFERENCES: CIC # 4941, 17724, 169889

CLOUD SAMPLING RESULTS

GROSS BETA INVENTORY IN CLOUD (at midtime of sampling): 6,000 Ci at 1410 PST.

RADIONUCLIDES IDENTIFIED IN THE EFFLUENT CLOUD (at 1410 PST):

Sr-91:	100 Ci	Sr-92:	44 Ci	Kr-85m:	4,000 Ci
Te-132:	37 Ci	I-131:	7 Ci	I-132:	69 Ci
I-133:	33 Ci	I-134:	290 Ci	I-135:	44 Ci
Xe-135:	220 Ci	Ba-139:	770 Ci		

MONITORING RESULTS

GROUND MONITORING: Effluent activity was detected only at Pahrump.

AIR SAMPLING: Fresh fission product activity was detected in samples from Lathrop Wells, Pahrump, and four temporary samplers along Highway 95 between Lathrop Wells and the Mercury Highway.

MAXIMUM ACTIVITY DETECTED IN AIR OFF SITE: 110 pCi/m^3 gross beta on Highway 95, 17 miles east-southeast of Lathrop Wells.

MAXIMUM GAMMA EXPOSURE RATE DETECTED OFF SITE: Less than 0.03 mr/hr at Pahrump.

DEVICE: **NRX-A3**

EXPERIMENTAL PLAN (EP): 5

SPONSOR: WANL

DATE: 5/20/65

TIME (PST): 0932-0946

LOCATION: Area 25

TEST CELL: "A"

NOMINAL POWER (MW): 1,080

INTEG. POWER (MW-sec): 840,000

RELEASE: OFF SITE

CLOUD DIRECTION: NE (40 to 60°)

SAMP. ALT. (MSL, ft): 8,500

DISTANCE CLOUD TRACKED (mi):

REFERENCES: CIC # 4941, 169889

CLOUD SAMPLING RESULTS

GROSS BETA INVENTORY IN CLOUD (at midtime of sampling): 53,000 Ci at 1128 PST (over the NTS).

RADIONUCLIDES IDENTIFIED IN THE EFFLUENT CLOUD (at 1128 PST):

Sr-91:	740 Ci	Sr-92:	1,300 Ci	Mo-99:	9.2 Ci
Te-129:	14,000 Ci	Te-131:	5,200 Ci	Te-132:	130 Ci
I-131:	37 Ci	I-133:	640 Ci	I-134:	9,200 Ci
I-135:	230 Ci	Ba-139:	1,400 Ci	Kr(gross):	25,700 Ci (gasses)

MONITORING RESULTS

GROUND MONITORING: Activity above background was detected at Goss Ranch, Coyote Summit, Hancock Summit, and Crystal Spring.

AIR SAMPLING: Air sampling detected fresh fission products at Diablo, Goss Ranch, Coyote Summit, Hancock Summit, Hiko, and Alamo.

ENVIRONMENTAL SAMPLES: Milk samples from Hiko contained radioiodine (30 to 90 pCi/l) for several weeks following the experiment.

MAXIMUM ACTIVITY DETECTED IN AIR OFF SITE: 290 pCi/m^3 gross beta at Coyote Summit. Highest reading at a populated location was 76 pCi/m^3 at Goss Ranch.

MAXIMUM GAMMA EXPOSURE RATE DETECTED OFF SITE: 0.06 mr/hr net peak dose rate at Coyote Summit.

DEVICE: **NRX-A3**

EXPERIMENTAL PLAN (EP): 6

SPONSOR: WANL

DATE: 5/28/65

TIME (PST): 0930-1000

LOCATION: Area 25

TEST CELL: "A"

NOMINAL POWER (MW): 400

INTEG. POWER (MW-sec): 500,000

RELEASE: OFF SITE

CLOUD DIRECTION: WSW (250°)

SAMP. ALT. (MSL, ft): Not given

DISTANCE CLOUD TRACKED (mi):

REFERENCES: CIC # 4941, 169889

CLOUD SAMPLING RESULTS

GROSS BETA INVENTORY IN CLOUD (at midtime of sampling): 5,400 Ci at 1043 PST.

RADIONUCLIDES IDENTIFIED IN THE EFFLUENT CLOUD (at 1043 PST):

Kr-85m:	7,000 Ci	Sr-91:	90 Ci	Sr-92:	160 Ci
Te-132:	16 Ci	I-131:	13 Ci	I-133:	380 Ci
I-134:	450 Ci	I-135:	240 Ci	Xe-135:	810 Ci
Ba-139:	830 Ci				

MONITORING RESULTS

AIR SAMPLING: Activity above background detected at Lathrop Wells and at one sampling station on Highway 95, 15 miles west of Lathrop Wells.

ENVIRONMENTAL SAMPLES: Radioiodine was detected in samples of milk and vegetation collected in Springdale (north of Beatty).

MAXIMUM ACTIVITY DETECTED IN AIR OFF SITE: 11 pCi/m^3 gross beta on prefilter from sampler 15 miles west of Lathrop Wells.

MAXIMUM GAMMA EXPOSURE RATE DETECTED OFF SITE: None detected.

DEVICE: **PHOEBUS 1A**

EXPERIMENTAL PLAN (EP): 4

SPONSOR: LASL

DATE: 6/25/65

TIME (PST): 1215-1226

LOCATION: Area 25

TEST CELL: "C"

NOMINAL POWER (MW): 1,070

INTEG. POWER (MW-sec): 740,000

RELEASE: OFF SITE

CLOUD DIRECTION: NNE (about 25°)

SAMP. ALT. (MSL, ft): 8,500

DISTANCE CLOUD TRACKED (mi): 120

REFERENCES: CIC # 4959, 169991

CLOUD SAMPLING RESULTS

GROSS BETA INVENTORY IN CLOUD (at midtime of sampling): 67,000 Ci at 1345 PST.

RADIONUCLIDES IDENTIFIED IN THE EFFLUENT CLOUD (at 1345 PST):

Kr-85m:	4,700 Ci	Kr-88:	17,000 Ci	Sr-91:	2,700 Ci
Sr-92:	9,800 Ci	Zr-95:	1.7 Ci	Zr-97:	95 Ci
Mo-99:	4.9 Ci	Te-132:	71 Ci	I-131:	14 Ci
I-133:	330 Ci	I-134:	3,400 Ci	I-135:	960 Ci
Xe-135:	720 Ci	Ba-139:	3,500 Ci	Ba-140:	65 Ci
La-142:	3,300 Ci	Ce-141:	24 Ci	Ce-143:	57 Ci

MONITORING RESULTS

GROUND MONITORING: Activity was detected at Queen City Summit.

CONTINUOUS RECORDERS: Diablo was the only populated location to receive a measurable external dose.

AIR SAMPLING: Radioiodine activity detected in air samples at Queen City Summit, Diablo, Alamo, and Hiko.

ENVIRONMENTAL SAMPLES: Detectable quantities of I-131 were found in milk (20 to 180 pCi/l) and vegetation samples from Alamo, Hiko, and Currant. Radioiodine was found in vegetation samples from Nyala and Caliente and in water samples from Caliente, Pioche, Twin Springs Ranch, Blue Jay Maintenance Station, and Warm Springs Ranch.

MAXIMUM ACTIVITY DETECTED IN AIR OFF SITE: 2.0 pCi/m^3 gross beta in prefilter from Alamo.

MAXIMUM GAMMA EXPOSURE RATE DETECTED OFF SITE: 0.065 mr/hr at Queen City Summit.

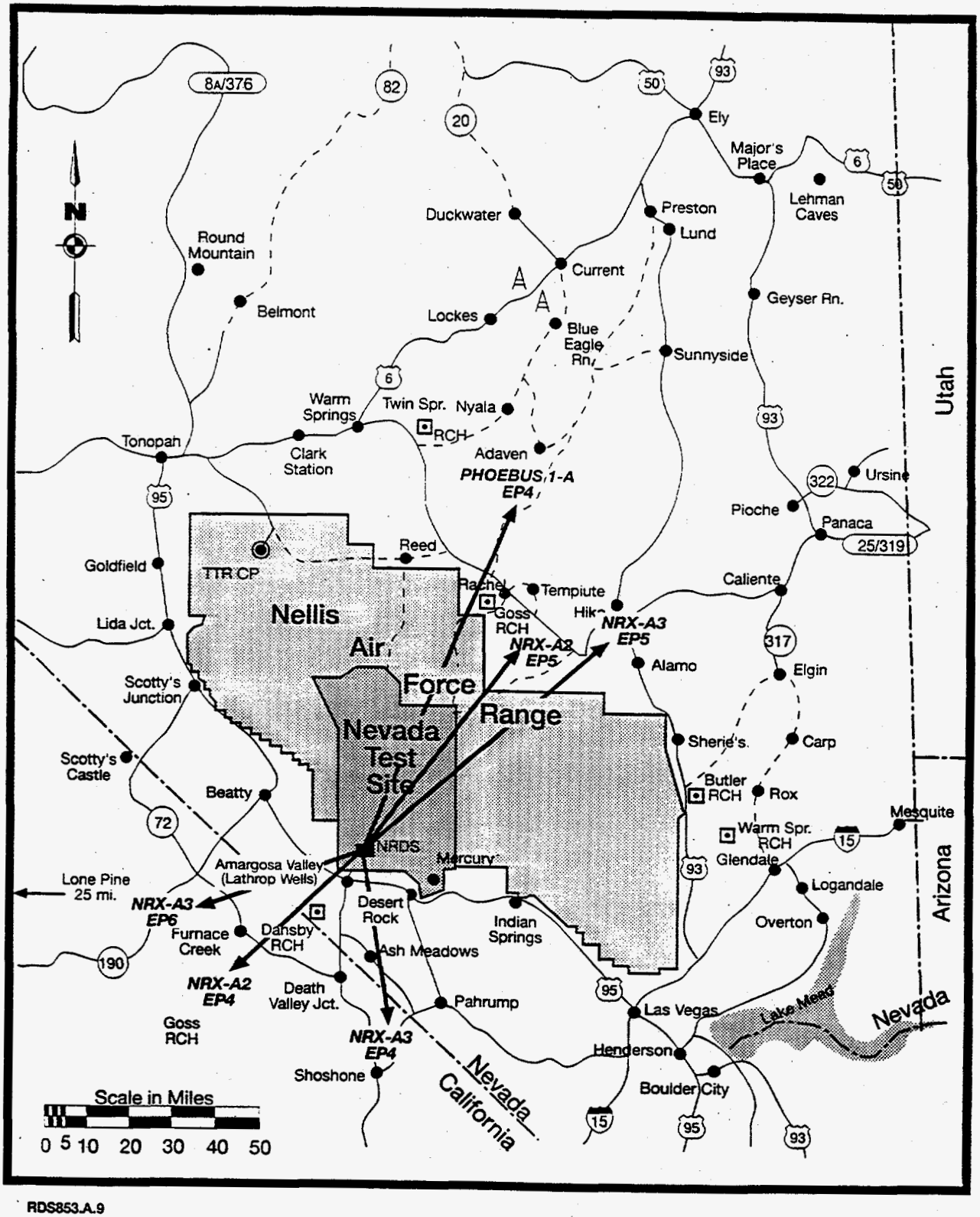


FIGURE 9. Cloud drift directions following NRX-A2 Experiments 4 (EP4) and 5 (EP5); NRX-A3 Experiments 4 (EP4), 5 (EP5), and 6 (EP6); and PHOEBUS 1A Experiment 4 (EP4).

DEVICE: **NRX-A4/EST**

EXPERIMENTAL PLAN (EP): 2B

SPONSOR: WANL

DATE: 2/3/66

TIME (PST): 1116-1123; 1459-1510

LOCATION: Area 25

TEST CELL: "A"

NOMINAL POWER (MW): 442

INTEG. POWER (MW-sec): 390,000

RELEASE: OFF SITE

CLOUD DIRECTION: N (10°)

SAMP. ALT. (MSL, ft): 7,400

DISTANCE CLOUD TRACKED (mi):

REFERENCES: CIC # 4964, 16336

CLOUD SAMPLING RESULTS

GROSS BETA INVENTORY IN CLOUD (at midtime of sampling): 130 Ci at 1600 PST.

RADIONUCLIDES IDENTIFIED IN THE EFFLUENT CLOUD (at 1600 PST):

Te-132: 0.5 Ci	I-133: 4 Ci	Cs-138: 150 Ci
Ba-139: 9.8 Ci		

MONITORING RESULTS

AIR SAMPLING: Fresh fission products detected in air sample prefilters from only Twin Springs Ranch, Diablo, and Hiko.

ENVIRONMENTAL SAMPLES: Milk samples were collected from Beatty, Twin Springs Ranch, Alamo, and Hiko; none contained radioiodine. Vegetation samples contained no activity above background.

MAXIMUM ACTIVITY DETECTED IN AIR OFF SITE: 0.062 pCi/m^3 gross beta on prefilter from Twin Springs Ranch; <0.2 pCi/m^3 I-133 at any site.

MAXIMUM GAMMA EXPOSURE RATE DETECTED OFF SITE: None detected.

DEVICE: **NRX-A4/EST**

EXPERIMENTAL PLAN (EP): 2C

SPONSOR: WANL

DATE: 2/11/66

TIME (PST): 1220-1230; 1422-1443

LOCATION: Area 25

TEST CELL: "A"

NOMINAL POWER (MW): --

INTEG. POWER (MW-sec): 430,000

RELEASE: ON SITE ONLY

CLOUD DIRECTION: SSE (170°)

SAMP. ALT. (MSL, ft): 6,500

DISTANCE CLOUD TRACKED (mi):

REFERENCES: CIC # 4964, 16336

CLOUD SAMPLING RESULTS

GROSS BETA INVENTORY IN CLOUD (at midtime of sampling): 200 Ci at 1335 PST.

RADIONUCLIDES IDENTIFIED IN THE EFFLUENT CLOUD (at 1335 PST):

Sr-91:	14 Ci	Sr-92:	25 Ci	Kr:	370 Ci
Cs-138:	140 Ci	Ba-137:	53 Ci	Xe:	6.6 Ci

DEVICE: **NRX-A4/EST**

EXPERIMENTAL PLAN (EP): 3

SPONSOR: WANL

DATE: 3/3/66

TIME (PST): 1310-1316; 1550-1605

LOCATION: Area 25

TEST CELL: "A"

NOMINAL POWER (MW): 1,140

INTEG. POWER (MW-sec): 880,000

RELEASE: OFF SITE

CLOUD DIRECTION: SSE (160°)

SAMP. ALT. (MSL, ft): 6,800

DISTANCE CLOUD TRACKED (mi):

REFERENCES: CIC # 4964, 16336

CLOUD SAMPLING RESULTS

GROSS BETA INVENTORY IN CLOUD (at midtime of sampling): 1,800 Ci at 1436 PST.

RADIONUCLIDES IDENTIFIED IN THE EFFLUENT CLOUD (at 1436 PST):

Sr-91:	39 Ci	Te-132:	13 Ci	I-131:	5 Ci
I-133:	42 Ci	I-134:	380 Ci	I-135:	92 Ci
Cs-138:	17 Ci	Ba-139:	240 Ci		

MONITORING RESULTS

GROUND MONITORING: One monitor detected activity of <0.01 mr/hr above background on Highway 95, 17 miles east-southeast of Lathrop Wells.

AIR SAMPLING: Activity was detected on prefilters from Ash Meadows and Pahrump.

MAXIMUM ACTIVITY DETECTED IN AIR OFF SITE: 1.6 pCi/m^3 gross beta on prefilter from Ash Meadows.

MAXIMUM GAMMA EXPOSURE RATE DETECTED OFF SITE: <0.01 mr/hr.

DEVICE: **NRX-A4/EST**

EXPERIMENTAL PLAN (EP): 4

SPONSOR: WANL

DATE: 3/16/66

TIME (PST): 1004-1020

LOCATION: Area 25

TEST CELL: "A"

NOMINAL POWER (MW): 1,100

INTEG. POWER (MW-sec): 1,000,000

RELEASE: OFF SITE

CLOUD DIRECTION: ENE (80°)

SAMP. ALT. (MSL, ft): 10,000

DISTANCE CLOUD TRACKED (mi):

REFERENCES: CIC # 4964, 16336

CLOUD SAMPLING RESULTS

GROSS BETA INVENTORY IN CLOUD (at midtime of sampling): 4,400 Ci at 1433 PST.

RADIONUCLIDES IDENTIFIED IN THE EFFLUENT CLOUD (at 1433 PST):

Kr:	6,200 Ci	Sr-91:	230 Ci	Mo-99:	10 Ci
Te-132:	110 Ci	I-131:	37 Ci	I-133:	310 Ci
I-135:	280 Ci	Ba-139:	250 Ci	Xe:	1,200 Ci

MONITORING RESULTS

GROUND MONITORING: Activity detected along Highway 93 from 36 miles northeast of Glendale to Alamo.

AIR SAMPLING: Samples containing radioiodines were obtained in Nevada from Alamo, Butler Ranch turnoff and Highway 93, Warm Springs Ranch, Glendale, and Caliente and in Utah at Cedar City and Parowan.

MAXIMUM ACTIVITY DETECTED IN AIR OFF SITE: 110 pCi/m^3 gross beta on prefilter from Butler Ranch turnoff and Highway 93; 75 pCi/m^3 I-132 gamma activity at same location.

MAXIMUM GAMMA EXPOSURE RATE DETECTED OFF SITE: <0.03 mr/hr along Highway 93.

DEVICE: **NRX-A4/EST**

EXPERIMENTAL PLAN (EP): 4A

SPONSOR: WANL

DATE: 3/25/66

TIME (PST): 0933-0948

LOCATION: Area 25

TEST CELL: "A"

NOMINAL POWER (MW): 1,200

INTEG. POWER (MW-sec): 1,100,000

RELEASE: OFF SITE

CLOUD DIRECTION: WSW (260°)

SAMP. ALT. (MSL, ft): 10,000

DISTANCE CLOUD TRACKED (mi): 600

REFERENCES: CIC # 4964, 16336, 105295, 17639

CLOUD SAMPLING RESULTS

GROSS BETA INVENTORY IN CLOUD (at midtime of sampling): 260,000 Ci at 1235 PST. Air Force aircraft tracked effluent to a distance of 400 miles southwest of Vandenberg Air Force Base, California.

RADIONUCLIDES IDENTIFIED IN THE EFFLUENT CLOUD (at 1235 PST):

Kr-85m:	44,000 Ci	Kr-87:	39,000 Ci	Kr-88:	45,000 Ci
Sr-91:	8,000 Ci	Sr-92:	26,000 Ci	Zr-95:	310 Ci
Zr-97:	5,200 Ci	Mo-99:	1,600 Ci	Ru-103:	320 Ci
Te-132:	3,900 Ci	I-131:	460 Ci	I-133:	6,100 Ci
I-134:	25,000 Ci	I-135:	13,000 Ci	Xe-133:	3,000 Ci
Xe-135:	36,000 Ci	Ba-139:	12,000 Ci	Ba-140:	680 Ci
Ce-141:	410 Ci	Ce-143:	3,700 Ci	Nd-147:	110 Ci

MONITORING RESULTS

GROUND MONITORING: Activity was detected along Highway 95, 14 miles southeast of Beatty, Nevada, and in the area between Lone Pine and Stovepipe Wells in California.

CONTINUOUS RECORDERS: Activity above background detected only at Beatty.

AIR SAMPLING: Samples containing fresh fission products obtained in Nevada at Scotty's Junction, Springdale, Beatty, and Lathrop Wells and in California at Stovepipe Wells, Bishop, Lone Pine, and Barstow.

ENVIRONMENTAL SAMPLES: Radioiodines were detected in milk samples collected in California at Lone Pine, Independence, and Big Pine; highest measured value was 230 pCi I-133 per liter of milk at Lone Pine, California. Vegetation samples were collected at 15 locations along Highway 95 from 8 miles north to 20 miles south of Beatty.

MAXIMUM ACTIVITY DETECTED IN AIR OFF SITE: 650 pCi/m^3 gross beta on prefilter from Lone Pine, California.

MAXIMUM GAMMA EXPOSURE DETECTED OFF SITE: 20 mr/hr at an unpopulated location 14 miles southeast of Beatty on Highway 95.

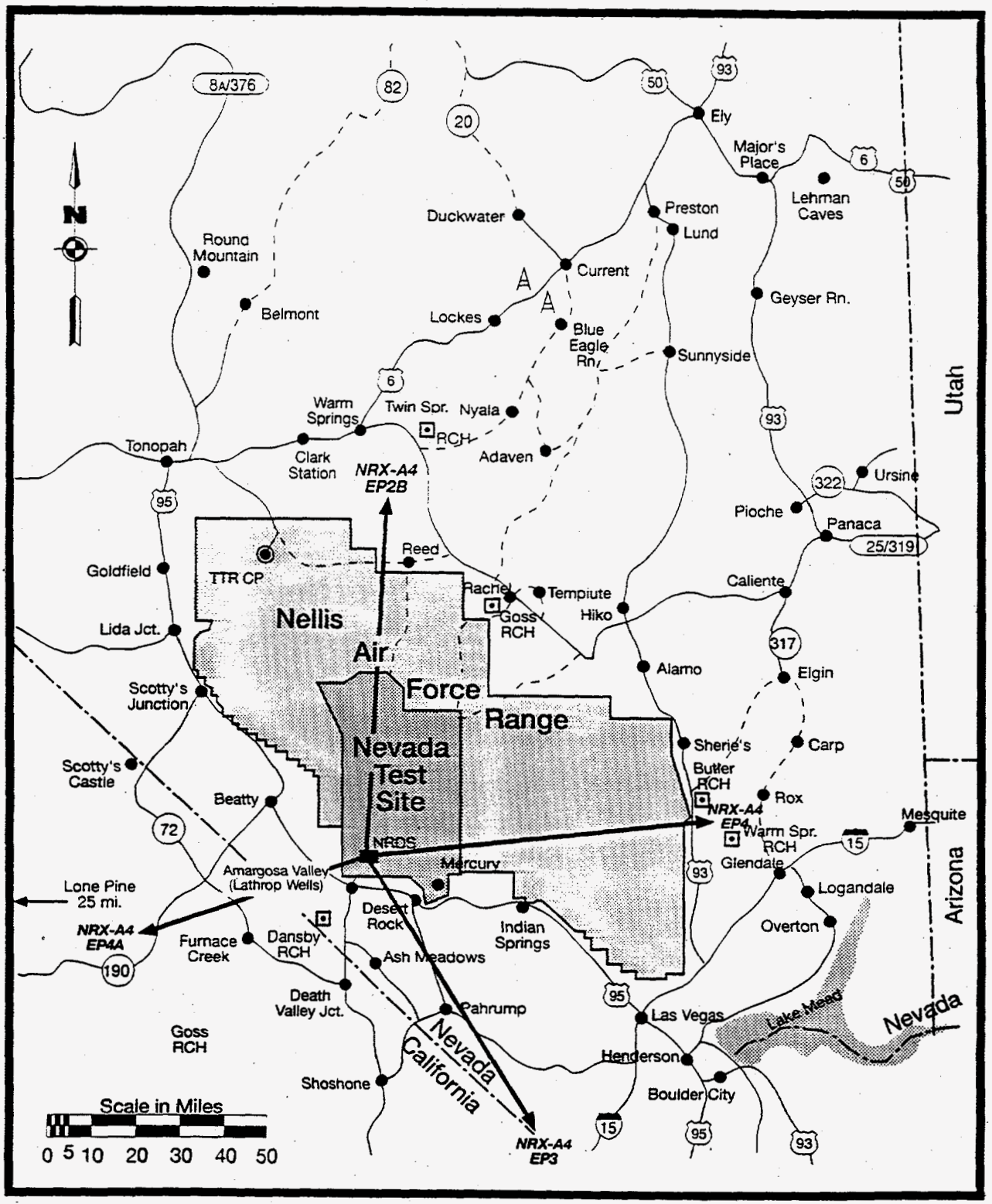


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FIGURE 10. Cloud drift directions following NRX-A4/EST Experiments 2B (EP2B), 3 (EP3), 4 (EP4), and 4A (EP4A).

DEVICE: **NRX-A5**

EXPERIMENTAL PLAN (EP): 1

SPONSOR: WANL

DATE: 5/26/66

TIME (PST): Cold Tests

LOCATION: Area 25

TEST CELL: "A"

NOMINAL POWER (MW): None

INTEG. POWER (MW-sec): 7

RELEASE: None

REFERENCES: CIC # 4961

DEVICE: **NRX-A5**

EXPERIMENTAL PLAN (EP): 2

SPONSOR: WANL

DATE: 6/8/66

TIME (PST): Morning

LOCATION: Area 25

TEST CELL: "A"

NOMINAL POWER (MW): --

INTEG. POWER (MW-sec): 52

RELEASE: None

REFERENCES: CIC # 4961

DEVICE: **NRX-A5**

EXPERIMENTAL PLAN (EP): 3

SPONSOR: WANL

DATE: 6/8/66

TIME (PST): 1302-1318

LOCATION: Area 25

TEST CELL: "A"

NOMINAL POWER (MW): 980

INTEG. POWER (MW-sec): 1,200,000

RELEASE: OFF SITE

CLOUD DIRECTION: SW (270°, but arcing down to about 180° about 15 miles north of Furnace Creek)

SAMP. ALT. (MSL, ft): 7,000

DISTANCE CLOUD TRACKED (mi): 30

REFERENCES: CIC # 4961, 13664, 17717, 14779

CLOUD SAMPLING RESULTS

GROSS BETA INVENTORY IN CLOUD (at midtime of sampling): 9,200 Ci at 1500 PST. Cloud hung over the NTS with the southern edge extending to Lathrop Wells; search on 6/9/66 as far as Gorman, California, failed to locate any remaining cloud.

RADIONUCLIDES IDENTIFIED IN THE EFFLUENT CLOUD (at 1500 PST):

Sr-91:	150 Ci	Sr-92:	4,100 Ci	Te-132:	77 Ci
I-131:	19 Ci	I-133:	190 Ci	I-134:	950 Ci
I-135:	330 Ci	Ba-139:	830 Ci		

MONITORING RESULTS

AIR SAMPLING: Fresh fission products were detected on air sampler prefilters obtained in Nevada from Springdale, Beatty, Lathrop Wells, and Pahrump and in California from Death Valley Junction, Furnace Creek, Shoshone, Barstow, and Ridgecrest.

ENVIRONMENTAL SAMPLES: Radioiodines were detected in vegetation samples from 10 miles south of Springdale, 5 miles south of Beatty, and at Dansby Ranch. Milk samples from only Dansby Ranch, southwest of Lathrop Wells, contained radioiodines. Fresh fission products were not detected in water samples from Dansby Ranch or Springdale.

MAXIMUM ACTIVITY DETECTED IN AIR OFF SITE: 2.3 pCi/m^3 gross beta on prefilter from Ridgecrest, California.

MAXIMUM GAMMA EXPOSURE RATE DETECTED OFF SITE: None detected.

DEVICE: **NRX-A5**

EXPERIMENTAL PLAN (EP): 4

SPONSOR: WANL

DATE: 6/23/66

TIME (PST): 0935-0950

LOCATION: Area 25

TEST CELL: "A"

NOMINAL POWER (MW): 1,030

INTEG. POWER (MW-sec): 1,000,000

RELEASE: OFF SITE

CLOUD DIRECTION: NNE (25°)

SAMP. ALT. (MSL, ft): 9,500

DISTANCE CLOUD TRACKED (mi): 910 (To Bowman, No. Dakota)

REFERENCES: CIC # 4961, 13665, 17303, 17304, 170127

CLOUD SAMPLING RESULTS

GROSS BETA INVENTORY IN CLOUD (at midtime of sampling): 646,000 Ci particulates plus gases at 1148 PST.

RADIONUCLIDES IDENTIFIED IN THE EFFLUENT CLOUD (at 1148 PST):

Particulates

Zr/Nb-97:	19,000 Ci	Mo-99:	5,000 Ci	Te-132:	7,500 Ci
I-131:	1,600 Ci	I-133:	27,000 Ci	I-135:	44,000 Ci
Ce-143:	75,000 Ci	Nd-147:	900 Ci		

Gasses

Kr-85m:	76,000 Ci	Kr-87:	9,000 Ci	Kr-88:	140,000 Ci
Xe-133:	38,000 Ci	Xe-135:	23,000 Ci		

MONITORING RESULTS

GROUND MONITORING: Activity was detected at Goss Ranch and Coyote Summit.

CONTINUOUS RECORDERS: Activity was detected at Sunnyside and Lund.

AIR SAMPLING: Air sampler prefilters containing gross beta activity were obtained in Nevada from Goss Ranch, Coyote Summit, Sunnyside, and Geyser Maintenance Station and from Garrison, Utah.

ENVIRONMENTAL SAMPLES: Radioiodines were detected in milk samples from Kirkeby Ranch (3 miles north of Shoshone, Nevada), Baker Ranch (3 miles south of Baker, Nevada), Harbecke Ranch (13 miles north of Shoshone, Nevada), and Cummings Ranch (5 miles south of Baker, Nevada); highest result was 1,300 pCi/l I-133 at Kirkeby Ranch. Highest radioiodine results from a vegetation sample, 2,700 pCi/kg, were for the same isotope at the same ranch. Fresh fission products were not detected in water samples.

MAXIMUM ACTIVITY DETECTED IN AIR OFF SITE: 14,400 pCi/m^3 gross beta at Goss Ranch; 1,700 pCi/m^3 I-133 in charcoal cartridge from Goss Ranch.

MAXIMUM GAMMA EXPOSURE RATE DETECTED OFF SITE: 1.2 mr/hr peak exposure rate at Goss Ranch.

DEVICE: **PHOEBUS 1B**

EXPERIMENTAL PLAN (EP): 1

SPONSOR: LASL

DATE: 1/25/67

TIME (PST): --

LOCATION: Area 25

TEST CELL: "C"

NOMINAL POWER (MW): --

INTEG. POWER (MW-sec): 2.5

RELEASE: None

REFERENCES: CIC # 4928

DEVICE: **PHOEBUS 1B**

EXPERIMENTAL PLAN (EP): 2

SPONSOR: LASL

DATE: 2/2/67

TIME (PST): --

LOCATION: Area 25

TEST CELL: "C"

NOMINAL POWER (MW): --

INTEG. POWER (MW-sec): 300

RELEASE: None

REFERENCES: CIC # 4928

DEVICE: **PHOEBUS 1B**

EXPERIMENTAL PLAN (EP): 3

SPONSOR: LASL

DATE: 2/10/67

TIME (PST): 1311-

LOCATION: Area 25

TEST CELL: "C"

NOMINAL POWER (MW): 588

INTEG. POWER (MW-sec): 150,000

RELEASE: OFF SITE

CLOUD DIRECTION: SSE (155°)

SAMP. ALT. (MSL, ft): 8,500

DISTANCE CLOUD TRACKED (mi):

REFERENCES: CIC # 4928, 13666, 37598

CLOUD SAMPLING RESULTS

GROSS BETA INVENTORY IN CLOUD (at midtime of sampling): (Reported as H+1 hour.)

RADIONUCLIDES IDENTIFIED IN THE EFFLUENT CLOUD (at H+1 hour):

Sr-91:	35 Ci	Sr-92:	30 Ci	Mo-99:	5 Ci
Ba-139:	160 Ci	Xe-135:	23 Ci	Kr (gross):	13,000 Ci

MONITORING RESULTS

GROUND MONITORING: Activity above background was detected only at the junction of Highway 95 and Ash Meadows Road.

AIR SAMPLING: Activity was detected on the prefilter obtained from the air sampler at the junction of Highway 95 and Ash Meadows Road.

ENVIRONMENTAL SAMPLES: Gross gamma counting of the vegetation samples showed a peak about 18 miles southeast of Lathrop Wells on Highway 95.

MAXIMUM ACTIVITY DETECTED IN AIR OFF SITE: 28 pCi/m^3 Ba-139 on a prefilter from the junction of Highway 95 and Ash Meadows Road.

MAXIMUM GAMMA EXPOSURE RATE DETECTED OFF SITE: Approximately 0.006 mr/hr at the junction of Highway 95 and Ash Meadows Road.

DEVICE: **PHOEBUS 1B**

EXPERIMENTAL PLAN (EP): 4

SPONSOR: LASL

DATE: 2/23/67

TIME (PST): 1400-1430

LOCATION: Area 25

TEST CELL: "C"

NOMINAL POWER (MW): 1,340

INTEG. POWER (MW-sec): 2,600,000

RELEASE: OFF SITE

CLOUD DIRECTION: NNE (20°)

SAMP. ALT. (MSL, ft): 7,500

DISTANCE CLOUD TRACKED (mi): 450

REFERENCES: CIC # 4928, 13667, 37598

CLOUD SAMPLING RESULTS

GROSS BETA INVENTORY IN CLOUD (at midtime of sampling): 2,000,000 Ci at H+1.6 hours. PHS tracked cloud to Dubois, Idaho.

RADIONUCLIDES IDENTIFIED IN THE EFFLUENT CLOUD (at H+1.6 hours):

Sr-91:	48,000 Ci	Mo-99:	3,400 Ci	Te-132:	14,000 Ci
I-131:	4,100 Ci	I-133:	59,000 Ci	I-134:	530,000 Ci
I-135:	36,000 Ci	Ba-139:	130,000 Ci		

MONITORING RESULTS

GROUND MONITORING: Activity detected at Queen City Summit.

CONTINUOUS RECORDERS: Activity was detected at Diablo, Twin Springs, and Lathrop Wells.

AIR SAMPLING: Fresh fission products were detected in Nevada at Beatty, Currant, Diablo, Twin Springs, Lathrop Wells, Warm Springs, Eureka, Blue Jay, Elko, Nyala, Wells, Clark Station, Goss Ranch, Queen City Summit, Goldfield, Warm Springs Ranch, Tonopah, and Round Mountain; in California at Death Valley Junction and Shoshone; at Boise, Idaho; and at Bozeman, Montana.

ENVIRONMENTAL SAMPLES: Radioiodine was detected on vegetation samples from 19 locations (mostly along highways); populated locations were Alamo, Springdale, Selbach Ranch, Warm Springs, Bradshaw Ranch, Sequra Ranch, Gardners Ranch, and Cold Creek Ranch. No fresh fission products were detected in water samples. Radioiodine isotopes were detected in milk samples from 12 locations, including locations as far north as Coeur d'Alene, Idaho, and Billings, Montana. The highest concentration of I-131 in milk (63 pCi/l) was obtained from Eureka, Nevada.

MAXIMUM ACTIVITY DETECTED IN AIR OFF SITE: 230 pCi/m^3 gross beta at Lathrop Wells.

MAXIMUM GAMMA EXPOSURE RATE DETECTED OFF SITE: <0.06 mr/hr at Diablo and Twin Springs.

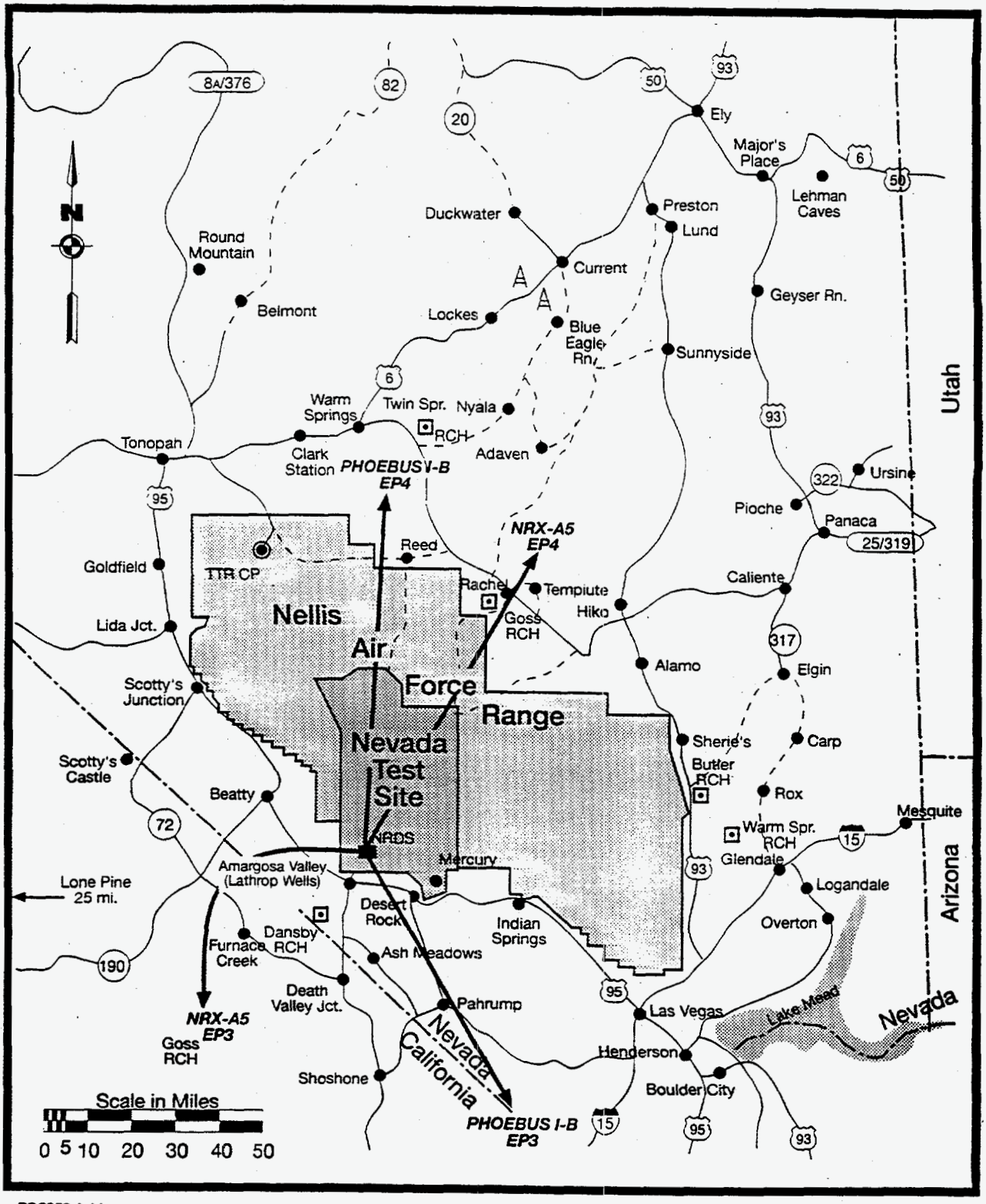

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FIGURE 11. Cloud drift directions following NRX-A5 Experiments 3 (EP3) and 4 (EP4) and PHOEBUS 1B Experiments 3 (EP3) and 4 (EP4).

DEVICE: **NRX-A6**

EXPERIMENTAL PLAN (EP): 3A

SPONSOR: WANL

DATE: 12/15/67

TIME (PST): 1059-1159

LOCATION: Area 25

TEST CELL: "C"

NOMINAL POWER (MW): 1,140

INTEG. POWER (MW-sec): 4,500,000

RELEASE: OFF SITE

CLOUD DIRECTION: SE (230°)

SAMP. ALT. (MSL, ft): 8,500

DISTANCE CLOUD TRACKED (mi):

REFERENCES: CIC # 37703, 13668, 38315, 37742

CLOUD SAMPLING RESULTS

GROSS BETA INVENTORY IN CLOUD (at midtime of sampling; H+1 hour): 500,000 Ci at 1230 PST. Three search missions were conducted in the area indicated by meteorological trajectories; no effluent was detected. Flights were restricted by inclement weather.

RADIONUCLIDES IDENTIFIED IN THE EFFLUENT CLOUD (at 1230 PST):

Sr-91:	5,800 Ci	Sr-92:	15,000 Ci	Ru-103:	20 Ci
Te-132:	3,800 Ci	Te-133m:	360,000 Ci	I-131:	820 Ci
I-133:	12,000 Ci	I-134:	160,000 Ci	I-135:	9,200 Ci
Ba-139:	27,000 Ci	Ba-140:	80 Ci	Ce-161:	60 Ci
Nd-147:	60 Ci				

MONITORING RESULTS

GROUND MONITORING: Activity was detected in Nevada at Lathrop Wells, along Highway 95 from Lathrop Wells to 25 miles W, Goldspar Mine, along Highway from Lathrop Wells to Death Valley Junction; and in California at Death Valley Junction, along roads in Death Valley, and along Highway 395 in Owens Valley.

CONTINUOUS RECORDERS: Activity was detected above background at Lathrop Wells and Death Valley Junction.

AIR SAMPLING: Fresh fission products were detected in air samples in Nevada from Lathrop Wells (several locations), Amargosa Farm Area (several locations), and Las Vegas and in California from Death Valley Junction, Furnace Creek, Shoshone, Ridgecrest, Barstow, San Bernardino, Fresno, and Silverlake.

ENVIRONMENTAL SAMPLES: Radioactivity was detected in 21 milk samples collected from the following 6 locations: in Nevada from 4 different ranches around Lathrop Wells and in California from Barstow and Olancha. The highest I-131 result was 90 pCi/l in a sample from Dansby Ranch near Lathrop Wells. Milk samples from 11 other locations contained no fresh fission products. Fresh fission products were detected in 3 of 79 water samples; two of the three samples were collected in Lathrop Wells, the other in Barstow. Fresh fission products were detected in samples of natural vegetation from along portions of highways around Lathrop Wells, through Death Valley, and in the Owens Valley on Highways 395 and 58 from Ridgecrest around to near the state line on I-15.

MAXIMUM ACTIVITY DETECTED IN AIR OFF SITE: 8.3 pCi/m^3 gross beta (4.1 pCi/m^3 I-131) at Death Valley Junction, California.

MAXIMUM GAMMA EXPOSURE RATE DETECTED OFF SITE: 1.5 mr/hr at Corder's Ranch near Lathrop Wells.

DEVICE: **PHOEBUS 2A**

EXPERIMENTAL PLAN (EP): 1

SPONSOR: LASL

DATE: 5/22/68
5/23/68

TIME (PST): 0831-1001
0804-1122

LOCATION: Area 25

TEST CELL: "C"

NOMINAL POWER (MW): --

INTEG. POWER (MW-sec): 102.3

RELEASE: None

REFERENCES: CIC # 4967

DEVICE: **PHOEBUS 2A**

EXPERIMENTAL PLAN (EP): 2

SPONSOR: LASL

DATE: 5/29/68

TIME (PST): 0825-1159

LOCATION: Area 25

TEST CELL: "C"

NOMINAL POWER (MW): --

INTEG. POWER (MW-sec): 1,330

RELEASE: None

REFERENCES: CIC # 4967

DEVICE: **PHOEBUS 2A**

EXPERIMENTAL PLAN (EP): 3

SPONSOR: LASL

DATE: 6/8/68

TIME (PST): 1014-1025

LOCATION: Area 25

TEST CELL: "C"

NOMINAL POWER (MW): 1,930

INTEG. POWER (MW-sec): 643,000

RELEASE: OFF SITE

CLOUD DIRECTION: SE (120°- 135°)

SAMP. ALT. (MSL, ft): 8,500

DISTANCE CLOUD TRACKED (mi):

REFERENCES: CIC # 4967, 37817

CLOUD SAMPLING RESULTS

GROSS BETA INVENTORY IN CLOUD (at midtime of sampling): Not given.

RADIONUCLIDES IDENTIFIED IN THE EFFLUENT CLOUD (at 1132 PST; H+1.2 hours):

Kr-85m: 24 Ci	Kr-88: 480 Ci	Sr-91: 14 Ci
Xe-135: 130 Ci	Cs-138: 310 Ci	Ba-139: 130 Ci

MONITORING RESULTS

GROUND MONITORING: Activity was detected at Indian Springs, Cactus Springs, and 8 miles west of Cactus Springs on Highway 95.

AIR SAMPLING: Activity was detected only at Cactus Springs and Indian Springs.

MAXIMUM ACTIVITY DETECTED IN AIR OFF SITE: 150 pCi/m^3 gross beta at Indian Springs.

MAXIMUM GAMMA EXPOSURE RATE DETECTED OFF SITE: 0.05 mr/hr gross gamma at Cactus Springs.

DEVICE: **PHOEBUS 2A**

EXPERIMENTAL PLAN (EP): 4

SPONSOR: LASL

DATE: 6/26/68

TIME (PST): 1137-1209

LOCATION: Area 25

TEST CELL: "C"

NOMINAL POWER (MW): 4,010

INTEG. POWER (MW-sec): 4,500,000

RELEASE: OFF SITE

CLOUD DIRECTION: NE (50°-55°)

SAMP. ALT. (MSL, ft): 11,000

DISTANCE CLOUD TRACKED (mi):
Cloud 1: 100 mi to Camp Irwin, California
Cloud 2: 160 mi to Cedar City, Utah

REFERENCES: CIC # 4967, 13670, 37793, 37817

CLOUD SAMPLING RESULTS

GROSS BETA INVENTORY IN CLOUD (at midtime of sampling): 200,000 Ci at 1415 PST.

RADIONUCLIDES IDENTIFIED IN THE EFFLUENT CLOUD (at 1415 PST):

Sr-91:	8,600 Ci	Sr-92:	10,000 Ci	Yr-93:	2,100 Ci
Mo-99:	150 Ci	Te-132:	2,700 Ci	Te-134:	51,000 Ci
I-131:	880 Ci	I-133:	13,000 Ci	I-134:	35,000 Ci
I-135:	10,000 Ci	Ba-139:	46,000 Ci	Ba-140:	140 Ci

MONITORING RESULTS

AIR SAMPLING: Activity was detected in air samples obtained in Nevada from Hiko, Alamo, Twin Springs Ranch, Indian Springs, Geyser Maintenance Station, and Nyala; in Utah from Bryce Canyon, Parowan, Monticello, Milford, and Capitol Reef National Monument; and Bishop, California.

ENVIRONMENTAL SAMPLES: Radioiodines were detected in milk and cow feed samples obtained from Hiko, Alamo, Caliente, and Panaca. No radioactivity associated with this test was detected in any of 76 water samples.

MAXIMUM ACTIVITY DETECTED IN AIR OFF SITE: 250 pCi/m^3 gross beta at Hiko; 56 pCi/m^3 I-133 at same location. (One unpopulated location had higher reported results.)

MAXIMUM GAMMA EXPOSURE RATE DETECTED OFF SITE: None detected.

DEVICE: **PHOEBUS 2A**

EXPERIMENTAL PLAN (EP): 5A&B

SPONSOR: LASL

DATE: 7/18/68

TIME (PST): 1210-1222; 1350-1408

LOCATION: Area 25

TEST CELL: "C"

NOMINAL POWER (MW): 3,430

INTEG. POWER (MW-sec): 2,660,000

RELEASE: OFF SITE

CLOUD DIRECTION: NNE (15°)

SAMP. ALT. (MSL, ft): 11,000

DISTANCE CLOUD TRACKED (mi): 90

REFERENCES: CIC # 4967, 13671, 37794, 37817

CLOUD SAMPLING RESULTS

GROSS BETA INVENTORY IN CLOUD (at midtime of sampling): 810,000 Ci at 1448 PST (H+0.8 hours). Cloud was slow moving and had not reached Adaven by run time plus 10 hours.

RADIONUCLIDES IDENTIFIED IN THE EFFLUENT CLOUD (at 1448 PST):

Kr (gross):	31,000 Ci	Sr-91:	11,000 Ci	Sr-92:	37,000 Ci
Y-93:	11,000 Ci	Mo-99:	44 Ci	Te-132:	3,300 Ci
Te-133m:	110,000 Ci	I-131:	1,100 Ci	I-133:	12,000 Ci
I-134:	130,000 Ci	I-135:	4,100 Ci	Xe-135:	1,800 Ci
Ba-139:	140,000 Ci	Ba-140:	310 Ci		

MONITORING RESULTS

GROUND MONITORING: Activity was detected at Queen City Summit.

AIR SAMPLING: Activity was detected in air samples obtained in Nevada from Queen City Summit, Coyote Summit, Diablo, Nyala, Hiko, Currant, Sunnyside, Duckwater, Lund, Geyser Maintenance Station, Ely, Shoshone, Currie, and Lathrop Wells and at Wendover, Utah.

ENVIRONMENTAL SAMPLES: Radioiodines were detected in milk samples obtained from Cherry Creek, Currant, Duckwater, and Nyala. Natural vegetation was sampled along principal highways and roads in the downwind area; 43 samples showed positive for reactor-related activity.

MAXIMUM ACTIVITY DETECTED IN AIR OFF SITE: 500 pCi/m^3 gross beta at Hiko, with corresponding high value of 110 pCi/m^3 I-133.

MAXIMUM GAMMA EXPOSURE RATE DETECTED OFF SITE: 0.08 mr/hr above background at Queen City Summit.

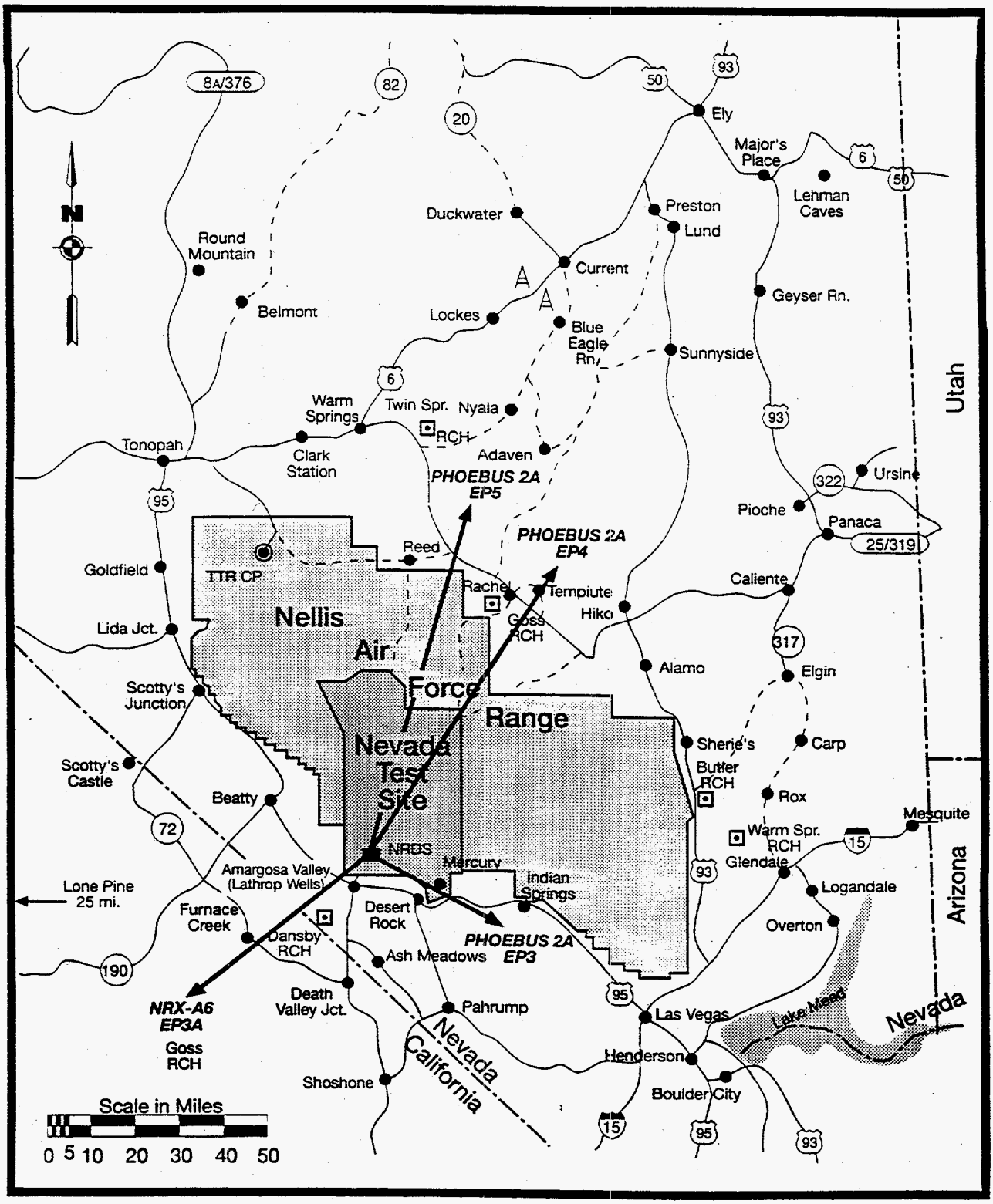

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FIGURE 12. Cloud drift directions following NRX-A6 Experiment 3A (EP3A) and PHOEBUS 2A Experiments 3 (EP3), 4 (EP4), and 5 (EP5).

DEVICE: **PEWEE 1**

EXPERIMENTAL PLAN (EP): 1

SPONSOR: LASL

DATE: 11/15/68

TIME (PST): 1053-1340

LOCATION: Area 25

TEST CELL: "C"

NOMINAL POWER (MW): --

INTEG. POWER (MW-sec): --

RELEASE: None

REFERENCES: CIC # 4951, 36203

DEVICE: **PEWEE 1**

EXPERIMENTAL PLAN (EP): 2

SPONSOR: LASL

DATE: 11/21/68

TIME (PST): 1358-1415

LOCATION: Area 25

TEST CELL: "C"

NOMINAL POWER (MW): 500

INTEG. POWER (MW-sec): 247,000

RELEASE: In air only

CLOUD DIRECTION: SSE (160°)

SAMP. ALT. (MSL, ft): 8,500

DISTANCE CLOUD TRACKED (mi): 80

REFERENCES: CIC # 4951, 36203, 36310

CLOUD SAMPLING RESULTS

GROSS BETA INVENTORY IN CLOUD (at midtime of sampling): 9,600 Ci at 1529 PST. Cloud was detected 6,000 feet above ground but not at ground surface.

RADIONUCLIDES IDENTIFIED IN THE EFFLUENT CLOUD (at 1529 PST):

Particulates

Sr-91:	200 Ci	Sr-92:	880 Ci	Y-93:	570 Ci
Ru-105:	270 Ci	Te-132:	50 Ci	I-131:	12 Ci
I-133:	230 Ci	I-134:	1,500 Ci	I-135:	240 Ci
Ba-139:	2,500 Ci	Ba-140:	4 Ci	Ce-143:	27 Ci

Gasses

Kr-85m:	12,500 Ci	Kr-87:	24,000 Ci	Kr-88:	4,500 Ci
Xe-135:	270 Ci				

DEVICE: **PEWEE 1**

EXPERIMENTAL PLAN (EP): 3

SPONSOR: LASL

DATE: 12/4/68

TIME (PST): 1332-1435

LOCATION: Area 25

TEST CELL: "C"

NOMINAL POWER (MW): 503

INTEG. POWER (MW-sec): 1,530,000

RELEASE: OFF SITE

CLOUD DIRECTION: ESE (110°)

SAMP. ALT. (MSL, ft): 7,500

DISTANCE CLOUD TRACKED (mi): 425

REFERENCES: CIC # 4951, 13673, 36204, 36310

CLOUD SAMPLING RESULTS

GROSS BETA INVENTORY IN CLOUD (at midtime of sampling): 1,300,000 Ci at 1540 PST. Cloud extended east from the NTS; edges undefined due to wide dispersion at low activity. Positive measurements in air over northern half of Arizona.

RADIONUCLIDES IDENTIFIED IN THE EFFLUENT CLOUD (at 1540 PST):

Sr-91:	7,200 Ci	Sr-92:	35,000 Ci	Zr-97:	1,700 Ci
Mo-99:	510 Ci	Te-132:	5,100 Ci	Te-133m:	94,000 Ci
Te-134:	110,000 Ci	I-131:	1,100 Ci	I-134:	110,000 Ci
Ba-139:	3,300 Ci	Ba-140:	260 Ci	Ce-141:	120 Ci
Ce-143:	1,900 Ci	Kr-85m:	118,000 Ci	Kr-87:	53,000 Ci
Kr-88:	100,000 Ci	Xe-135:	27,000 Ci		

MONITORING RESULTS

AIR SAMPLING: Radioactivity was detected in air samples obtained in Nevada from Caliente, Indian Springs, Las Vegas, Lathrop Wells (several ranches), Mesquite, Warm Springs Ranch, and Pahrump; in Arizona from Seligman and Winslow; in California from Barstow, Death Valley Junction, Lone Pine, Needles, Ridgecrest, and Shoshone; in Utah from Enterprise, Milford, Monticello, and Parowan; and from Durango, Colorado, and Albuquerque, New Mexico.

ENVIRONMENTAL SAMPLES: No reactor-related radioactivity detected in milk, cow feed, or water samples. Samples of natural vegetation were positive (no values reported) for reactor-related activity along several highways but not at populated locations.

MAXIMUM ACTIVITY DETECTED IN AIR OFF SITE: 87 pCi/m^3 gross beta at Henderson Ranch near Lathrop Wells. (Highest activity detected outside Nevada: 28 pCi/m^3 gross beta at Albuquerque, New Mexico.)

MAXIMUM GAMMA EXPOSURE RATE DETECTED OFF SITE: None detected.

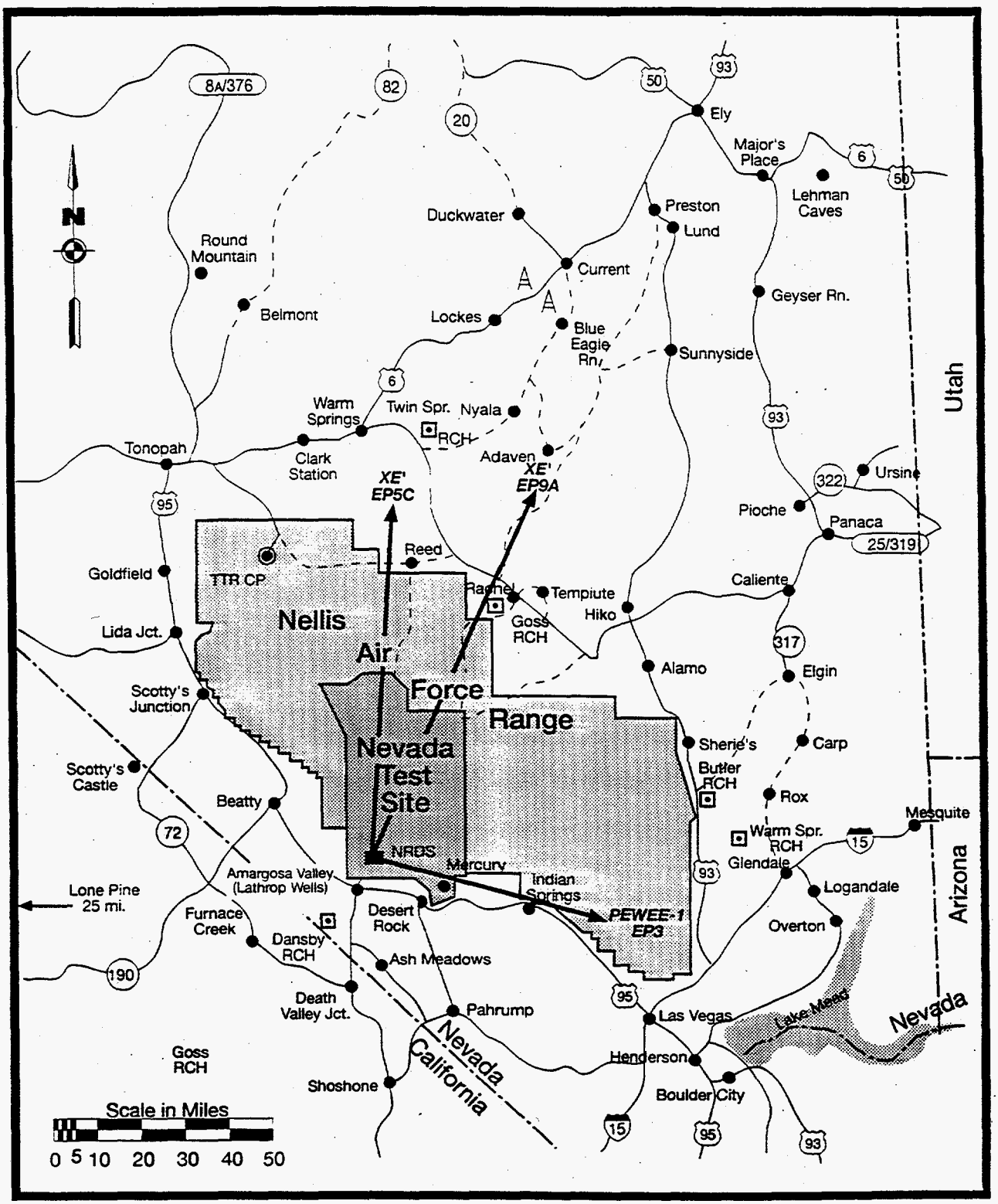

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FIGURE 13. Cloud drift directions following PEWEE 1 Experiment 3 (EP3) and XE PRIME Experiments 5C (EP5C) and 9A (EP9A).

DEVICE: **XE PRIME**

EXPERIMENTAL PLAN (EP): 1

SPONSOR: LASL

DATE: 12/4/68

TIME (PST): 1038-2145

LOCATION: Area 25

TEST CELL: "ETS-1"

NOMINAL POWER (MW): 0.2

INTEG. POWER (MW-sec): 39

RELEASE: None

REFERENCES: CIC # 6068

DEVICE: **XE PRIME**

EXPERIMENTAL PLAN (EP): SL2

SPONSOR: LASL

DATE: 12/6/68

TIME (PST): 1234-2142

LOCATION: Area 25

TEST CELL: "ETS-1"

NOMINAL POWER (MW): 1.2

INTEG. POWER (MW-sec): 23

RELEASE: None

REFERENCES: CIC # 6068

DEVICE: **XE PRIME**

EXPERIMENTAL PLAN (EP): 1A

SPONSOR: LASL

DATE: 2/20/69

TIME (PST): 1208-1542

LOCATION: Area 25

TEST CELL: "ETS-1"

NOMINAL POWER (MW): 0.9

INTEG. POWER (MW-sec): 877

RELEASE: None

REFERENCES: CIC # 6068

DEVICE: **XE PRIME**

EXPERIMENTAL PLAN (EP): 1B

SPONSOR: LASL

DATE: 2/27/69

TIME (PST): 1249-1831

LOCATION: Area 25

TEST CELL: "ETS-1"

NOMINAL POWER (MW): <0.01

INTEG. POWER (MW-sec): 117

RELEASE: None

REFERENCES: CIC # 6068

DEVICE: **XE PRIME**

EXPERIMENTAL PLAN (EP): 2

SPONSOR: LASL

DATE: 3/13/69

TIME (PST): 1619-1643

LOCATION: Area 25

TEST CELL: "ETS-1"

NOMINAL POWER (MW): 0.05

INTEG. POWER (MW-sec): 41

RELEASE: None

REFERENCES: CIC # 6068

DEVICE: **XE PRIME**

EXPERIMENTAL PLAN (EP): 2A

SPONSOR: LASL

DATE: 3/20/69

TIME (PST): 1001-1343

LOCATION: Area 25

TEST CELL: "ETS-1"

NOMINAL POWER (MW): 200

INTEG. POWER (MW-sec): 9,280

RELEASE: None

REFERENCES: CIC # 6068

DEVICE: **XE PRIME**

EXPERIMENTAL PLAN (EP): 3C

SPONSOR: LASL

DATE: 4/17/69

TIME (PST): 1512-1525

LOCATION: Area 25

TEST CELL: "ETS-1"

NOMINAL POWER (MW): 445

INTEG. POWER (MW-sec): 148,000

RELEASE: ON SITE ONLY

CLOUD DIRECTION: None

SAMP. ALT. (MSL, ft): 9,000

DISTANCE CLOUD TRACKED (mi):

REFERENCES: CIC # 6068, 170954

CLOUD SAMPLING RESULTS

GROSS BETA INVENTORY IN CLOUD (at midtime of sampling): 530 Ci at 1515 PST.

RADIONUCLIDES IDENTIFIED IN THE EFFLUENT CLOUD (at 1515 PST):

Kr-85m:	130 Ci	Kr-87:	380 Ci	Kr-88:	850 Ci
Sr-91:	17 Ci	Mo-99:	4 Ci	Te-132:	1 Ci
I-133:	4 Ci	I-134:	15 Ci	I-135:	10 Ci
Cs-138:	200 Ci	Ba-139:	130 Ci		

DEVICE: **XE PRIME**

EXPERIMENTAL PLAN (EP): 5C

SPONSOR: LASL

DATE: 6/11/69

TIME (PST): 0942-0953

LOCATION: Area 25

TEST CELL: "ETS-1"

NOMINAL POWER (MW): 1,070

INTEG. POWER (MW-sec): 425,000

RELEASE: OFF SITE

CLOUD DIRECTION: N (10°)

SAMP. ALT. (MSL, ft): 8,500

DISTANCE CLOUD TRACKED (mi):

REFERENCES: CIC # 6068, 170954

CLOUD SAMPLING RESULTS

GROSS BETA INVENTORY IN CLOUD (at midtime of sampling): 6,400 Ci at 1130 PST. Cloud appeared to dissipate while over the NTS.

RADIONUCLIDES IDENTIFIED IN THE EFFLUENT CLOUD (at 1130 PST):

Sr-91:	170 Ci	Te-132:	650 Ci	Te-134:	1,700 Ci
I-131:	18 Ci	I-133:	160 Ci	I-134:	1,600 Ci
I-135:	300 Ci	Cs-138:	3,000 Ci	Ba-139:	2,600 Ci
Ba-140:	3 Ci				

MONITORING RESULTS

AIR SAMPLING: Fresh fission products detected in one air sample from Diablo Maintenance Station.

MAXIMUM ACTIVITY DETECTED IN AIR OFF SITE: 2.4 pCi/m^3 gross beta at Diablo Maintenance Station.

MAXIMUM GAMMA EXPOSURE RATE DETECTED OFF SITE: None detected.

DEVICE: **XE PRIME**

EXPERIMENTAL PLAN (EP): 4A

SPONSOR: LASL

DATE: 6/26/69

TIME (PST): 1208-1601

LOCATION: Area 25

TEST CELL: "ETS-1"

NOMINAL POWER (MW): 58

INTEG. POWER (MW-sec): 49,000

RELEASE: ON SITE ONLY

CLOUD DIRECTION: None

REFERENCES: CIC # 6068, 170954

CLOUD SAMPLING RESULTS: Cloud not sampled; effluent measurements by instruments in aircraft deemed too low for practical sampling.

DEVICE: **XE PRIME**

EXPERIMENTAL PLAN (EP): 6A

SPONSOR: LASL

DATE: 7/10/69

TIME (PST): 1101-1144

LOCATION: Area 25

TEST CELL: "ETS-1"

NOMINAL POWER (MW): 200

INTEG. POWER (MW-sec): 101,000

RELEASE: ON SITE ONLY

CLOUD DIRECTION: None

REFERENCES: CIC # 6068

DEVICE: **XE PRIME**

EXPERIMENTAL PLAN (EP): 7A

SPONSOR: LASL

DATE: 7/24/69

TIME (PST): 1054-1141

LOCATION: Area 25

TEST CELL: "ETS-1"

NOMINAL POWER (MW): 160

INTEG. POWER (MW-sec): 54,000

RELEASE: ON SITE ONLY

CLOUD DIRECTION: N (360°)

REFERENCES: CIC # 6068, 170954

CLOUD SAMPLING RESULTS

GROSS BETA INVENTORY IN CLOUD: No estimate. Cloud dissipated over the NTS, and cloud boundaries could not be defined due to low readings.

DEVICE: **XE PRIME**

EXPERIMENTAL PLAN (EP): 8A

SPONSOR: LASL

DATE: 8/13/69

TIME (PST): 1446-1531

LOCATION: Area 25

TEST CELL: "ETS-1"

NOMINAL POWER (MW): 440

INTEG. POWER (MW-sec): 436,000

RELEASE: ON SITE ONLY

CLOUD DIRECTION: N (10°)

SAMP. ALT. (MSL, ft): 11,000

DISTANCE CLOUD TRACKED (mi):

REFERENCES: CIC # 6068, 170954

CLOUD SAMPLING RESULTS: No estimates. Cloud dissipated over the NTS. Radioactivity readings from the sampled cloud were too low to assign definite values. Cloud edges could not be defined because of the low values so no other estimates could be calculated.

DEVICE: **XE PRIME**

EXPERIMENTAL PLAN (EP): 9A

SPONSOR: LASL

DATE: 8/28/69

TIME (PST): 1518-1551

LOCATION: Area 25

TEST CELL: "ETS-1"

NOMINAL POWER (MW): 680

INTEG. POWER (MW-sec): 338,000

RELEASE: OFF SITE

CLOUD DIRECTION: NNE (25°)

SAMP. ALT. (MSL, ft): 11,000

DISTANCE CLOUD TRACKED (mi):

REFERENCES: CIC # 6068, 170954

CLOUD SAMPLING RESULTS

GROSS BETA INVENTORY IN CLOUD (at midtime of sampling): 2,000 Ci at 1630 PST.

RADIONUCLIDES IDENTIFIED IN THE EFFLUENT CLOUD (at 1630 PST):

Sr-91:	72 Ci	Sr-92:	68 Ci	Te-132:	15 Ci
Te-133m:	1,800 Ci	Te-134:	2,500 Ci	I-131:	10 Ci
I-133:	110 Ci	I-134:	1,100 Ci	I-135:	110 Ci
Ba-139:	1,300 Ci				

MONITORING RESULTS

GROUND MONITORING: Activity was detected at Queen City Summit, Koyne's Mill, and Coyote Summit.

AIR SAMPLING: Positive air sample results were obtained from Currant, Diablo, Ely, Lund, Blue Eagle Ranch, Sunnyside, Nyala, Koyne's Mill, Coyote Summit, and Queen City Summit.

MAXIMUM ACTIVITY DETECTED IN AIR OFF SITE: 11 pCi/m^3 gross beta at Blue Eagle Ranch and Nyala (5,700 pCi/m^3 gross beta at the unpopulated Queen City Summit).

MAXIMUM GAMMA EXPOSURE RATE DETECTED OFF SITE: "About twice background" at Queen City Summit, Koyne's Mill, and Coyote Summit.

DEVICE: **XE PRIME**

EXPERIMENTAL PLAN (EP): 10A

SPONSOR: LASL

DATE: 9/11/69

TIME (PST): 1039-1127

LOCATION: Area 25

TEST CELL: "ETS-1"

NOMINAL POWER (MW): 50

INTEG. POWER (MW-sec): 17,100

RELEASE: ON SITE ONLY

CLOUD DIRECTION: None

REFERENCES: CIC # 6068, 170954

Cloud searches at several altitudes found no activity above background.

REFERENCES

Abbreviations (in addition to those identified earlier) used in these references:

ARMS	Aerial Radiological Measuring System
CIC	Coordination and Information Center
DHEW	United States Department of Health, Education, and Welfare
NATS	Nevada Aerial Tracking System
NERC	National Environmental Research Center - Las Vegas
PANAM	Pan American World Airways, Inc.
SNPO-N	Space Nuclear Propulsion Office - Nevada
SWRHL	Southwestern Radiological Health Laboratory
USAEC	United States Atomic Energy Commission
USPHS	United States Public Health Service
WERL	Western Environmental Research Laboratory

NOTE: "CIC No." refers to the accession number assigned by the Coordination and Information Center and provides an easy reference for document access.

CIC No.

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APPENDIX 1

TEST RUNS OF NUCLEAR ROCKET AND RAMJET ENGINES AND COMPONENTS

Many tests of engine components and procedures preceded each power-generating run. This appendix lists most test runs leading up to actually generating power for each of the devices tested.

For the TORY IIA, several criticality test runs were conducted at the Lawrence Radiation Laboratory, Livermore, California, before the device was shipped to the NRDS. Many facility and system tests were conducted after December 17, 1960, leading up to the first real power test on May 14, 1961; details are repetitive, missing, or not very informative (see UCRL-7249).

Following each full power run, the engine or device was allowed to cool then was dismantled for thorough examination of all components.

RUN DATE	DEVICE	EP. NO.	TEST CELL	PURPOSE
NOTE: TESTS SHOWN IN BOLD TYPE GENERATED RADIOACTIVE EFFLUENT DETECTED BEYOND THE BORDERS OF THE TEST RANGE COMPLEX.				
11/18/58	KIWI A	1	A	Test of main coolant pressure regulating system.
01/15/59	KIWI A	2	A	Frequency response test of main gas coolant.
01/24/59	KIWI A	3	A	Test of automatic mode.
02/28/59	KIWI A	6	A	Check on MAD building disassembly bay.
02/28/59	KIWI A	7	A	Initial critical operation of KIWI A.
03/13/59	KIWI A	10	A	Load dump qualification test.
03/19/59	KIWI A	8	A	Test of H_2O and D_2O system through mockup reactor.
03/25/59	KIWI A	9	A	Test of H_2O and D_2O system through mockup reactor.
04/2/59	KIWI A	11	A	H_2 flow test. Dry - no gas on dry run.
04/3/59	KIWI A	11	A	H_2 flow test. Hot - hydrogen fire damaged mockup.
04/10/59	KIWI A	4	A	Simulated reactor operation.
04/11/59	KIWI A	4/A	A	Using KIWI A control rods.
04/28/59	KIWI A	15	A	Gas and water flow; dry - mockup used.
04/30/59	KIWI A	15	A	Gas and water flow; hot - helium used.
05/2/59	KIWI A	15/A	A	Gas and water flow; hot - hydrogen used.
06/3/59	KIWI A	12	A	Subsystem integral test; dry dry - no gas or water.
06/4/59	KIWI A	12	A	Subsystem integral test; wet dry - water flow.
06/5/59	KIWI A	12	A	Subsystem integral test; Hot 1 - helium and water.
06/6/59	KIWI A	12	A	Subsystem integral test; Hot 2 - noncritical.
06/13/59	KIWI A	14	A	Dry 1 - No gas or D_2O flow.
06/15/59	KIWI A	14	A	Dry 2 - Aborted due to D_2O troubles.
06/16/59	KIWI A	14	A	Dry 3 - No gas and noncritical.
06/17/59	KIWI A	14	A	Hot 1 - critical, power calibration.
06/19/59	KIWI A	14/A	A	Hot 2 - reactor transfer function measurements.
06/20/59	KIWI A	14/B	A	Hot 3 - practice power run, hydrogen used.
06/24/60	KIWI A Prime	1-112-A	A	Facility checkout.
06/25/60	KIWI A Prime	2-112-B	A	Gas flow.
06/28/60	KIWI A Prime	3-112-C	A	Neutronic calibration.
06/29/60	KIWI A Prime	4-112-D	A	Canceled.
06/30/60	KIWI A Prime	5-112-E	A	Final subsystem checkout.
06/30/59	KIWI A	16	A	Dry - First full power run; dry to 80 KW and helium.
07/1/59	**KIWI A**	**16**	**A**	**Hot - Full power run; hot to 70 MW and H_2.**
07/6/60	KIWI A Prime	6-116-A	A	Dry run (low power run).
07/8/60	**KIWI A Prime**	**7-116-B**	**A**	**Full power run.**
09/15/60	KIWI A-3	1-208-A	A	Gas flow system checkout.

RUN DATE	DEVICE	EP. NO.	TEST CELL	PURPOSE
09/22/60	KIWI A-3	2-208-B	A	Nitrogen flow (MV-8A).
09/23/60	KIWI A-3	3-208-C	A	Nitrogen flow (MV-8A).
10/7/60	TORY II-A			First criticality test.
10/8/60	KIWI A-3	4-212-A	A	Neutronic calibration.
10/13/60	KIWI A-3	5-216-A	A	Dry run (low power run).
10/17/60	KIWI A-3	6-216-B	A	Canceled.
10/19/60	**KIWI A-3**	**7-216-B**	**A**	**Full power run.**
12/7/60	TORY II-A		B	"Dry" approach to near criticality.
12/9/60	TORY II-A		B	First criticality at the NRDS; heavy water reflector.
12/17/60	TORY II-A		B	Details repetitive, some missing for next 5 months.
05/14/61	TORY II-A		B	First real power test.
09/14/61	KIWI B-1A	1	A	Flow system checkout.
09/15/61	KIWI B-1A	2	A	Flow system checkout.
09/18/61	KIWI B-1A	2/A	A	Flow system checkout.
10/26/61	KIWI B-1A	3	A	Simulator run of the full power run.
10/31/61	KIWI B-1A	4	A	Neutronic calibration.
11/2/61	KIWI B-1A	--	A	Nozzle flow test.
11/7/61	KIWI B-1A	5	A	Canceled.
12/1/61	KIWI B-1A	5/A	A	Neutronic calibration/scaled down full power.
12/6/61	KIWI B-1A	6	A	Canceled.
12/7/61	**KIWI B-1A**	**6/A**	**A**	**Full power run.**
03/2/62	KIWI B/CF	1	A	PCV-50 test. (CF is Cold Flow)
04/13/62	KIWI B/CF	2	A	Dewar pressurization test.
05/8/62	KIWI B/CF	3	A	NFS-1 acceptance test (Part I).
05/8/62	KIWI B/CF	3/A	A	NFS-1 acceptance test (Part II).
05/11/62	KIWI B/CF	4	A	NFS-1 acceptance test (Part I).
06/8/62	KIWI B/CF	5	A	NFS-1 turbine duration test.
06/16/62	KIWI B/CF	5/A	A	NFS-1 duration test.
06/29/62	KIWI B/CF	6	A	First cold flow run.
07/7/62	KIWI B/CF	6/A	A	First cold flow run.
07/14/62	KIWI B/CF	6/B	A	Second cold flow run.
08/9/62	KIWI B-1B	1	A	Simulated full power run.
08/25/62	KIWI B-1B	2	A	Reactor calibration.
08/29/62	KIWI B-1B	3	A	Low power run profile.
09/1/62	**KIWI B-1B**	**4**	**A**	**Full power run.**
09/19/62	KIWI B-4A	1	A	NFS-1 duration test.
10/10/62	KIWI B-4A	2	A	NFS-1 turbine test.
10/31/62	KIWI B-4A	3	A	LN_2 startup test.
11/14/62	KIWI B-4A	4	A	Power calibration.
11/20/62	KIWI B-4A	5	A	Scaled down power run.
11/30/62	**KIWI B-4A**	**6**	**A**	**Full power run.**

RUN DATE	DEVICE	EP. NO.	TEST CELL	PURPOSE

NOTE: The following handwritten note appears in the margin of the source document: "Fuel element fragments discharged from nozzle; test terminated. All of 1963 was spent on cold flow tests. Identified causes as excessive vibration by high velocity of H gas coolant."
END OF NOTE.

12/14/62	Cold Flow	1	C	PCV-87 and PCV-89 checkout.
01/10/63	Cold Flow	2	C	Dewar pressurization test.
01/23/63	Cold Flow	2/A	C	Dewar pressurization test.
02/19/63	Cold Flow	3	C	NPS-1 electric drive test.
02/21/63	Cold Flow	3/A	C	NPS-1 electric drive test.
03/6/63	Cold Flow	3/B	C	NPS-1 electric drive test.
03/14/63	Cold Flow	3/C	C	NPS-1 electric drive test.
03/28/63	Cold Flow	4	C	LH_2 flow startup test.
04/24/63	KIWI B-4A/CF	1	A	NFS-1 checkout.
05/15/63	KIWI B-4A/CF	2	A	Gas flow section.
05/22/63	Cold Flow	5	C	Cart LH_2 piping.
06/20/63	KIWI B-2A/CF	1	C	Cold flow.
06/27/63	Cold Flow	1	A	Mixing chamber.
07/10/63	KIWI B-2A/CF	2	C	Cold gas flow and LH_2 run.
07/12/63	KIWI B-2A/CF	3	C	Cold gas flow and LH_2 run.
07/19/63	KIWI B-2A/CF	4	C	Cold gas flow and LH_2 run.
07/26/63	Cold Flow	2	A	Mixing chamber.
08/8/63	KIWI B-4B/CF	1	C	Facility checkout.
08/15/63	Cold Flow	3	A	Mixing chamber.
08/21/63	KIWI B-4B/CF	2	C	Gas and LH_2 run.
08/21/63	KIWI B-4B/CF	3	C	Gas and LH_2 run.
08/28/63	Cold Flow	4	A	Mixing chamber.
09/20/63	Cold Flow	5	A	Mixing chamber.
10/3/63	Cold Flow	6	A	Mixing chamber.
11/6/63	Cold Flow	1	C	NFS-2 turbopump checkout.
11/21/63	Cold Flow	2	C	NFS-2 turbopump checkout.
12/6/63	CEL	1	C	Facility checkout (Hadley Valve Test).
12/13/63	CEL	2	C	Facility checkout (Hadley Valve Test).
01/8/64	High Flow	1	C	Acoustic checkout (high flow test).
01/31/64	KIWI B-4D/CF	1	C	High flow test. (KIWI B-4D/CF)
02/13/64	KIWI B-4D/CF	2	C	Gas and LH_2 run. (KIWI B-4D/CF)
02/13/64	KIWI B-4D	3	C	Gas and LH_2 run. (KIWI B-4D/CF)
04/10/64	KIWI B-4D-202	1	C	Facility checkout.
04/22/64	KIWI B-4D-202	1/A	C	Core instrumentation check.
04/30/64	KIWI B-4D-202	2	C	Reactor calibration.
05/2/64	KIWI B-4D-202	2/A	C	Reactor calibration.
05/5/64	KIWI B-4D-202	2/A	C	Reactor calibration.
05/8/64	KIWI B-4D-202	3	C	Scaled down full power run.
05/13/64	**KIWI B-4D-202**	**4**	**C**	**Full power run.**

RUN DATE	DEVICE	EP. NO.	TEST CELL	PURPOSE
06/4/64	Cart Valve	1	C	Elimination study.
06/18/64	Cart Valve	2	C	Elimination study.
07/2/64	Cart Valve	3	C	Elimination study.
07/8/64	Cart Valve	4	C	Elimination study.
08/6/64	KIWI B-4E-301	1	C	Facility checkout.
08/12/64	KIWI B-4E-301	2	C	Core calibration check.
08/20/64	KIWI B-4E-301	3	C	Reactor calibration.
08/26/64	KIWI B-4E-301	4	C	Scaled down full power run.
08/28/64	**KIWI B-4E-301**	**5**	**C**	**Full power run.**
09/10/64	**KIWI B-4E-301**	**6**	**C**	**Power restart run.**
NRX-A2 DETAILS ON PRELIMINARY RUNS NOT FOUND				
09/24/64	NRX-A2	4	C	Verify steady state design analysis for power operation.
10/29/64	CEL	3	C	Rocketdyne flow meter calibration.
11/19/64	CEL	4	C	Rocketdyne flow meter calibration.
01/12/65	**KIWI**	**TNT**	**C**	**Transient Nuclear Test (nuclear safety experiment).**
03/26/65		1	C	Heat exchanger.
04/15/65		2	C	Heat exchanger.
04/15/65		2/A	C	Heat exchanger.
04/20/65		3	C	Heat exchanger (turbine bootstrap).
04/29/65		4	C	Heat exchanger (turbine bootstrap "Hex Reverse Flow").
NRX-A3 DETAILS ON PRELIMINARY RUNS NOT FOUND				
05/27/65	PHOEBUS 1A-321	1	C	Facility checkout.
06/10/65	PHOEBUS 1A-321	2	C	Reactor calibration.
06/23/65	PHOEBUS 1A-321	3	C	Scaled down full power run.
06/25/65	**PHOEBUS 1A-321**	**4**	**C**	**Full power run.**
11/23/65	CEL	5	C	Invar heat transfer studies and cryogenic coupling evaluation.
12/8/65	NRX-A4/EST	1A	A	Initial criticality and control drum measurements.
12/9/65	CEL	6	C	Invar heat transfer studies and turbine flow meter calibration.
12/15/65	NRX-A4/EST	1A'	A	Pressure loop checkout and initial cold flow tests.
12/21/65	CEL	7	C	Heat exchanger studies and LH_2 orifice calibration.
01/1/66	CEL	8	C	Heat exchanger studies with LN_2.
01/6/66	NRX-A4/EST	1A	A	Initial cold flow bootstrap.
01/19/66	NRX-A4/EST	1A - 4	A	Cold flow tests.

RUN DATE	DEVICE	EP. NO.	TEST CELL	PURPOSE
01/21/66	NRX-A4/EST	1B'	A	Neutronics calibration, control drum worth measurements, and low power dosimetry.
02/2/66	NRX-A4/EST	2A	A	Neutronics RAMS set, scaled down power test, and intermediate power bootstrap tests.
02/3/66	**NRX-A4/EST**	**2B**	**A**	**Same as above (2A).**
02/11/66	NRX-A4/EST	2C	A	Intermediate power bootstrap and controls test.
03/2/66	Local Test	1	C	Process water system checkout.
03/2/66	Local Test	2	C	Process water system checkout.
03/3/66	**NRX-A4/EST**	**3**	**A**	**Full power and engine mapping test.**
03/15/66	Local Test	3	C	Reactor cool-down vaporizer checkout.
03/15/66	Local Test	4	C	Reactor cool-down vaporizer checkout.
03/16/66	**NRX-A4/EST**	**4**	**A**	**Engine duration test.**
03/25/66	**NRX-A4/EST**	**4A**	**A**	**Engine duration test #2.**
04/13/66	PHOEBUS 1B	1	C	Mixing chamber check.
04/22/66	PHOEBUS 1B	2	C	Mixing chamber check.
05/26/66	NRX-A5	1	A	Initial criticality and cold flow test.
06/8/66	NRX-A5	2	A	Neutronics calibration, dosimetry and scaled down power.
06/8/66	**NRX-A5**	**3**	**A**	**First full power test.**
06/22/66	PHOEBUS 1B	3	C	Pressurization and cryogenic line chilldown of Dewars 1 and 2.
06/23/66	**NRX-A5**	**4**	**A**	**Second full power test.**
07/8/66	PHOEBUS 1B	4	C	Turbine energy source checkout.
07/15/66	PHOEBUS 1B	4/A	C	Turbine energy source checkout.
07/22/66	PHOEBUS 1B	4/B	C	Turbine energy source checkout.
08/31/66	PHOEBUS 1B	6	C	Mark 25 turbopump and high pressure Dewar test.
09/2/66	PHOEBUS 1B	6	C	Mark 25 duration run.
09/14/66	PHOEBUS 1B	6/A	C	Mark 25 turbopump and high pressure Dewar checkout.
09/15/66	PHOEBUS 1B	6/A	C	Mark 25 turbopump and high pressure Dewar checkout.
09/29/66	PHOEBUS 1B	6/B	C	Mark 25 duration run.
09/30/66	PHOEBUS 1B	6/B	C	Mark 25 duration run.
10/6/66	PHOEBUS 1B	6/B	C	Program check and high pressure Dewar checkout.
10/18/66	Local Test	7	C	Borated water system check.
10/19/66	Local Test	7'	C	Borated water system check.
10/19/66	Local Test	7/A	C	Borated water system check with sodium-24.
11/3/66	PHOEBUS 1B	10	C	Dummy pressure vessel test.
11/17/66	Local Test	7/B	C	Borated water stratification test.
12/7/66	PHOEBUS 1B	7	C	Facility checkout.
12/9/66	PHOEBUS 1B	7	C	Facility checkout.
12/15/66	PHOEBUS 1B	7/A	C	Facility checkout - Mark 25 duration test.

RUN DATE	DEVICE	EP. NO.	TEST CELL	PURPOSE
01/6/66	PHOEBUS 1B	X/A	C	Facility checkout - Mark 25 green run and high flow.
01/18/67	Local Test		C	Shield reactivity worth test.
01/20/67	Local Test		C	Rods hydraulic accumulator capacity test.
01/25/67	PHOEBUS 1B	1	C	Reactor calibration and gas flow run.
01/26/67	PHOEBUS 1B	1'	C	Reactor calibration and gas flow run.
02/2/67	PHOEBUS 1B	2	C	Simulation run and thermal instrumentation check.
02/3/67	PHOEBUS 1B	2	C	Simulation run and thermal instrumentation check.
02/10/67	**PHOEBUS 1B**	**3**	**C**	**Startup to intermediate power.**
02/17/67	PHOEBUS 1B	4	C	Full power run - canceled.
02/23/67	**PHOEBUS 1B**	**4**	**C**	**Full power run.**
04/19/67	NFS-3B	1	C	Initial operation and intermediate speed testing.
04/26/67	NFS-3B	2	C	Intermediate and high-speed testing.
05/10/67	NFS-3B	3	C	Single mode high-speed pump test.
05/25/67	NFS-3B	4	C	High-speed testing and control system response test.
05/26/67	NFS-3B	4	C	NRX-A6 startups and stall tests.
06/14/67	NFS-3B	5	C	PHOEBUS - startups and shutdowns.
06/15/67	NFS-3B	5	C	High-speed duration run.
07/12/67	PHOEBUS 2/CF	1	C	Cold flow.
07/19/67	PHOEBUS 2/CF	2	C	Cold flow.
07/23/67	PHOEBUS 2/CF	4	C	Cold flow.
07/27/67	Local Test		C	Reactor cool-down vaporizer performance.
08/17/67	PHOEBUS 2/CF	3	C	Cold flow.
08/31/67	NRX-A6		C	Local Test #1.
09/7/67	NRX-A6	1	C	Facility checkout.
09/21/67	NRX-A6	2	C	Facility checkout.
10/5/67	PHOEBUS 2	1	C	Shutdown studies.
10/19/67	NRX-A6	3	C	Facility checkout.
11/21/67	NRX-A6	1	C	Initial criticality test.
12/6/67	NRX-A6	2	C	System interaction checkout.
12/6/67	NRX-A6	3	C	Full power run - aborted.
12/7/67	NRX-A6	3	C	Full power run - aborted.
12/8/67	NRX-A6	3	C	Full power run - aborted.
12/14/67	NRX-A6	3/A	C	Full power run - aborted.
12/15/67	**NRX-A6**	**3/A**	**C**	**Full power run.**
01/19/68	PHOEBUS 2A		C	Turbine spin local test.
02/14/68	PHOEBUS 2	2	C	Facility checkout - shutdown studies.
02/15/68	PHOEBUS 2	2	C	Facility checkout - shutdown studies.
02/21/68	PHOEBUS 2	2A	C	Facility checkout - shutdown studies.
03/6/68	PHOEBUS 2	2B	C	Facility checkout - shutdown studies.
03/20/68	PHOEBUS 2	3	C	Facility checkout - shutdown studies.
04/2/68	PHOEBUS 2A		C	Dewar 3 checkout.
04/8/68	PHOEBUS 2A		C	Shield annulus borated water system test.

RUN DATE	DEVICE	EP. NO.	TEST CELL	PURPOSE
04/24/68	PHOEBUS 2A		C	Rods and servo hydraulics system checkout.
04/25/68	PHOEBUS 2A		C	Emergency and critical power systems checkout.
04/25/68	PHOEBUS 2A		C	Shield annulus and privy roof borated water test.
05/7/68	PHOEBUS 2A		C	Thermal spray system test.
05/15/68	PHOEBUS 2A		C	Privy inerting checkout.
05/16/68	PHOEBUS 2A		C	Shield annulus borated water system.
05/17/68	PHOEBUS 2A		C	Thermal spray system test.
05/20/68	PHOEBUS 2A		C	GN_2 high flow test.
05/22/68	PHOEBUS 2A	1	C	Reactor calibration run.
05/23/68	PHOEBUS 2A	1	C	Reactor calibration run.
05/29/68	PHOEBUS 2A	2	C	Facility interaction test.
06/5/68	PHOEBUS 2A	3	C	Intermediate power run - aborted.
06/7/68	PHOEBUS 2A	3	C	Intermediate power run - aborted.
06/8/68	**PHOEBUS 2A**	**3**	**C**	**Intermediate power run.**
06/26/68	**PHOEBUS 2A**	**4**	**C**	**High power run.**
07/18/68	**PHOEBUS 2A**	**5(A&B)**	**C**	**High power run.**
08/14/68	MARK 25	1	C	Acceptance test.
08/21/68	MARK 25	1	C	Acceptance test.
09/19/68	MARK 25	1	C	Acceptance test.
09/19/68	PEWEE 1	1	C	Facility checkout.
10/9/68	PEWEE 1	2	C	Facility checkout.
10/17/68	PEWEE 1		C	Emergency power local test.
10/18/68	PEWEE 1	3	C	Facility checkout.
11/5/68	PEWEE 1		C	Borated water local test.
11/6/68	PEWEE 1		C	Servo hydraulics system local test.
11/6/68	PEWEE 1		C	Supercritical and 28-V battery bank decay tests. (Conducted through 11/13/68.)
11/11/68	PEWEE 1		C	Rods hydraulic system local test.
11/12/68	PEWEE 1		C	Borated water local test.
11/13/68	PEWEE 1		C	Annulus purge and privy inerting.
11/15/68	PEWEE 1	1	C	Reactor calibration run.
11/21/68	PEWEE 1	2	C	Interaction check and high power run.
12/4/68	**PEWEE 1**	**3**	**C**	**Full power run.**
12/4/68	XE PRIME	1	ETS-1	
12/5/68	PEWEE 1		C	Post-criticality attempt.
12/6/68	PEWEE 1		C	Post-criticality test.
12/6/68	XE PRIME	SL2	ETS-1	
12/11/68	PEWEE 1		C	Post-criticality test.
02/20/69	XE PRIME	1A	ETS-1	Obtain drum worth measurements; test autostart; perform thermal calibration.
02/27/69	XE PRIME	1B	ETS-1	Test steam generation.
03/13/69	XE PRIME	2	ETS-1	
03/20/69	XE PRIME	2A	ETS-1	Three nuclear-powered bootstraps with varying temperature and pressure.

RUN DATE	DEVICE	EP. NO.	TEST CELL	PURPOSE
04/17/69	XE PRIME	3C	ETS-1	
06/11/69	**XE PRIME**	**5C**	**ETS-1**	**Nuclear-powered bootstrap to full power.**
06/26/69	XE PRIME	4A	ETS-1	"Wet and dry" autostarts at low reactor power.
07/10/69	XE PRIME	6A	ETS-1	"Wet and dry" autostarts at low reactor power.
07/24/69	XE PRIME	7A	ETS-1	Wet autostart/hot core restart.
08/13/69	XE PRIME	8A	ETS-1	Fixed drum, low Dewar pressure/cold core restart.
08/28/69	**XE PRIME**	**9A**	**ETS-1**	**Intermediate power test; wet autostart.**
09/11/69	XE PRIME	10A	ETS-1	High specific impulse start/restart to power.

REFERENCES: CIC # 78434, 36305, 35039, 36135, 36136, 36137, 36138, 36140, 170952

APPENDIX 2

NUCLEAR FURNACE 1 EXPERIMENTAL PLAN V

AERIAL MONITORING AND SAMPLING PRELIMINARY REPORT

Nuclear Furnace 1 Experimental Plan V
Aerial Monitoring and Sampling
Preliminary Report

35091

Environmental Surveillance
National Environmental Research Center
Environmental Protection Agency
Las Vegas, Nevada

INTRODUCTION

The Environmental Surveillance Program of the National Environmental Research Center-Las Vegas performed aerial tracking, monitoring, and sampling following Experimental Plan V (EP-V) of Nuclear Furnace 1 on July 27, 1972. The Nuclear Furnace was operated between 1136 and 1330 hours PDT at 44 Mw (thermal) in Test Cell C at the Nuclear Rocket Development Station.

AIRCRAFT

The initial cloud tracking was performed with an Air Force UH-1N helicopter. The NERC-LV and REECo monitors on board were equipped with the portable radiation detection instruments described in Table 1.

Table 1
Portable Radiation Detection Instruments

Instrument	Type	No. of Scales	Range
Baird Atomic NE-148	Scintillator	3 log	0-3 mR/h
Eberline E-500B	Geiger Counter	5 linear	0-2 R/h
Victoreen Radector II	Ionization Chamber	2 log	0.05 mR/h - 50 R/h

Two NERC-LV aircraft (Vegas 7 and 8), modified C-45's with turbo-prop engines, were used during three different aerial monitoring missions. These aircraft were equipped with a complete set of sampling systems, a gross gamma detection system, and portable survey instruments. Detailed descrip-

tions of the instruments and equipment are available in earlier reports of aerial surveillance.

CLOUD MEASUREMENT

UH-1N Helicopter

Two missions were flown with the helicopter. The first was during the full-power run, and the second was during the warm-up of the charcoal trap of the Nuclear Furnace Effluent Clean-up System. On the first mission, the helicopter took off from NRDS at 1130 hours and crossed the anticipated trajectory of the effluent at 3 miles from Test Cell C at an elevation of 6000 feet MSL. Radiation levels above background were first detected at 1145 hours on an azimuth of 20° from Test Cell C. East to west and west to east passes were continued at this distance from 1145 to 1250 hours, at which time the aircraft had to land for refueling. The maximum radiation level measured during this period was 15 mR/h at 1222 hours at an azimuth of 15°. A summary of the radiation readings is shown in Table 2.

After heating of the charcoal trap had commenced, the helicopter was sent on a second mission at 1450 hours to locate the trap effluent. The aircraft flew north from Test Cell C in a zig-zag pattern to the Area 16 tunnel where the aircraft mission was terminated at 1520 hours. Only intermittent readings were observed. The highest exposure rate observed during this mission was 0.15 mR/h at 7 miles and 0° azimuth from Test Cell C. All readings are listed in Table 2.

Table 2

UH-1N Monitoring Results Nuclear Furnace 1, EP V

July 27, 1972

Time (PDT)	Altitude (ft, MSL)	Miles from Test Cell C	Azimuth (Degrees)	Centerline Exposure Rate (mR/h)	Remarks
1145	6000	3	020	0.1	Peak
1146	"	"	045		E. Edge
1147	"	"	015	0.6	Peak

Time (PDT)	Altitude (ft,MSL)	Miles from Test Cell C	Azimuth (Degrees)	Centerline Exposure Rate (mR/h)	Remarks
1148	6000	3	330		W. Edge
1149	"	"	350		W. Edge
1150	"	"	015	1.0	Peak
1151	"	"	045		E. Edge
1152	"	"	025		E. Edge
1153	"	"	015	1.2	Peak
1154	"	"	345		W. Edge
1155	"	"	015		W. Edge
1156	"	"	025		Peak
1157	"	"	050		E. Edge
1158	"	"	040		E. Edge
1159	"	"	015	0.6	Peak
1159.5	"	"	345		W. Edge
1200	"	"	345		W. Edge
1200.5	"	"	025	0.3	Peak
1201	"	"	050		E. Edge
1202	"	"	040		E. Edge
1203	"	"	010	0.3	Peak
1204	"	"	345		W. Edge
1205	"	"	350		W. Edge
1205	"	"	025	2.0	Peak
1206	"	"	050		E. Edge
1207	"	"	050	1.5	E. Edge
1208	"	"	020	1.5	Peak-Center
1209	"	"	345		W. Edge
1209	"	"	345		W. Edge
1210	"	"	020	5.0	Peak
1212	"	"	070		E. Edge
1214	"	"	055		E. Edge
1215	"	"	015	0.3	Peak
1216	"	"	345		W. Edge
1220	"	"	350		W. Edge
1222	"	"	015	15	Peak
1223	6500	"	065		E. Edge
1225	6000	"	065		E. Edge
1227	"	"	350	9.0	Peak
1230	"	"	310		W. Edge
1231	"	"	340		W. Edge
1232	"	"	015	8.0	Peak
1233	"	"	030	10	Peak
1233	"	"	055		E. Edge
1236	8000	"	060		E. Edge
1238	"	"	005	7.0	Peak
1239	"	"	330		W. Edge
1241	"	"	345		W. Edge
1242	"	"	015	2.0	Peak
1244	7500	"	065		E. Edge
1247	6500	"	065		E. Edge

Time (PDT)	Altitude (ft,MSL)	Miles from Test Cell C	Azimuth (Degrees)	Centerline Exposure Rate (mR/h)	Remarks
1248	6500	3	030	4.0	Peak
1249	"	"	015	5.0	>Peak
1250	"	"	335		W. Edge
			REFUEL AT CP		
1457	6300	5	040	.01	
1500	5500	6	005	.003	
1506	6600	7	0	.15	Tonopah Springs
1510	"	8	0	.13	Shoshone Peak
1520	"	16	020	.10	Area 16 Tunnel
1530	4500	16	020	.10	Area 16

Vegas 7

Vegas 7 first contacted the cloud at 1158 hours 6 miles north of Test Cell C at an elevation of 10,000 feet MSL. The aircraft was flown above the cloud at this location, and a spiral descent was begun at an elevation of 13,500 feet MSL. The cloud top was detected at 12,000 feet MSL. Beginning at 13,500 feet sequential air samples were collected over each 1000-foot-altitude segment to 6500 feet MSL where the descent was stopped due to high terrain. The highest radiation reading during the descent was 0.5 mR/h at 7000 feet MSL.

A northwest to southeast sampling pattern was then established at an elevation of 7000 feet MSL between two check points on the ground as shown in Figure 1. Activity was first detected between the check points 16 miles from Test Cell C at 1233 hours. Based on this time and a reactor full power startup time of 1136, an average cloud transport speed to this location was calculated to be 17 mph. During the passes across the cloud, the maximum exposure rates in Table 3 were observed. All maximum exposures were measured at about the same location, 7000 feet MSL at 16.0 miles and 8° from Test Cell C. The maximum cloud width measured was 10.9 miles, corrected for the skewness of the flight line. Between 1257 and 1302 hours, six sequential filter samples were collected during the monitoring between check points. Using the wind speed of 9.7 mph between 1233 and 1413 hours

determined from Vegas 7 and Vegas 8 measurements, the plume volume crossing the sampling line between 1233 and 1411 hours was calculated to be $5.7 \times 10^{11} m^3$.

Table 3

Vegas 7 Monitoring Results Nuclear Furnace 1, EP-V

July 27, 1972

Time (PDT)	Maximum Exposure Rate (mR/h)
1236	0.01
1241	0.01
1245	0.02
1254	0.07
1259	0.09
1305	0.5
1322	1.5
1335	1.0
1351	0.5
1357	0.5
1404	0.3
1411	0.14

Vegas 8

Vegas 8 initiated plume tracking at 1400 hours over the northern end of NTS. On an initial east-west pass at 11,000 feet MSL from the EPA farm to the Greeley Event crater, a plume was detected from 0.9 miles east of the Area 12 camp to 1.25 miles west of the Greeley Crater. The exposure rates were fairly uniform at 0.01 to 0.02 mR/h over the entire width. On a south to north pass at 1413 hours, the leading edge was located 31 miles at 2° from Test Cell C. At 1421 hours the leading edge was located at 33.3 miles at 4° from Test Cell C. The two leading edge locations provide an average cloud transport speed of 12 mph. However, the time between leading edge arrival at 16 miles and 31 miles results in an average transport speed between those locations of 9.7 mph, indicating a reduction in wind speeds from the average 16 mph measured between 1136 and 1233 hours. The calculated plume transport speeds are listed in Table 4.

Table 4

Plume Transport Speeds, Nuclear Furnace 1, EP-V

July 27, 1972

Time Interval (Hours, PDT)	Distance Interval (Miles)	Average Speed (mph)
1136-1233	0-16	16
1233-1413	16-31	9.7
1413-1502	31-47	16

A spiral descent was performed 32 miles at 004 degrees from Test Cell C at 1432 hours. The plume top was at 15,300 feet MSL. Between 12,000 and 7,000 feet MSL exposure rates were relatively uniform at 0.15 to 0.2 mR/h with a maximum of 0.2 mR/h at 7,500 feet.

A picket line flight pattern was established at 8,000 feet MSL between Standard and the ridge of the Belted Range east of Kawich Valley. The cloud arrival at the north end of the Kawich dry lake (47 miles at 3° from Test Cell C) at 1502 hours gives a calculated average speed between the 31-mile and 47-mile distances of 16 mph. Until approximately 1540 hours, the detectable plume at 8,000 feet MSL was contained between the mountain ridges on the east and west sides of Kawich Valley. Because of increased radiation levels due to high terrain over the Belted Range, it was not immediately obvious when the plume's eastern edge crossed the range. A pass east of the Belted Range at 1530 showed no activity east of the ridge. Assuming that the ridge of the Belted Range defined the eastern edge of the plume at 1602 hours, a maximum width of 15.9 miles was measured from 4 miles west of Standard (2.5 miles west of the mountain ridge west of Kawich Valley) to the ridge of the Belted Range. Because of Air Force activities which forced closure of the Bombing and Gunnery Range, a final pass was made at 1608 hours. This west-east pass was continued across the Belted Range to Valley Road, south over Gate 700 to Area 3 of NTS. East of the Belted Range the exposure rates were continuous at 4 to 6 μR/h to the Valley Road, increasing to 0.1 mR/h 2 miles south of Gate 700 and returning to background 3 miles north of the Area 3 access road. A northerly pass along the Mercury Highway located

the southern edge at 2.3 miles north of BJY. A peak of 0.08 mR/h was located 2.8 miles north of the EPA farm at 1624 hours. At this time the mission was terminated.

Tracking by the UH-1N helicopter of the effluent released during warm-up indicated a north-northeast trajectory. It is likely that this effluent was the source of the radioactivity detected over the north end of Yucca Flat. The radioactivity detected east of the Belted Range could have been from this source or may have been from the primary plume.

Assuming that the point of rapid increase in exposure rate 2.3 miles north of Gate 700 was the leading edge of the warm-up effluent, a mean transport speed of 19 mph is calculated for this material. Representative exposure rates measured during this mission are presented in Table 5. Since the entire plume had not crossed the sampling path in Kawich Valley, the plume volume could not be determined. Accordingly, an inventory could not be calculated for the plume at that distance.

Table 5

Vegas 8 Monitoring Results Nuclear Furnace 1, EP-V

July 27, 1972

Time	Altitude (ft,MSL)	Distance (Miles)	Azimuth (Degrees)	Exposure Rate (uR/h)
1432	7500	32	004	200
1502	8000	47	003	1
1506	"	"	004	1
1511	"	"	002--004	1
1517	"	"	002--004	1
1523	"	"	002--004	1
1529	"	"	002--003	2
1537	"	"	006	9
1544	"	"	006--008	16
1549	"	"	005--009	20
1556	"	"	005	25
1602	"	"	004--006	60
1608	"	"	002--006	60
1617	"	30	037	100
1623	"	25	031	80
1624	"	28	027	80

Vegas 7, Second Mission

A second aerial monitoring mission was flown by Vegas 7 between 1650 and 1820 hours. Two round trips were flown along Highway 25 between Hiko and Reed Ranch at 10,500 feet MSL. No exposure rates above background were observed, indicating the effluent in detectable quantities had not yet reached Highway 25 by 1800 hours.

SAMPLING RESULTS

Vegas 7

Analysis of the samples collected by Vegas 7 showed the majority of the airborne radioactivity was due to ^{88}Kr-Rb and ^{85m}Kr. Approximately 8% was ^{133}Xe and ^{135}Xe. Particulate radioactivity (^{91}Sr, ^{138}Cs, and ^{139}Ba) constituted 1% of the airborne effluent at the mid-time of sampling, 1330 hours. This was the only Experimental Plan run which resulted in the detection by NERC-LV aircraft of particulate radioactivity other than the ^{88}Rb daughter product of ^{88}Kr. Table 6 summarizes the results of average concentration, plume inventory at 1330 hours (H+1 hour), and plume inventory at H+12 hours.

Table 7 lists the estimated average concentrations crossing the NTS boundary, based on the measured average concentrations at 1330 hours, predicted plume diffusion, and individual radionuclide decay.

Table 6

Vegas 7 Aerial Sample Results Nuclear Furnace 1, EP-V

July 27, 1972

Radionuclide	Concentration (pCi/m^3)	Inventory, Ci	
		1330 Hours	H+12 Hours
^{85m}Kr	29,000	17,000	3,000
^{88}Kr	34,000	19,000	1,200
^{88}Rb	37,000	21,000	1,300
^{91}Sr	13	7.4	3.3
^{133}Xe	7,800	4,400	4,400
^{135}Xe	1.200	680	290
^{138}Cs	980	560	3×10^{-4}
^{139}Ba	79	45	0.2

Table 7

Estimated Average Concentrations at NTS Boundary

Nuclear Furnace 1, EP-V

July 27, 1972

Radionuclide	Concentration (pCi/m^3)
^{85m}Kr	9,400
^{88}Kr	9,000
^{88}Rb	9,900
^{91}Sr	5
^{133}Xe	3,500
^{135}Xe	450
^{138}Cs	33
^{139}Ba	12

Vegas 8

The average radionuclide concentrations determined from the Vegas 8 samples collected over Kawich Valley are presented in Table 8. Because Vegas 8 had to depart shortly after the arrival of the major portion of the plume, the average concentrations measured are probably somewhat low. However, they agree reasonably well with the expected average concentrations at that location.

Table 8

Vegas 8 Aerial Sample Results Nuclear Furnace 1, EP-V

July 27, 1972

Radionuclide	Concentration (pCi/m^3)
^{85m}Kr	910
^{88}Kr	1,500
^{88}Rb	1,700
^{133}Xe	110

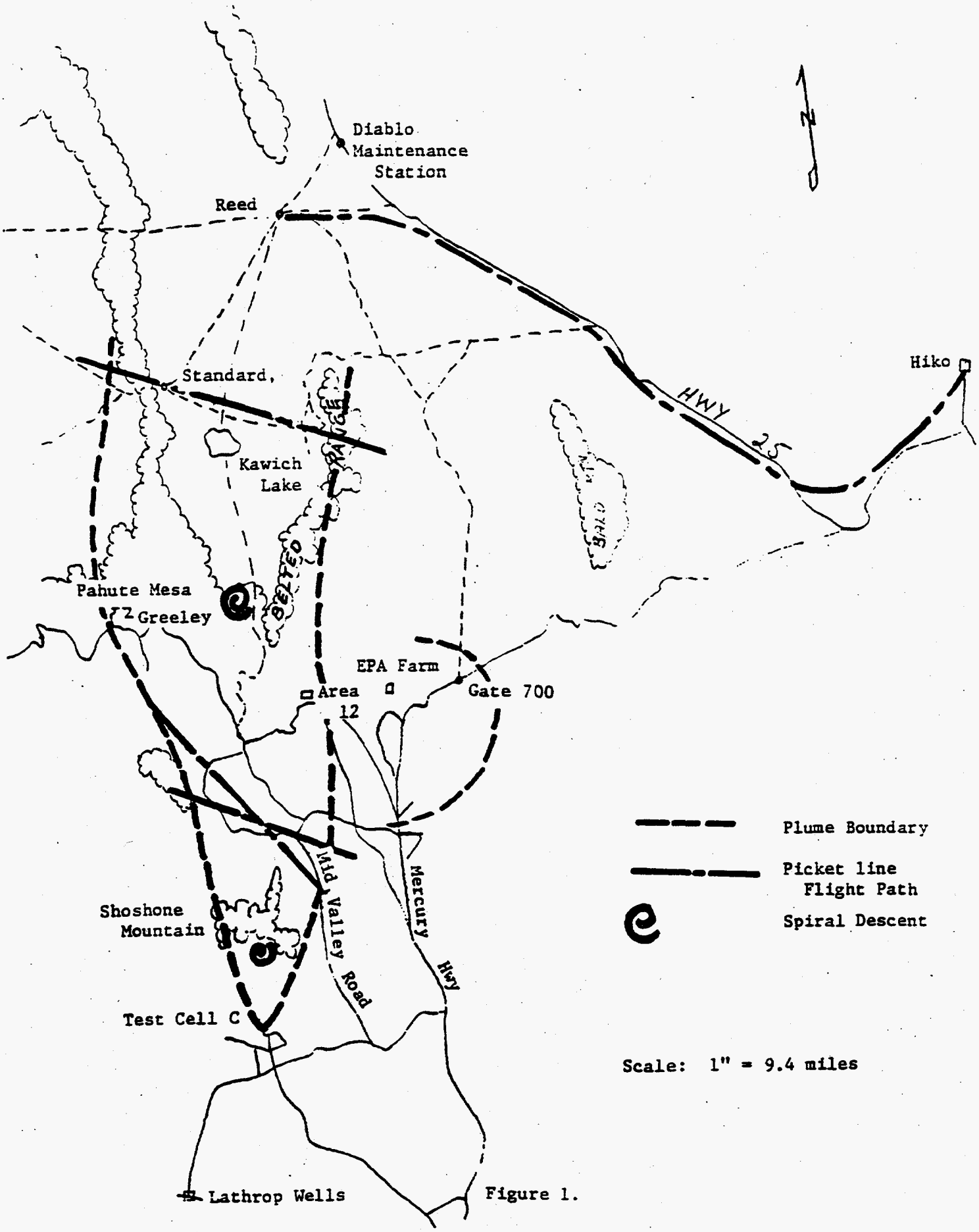
Diablo
Maintenance
Station
Reed
Standard
Kawich
Lake
HWY 25
Hiko
Pahute Mesa
Greeley
EPA Farm
Area
12
Gate 700
Mid Valley Road
Mercury
Hwy
Shoshone
Mountain
Test Cell C
Lathrop Wells
Plume Boundary
Picket line
Flight Path
Spiral Descent
Scale: 1" = 9.4 miles

Figure 1.