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HEADQUARTERS

AIR FORCE SPECIAL WEAPONS CENTER

AIR RESEARCH AND DEVELOPMENT COMMAND
KIRTLAND AIR FORCE BASE, NEW MEXICO

AD 245 602

FISSION PRODUCTS FIELD RELEASE TEST II

U.S. AIR FORCE

Nuclear Aircraft Research Facility
operated by

CONVAIR

A DIVISION OF GENERAL DYNAMICS CORPORATION
FORT WORTH, TEXAS

SEPTEMBER 1960

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AIR FORCE SPECIAL WEAPONS CENTER
Air Research and Development Command
Kirtland Air Force Base, New Mexico

Major General Charles M. McCorkle
Commander

Colonel Carey L. O'Bryan, Jr.
Deputy Commander

Colonel Leonard A. Eddy
Director, Research Directorate

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Research Directorate
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Kirtland Air Force Base, New Mexico

Approved:

SOLOMON E. LIFTON
Colonel USAF
Chief, Biophysics Division

Project No. 7809
Task No. 78016
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LEONARD A. EDDY
Colonel USAF
Director, Research Directorate

U.S. AIR FORCE
USAF

ABSTRACT

The second in a series of experimental field programs for investigating the release, environmental dispersal, and biological effects of fission products was conducted at the Dugway Proving Ground, Utah, during the summer and fall of 1959.

Eleven release experiments were performed in which metallic ANP-type fuel elements were melted in high-temperature induction furnaces to simulate the slow meltdown and release of fission products accompanying a nuclear propulsion system reactor accident. Eight releases were made to the atmosphere under strong meteorological inversion conditions, and the fission products were allowed to disperse onto an instrumented sampling network extending 20 miles downwind from the release point. Three releases were made into collectors designed to collect 100% of the released fission products.

The procedures and techniques employed in measuring deposition velocities, release percentages, and long-range diffusion parameters are described. Experimental results are presented, and interpretative comments are made with respect to improvements in the predictability of environmental contamination resulting from a reactor meltdown accident.

PUBLICATION REVIEW

This report has been reviewed and is approved.

CAREY E. O'BRYAN, JR.
Colonel USAF
Deputy Commander

ACKNOWLEDGEMENTS

From the standpoint of both the scope of the experimental-design and the operational-support requirements, the FRT-II field program was a very large undertaking. Those who have participated in other field programs will appreciate the many problems associated with maintaining a 24-hour testing capability for an elaborately instrumented test grid, remotely located and covering some 210 square miles of roadless desert terrain.

This program could not have been completed without the spirited and efficient cooperation of the many scientists and technicians who participated in the planning and performance of the experiments. Organizations participating in the program are listed below.

Air Force Special Weapons Center, Air Research and Development Command, U.S. Air Force

Research Directorate	Test Management
Biophysics Division	Biological Studies
4950th Test Group (Nuclear)	Operational Support

Convair-Fort Worth

Nuclear Aircraft Research Facility	Test Management, Physical Measurements, and Health Physics

U. S. Army Chemical Corps

Dugway Proving Ground	Test Support in Meteorology, Radiological Safety, Maintenance of Equipment, and Transportation

Air Weather Service

4th Weather Group.....	Meteorological Observations and Forecasting

University of Rochester

Atomic Energy Project.....	Biological Studies

Hanford Atomic Products Operation

Plant Nutrition and Microbiology Department.....	Plant Physiology and Decontamination Studies

Phillips Petroleum Corporation

Analytical Chemistry Laboratory.....	Chemical Analyses

Idaho Operations Office

National Reactor Testing Station.....	Fuel Element Transfer and Accountability

General Electric Company

Aircraft Nuclear Propulsion Facility (NRTS).....	Fuel Element Procurement, Irradiation, and Inventory Analysis

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NOTE

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I. INTRODUCTION

The development of nuclear-powered aircraft requires that the hazards associated with the release and dispersal of fission products from high-power and high-temperature nuclear power plants be determined and the resulting impact on operations be evaluated. As part of the Air Force's overall safety-analysis program for nuclear-powered aircraft, a series of experimental field tests for investigating these hazards was initiated in the summer of 1958 (Ref. 1).

Fission-Products Field Release Test II (FRT II) was the second in this series of field programs sponsored by the Joint USAF-USAEC Aircraft Nuclear Propulsion Office. The Air Force Special Weapons Center provided technical management and support for the operation. Convair scientists assisted in experiment design, in installation and operation of the sampling grid, in coordinating the scientific effort with other participants, in performing the bulk of physical measurements and data reduction. Biological aspects of the program were the responsibility of University of Rochester scientists.

The main objectives of this program were:

1. To obtain experimental data on the atmospheric diffusion of fission products out to 20 miles under strong inversion conditions.

2. To obtain direct measurements of isotopic release percents from metallic aircraft-type fuel elements.

3. To add statistically to isotopic-deposition-velocity data available from previous experiments.

4. To observe changes in fission-product particle sizes and dispersal characteristics caused by condensation nuclei (JP4-fuel).

5. To obtain more data on particle sizes and size distribution of fission products.

6. To obtain diffusion parameters for fission products and correlate them with basic meteorological measurements.

7. To obtain data on the biological effects of fission products.

8. To obtain data on the ecological fate of fission products.

To achieve the broad objectives of this program, it was necessary to make a large number of separate measurements involving isotope production, meteorological conditions, isotopic releases, air concentrations, deposition, ground and vegetation contamination, and metabolism of fission products. A total of eleven releases were made, three of which were contained (i.e., all the effluent was collected). For each release, an irradiated metallic-type fuel-element specimen was melted in an induction-type furnace. Specially designed total and partial effluent collectors were used to obtain direct measurements of release percentages. Charged-vertical-wire collectors were placed downwind to determine vertical diffusion. The perturbations in atmospheric dispersal caused by releasing the furnace effluent into a JP4-fire smoke plume were assessed. Heat-budget studies were performed from radiometer and heat-flux-plate data, in addition to standard meteorological data. Deposition

studies were made from gummed-paper, grass, and soil data. Inhalation and metabolism studies were performed by exposing dogs and rats to the effluent. The soil uptake of radioactivity was assessed and decontamination studies were made on vegetation samples.

This report describes the physical equipment and the methods used in measuring the release and long-range dispersal of fission products resulting from the slow meltdown of ANP-type metallic fuel elements. Analyses of the data are made and results are presented.

The biological phase of the program and the plant decontamination studies will be treated in separate reports to be published by the University of Rochester and Hanford Atomic Products Operation, respectively.

II. EXPERIMENT DESIGN

The first series of field experiments (FRT I) designed to simulate the slow meltdown and release of fission products was performed at the National Reactor Testing Station (NRTS), Idaho, during the summer and fall of 1958. In this series of tests, segments of metallic ANP-type fuel elements were melted under controlled conditions in an induction furnace, and the radioactive effluent was dispersed downwind onto a highly instrumented sampling network. Data were obtained on the release, dispersal, and atmospheric diffusion of fission products out to 8 kilometers from the release point, under both lapse and inversion conditions. These data helped to resolve many of the uncertainties in hazards-evaluation criteria (Ref. 2), and suggested refinements in procedures and techniques to be used in future tests.

The present series of tests, Fission-Products Release Test II, performed at the Dugway Proving Ground during the summer and fall of 1959, was designed to extend the dispersal range of earlier simulated-reactor-meltdown experiments. Employing refinements in sampling techniques and meteorological measurements, fission-products releases were made onto a highly instrumented sampling network located on flat desert terrain and extending 32 kilometers downwind from the release point. Releases were made under strong inversion conditions in order to obtain data required to establish the upper limit of the possible hazards of a nuclear accident of the meltdown type.

Descriptions of the test site, instrumentation, and techniques used in this series of experiments are presented below.

2.1 Test Site

Technical and logistical considerations led to the selection of a remotely situated section of the Great Salt Lake Desert within the Dugway Proving Ground, Utah, as the test site for this series of experiments (Fig. 1). To meet the objectives of this program, it was necessary to select a site which would permit the sampling of fission products 32 kilometers downwind from the point of release. In addition to meeting this requirement, the Dugway site offered other advantages: excellent supply and maintenance facilities, personnel quarters, and facilities for a test staging area (Fig. 2).

The area encompassed by the 210-square-mile test grid is composed of salt flats and silty clay flats (Fig. 3). Except for a ridge of large silty dunes situated in the northeast portion of the grid, the terrain within the test network is flat and almost completely barren. The average density of vegetation, mainly pickleweed, is approximately one hundred plants per square mile.

The area of meterological interest covers approximately 2500 square miles. It is influenced by two types of wind regimes: the synoptic wind associated with large-scale migratory pressure systems and the local winds resulting from an inter-basin circulation set up by the temperature difference between the Salt Flats and the Sevier Basin, about 40 miles to the South. Optimum atmospheric conditions

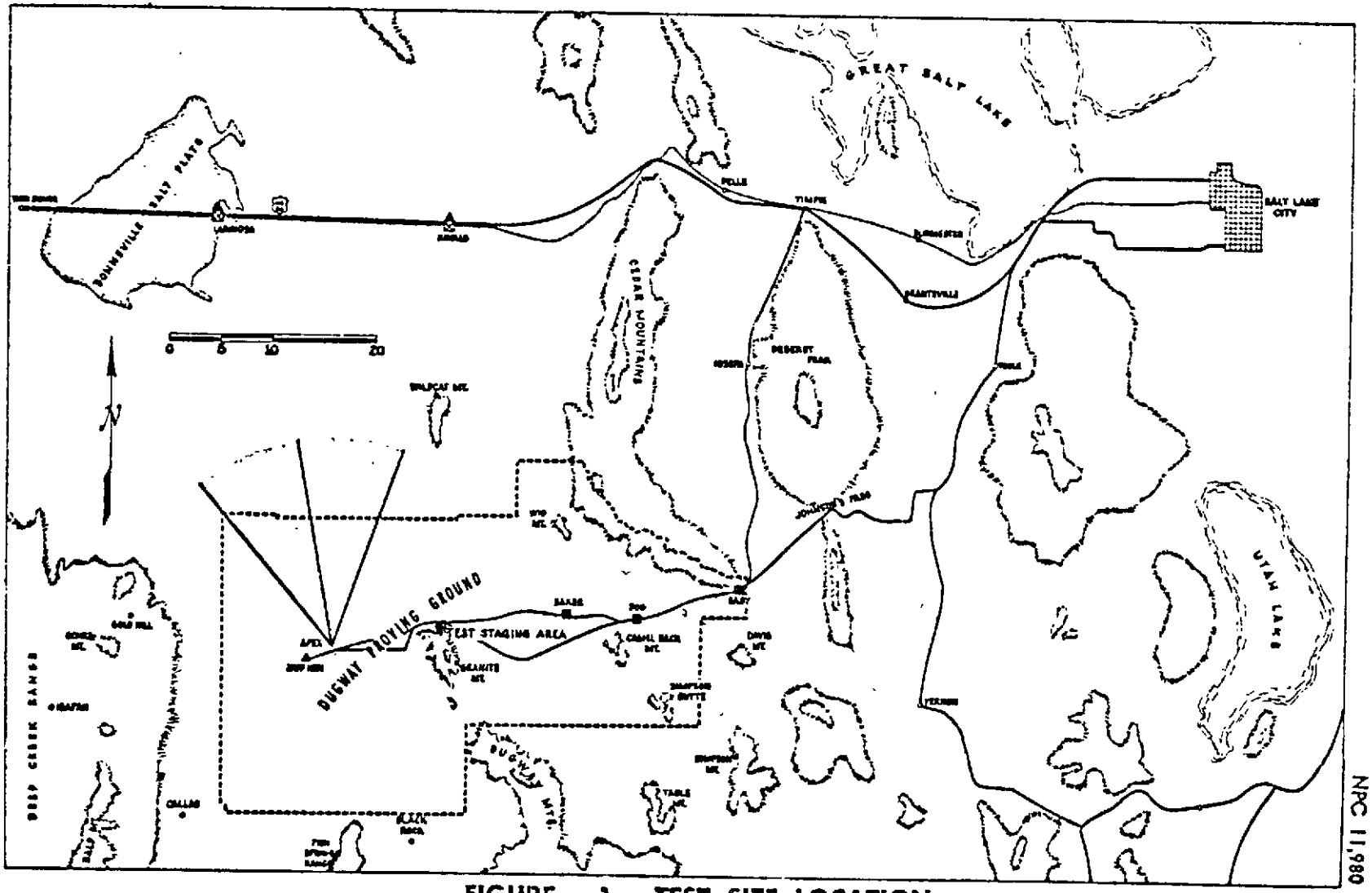

FIGURE 1. TEST SITE LOCATION

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FIGURE 2. GRANITE PEAK TEST STAGING AREA

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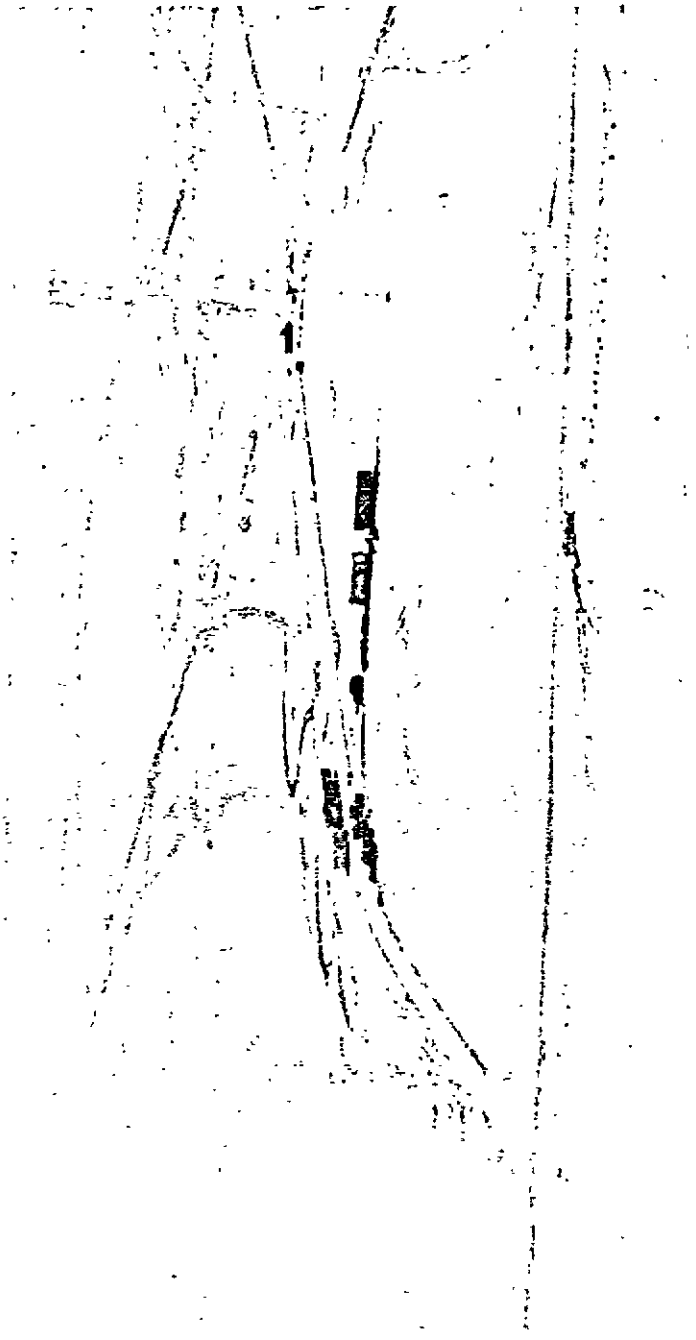

FIGURE 3. AERIAL VIEW OF TEST SITE

for the tests were produced by the latter system and the strong temperature gradient caused by high nocturnal radiation from the flats.

2.2 Source

Segments of freshly irradiated metallic fuel elements, representative of the type used in direct air cycle reactors, were melted in induction-type furnaces (Fig. 4) to provide a radioactive point source. The fuel-element specimens were irradiated in the MTR to provide an inventory of the biologically hazardous isotopes that are found in abundance in an operational aircraft reactor – namely, I^{131}, Cs^{137}, Ru^{103}, Zr^{95}, Sr^{89}, Sr^{90}, Ce^{141}, and Ce^{144}.

The melting program was designed to simulate the slow meltdown case. The design and operation of the induction furnace and associated equipment are described in Appendix A.

2.3 Sampling Network

The sampling network consisted of a 60-degree, fan-shaped grid with a centerline bearing of 350 degrees to coincide with the most probable nighttime wind direction during summertime inversion conditions. The grid was divided into nine concentric arcs extending downwind 32 kilometers from the release point (Fig. 5).

Approximately 450 sampling stations, employing a variety of sampling devices and techniques, were utilized in measuring release percents, deposition velocities, internal dose, and long-range atmospheric diffusion parameters.

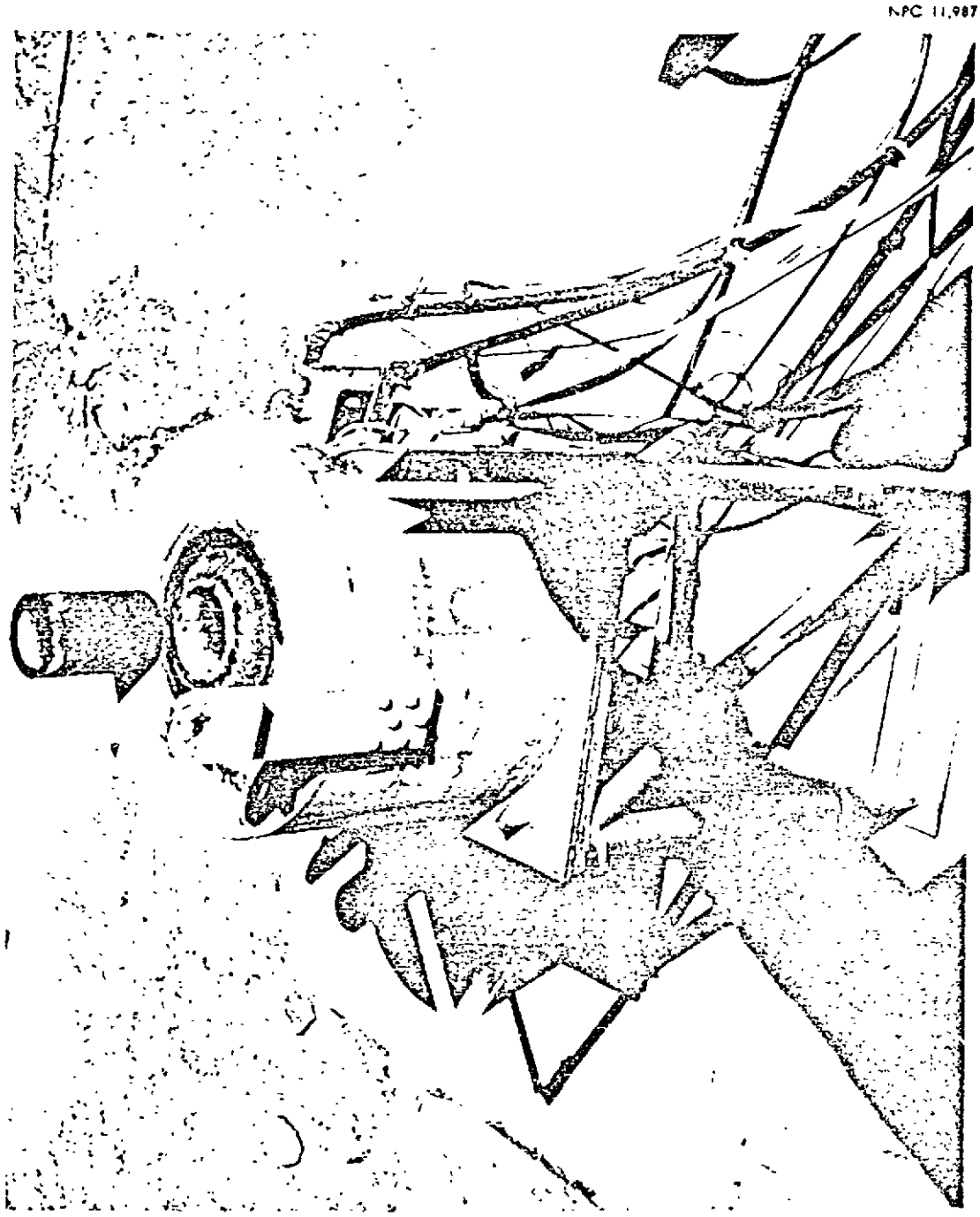

FIGURE 4. INDUCTION FURNACE WITH CRUCIBLE REMOVED

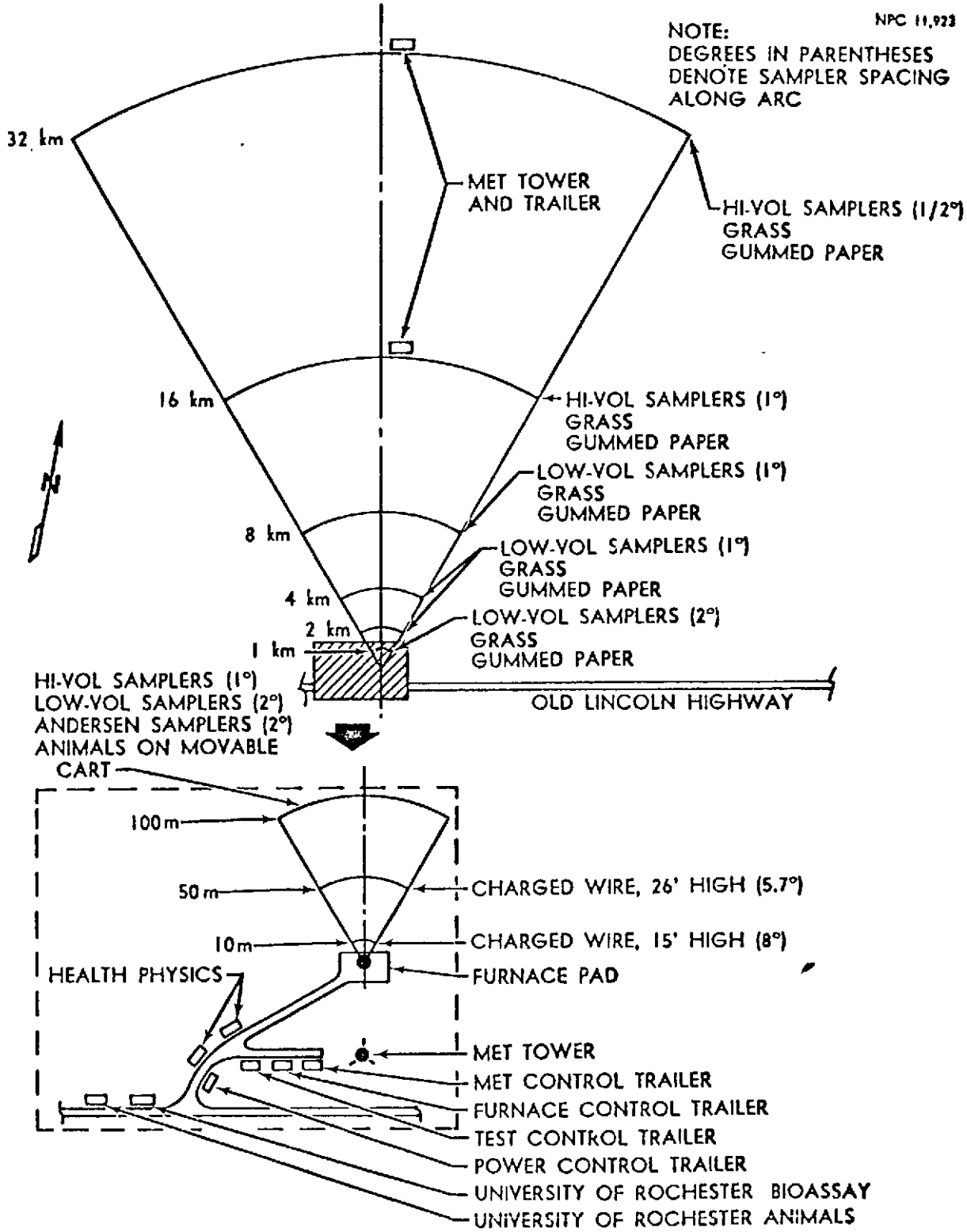

FIGURE 5. SAMPLING-NETWORK INSTRUMENTATION

Electrical power for the operation of the sampling network was provided by 257 gasoline- and diesel-powered portable electric generators (Fig. 6).

2.3.1 Radioactivity Deposition Measurements

Deposition measurements were obtained from three collecting media: gummed paper, rye grass, and native soil. These media were utilized over the network in varying patterns and distances from the release point during the eight open-release experiments.

The gummed paper used was the standard adhesive-coated cellulose acetate paper measuring 0.0015 by 13 by 13 inches and being pressure sensitive over a temperature range of 0-65°C. A piece of standard 0.5-inch mesh hardware cloth of the same dimensions, pressed against the sticky side of the paper, held the paper rigid and served to hold the paper in position, face up, in the network. Gummed paper was positioned at ground level at selected sampling stations.

The rye grass was planted and grown indoors in aluminum and paper trays 8 by 6 inches in size, and samples were placed on the test grid at ground level just prior to a release. Native soil samples were collected in plastic bags at various sampling stations following a release.

2.3.2 Radioactivity Dispersal Measurements

Diffusion measurements were made with high- and low-volume air samplers. All samplers were mounted on steel fence posts 1.2 meters

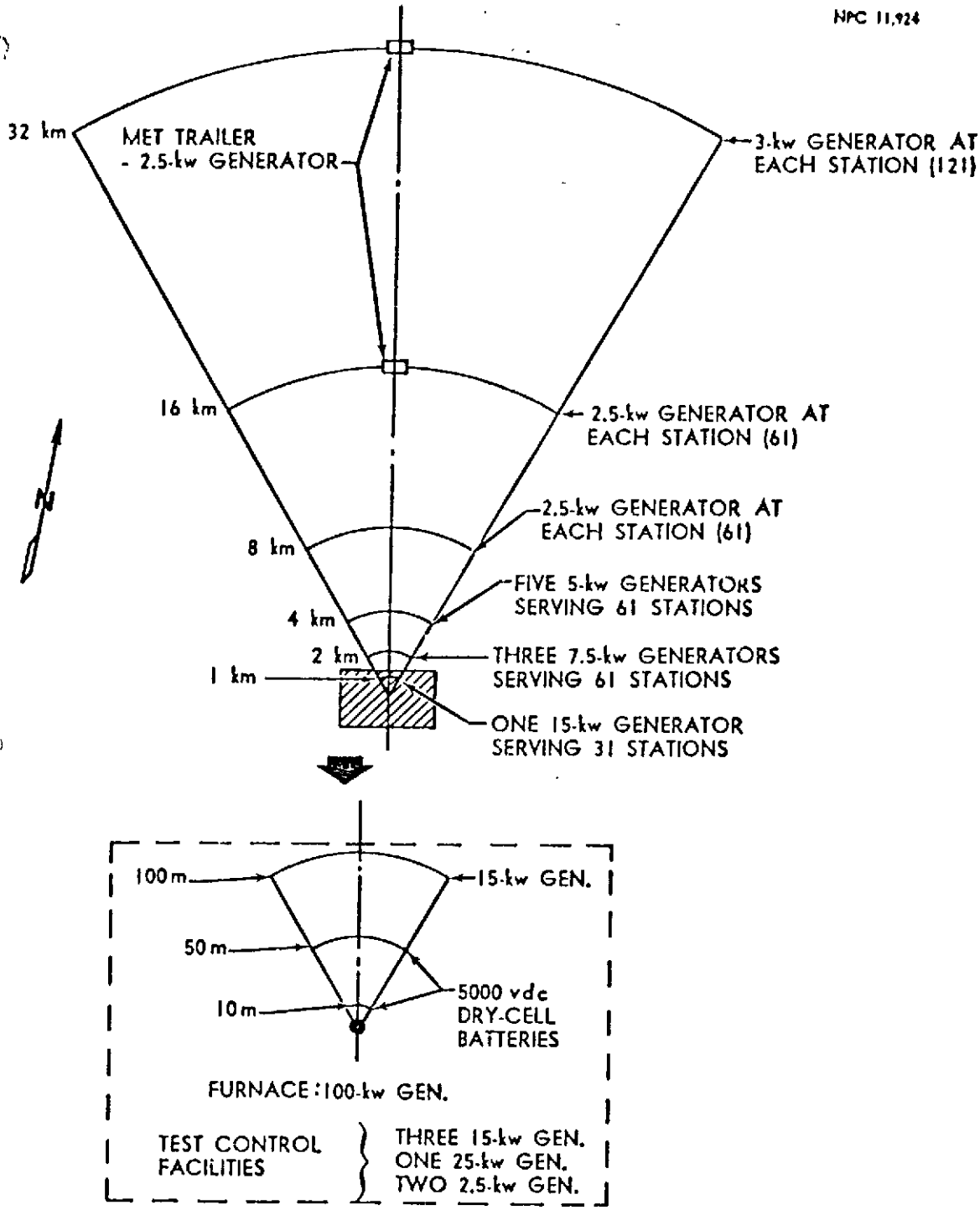

FIGURE 6. POWER-DISTRIBUTION SYSTEM

above the ground. The 16- and 32-kilometer arcs were equipped with Staplex high-volume samplers powered by individual gasoline-engine-driven generators (Fig. 7). The high-volume samplers were equipped with a filter chain consisting of a 4-inch-diameter MSA pleated filter backed by an activated MSA charcoal cannister (Fig. 8). The Staplex unit has a mean flow rate of 19 cfm and a collection efficiency of 99.98% for 0.3-micron-diameter particulates and 100% for gaseous iodine.

The 1-, 2-, 4-, and 8-kilometer arcs were equipped with low-volume samplers using millipore filters backed with activated charcoal cartridges (Fig. 9). The millipore filter is effective in collecting small-diameter particulates, and the activated carbon cartridge is virtually 100% effective in collecting gaseous iodine. Gast pumping units powered by individual engine generator sets were used on the 8-kilometer arc (Fig. 10). The mean flow rate through the filter chain was 3.6 cfm. On the 1-, 2-, and 4-kilometer arcs, where Eglin pumping units powered by large, centrally located engine generators were used, the mean flow rate for the filter chain was 1.5 cfm. A low-volume sampler station using the Eglin pump is shown in Figure 11.

Determination of effective release heights, an important parameter in the atmospheric diffusion equations, was accomplished by the use of a network of vertical charged wires across the 10- and 50-meter arcs (Figs. 12 and 13). Six wires, extending from

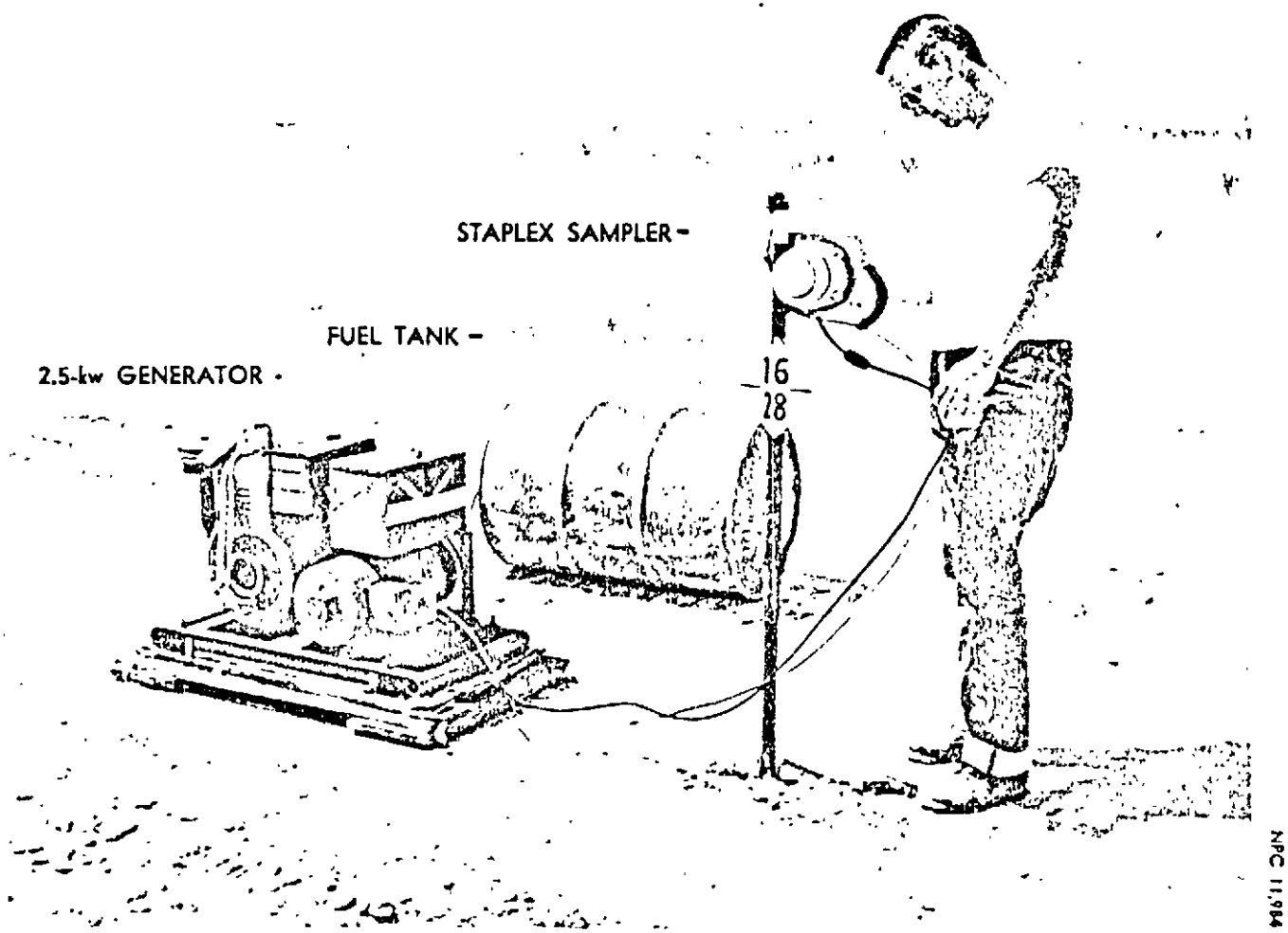

FIGURE 7. HIGH-VOLUME AIR-SAMPLING STATION

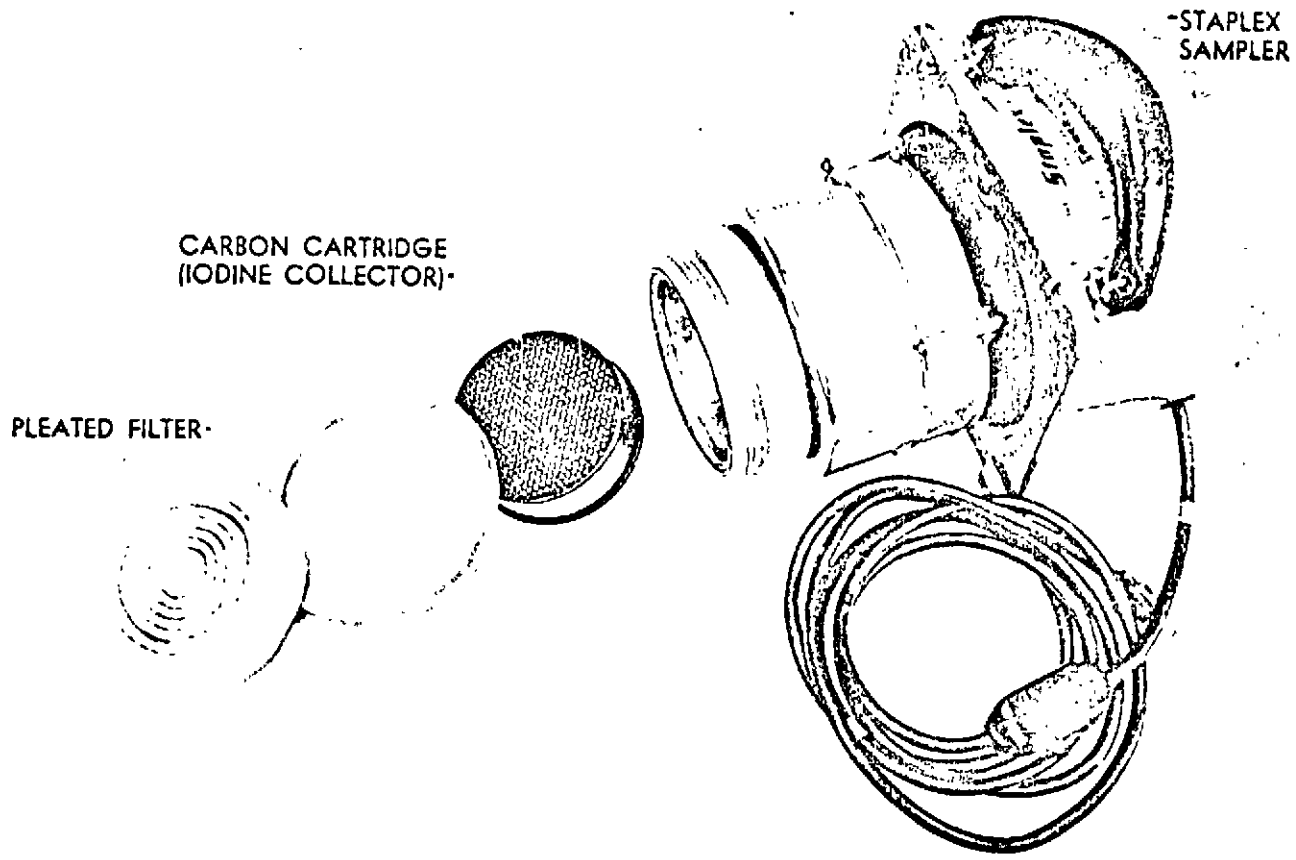

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FIGURE 8. HIGH-VOLUME FILTER CHAIN

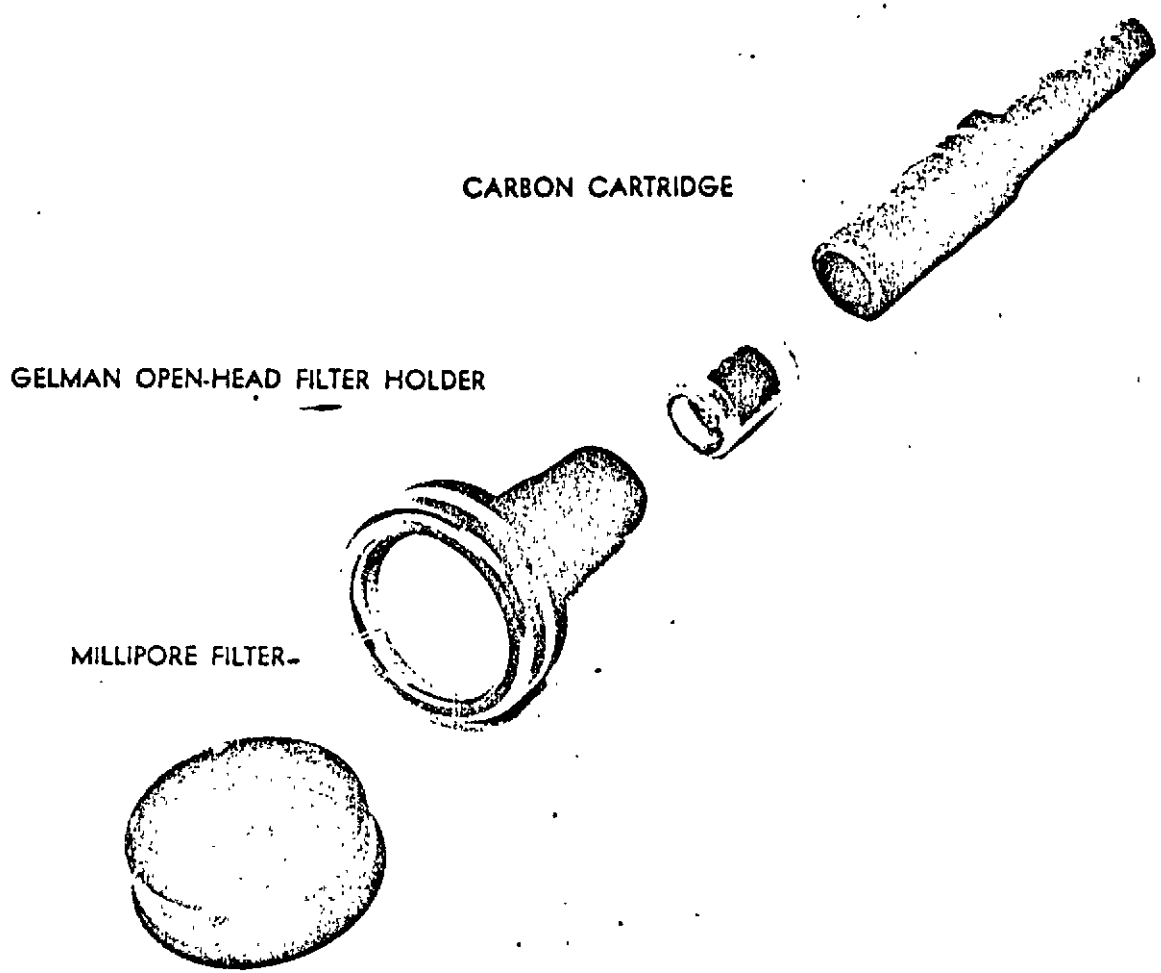

FIGURE 9. LOW-VOLUME FILTER CHAIN

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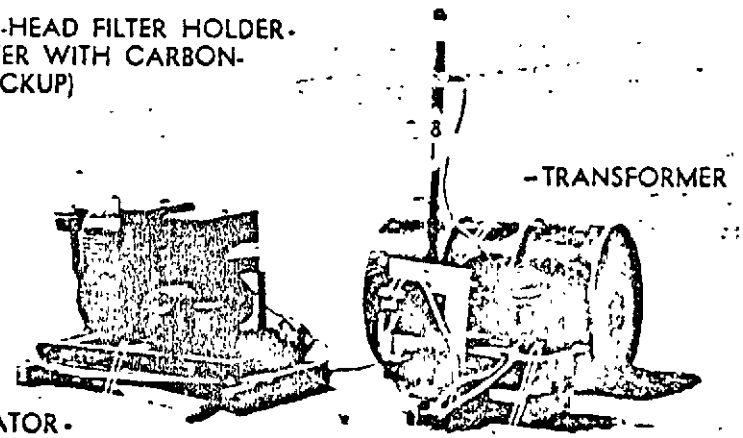

FIGURE 10. LOW-VOLUME AIR-SAMPLING STATION (GAST PUMP)

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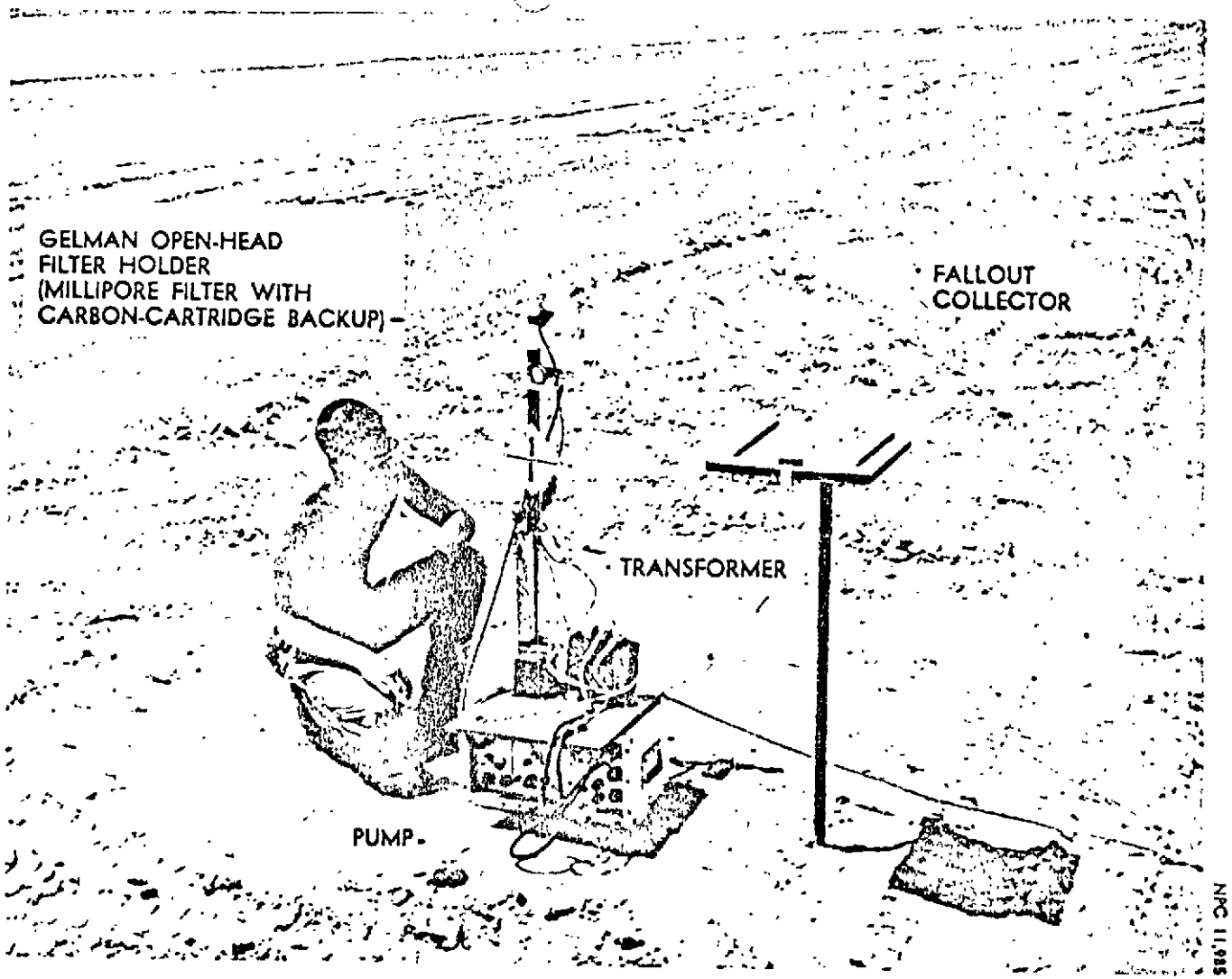

FIGURE 11. LOW-VOLUME AIR-SAMPLING STATION (EGLIN PUMP)

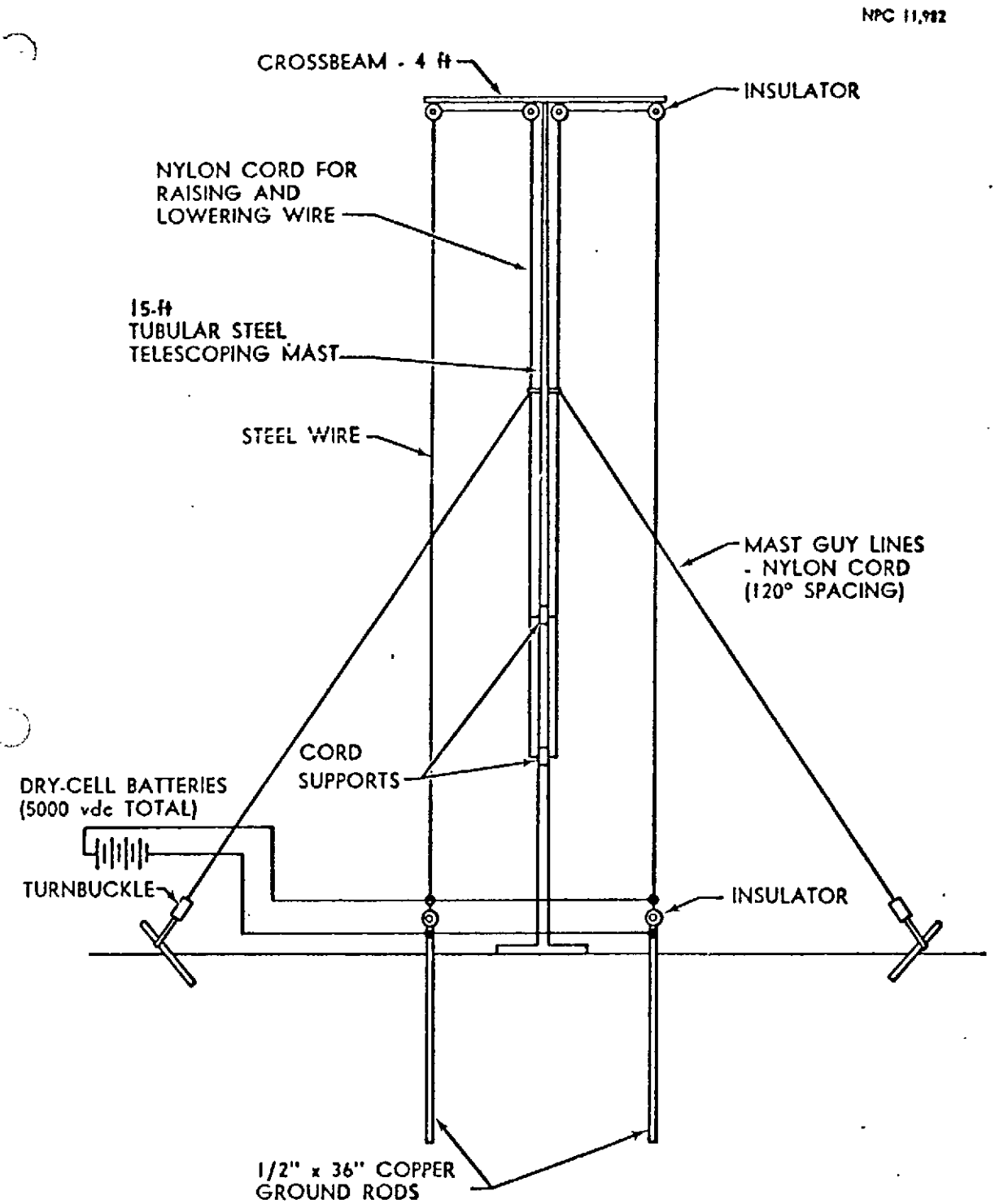

FIGURE 12. CHARGED-WIRE SAMPLER - 10-METER ARC

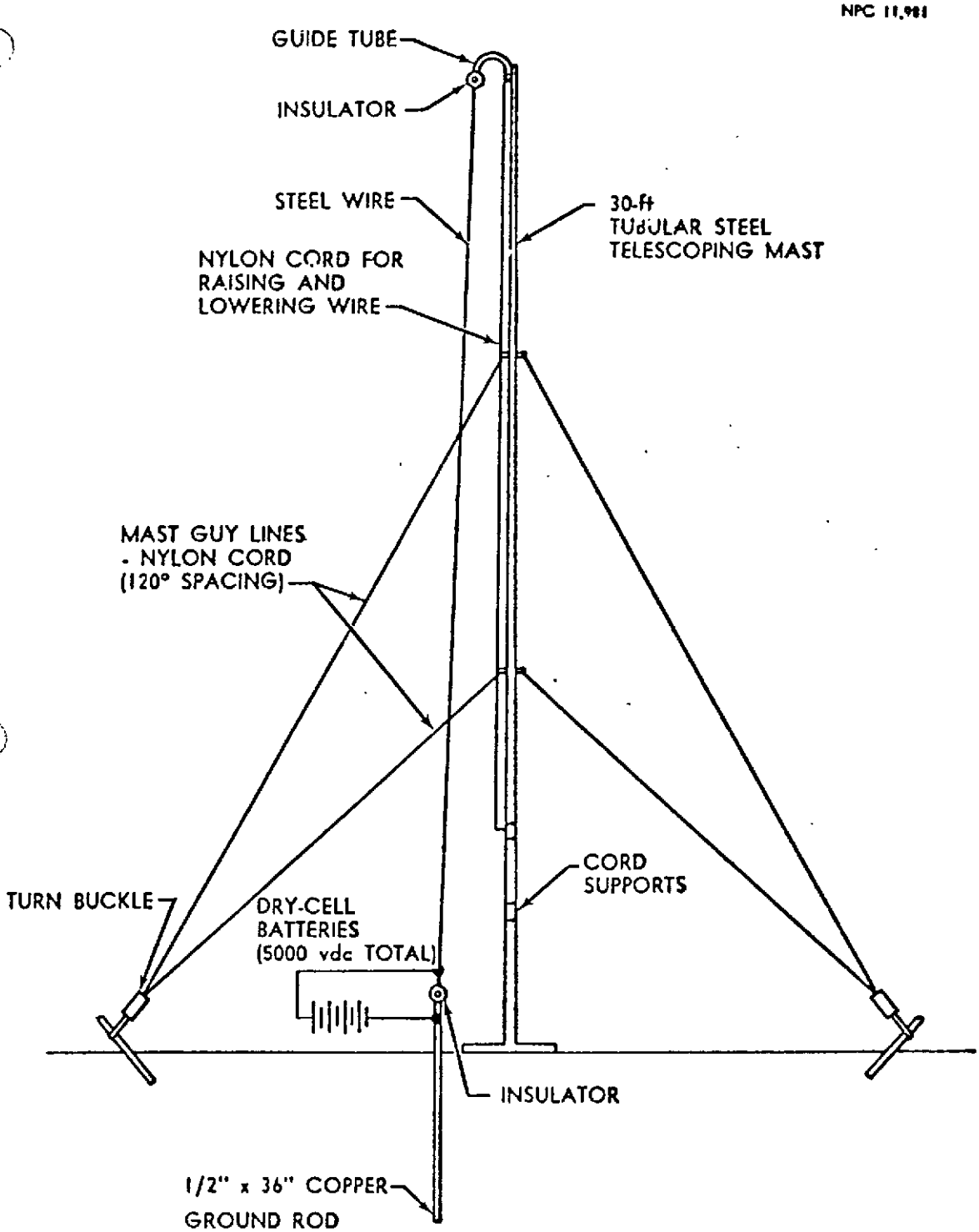

FIGURE 13. CHARGED-WIRE SAMPLER - 50-METER ARC

8 inches above ground level to a height of 12 feet were spaced evenly across the central 40 degrees of the 60-degree, 10-meter arc. Eight wires, extending from 8 inches above ground level to a height of 26 feet, were spaced at equal intervals across the central 40 degrees of the 50-meter arc. The steel wires were charged negatively with 5000 volts by means of dry-cell batteries. After each release, the wires were taped and cut into 6-inch lengths for gamma spectral analysis.

2.3.3 Particle Size Measurements

Six-stage, cascade-type impactors (Andersen) backed up with a filter chain consisting of a millipore filter and charcoal cartridge were used on the 100-meter arc to obtain isotopic particle-size measurements during the final release of the test series (Figs. 14 and 15).

The percentage of iodine in gaseous form was measured by means of the air-sampler filter chains employed on the sampling network during the open releases. The millipore filter, which is 100% effective in collecting particles of 0.1-micron diameter, backed by a carbon cartridge, which is 100% effective in collecting gaseous iodine, was used on the inner arcs. On the outer arcs, pleated filters having a collection efficiency of 99.98% for particles having a mean size of 0.3 microns were used with carbon cannister backup filters.

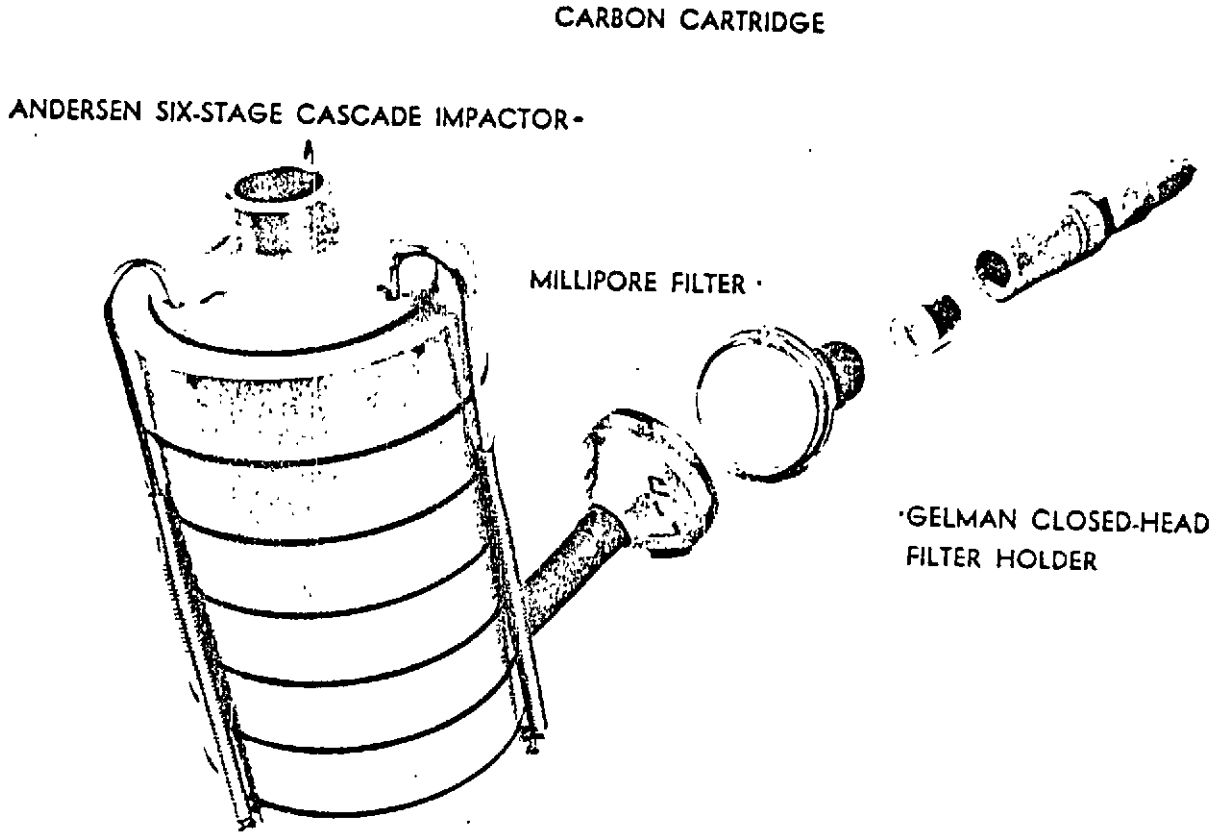

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FIGURE 14. ANDERSEN SAMPLER WITH LOW-VOLUME FILTER CHAIN

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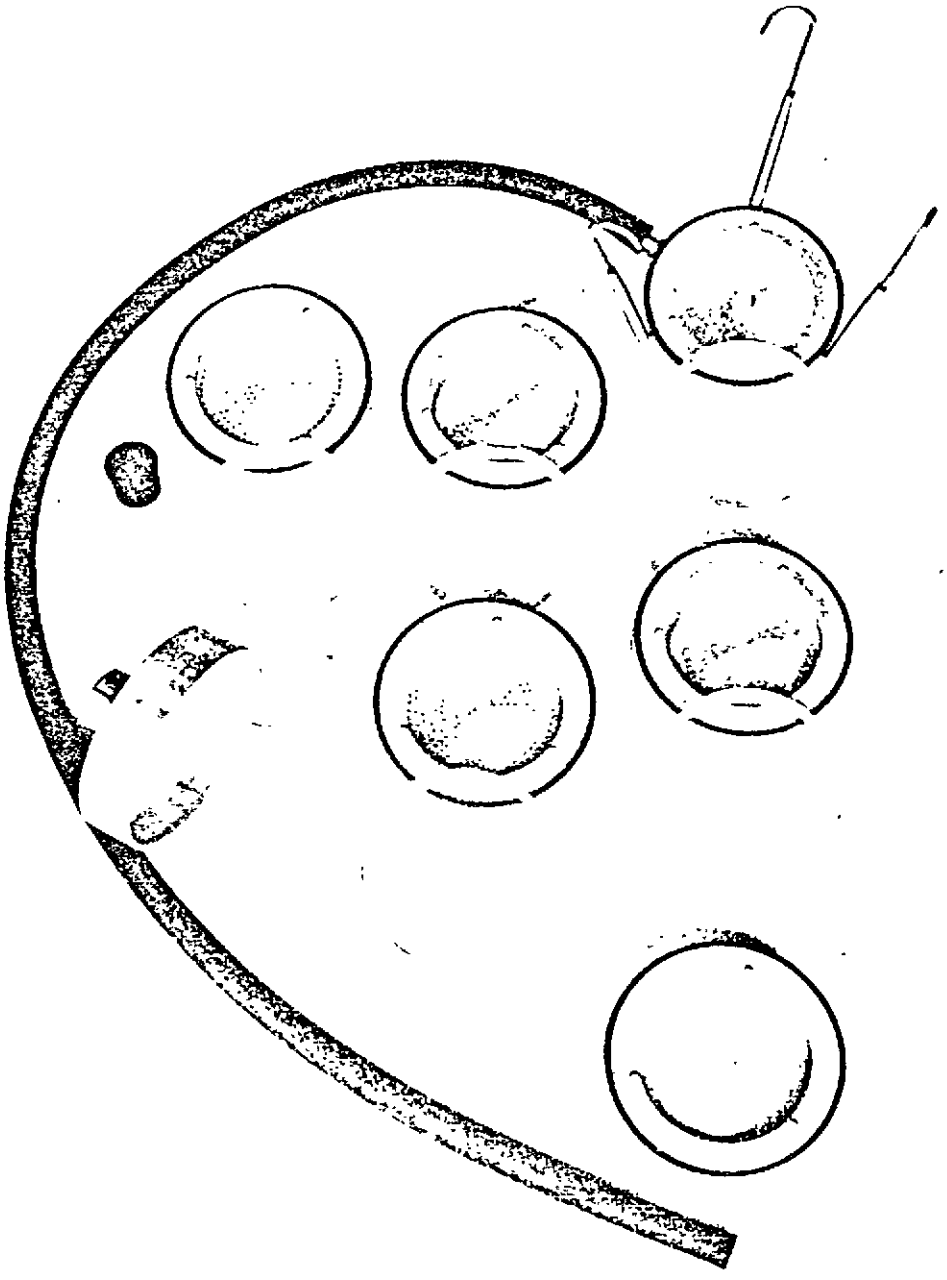

FIGURE 15. DISMANTLED ANDERSEN SAMPLER

2.3.4 Release Percent Measurements

Four methods were applied to determine isotopic release percents: (1) contained releases, (2) fractional sampling of atmospheric releases, (3) integrated horizontal and vertical distributions of isotopic activity collected by charged wires, and (4) crosswind integrals from low- and high-volume air samplers.

The contained releases, in which 100% of the effluent was collected by a means of specially designed total effluent collector (Figs. 16 and 17) and quantitatively analyzed, permitted direct and precise measurement of isotopic release percent.

Direct fractional sampling of the effluent from inside the crucible during the atmospheric releases was accomplished by means of a sniffer tube and filter chain assembly (Appendix A).

2.4 Meteorological Program

2.4.1 Instrumentation

A layout of the meteorological stations is shown in Figure 18. Further details of the micrometeorological system are presented in Table 1. Wind direction, velocity, and temperature profiles were recorded at each of the 110-foot meteorological towers (Figs. 19 and 20). The 2-kilometer-arc wind data were telemetered to the Apex. Instrumentation for measuring and recording surface pressure, humidity, winds aloft, and heat-budget data was located at the Apex station. Upper wind (pibal) stations located at Black Rock, Callao, and Knolls helped to ascertain the air-flow pattern over the grid

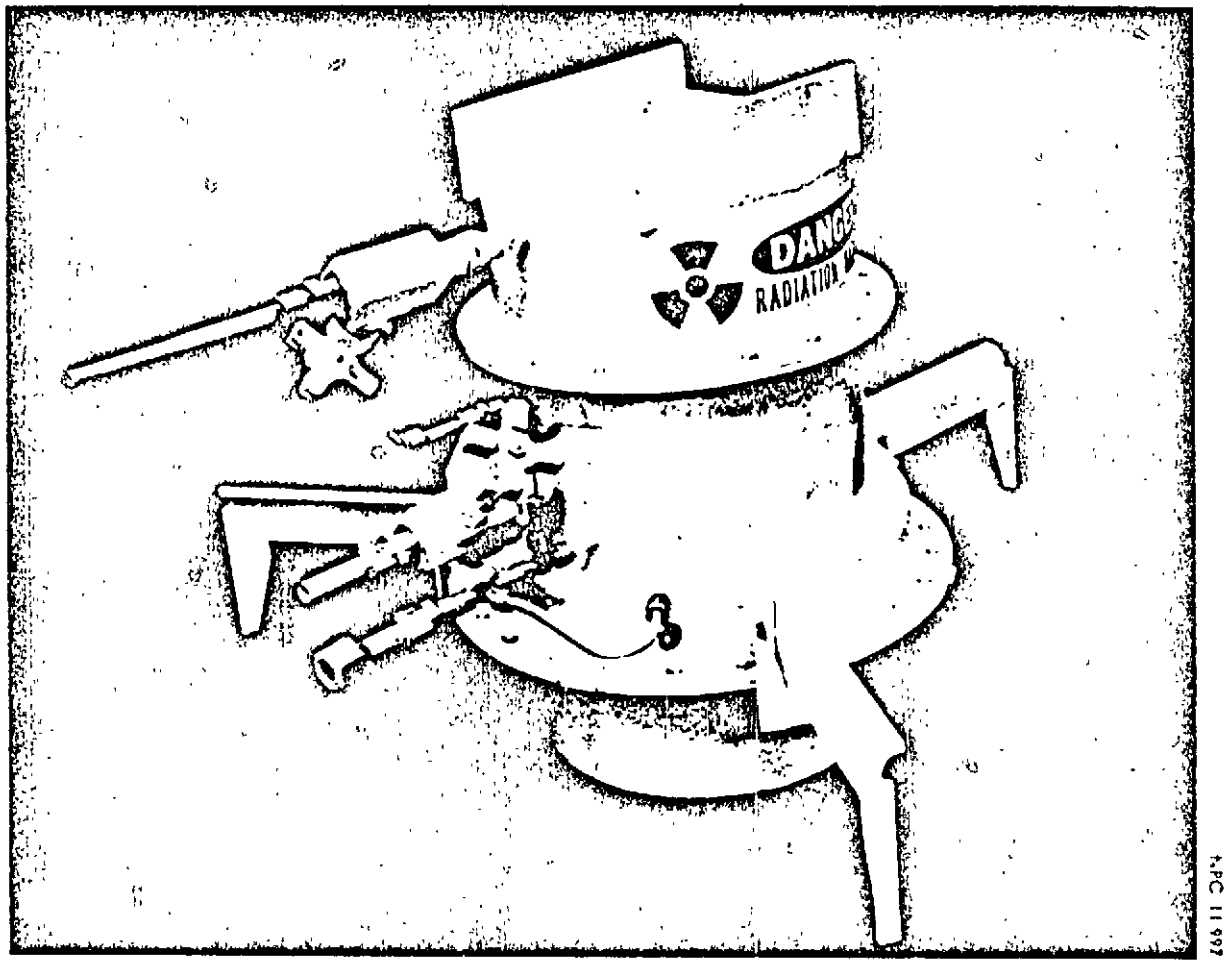

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FIGURE 16. TOTAL EFFLUENT COLLECTOR

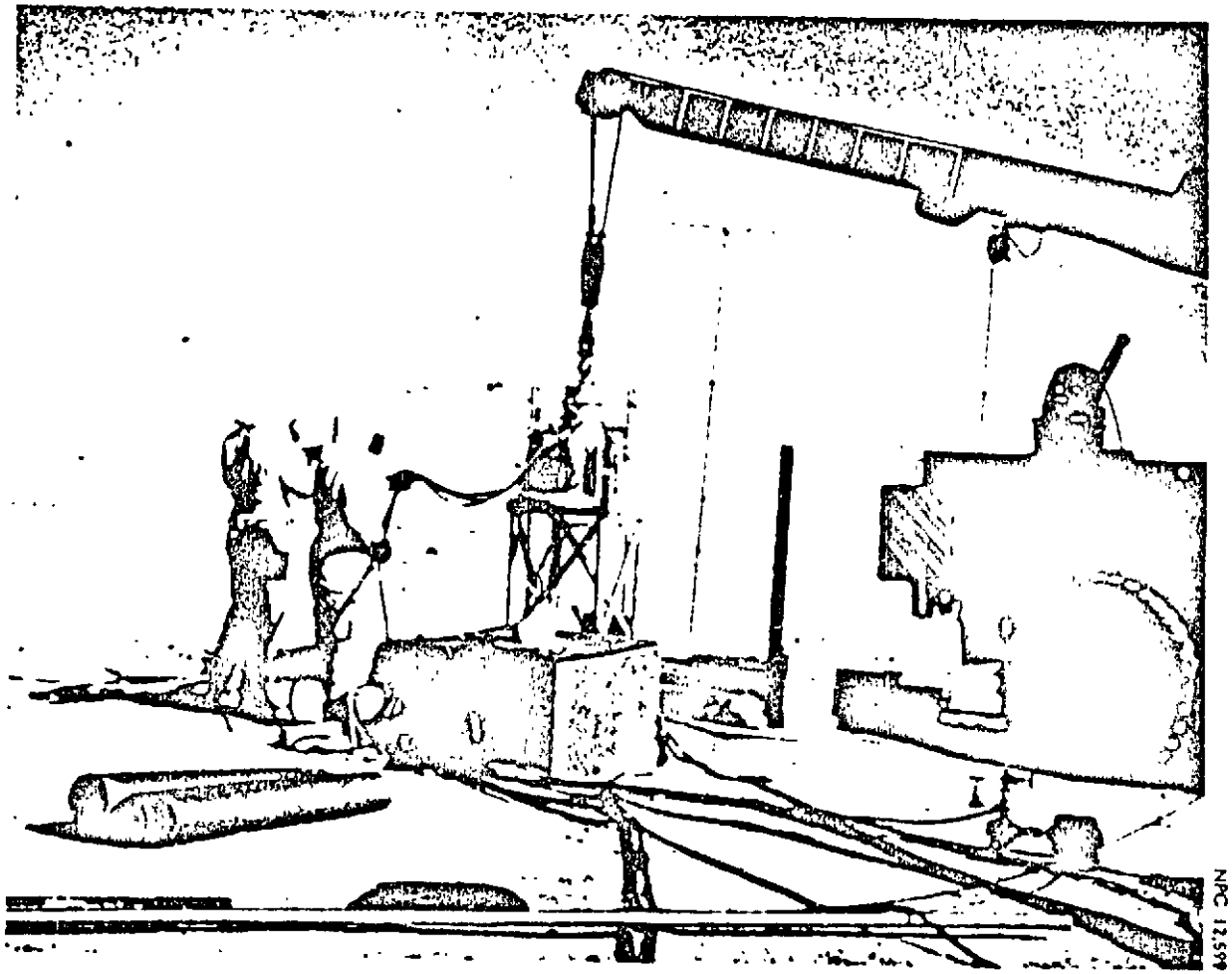

FIGURE 17. TOTAL EFFLUENT COLLECTOR ASSEMBLY BEING INSTALLED ON FURNACE

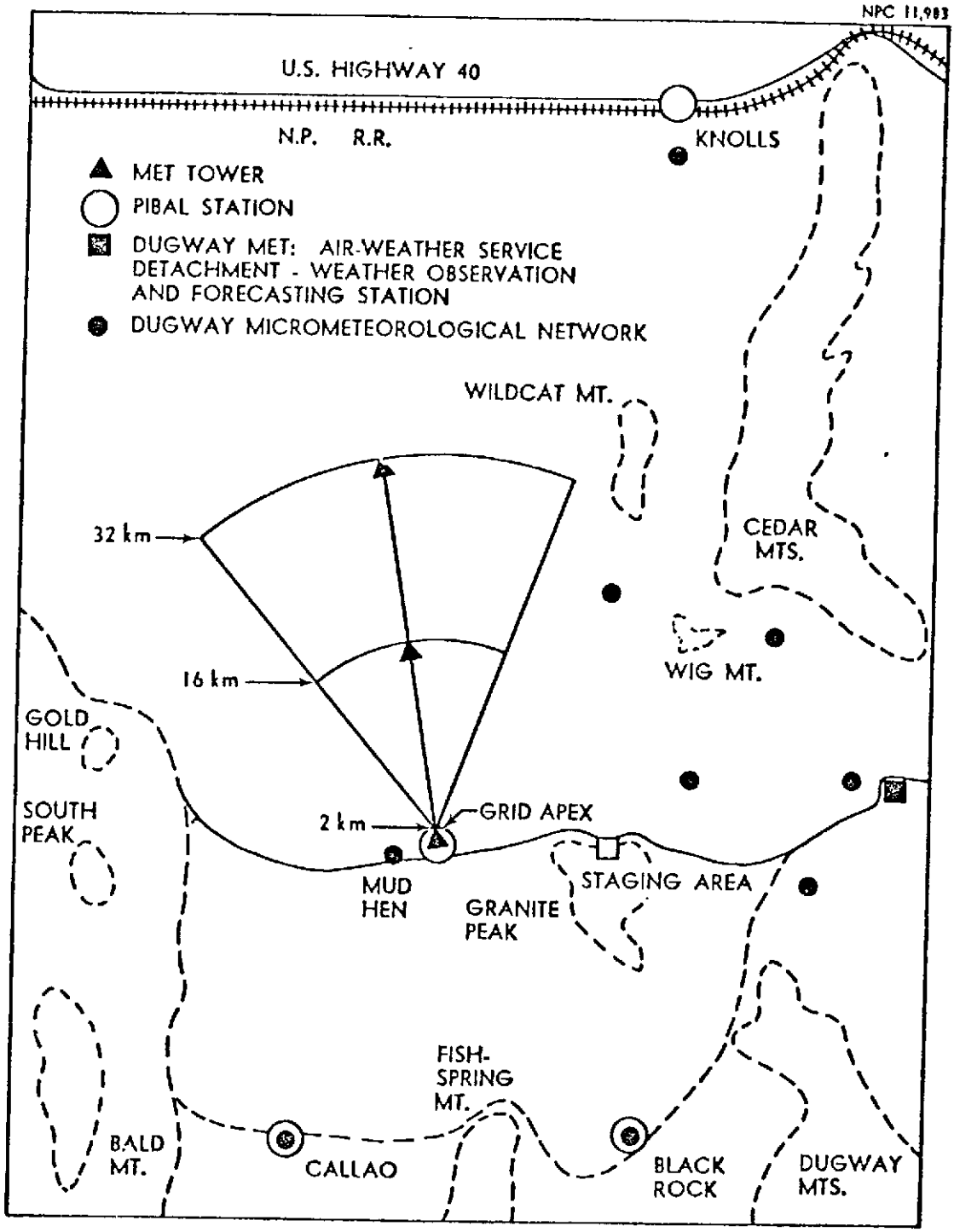

FIGURE 18. METEOROLOGICAL NETWORK LAYOUT

TABLE 1

METEOROLOGICAL INSTRUMENTATION

Measurement	Instrument	Height of Measurement Relative to Ground (meters)			
		100 m Upwind of Grid Apex	2-km-Arc Station	16-km-Arc Station	32-km-Arc Station
Wind Direction	Beckman-Whitley Wind Vanes	32, 16, 2	2	32, 16, 2	32, 16, 2
Wind Velocity	Beckman-Whitley Anemometers	32, 16, 8, 4, 2, 1	Not Measured	32, 16, 8, 4, 2, 1	32, 16, 8, 4, 2, 1
Temperature	Aspirated Thermocouples	32, 16, 8, 4, 2, 1, 0.5, 0.25, 0, -0.03, -1	2	32, 16, 8, 4, 2, 1, 0.5, 0.25, -0.03, -0.06, -0.12, -1	32, 16, 8, 4, 2, 1, 0.5, 0.25, -0.03, -0.06, -0.12, -1
Heat Exchange	Gier and Dunkle Net Radiometers; Soil Heat Plate; Eppley Upright and Inverted Pyrheliometers.	Surface	Not Measured	Not Measured	Not Measured
Surface Pressure, Humidity and Temperature	Barograph, Psychrometer, and Hygrothermograph.	Surface	Not Measured	Not Measured	Not Measured

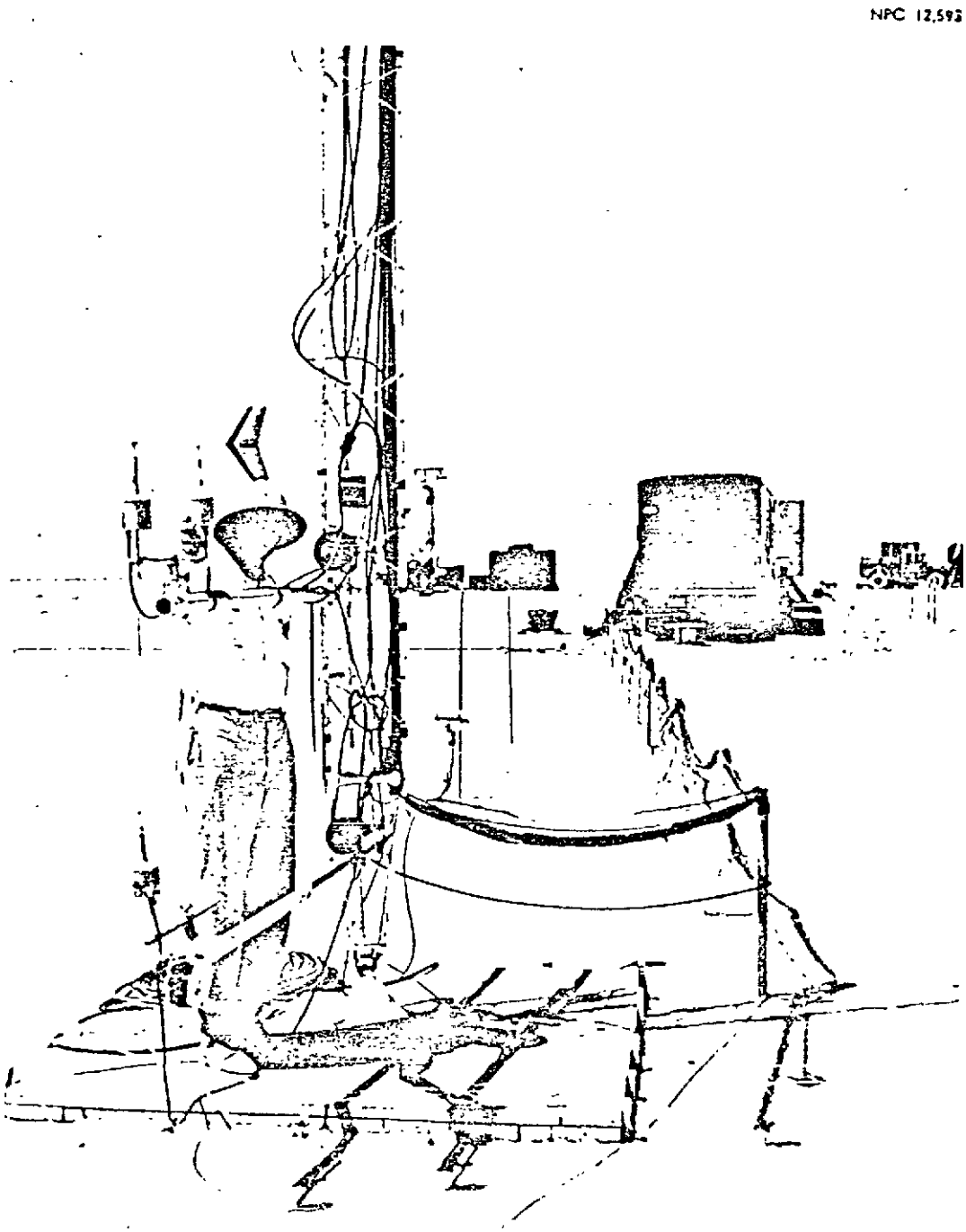

FIGURE 20. METEOROLOGICAL-TOWER INSTRUMENTATION

and to provide information which would assist in forecasting when a release could be made.

2.4.2 Operations

Special briefings on general weather conditions and 30-hour outlook forecasts were furnished by the Dugway USAF Weather Detachment. Each afternoon a general forecast was provided for the following day to determine whether a release could be made. Each morning a detailed weather briefing applicable to the test site was given by the Air Force Forecast Service. A final forecast was furnished at four o'clock each day. If conditions appeared favorable for a release, pibal teams were directed to go to assigned stations. Communications between the test network stations and the Forecast Center were maintained by radio and telephone. During a release, the wind and temperature instruments were closely monitored at network meteorological stations to estimate the cloud trajectory over the test site. The pibal observations and tower measurements continued until it was certain the radioactive cloud had passed the 32-kilometer arc. All measurements were recorded for subsequent analysis.

III. RESULTS AND DISCUSSION

3.1 Fission-Products Source

The sources for the eleven releases of the FRT-II series were segments of metallic-type nuclear-aircraft fuel elements. Each sample contained between 55 and 63 grams of U^{235} and was irradiated in the Materials Testing Reactor (MTR) at NRTS. Each sample was subjected to a slow meltdown and held in the molten state for approximately 10 minutes. A forced airflow was maintained around the sample to assure the escape of all released fission products. These conditions were designed to simulate a reactor core meltdown and produce upper limits of release percents.

The irradiation of the fuel-element samples produced an inventory of isotopes which, because of their high yield fractions, long half lives, energetic decay, and selective body-organ uptake, are biologically significant. These isotopes include I^{131}, Cs^{137}, Ru^{103}, Sr^{90}, Sr^{89}, Zr^{95}, Te^{127m}, Te^{129m}, Ba^{140}, Ce^{141}, and Ce^{144}.

The prerelease inventories of fission products were computed by an IBM-704 program. Nuclear yield fractions and half lives were taken from the literature and used with the irradiation history to obtain the computed inventories (Table 2). Aluminum-uranium wires exposed in each sample during irradiation made it possible to correct for the effects of flux depression and to obtain the necessary average flux value for each release.

TABLE 2

COMPUTED FISSION PRODUCTS INVENTORIES

(curies at time of release)

Release	I^{131}	Cs^{137}	Ru^{103}	Zr^{95}	Sr^{90}	Sr^{89}	Te^{127m}	Te^{129m}	Ce^{141}	Ce^{144}	Ba^{140}
1	42	0.35	33	53	0.37	45	1.6	13	72	11	103
2	27	0.41	33	55	0.41	46	1.6	13	73	13	84
3	16	0.41	33	58	0.46	48	1.7	13	64	13	61
4	12	0.41	31	55	0.46	45	1.7	12	60	13	50
5	8.3	0.48	28	52	0.46	42	1.6	10	61	15	42
6	0.52	0.36	14	30	0.37	23	1.0	4.4	25	11	6.7
7	3.6	0.38	25	48	0.46	38	1.5	8.9	41	12	23
8	16	0.45	45	78	0.63	64	2.4	17	68	14	63
9	11	0.65	38	70	0.63	57	2.2	14	82	20	55
10	2.4	0.51	30	60	0.63	47	2.0	10	46	16	20
11	2.4	0.57	29	59	0.63	46	1.9	9.8	51	17	21

The computed inventories were experimentally checked by analyzing the prerelease segments of each sample for Zr^{95}, Cs^{137}, and Ce^{144}. There was considerable spread in the ratios (Table 3) of the computed to measured inventories (0.77 to 2.15), the average ratio being 1.38.

3.2 Meltdown Release of Fission Products

The furnace melting conditions (Table 4) for the release of fission products were measured to investigate their effects on release percents (Appendix B). Although the resulting data points were widely scattered, the trend, in general, was that of increasing percents with furnace temperature, time held at melt (molten state), and total energy input. Of all the data correlated, iodine data were most indicative of this trend.

The release sequence of the various isotopes was measured for Release 1 and compared with the measured FRT-I release sequence. During FRT I, cesium became saturated in about 13 minutes, after which no more was released. In FRT II (Fig. 21), it was released for approximately 20 minutes, although about 95% of that released had been released within 13 minutes (the time held in molten state).

TABLE 3

COMPARISON OF MEASURED AND COMPUTED INVENTORIES
(Curies at time of release)

Release	Cs^{137}			Zr^{95}-Nb^{95}			Ce^{144}		
	Computed	Measured	Ratio	Computed	Measured	Ratio	Computed	Measured	Ratio
1	0.348	0.294	1.19	47.5	37.9	1.25	11.5	10.2	1.13
2	0.410	0.271	1.51	51.9	40.9	1.28	13.4	10.4	1.29
3	0.407	0.189	2.15	48.3	23.6	2.04	13.1	6.57	1.99
4	0.424	0.285	1.49	47.3	37.4	1.26	13.2	10.0	1.32
5	0.478	0.570	0.84	51.0	65.9	0.77	14.9	17.6	0.85
6	0.364	0.281	1.30	28.3	26.2	1.08	10.6	9.77	1.09
7	0.376	0.280	1.34	37.2	25.1	1.48	11.6	9.18	1.28
8	0.443	0.276	1.63	52.7	37.9	1.39	14.4	9.86	1.46
9	0.652	0.399	1.63	69.0	43.3	1.59	20.4	13.2	1.55
10	0.512	0.313	1.64	46.2	27.8	1.66	15.5	9.63	1.61
11	0.571	0.466	1.23	50.9	44.6	1.14	17.3	14.9	1.16

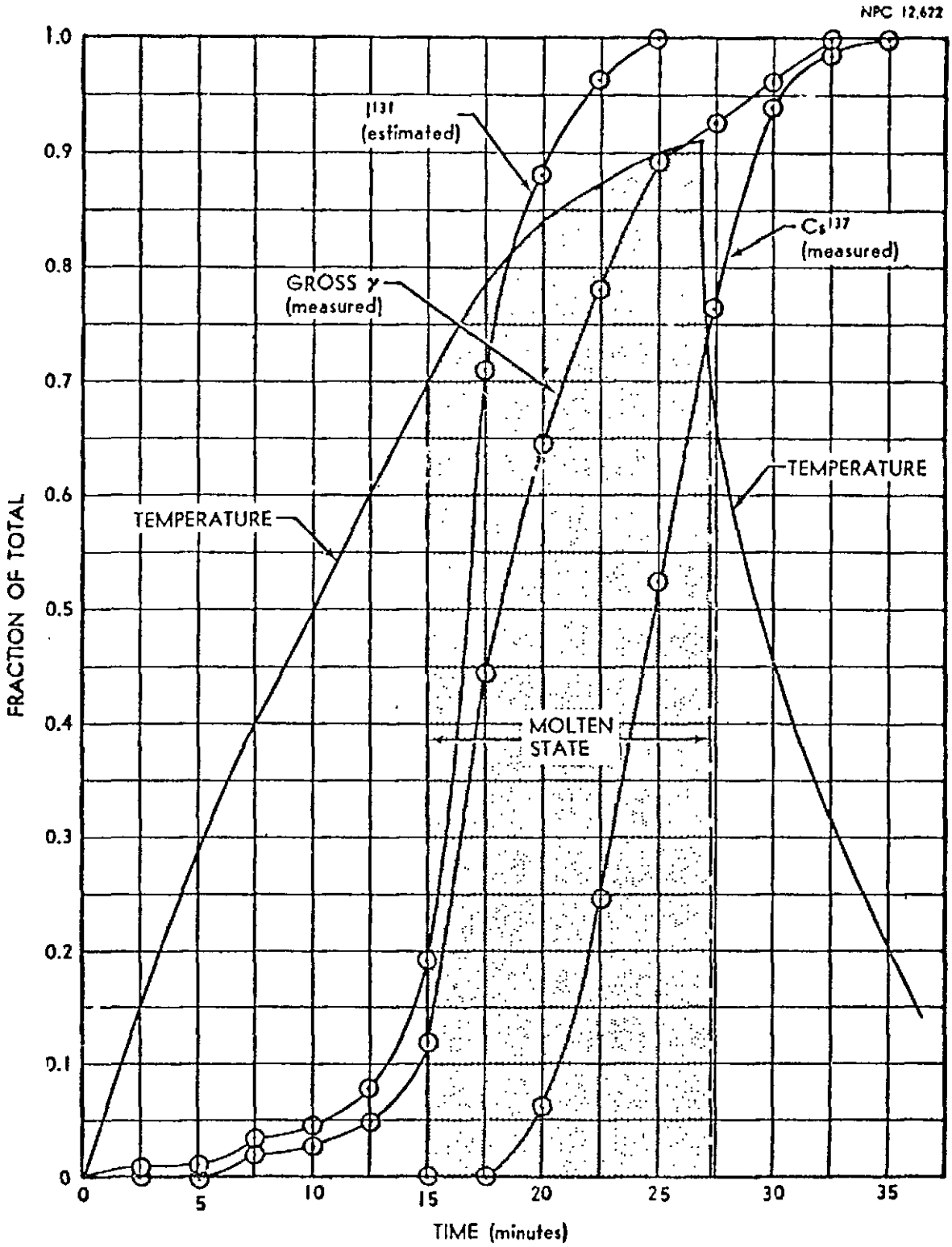

FIGURE 21. FISSION-PRODUCTS RELEASE SEQUENCE

TABLE 4

FURNACE MELTING CONDITIONS

Release	Maximum Temperature* (arb.units)	Time to Reach Melt (min)	Time Held at Melt (min)	Energy Input (kw-hr)
1	9.2	15	13	15.4
2	9.0	15	13	14.3
3	9.7	15	16	16.6
4	8.95	14.5	10.5	13.7
5	9.4	- -	- -	16.0
6	9.7	15	17.2	17.6
7	9.45	15	16.7	17.3
8	9.0	- -	- -	13.7
9	9.6	- -	- -	17.2
10	10.0	21	19.5	20.2
11	9.2	- -	- -	14.9

*Melt temperature = $\sim$ 7 arbitrary units

The iodine behaved somewhat differently. It began coming off almost immediately after the furnace power was applied; by the time the sample melted, 20% of the total iodine released had been given off. Essentially all iodine was released in approximately 10 minutes, compared to 5 minutes during FRT I.

In analyzing the FRT-II field samples, a nonfission-product element was detected and identified as a product of $Ni^{58}(n,p)Co^{58}$ activation of Ni^{58}. The activity was present in sufficient quantity to merit concern; in fact, on Release 8 the network Co^{58} activity roughly equalled the Zr^{95}-Nb^{95} activity.

MEASURED ELEMENT RELEASE PERCENTS
FROM ANP METALLIC-TYPE FUEL ELEMENTS

Element	Total Collection	Fractional Sampling*	Total and Fractional	Network Arc Integrals	Charged Wire Integrals	FRT I
Iodine	24 ± 13 [6]	15 ± 11 [13]	16 ± 11 [19]	24**	24**	44 [1]
Cesium	5.7 ± 3.8 [3]	36 ± 34 [8]	28 ± 32 [11]	13 ± 7 [33]	21 [12]	55 ± 19
Ruthenium	0.09 ± 0.10 [3]	0.64 ± 0.98 [8]	0.49 ± 1 [11]	0.70 ± 0.60 [33]	1.5 [12]	0.73 ± 0.16 [4]
Strontium	0.0090 ± 0.0095 [3]	0.011 ± 0.021 [8]	0.010 ± 0.018 [11]	--	--	0.71 ± 0.61 [5]
Cerium	0.0094 ± 0.0071 [6]	0.057 ± 0.051 [3]	0.025 ± 0.035 [9]	--	--	0.10 ± 0.16 [37]
Barium-Lanthanum	0.021 ± 0.019 [3]	0.013 ± 0.020 [8]	0.015 ± 0.019 [11]	--	--	--
Uranium	0.0093 ± 0.0074 [3]	0.10 ± 0.12 [5]	0.076 ± 0.109 [7]	--	--	--
Tellurium	--	--	--	0.44 ± 0.23 [2]	--	--
Zirconium	--	--	--	--	0.0012	0.073 ± 0.13 [3]
Gross Gamma	--	--	--	--	--	31 ± 21*** [3]

* 0.07 – 0.46%
** Normalized to a 24% I^{131} release
*** For aged fuel elements
[ ] Number of determinations

3.2.1 Isotopic Release Percents

Four methods were used in determining isotopic release percents: (1) total collection of the effluent, (2) fractional sampling of the effluent, (3) normalization of network arc integrals, and (4) two-dimensional charged-wire integrals. On three releases, 100% of the furnace effluent was contained and analyzed to give the most accurate release percents. Release-percent measurements obtained by the various methods are compared with FRT-I results in Table 5.

Estimates obtained from charged-wire data allow for differences in isotopic source heights. The release percents based on charged-wire data from the 10- and 50-meter arcs are given in Table 6.

TABLE 6

AVERAGE ISOTOPIC RELEASE PERCENTS BASED ON CHARGED WIRE PROFILES
(normalized to I^{131} = 24%)

Isotope	10-Meter Arc (range)	50-Meter Arc (range)
Zr^{95}-Nb^{95}	0.0009 (0.00005-0.0022)	0.0014 (0.0001-0.0022)
Cs^{137}	24 (8-57)	18 (2.3-65)
Ru^{103}	1.8 (0.15-3.7)	1.2 (0.26-3.4)
I^{131}	24	24

Since these release percents correct for the difference in vertical diffusion of the isotopes, one would expect them to be more accurate than those based on network arc profiles. However,

low-volume air-sampler data obtained on the 10-meter arc during Release 3 indicated that the relative isotopic collection efficiency of charged wires for the various isotopes were: 1 for I^{131}, 2 for Ru^{103}, 3 for Cs^{137}, and 200 for Zr^{95}-Nb^{95}. The release percents shown in Table 6 were calculated on the assumption that these efficiencies held for other arcs and other releases. These differences in collection efficiencies need to be investigated more thoroughly. Their investigation may lead to a better understanding of the physical form of the radioactive effluent.

3.2.2 Particle Size

Early reactor hazards studies were limited in accuracy because of lack of knowledge about particle sizes. It was necessary to assume that the release effluent separated into aerosol (gas-like) and particulate (effected by gravitational settling) components and to predict their atmospheric dispersal by different means. It was concluded that any particles smaller than 10 microns were gas-like and could be considered as a source term in the aerosol atmospheric diffusion equation.

The field-test results were expected to indicate a more realistic mean and size range. In view of the previously postulated particle size distributions for a reactor meltdown, the Andersen sampler was chosen to determine the size distribution of particles with median diameters of about 7 microns (Appendix C).

The results from the field tests obviate the need to consider the particulate component in hazards studies involving the reactor meltdown. About 85% of all iodine, cesium, and ruthenium particles had a median diameter smaller than 1 micron. These findings are in agreement with the results of Field Release Test I.

By multiplying a reactor inventory by FRT-II release percents, a source term can be derived that may be used directly in atmospheric diffusion equations for calculating the dispersal of fission products for the meltdown case.

3.2.3 Effect of JP4 Smoke

The percent of iodine collected in the final stage of the Andersen sampler ($\leq 1\mu$ diameter) was reduced from 85 to 35% as a result of releasing the furnace effluent into the smoke from a jet-fuel fire. This indicates that 50% or more of the released I^{131} tended to collect on the smoke particles present in the atmosphere and consequently assumed the particle size distribution of the smoke. No significant change was observed in the percent of other isotopes collected.

3.3 Atmospheric Diffusion

3.3.1 Meteorological Conditions

In assessing reactor safety, predictions must be made of downwind air concentrations, which depend on the meteorological conditions existing during the atmospheric dispersal time. There are two basic conditions: lapse, normally occurring during the daytime; and inversion, normally a nocturnal phenomenon. Of these

two, inversion results in the larger air concentration for the greatest distance from the release point and consequently is of more concern.

The FRT-II series consisted of eight moderate-to-strong inversion atmospheric releases in which the meteorological conditions (Table 7) and air concentrations (Appendix E) were measured out to 20 miles.

The release times were between the hours of 2336 and 0735. The average wind direction measured at the release point was within 20 degrees of the centerline. Average wind velocities varied between 2.4 and 4.4 meters per second during the eight releases. Temperature gradients between the 1- and 32-meter levels varied from -1.1 to -6.4°C (Appendix D). The "typical" inversion parameters suggested by Brookhaven National Laboratories (BNL) and used in hazards evaluations are for a temperature gradient of -1°C per 100 meters and a wind velocity of 3 meters per second (Ref. 3).

3.3.2 Fission-Products Release Height

Charged-wire data from the 10- and 50-meter arcs established the effective release heights of I^{131}, Cs^{137}, Ru^{103}, and Zr^{95}-Nb^{95} (Table 8 and Figs. 22 and 23). Arc profiles of isotopic activities at selected charged wire locations are presented in Appendix H.

TABLE 7

SUMMARY OF RELEASE POINT WIND AND THERMAL CONDITIONS

Release No.	Date (Time)	Wind Direction*	Wind Velocity (m/sec)	Inversion** Temperature Gradient (°C.)	Relative Humidity	Pressure (in. Hg)	Comments
1	8-5-59 (0000)	154 (145-166)	5.0 (2.6-7.4)	-2.4 (1.to 32m)	47%	25.52	Clear skies
2	8-10-59 (2336)	183 (172-198)	4.2 (2.8-5.7)	-5.0 (1 to 32m)	37%	25.46	Clear skies
3	9-8-59 (0241)	173 (107-218)	3.2 (1.2-6.2)	-1.6 (1 to 32m)	31%	25.37	Scattered high clouds
4	9-12-59 (0143)	170 (116-225)	2.4 (0.5-7.1)	-3.1 (1 to 32m)	60%	25.70	Partly cloudy
5	9-18-59 (0219)	168 (149-186)	4.4 (2.9-6.1)	-1.1 (1 to 32m)	61%	25.49	Partly cloudy
8	9-30-59 (0207)	150 (139-158)	2.7 (1.5-4.1)	-1.5 (1 to 32m)	62%	25.42	Clear skies
10	10-24-59 (0735)	171 (134-202)	2.6 (0.5-5.0)	-1.3 (1 to 32m)	72%	25.80	Clear skies
11	10-25-59 (0435)	165 (149-191)	4.4 (1.8-7.4)	-6.4 (1 to 32m)	68%	25.80	Clear skies

*Network centerline coincides with wind direction of 170°; the values are 60-minute averages.
**Refer to graphs of temperatures in Appendix D (not a linear profile).

TABLE 8

EFFECTIVE RELEASE HEIGHTS*

Release	Arc	I^{131} (ft)	Cs^{137} (ft)	Ru^{103} (ft)	Zr^{95}-Nb^{95} (ft)
3	10m	5.4	6.2	6.2	--
	50m	2.4	2.4	2.4	--
4	10m	13.2	13.2	13.2	--
	50m	12.2	12.2	12.2	--
8	10m	5.2	6.2	6.2	6.7
	50m	3.7	2.7	4.2	4.7
10	10m	9.2	9.2	9.5	--
	50m	13.2	12.7	13.2	--
11	10m	6.5	5.2	5.2	--
	50m	8.4	5.5	2.5	--

*Furnace height = 7 ft
Sampler height = 3 ft

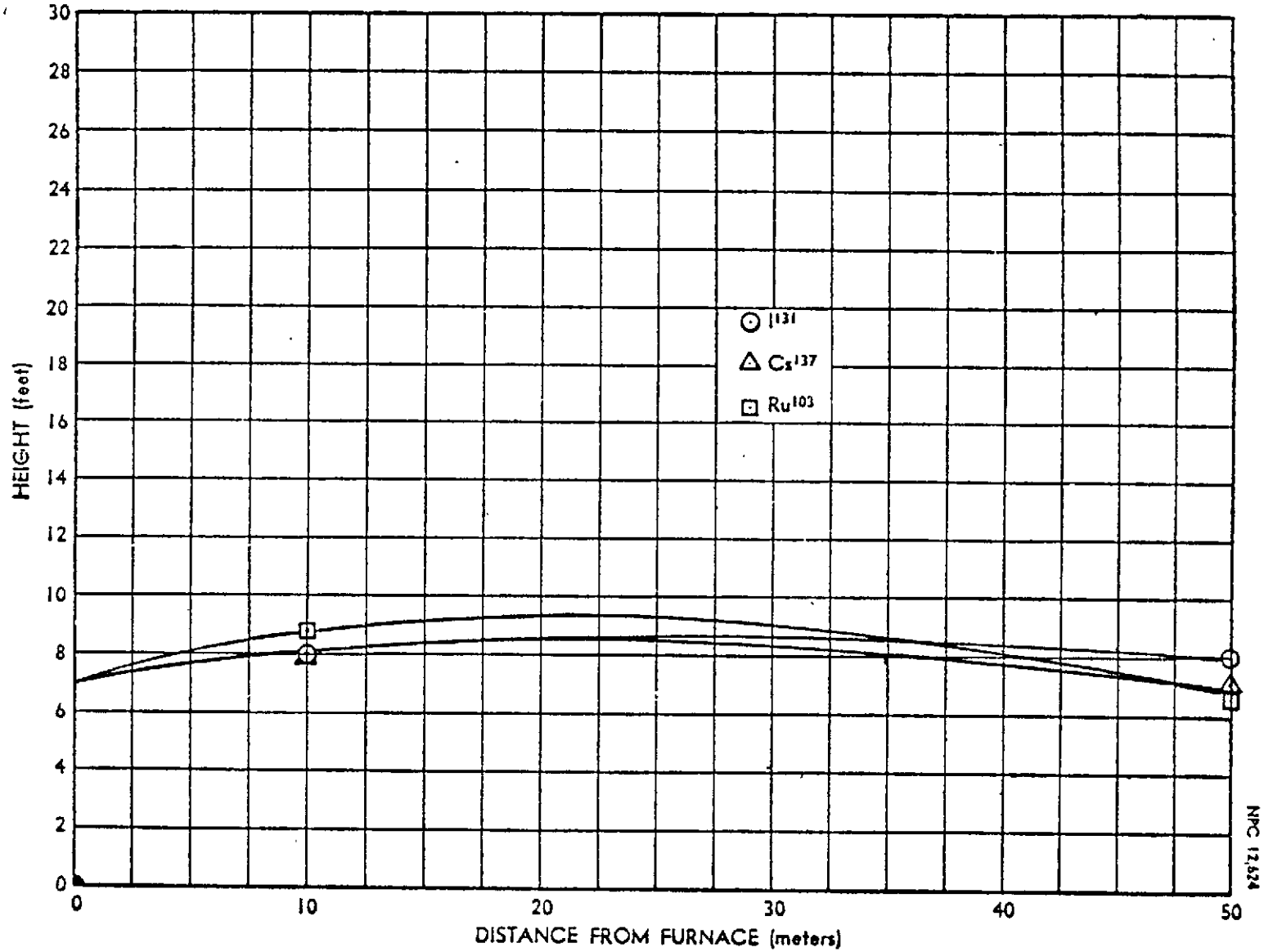

FIGURE 22. AVERAGE EFFECTIVE RELEASE HEIGHTS FOR PROMINENT ISOTOPES (BASED ON CHARGED-WIRE DATA)

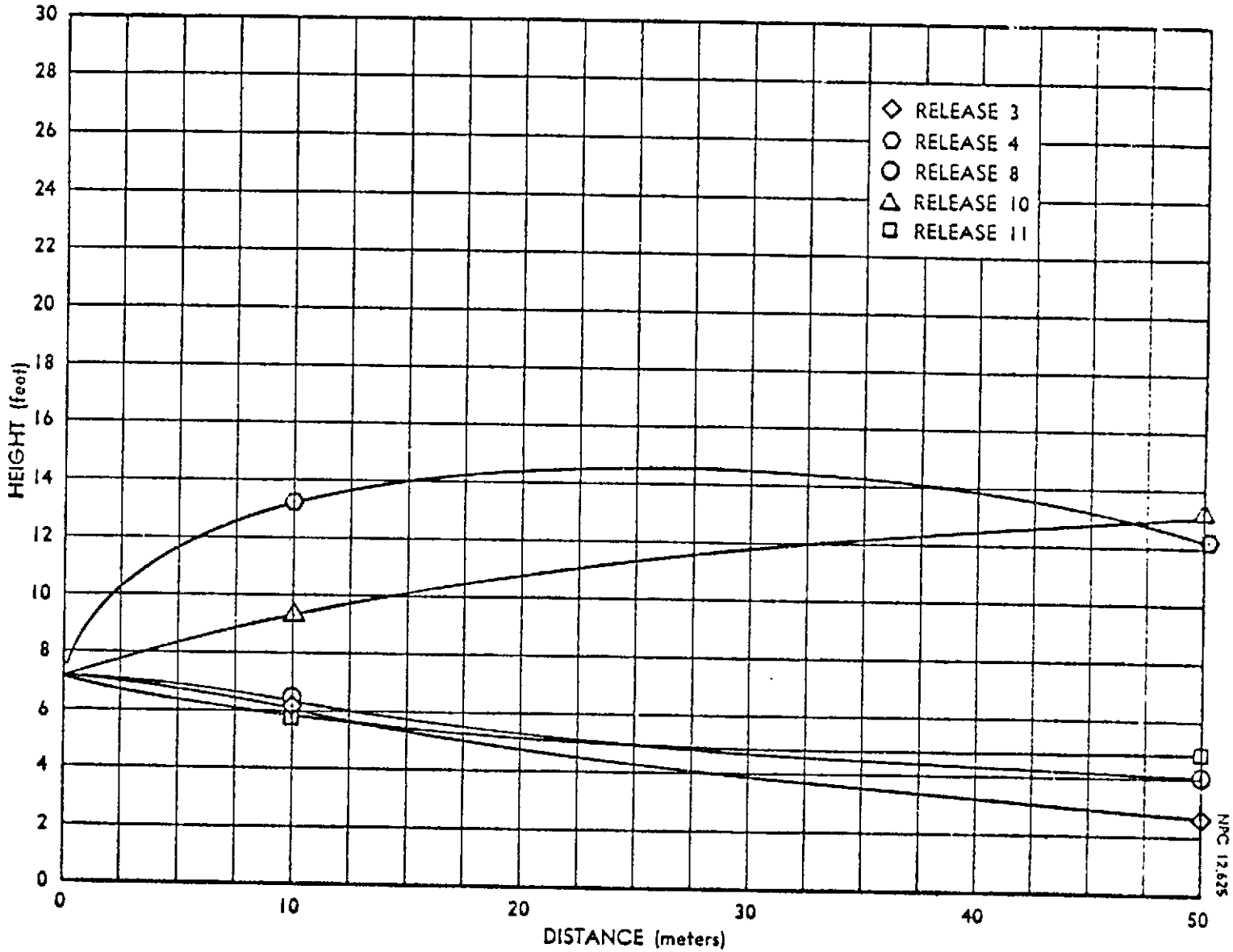

FIGURE 23. AVERAGE HEIGHT OF MAXIMUM ISOTOPIC CONCENTRATIONS (BASED ON CHARGED-WIRE DATA)

3.3.3 Isotopic Air Concentrations

The centerline maximum air concentrations reflect the release isotopic source strengths as well as the actual atmospheric dispersal conditions. These values for I^{131}, Cs^{137}, and Ru^{103} have been plotted to show their decrease with distance (Figs. 24, 25, and 26).

Concentration slopes for Releases 5, 8, and 11 are comparable in steepness to the slopes of lapse release. This anomaly was caused by a faster decrease in concentration beyond five miles due to cloud meandering.

Centerline maximum concentrations were normalized to unit isotopic inventories and wind velocities to compare the measured concentrations with the predicted concentrations (Figs. 27, 28, and 29). The corresponding results from FRT I are added. Predictions were based on the average experimental parameters obtained from fitting the Stanford and Project Prairie Grass SO_2 diffusion data. The decrease in concentration with distance is about as expected. The effect of cloud meandering beyond about 8000 meters is quite apparent. The experimental parameters were effective in predicting measured concentrations.

Separating FRT-I and FRT-II data and normalizing isotopic data to the same predicted centerline concentrations (Figs. 30 and 31) show that the average parameters predicted FRT-I concentrations

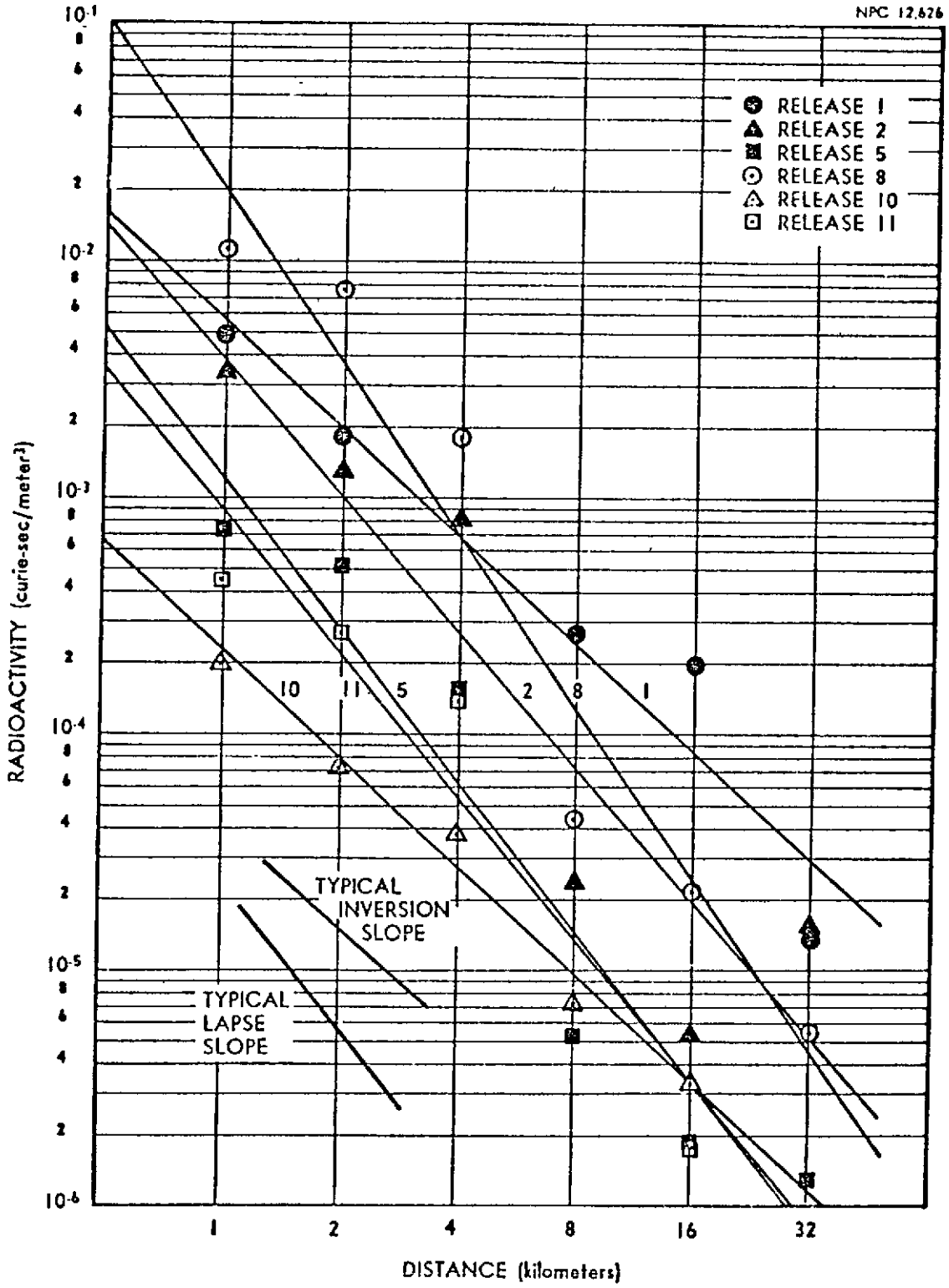

FIGURE 24. MAXIMUM CENTERLINE CONCENTRATION OF IODINE-131

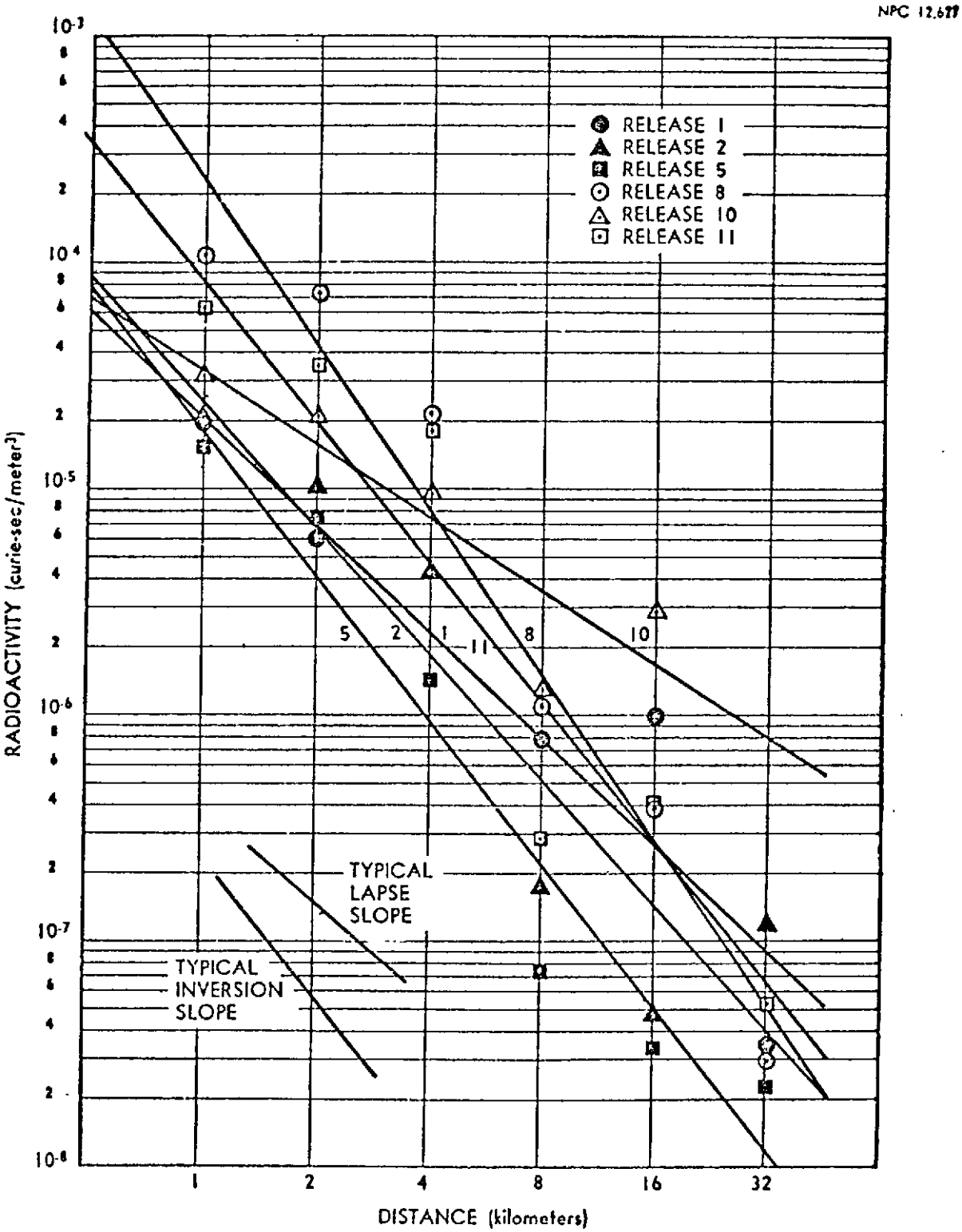

FIGURE 25. MAXIMUM CENTERLINE CONCENTRATION OF CESIUM-137

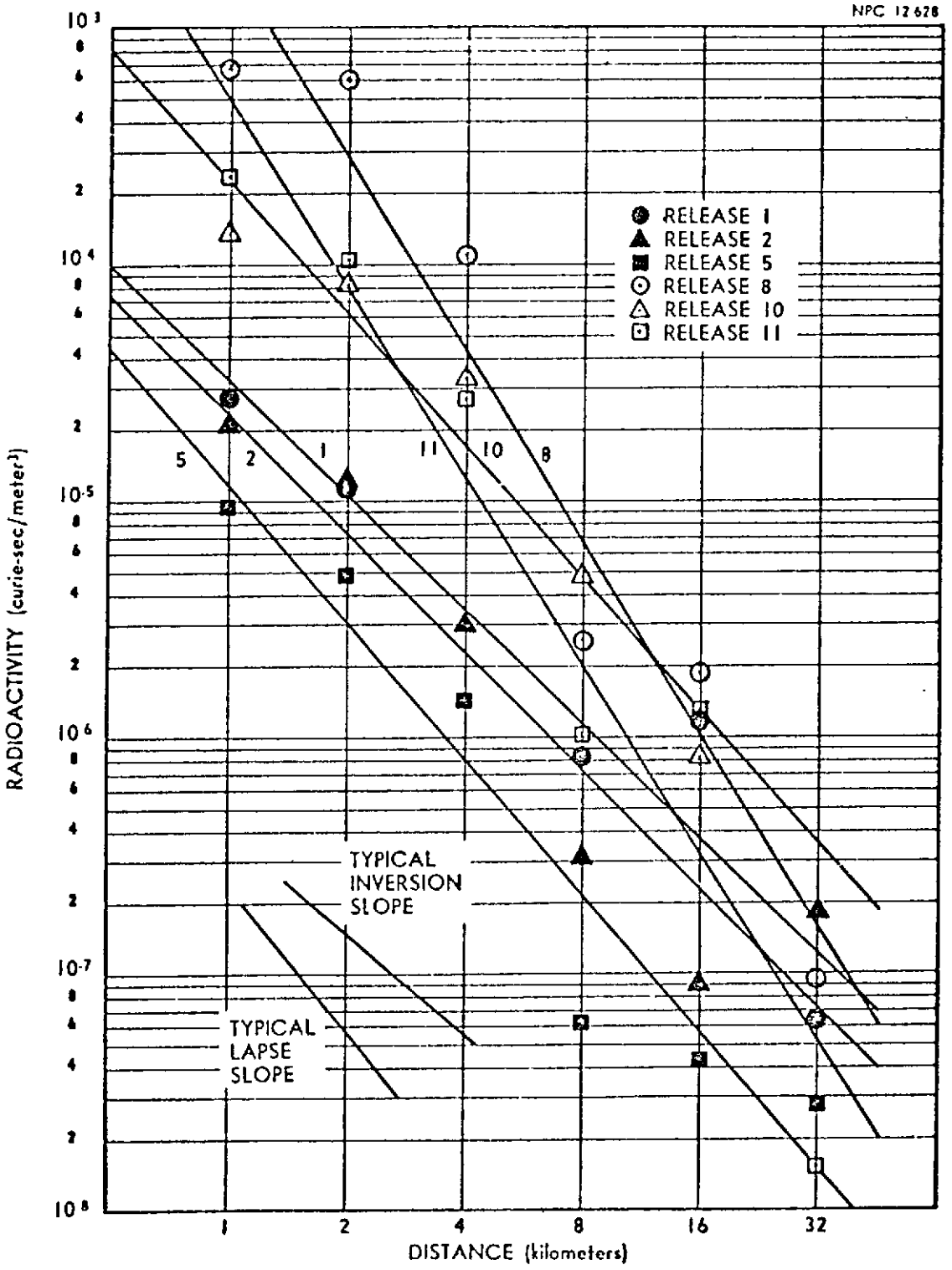

FIGURE 26. MAXIMUM CENTERLINE CONCENTRATION OF RUTHENIUM-103

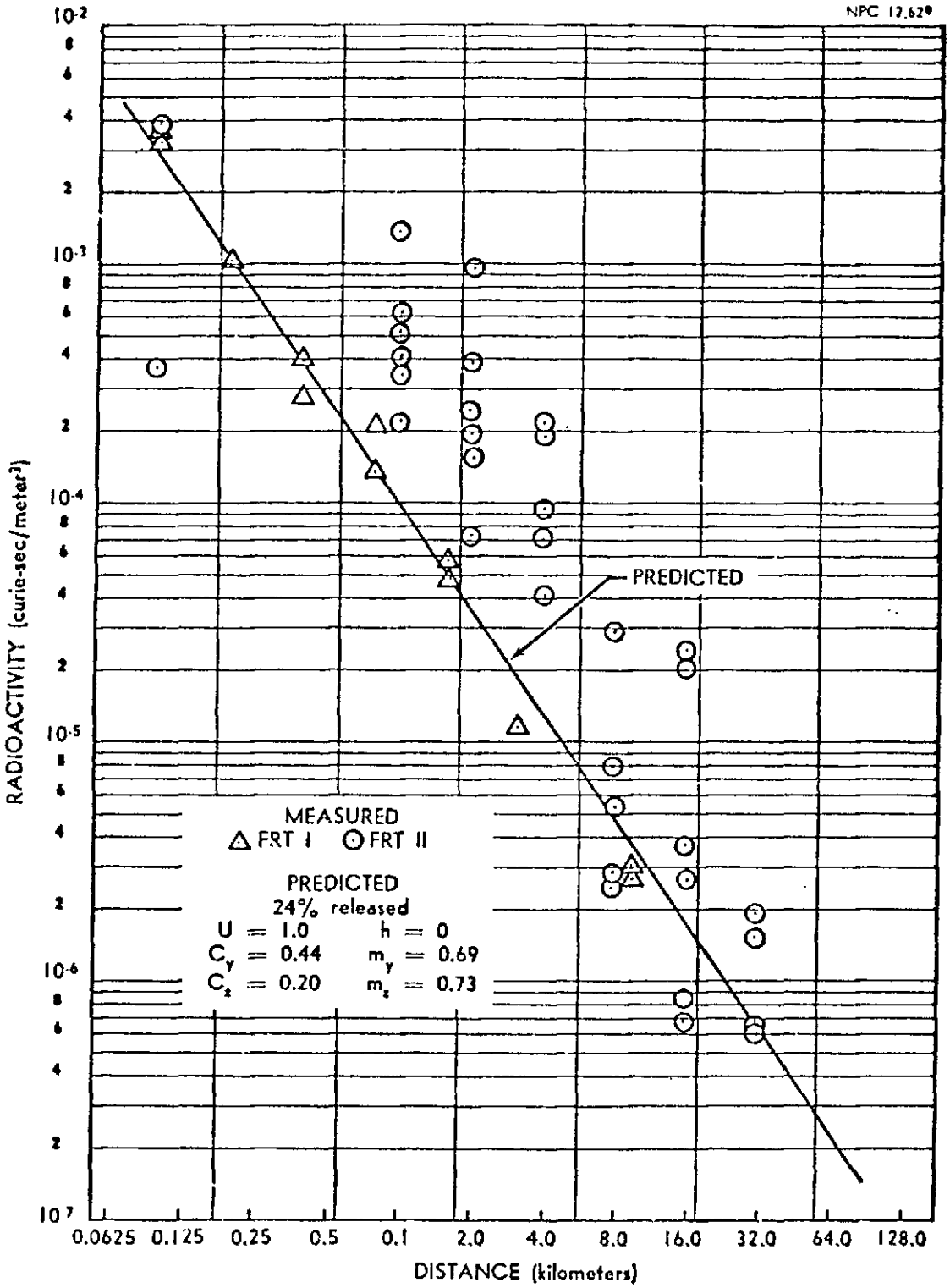

FIGURE 27. MAXIMUM CENTERLINE CONCENTRATIONS OF IODINE-131 NORMALIZED TO UNIT WIND VELOCITY AND INVENTORY

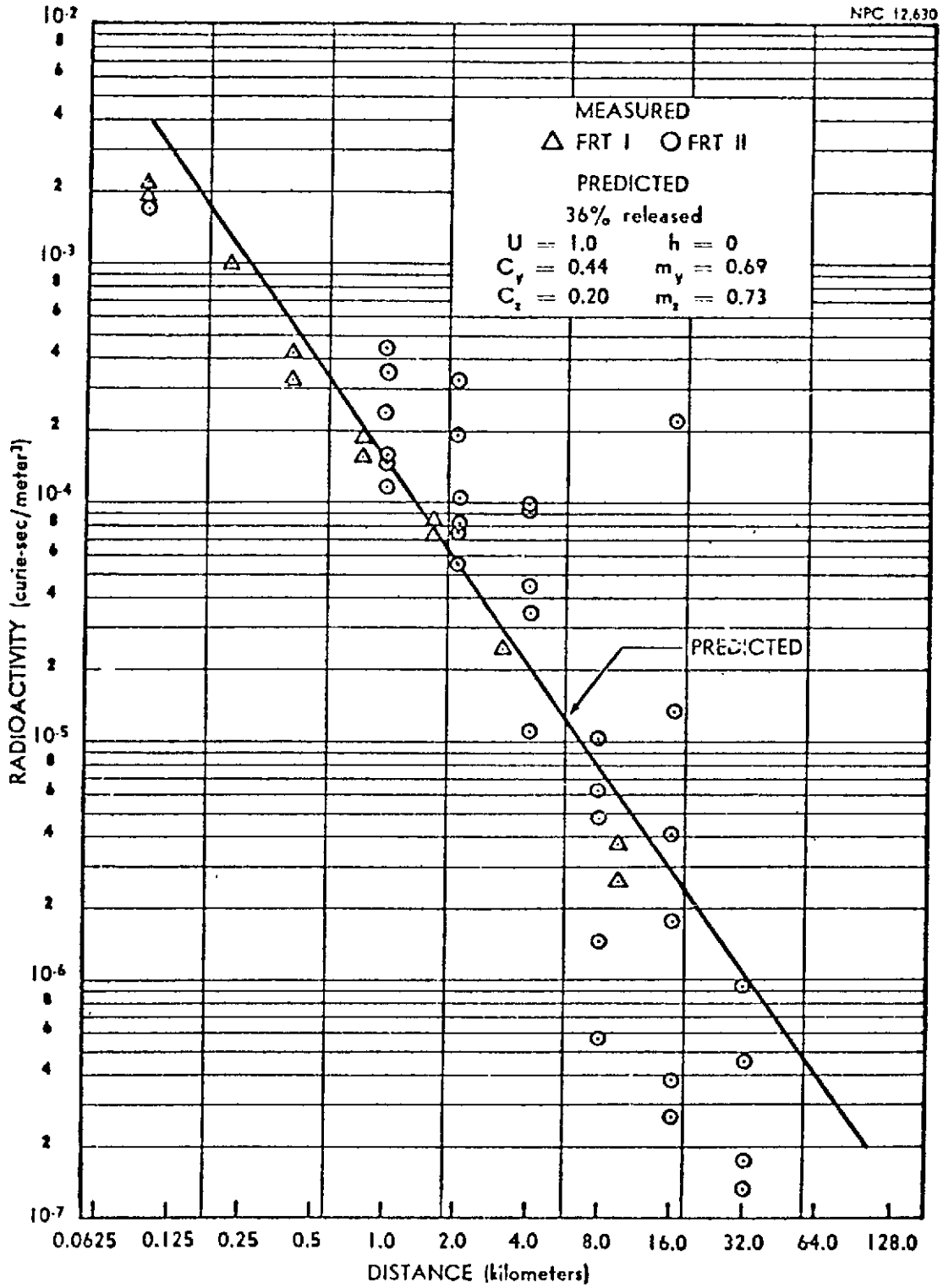

FIGURE 28. MAXIMUM CENTERLINE CONCENTRATION OF CESIUM-137 NORMALIZED TO UNIT WIND VELOCITY AND INVENTORY

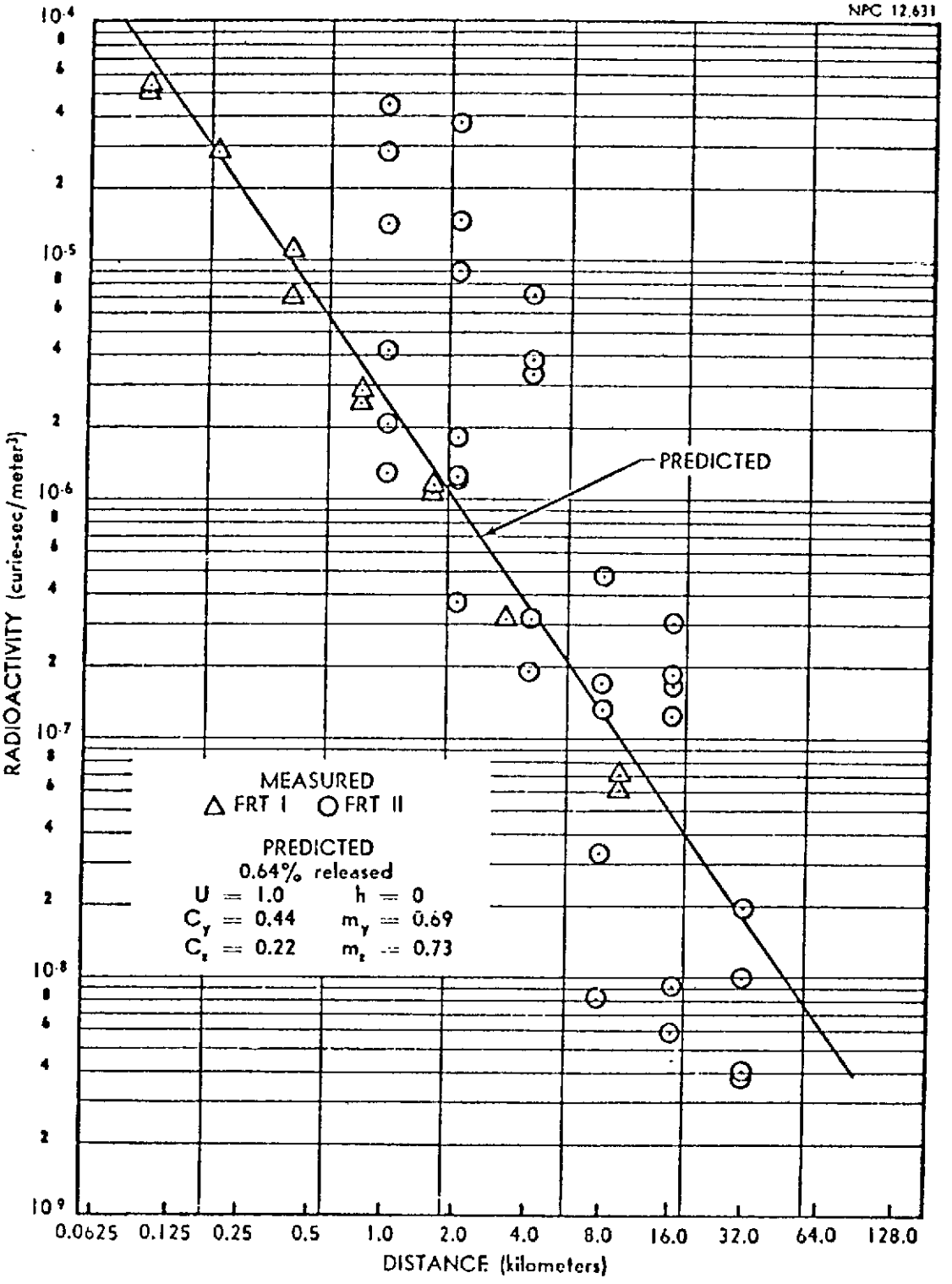

FIGURE 29. MAXIMUM CENTERLINE CONCENTRATIONS OF RUTHENIUM-103 NORMALIZED TO UNIT WIND VELOCITY AND INVENTORY

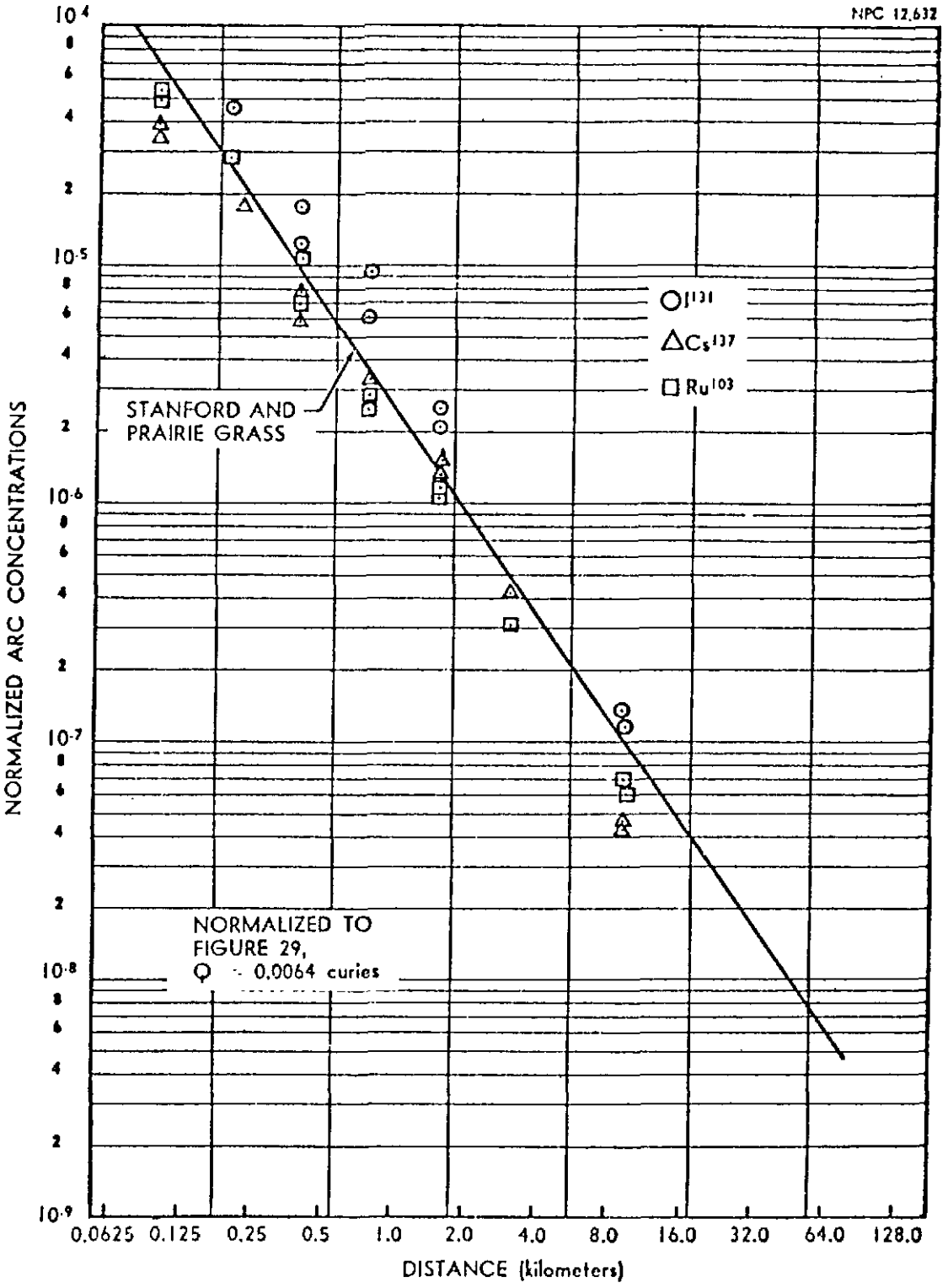

FIGURE 30. NORMALIZED MAXIMUM CENTERLINE CONCENTRATIONS OF SIGNIFICANT ISOTOPES (FRT 1)

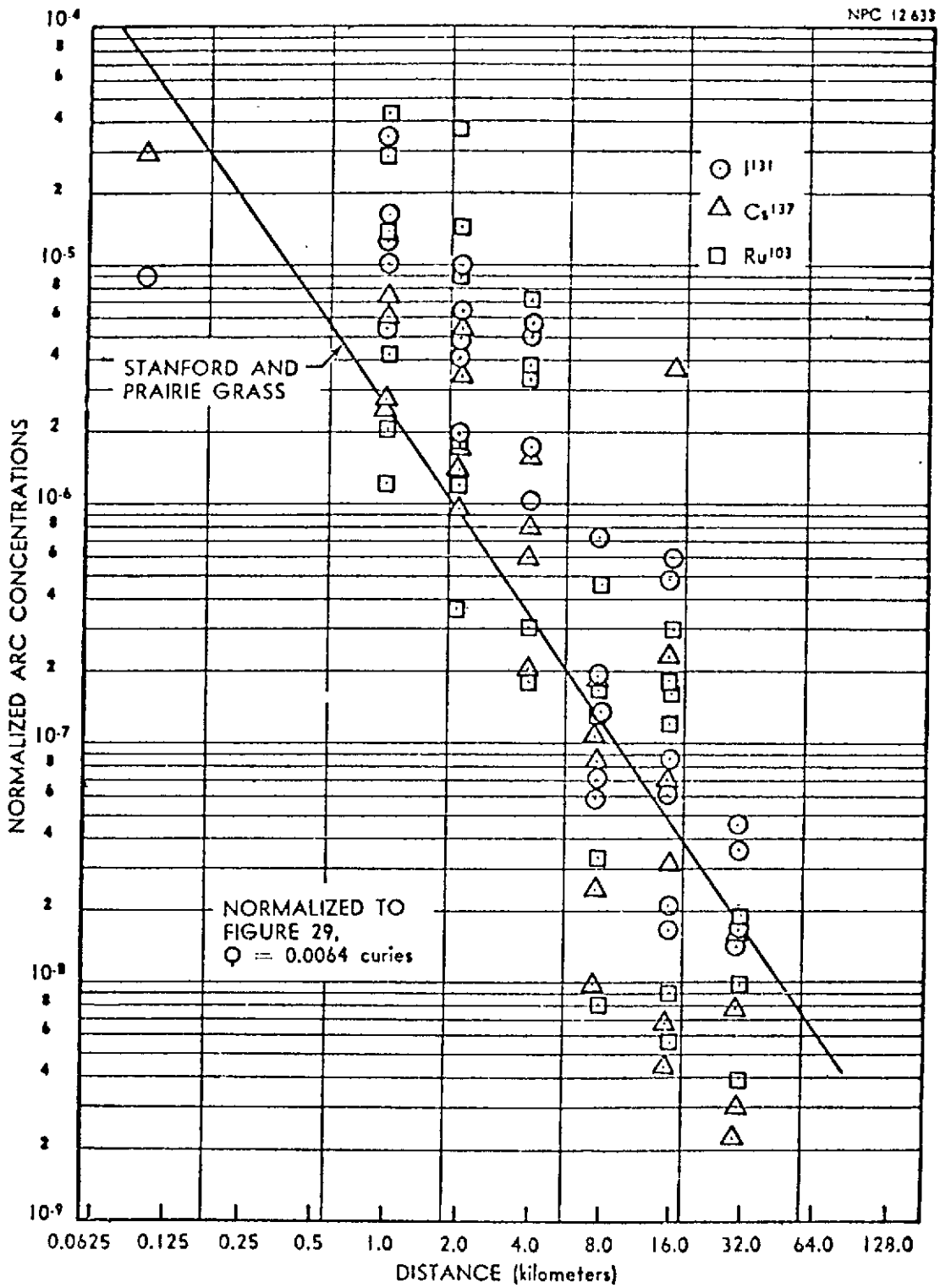

FIGURE 31. NORMALIZED MAXIMUM CENTERLINE CONCENTRATIONS OF SIGNIFICANT ISOTOPES (FRT II)

within about a factor of 2 out to 800 meters. During FRT II, the predictions were within a factor of about 10, probably caused by the steeper inversions of FRT-II.

Combined FRT-I and FRT-II data (Fig. 32) indicate that the average experimental parameters are generally good for predicting average concentrations out to 32,000 meters, with a tendency to underestimate concentrations between 1,000 and 16,000 meters and a tendency to overestimate concentrations at 32,000 meters.

3.3.4 Isotopic Deposition Velocities

The mechanisms by means of which the particles are transferred from the air stream to the surface may be quite complex, probably involving Brownian motion, impaction, and electrostatic forces. The term "deposition velocity," as used here, refers to the ratio of area concentration on the collecting surface to the time integral of air concentration over the sampling period. The units used are curies/cm^2 and curie-seconds/cm^3, respectively. Thus, the unit of deposition velocity is cm/sec.

Deposition velocities were measured for gummed paper, rye grass, and soil during FRT II (Appendix F). The sampling arcs had radii about the source point of 1,000, 2,000, 4,000, 8,000, 16,000, and 32,000 meters, a factor of 10 scale-up from FRT I. All releases were made at night under meteorological conditions characterized by strong temperature inversions and light winds. For all eight releases, gummed paper was placed on the 1000-meter

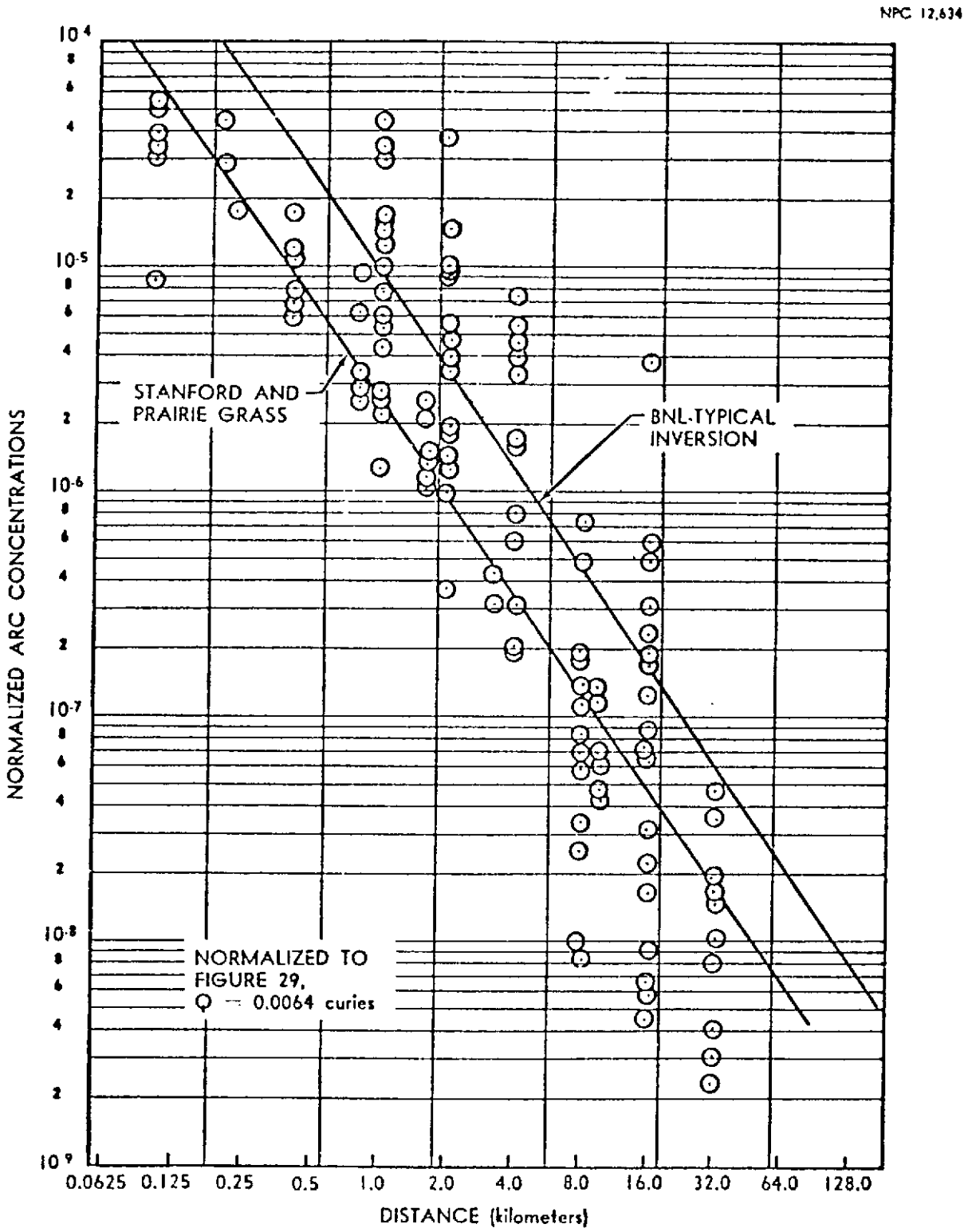

FIGURE 32. NORMALIZED MAXIMUM CENTERLINE CONCENTRATIONS FOR ALL ISOTOPES (FRT I AND FRT II)

arc at 2-degree intervals at ground level adjacent to air samplers located four feet above ground. For six of these releases, gummed paper was also placed four feet above the ground adjacent to the air samplers. On the first release, ground-level gummed papers were also placed on the 4,000-, 16,000-, and 32,000-meter arcs; and on the last two releases, it was placed on the 4,000-meter arc.

Rye seedlings planted and grown indoors in 8-inch trays were exposed on the 1000- and 2000-meter arcs during two of the releases.

Native soil samples, about 1-foot square, were taken at ground level from the 1000- and 2000-meter-arc sampler stations on the final release only.

Figure 33 shows histograms of deposition velocity data from all FRT-II open releases. The gummed-paper and iodine-on-grass results are quite good. However, the ruthenium-on-grass data are so scattered that it is impossible to specify a meaningful average. This is probably a result of the samples being weaker in ruthenium than in iodine activity. The cesium-on-grass values are more scattered than one would wish, but are not unreasonable — especially considering the difficulties of working with the rye-seedling grass and low-activity levels. Table 9 shows recommended deposition velocities for iodine, cesium, and ruthenium, estimated from the histograms.

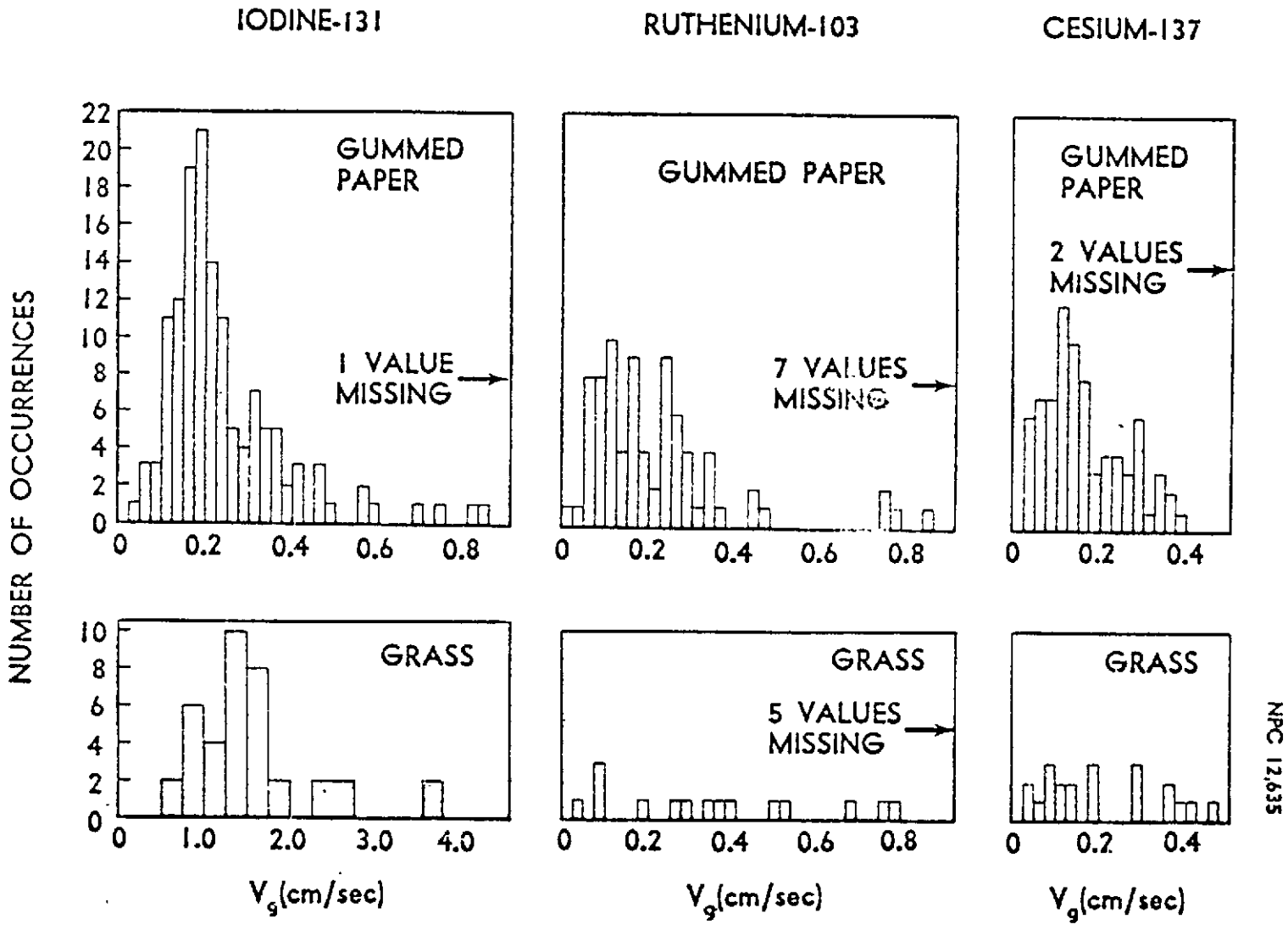

FIGURE 33. DEPOSITION VELOCITIES ON GUMMED PAPER AND GRASS (FRT II)

TABLE 9.

RECOMMENDED DEPOSITION VELOCITIES
(cm/sec)

Isotope	Surface	Probable Range	Recommended Value
I^{131}	Gummed paper	0.05 - 0.5	0.20
	Grass	0.5 - 3	1.50
	Soil**	(See Table F-1)	
Cs^{137}	Gummed paper	0.03- 0.4	0.15
	Grass	0.03- 0.4	0.20
	Soil**	(See Table F-1)	
Ru^{103}	Gummed paper	0.03- 0.4	0.20
	Grass	0.03- 0.8	0.20*
	Soil**	(See Table F-1)	
$Te^{127m-129m}$	Gummed paper **	(See Tables F-1 and F-2.)	

* Until more data are available
** Insufficient data to support a recommended value

FRT-II deposition velocities for the 1000-meter arc are listed in Table 10 along with average temperature, wind velocity, lapse rate, humidity, and pressure. Results indicate an increase in deposition velocity with wind velocity. However, nothing can be concluded with regard to a dependence of deposition velocity on other release conditions. The fact that no significant dependence upon lapse rate was observed supports the results from FRT I, which indicated the deposition velocities should be the same for lapse and inversion releases.

TABLE 10

GUMMED-PAPER DEPOSITION VELOCITIES FOR VARIOUS METEOROLOGICAL CONDITIONS

Release Number	Isotopic Deposition Velocities (V_g)						Meteorological Conditions				
	I^{131}		Cs^{137}		Ru^{103}						
	Surface (cm/sec)	1 meter up (cm/sec)	Surface (cm/sec)	1 meter up (cm/sec)	Surface (cm/sec)	1 meter up (cm/sec)	Temperature (°F)	Wind Velocity (m/sec)	Lapse Rate (°C/1to32m)	Humidity (%)	Pressure (in.Hg)
1	0.41 ±0.06		0.32 ±0.05		0.40 ±0.06		75	5.0	-2.4	47	25.52
2	0.34 ±0.21		0.19 ±0.03		0.48 ±0.34		78	4.2	-5.0	37	25.46
3	0.12 ±0.04	0.19 ±0.03	0.29	0.11 ±0.04	0.26 ±0.12	0.22 ±0.11	68	3.2	-1.6	31	25.37
4	0.18 ±0.07	0.068±0.001					69	2.4	-3.1	60	25.70
5	0.22 ±0.09	0.29 ±0.05	0.23 ±0.09	0.204	0.74 ±0.65		57	4.4	-1.1	61	25.49
8	0.28 ±0.25	0.30 ±0.22	0.18 ±0.06	0.16 ±0.03	0.36 ±0.41	0.40 ±0.26	41	2.7	-1.5	62	25.42
10	0.16 ±0.04	0.23 ±0.06	0.10 ±0.04	0.14 ±0.05	0.13 ±0.06	0.20 ±0.08	47	2.6	-1.3	72	25.8
11	0.63 ±0.67	1.1 ±1.3	0.52 ±0.49	0.77 ±0.87	0.35 ±0.41	0.50 ±0.63	49	4.4	-6.4	68	25.8

Gummed-paper deposition velocities measured during FRT I were, on the average, higher than those measured during FRT II (see Table 11. Since gummed paper is much more efficient for relative humidities below 20% (Ref. 4), this difference was to be expected. It may be concluded from the data shown in Figure 34 and Table 12 that, for particle sizes near the 0.5 to 10μ range, the deposition velocities measured on gummed paper during FRT I should be higher than those measured during FRT II.

3.3.5 Diffusion Parameters

Diffusion parameters have been fitted to numerous field release tests by the numerical method presented in References 1 and 5. The method involves fitting an equation of the form

$$\chi(x,y,z) = \frac{2Q}{\bar{u}\, C_y\, C_z\, x^{m_y+m_z}} \exp-\left[\frac{y^2}{C_y^2\, x^{2m_y}} + \frac{z^2}{C_z^2\, x^{2m_z}}\right]$$

where

$\chi(x,y,z)$	is the activity at x, y, z (curie-sec/meter^3),
Q	is the release activity (curies),
$\bar{u}$	is the wind velocity (meter/sec),

to network arc profiles to obtain values for the diffusion constants C_y, C_z, m_y, and m_z.

A plot of the results for FRT-II and other field release experiments (Table 13) indicates that the average diffusion parameters change with network length (Fig. 35). The most pronounced change is the increase in the power m_y and an associated decrease in the diffusion coefficient C_y.

TABLE 11

DEPOSITION VELOCITIES FOR FRT I AND FRT II
(cm/sec)

Isotope	Gummed Paper		Soil		Water		Grass	
	FRT I	FRT II	FRT I*	FRT II	FRT I	FRT II	FRT I	FRT II
Cs^{137}	0.1 ±0.06 [38]	0.15	0.04 ±0.02 [5]	0.045 ± 0.053 [10]	0.09 ±0.06 [5]	--	0.20	0.20
I^{131}	1.1 ±0.4 [14]	0.2	0.7 ±0.5	--	1.6 ±0.7 [8]	--	--	1.50
Ru^{103}	2.0 ±1.0 [11]	0.20	0.6 ±0.4 [9]	0.11 ± 0.18 [7]	2.3 ±1.0 [9]	--	--	0.20
Zn^{95}-Nb^{95}	1.4 ±0.7 [10]	--	2.9 ±2.7 [6]	--	5.7 ±3.4 [6]	--	--	--
$Te^{127m,-129m}$	--	0.71±1.3 [8]	--	--	--	--	--	--
Ce^{141}	0.7 ±0.6	--	--	--	--	--	--	--

*Sand
[ ] Number of determinations

TABLE 12

AVERAGE RELATIVE HUMIDITY FOR FRT I AND FRT II

Test	Release										
	1	2	3	4	5	6	7	8	9	10	11
FRT-I	18.5%	21%	12.5%	15%	15%	23%	38%	22%	24%	--	--
FRT-II	47%	37%	31%	60%	61%	--	--	62%	--	72%	68%

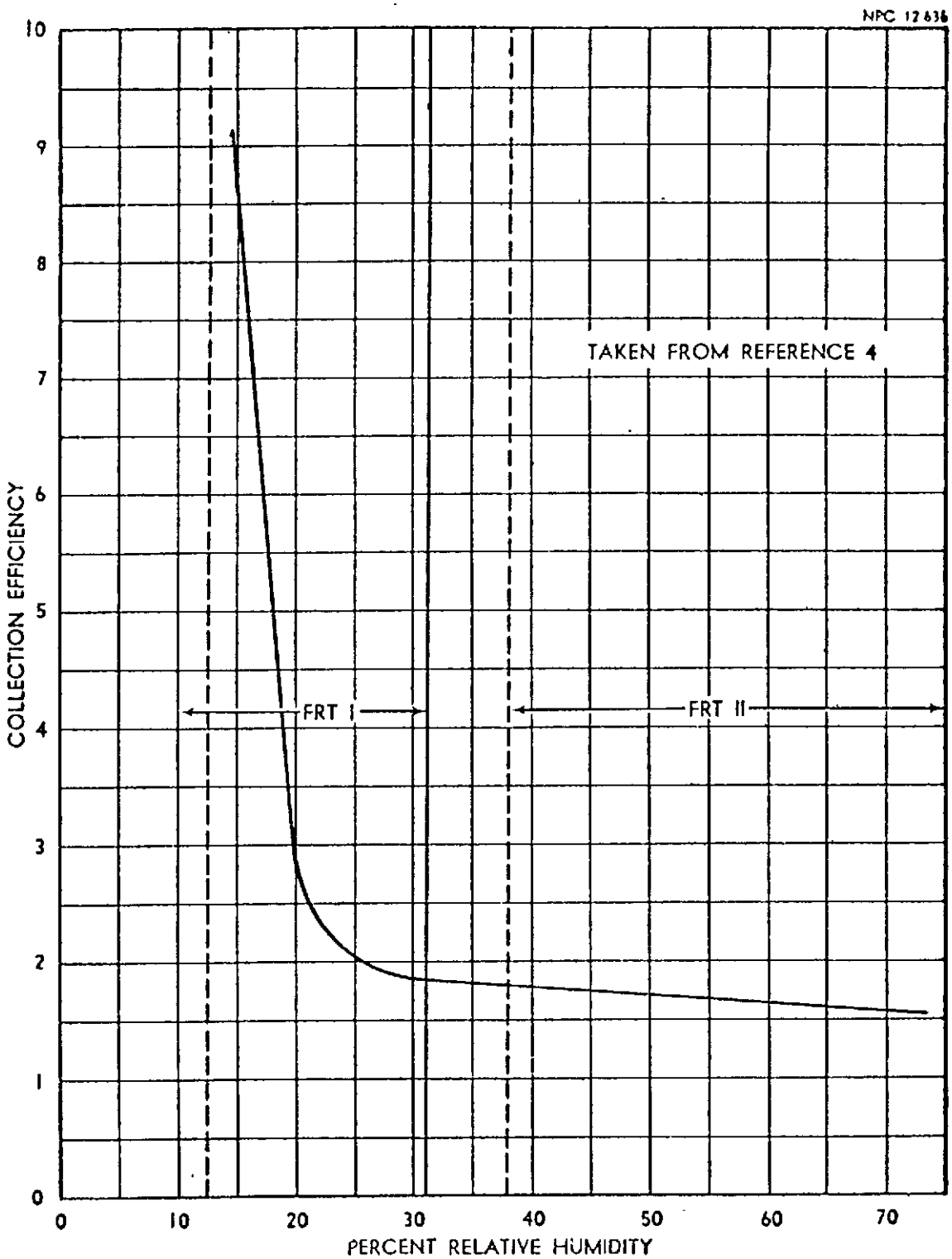

FIGURE 34. EFFECT OF HUMIDITY ON CAPTURE OF PARTICLES ON GUMMED PAPER

TABLE 13

SUMMARY OF FITTED DIFFUSION PARAMETERS

Test	C_y	m_y		C_z		m_z	
	Lapse and Inversion	Lapse	Inversion	Lapse	Inversion	Lapse	Inversion
Stanford (200m)	0.47±0.28	0.82±0.11	0.66±0.20	0.03±0.03	0.15±0.07	1.29±0.33	0.73±0.21
Prairie Grass (800m)	0.43±0.18	0.83±0.08	0.69±0.09	0.03±0.03	0.20±0.13	1.27±0.28	0.73±0.18
FRT I (3200m)	0.76±0.76	0.64±0.09	0.80±0.13	0.09±0.06	0.33±0.31	1.3±0.2	0.82±0.43
FRT II (32000m)	0.11±0.21	- -	1.1±0.2	- -	0.8±1.5	- -	0.71±0.38

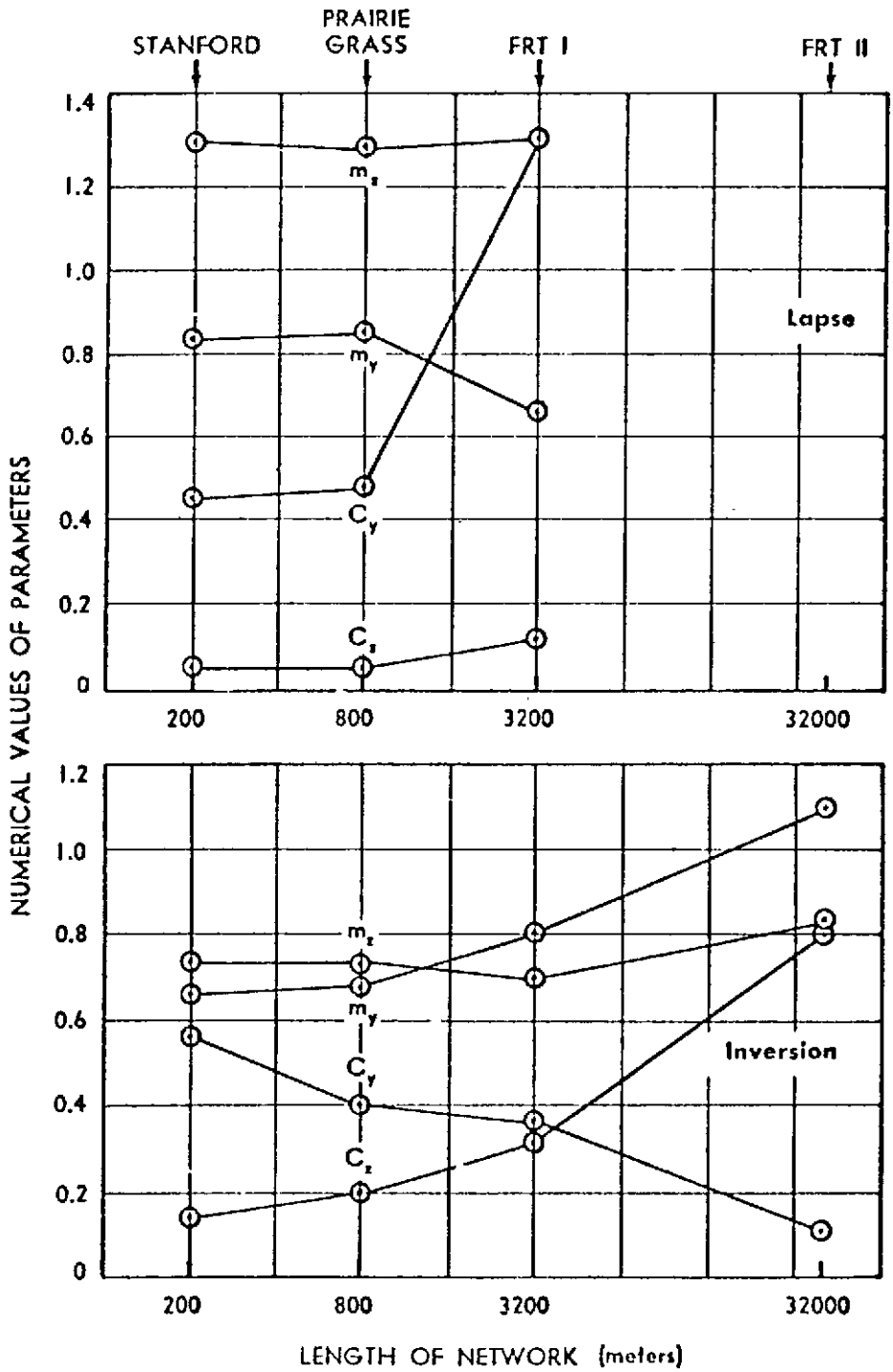

FIGURE 35. DEPENDENCE OF DIFFUSION PARAMETERS ON DISTANCE

The cause of the changes in horizontal diffusion parameters is illustrated in the data collected (Appendix G). Figure 36 shows the number of arc degrees within 10% of the centerline maximums that were measured during FRT I. A fit to the data predicts that FRT II should cover about 5 degrees at 32,000 meters. Results, however, indicated that the distribution covered 15 to 20 degrees. This change was caused by cloud meandering, as may be seen by examining the included arc profiles for the 1,000- and 32,000-meter arcs.

The short-range diffusion parameters should be preferentially used for predicting diffusion, with possibly an added term for cloud meandering. Such a change might be achieved by replacing $C_y x^{m_y}$ in the atmospheric diffusion equations by $(C_y x^{m_y} + K_y x^k)$ where $K_y x^k$ corrects for cloud meandering.

3.4 Ecological Soil Uptake

Six-inch soil samples were taken from the charged-wire locations three months after the last release. The plugs were cut into one-inch segments and analyzed for cesium, ruthenium, and zirconium-niobium. Results indicated that over 90% of the activity remained in the top two inches of the soil (Appendix A).

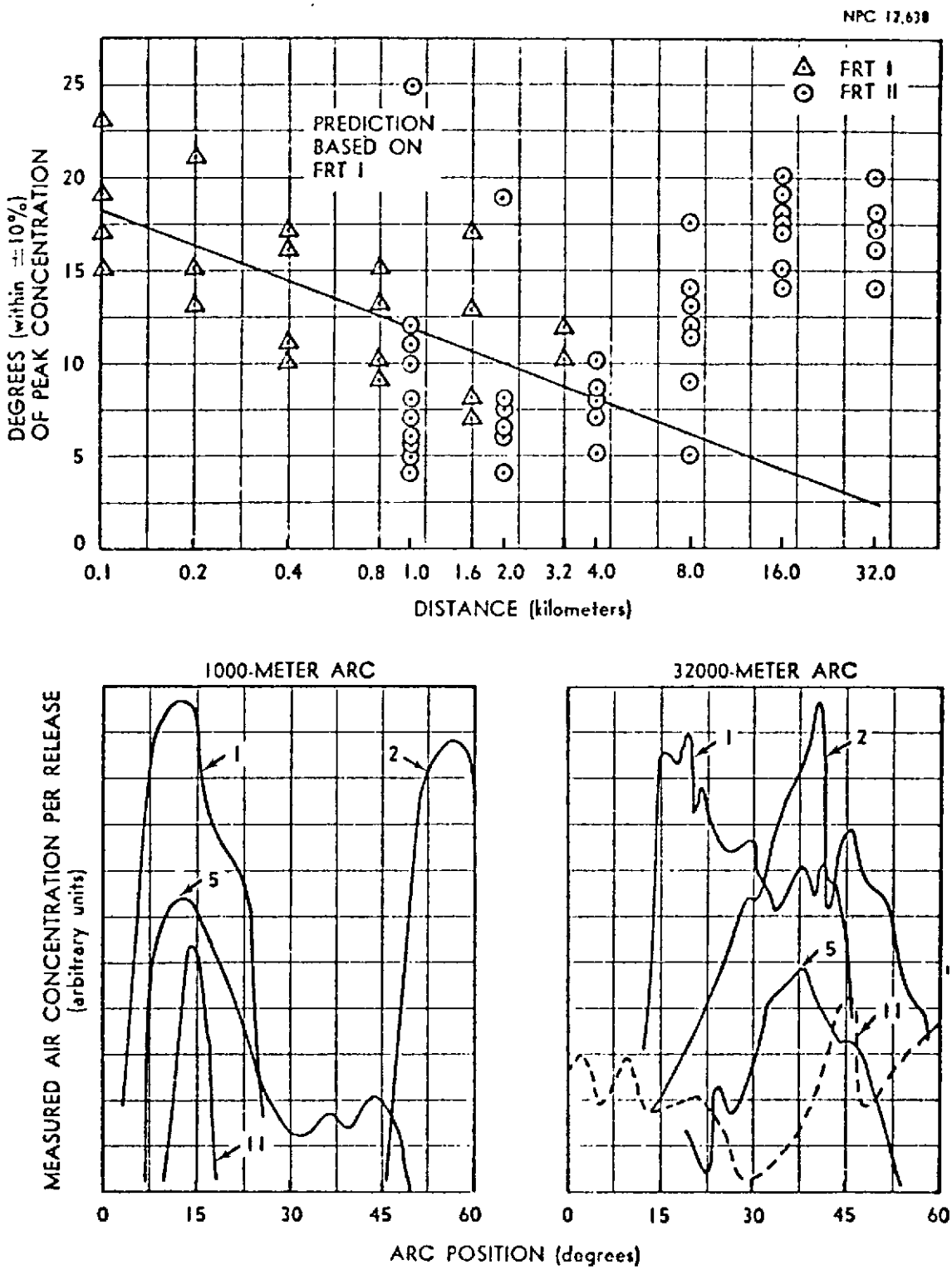

FIGURE 36. INFLUENCE OF CLOUD MEANDERING ON ARC PROFILES

IV. SUMMARY AND CONCLUSIONS

1. FRT II Simulated a Reactor Core Meltdown

The slow meltdown of the metallic-type ANP fuel element in an induction furnace simulated the conditions to be expected in the most probable type of reactor accident - the reactor core meltdown. Results from this series of releases provide probable upper limits of what may be expected from such a reactor accident.

2. The Measured Isotopic Release Percents May be Regarded as Upper Limits

A forced air flow through the melt crucible during each release resulted in ideal conditions for the escape of all liberated fission products. The results presented in this report may be considered as upper limits of the amounts of the various isotopes to be released from a reactor core meltdown.

3. FRT-II Release Percents Were Lower Than FRT I Indicated

The more specialized measurements for the contained releases and the precise sampling procedures (see the discussion of Table A-47) gave release percents that were lower than those determined during FRT I.

4. The Released Effluent Diffused Downwind at Ground Level

An isotopic analysis of segments of 10- and 50-meter downwind vertical charged wires showed that the maximum concentrations remained within approximately 8 feet of the ground.

5. The Meltdown Effluent Was All Aerosol

Andersen sampler results showed that the great majority of all the released effluent were smaller than 10 microns in diameter. For predicting atmospheric dispersal, all the effluent from the core meltdown (involving this type of fuel element) can be considered as an aerosol.

6. Iodine Selectively Collected on JP4 Fire Smoke

As demonstrated by particle size changes during one release, over 50% of the collected iodine agglomerated with smoke particulates. No change was detected for the other isotopes.

7. Experimental Diffusion Parameters Predicted Downwind Concentrations with a Factor-of-10 Accuracy to 20 Miles

The inversion parameters obtained from the Stanford and Project Prairie Grass release data predicted measured FRT-I and FRT-II isotopic centerline concentrations within an average factor-of-10 out to the 20-mile arc of FRT II.

8. Isotopic Deposition Velocities are Now Available

The results from FRT II have statistically improved the isotopic deposition velocities that were measured during FRT I and, in addition, provided new values for soil and grass. The values (included in the text) represent a valuable source of isotopic deposition velocities for reactor hazards analysis.

9. Deposition Velocities May Be Independent of Lapse Rates

This conclusion supports that presented in the FRT-I report, and obviates the need to use a different deposition velocity for lapse and inversion releases. The data, however, demonstrate a tendency for deposition velocities to increase with wind velocities.

10. Fitted Diffusion Parameters Varied with the Length of Network

The change was caused by increased horizontal diffusion resulting from cloud meandering. A "meandering" term should be included in an atmospheric diffusion equation (short release times) to account for the effect of cloud meandering, which becomes important beyond 5 miles.

11. Radioactivity Stayed in the Top Two Inches of the Soil

Soil samples taken three months after the last release showed that over 90% of the deposited radioactivity stayed within the top two inches.

V. ANP SAFETY PREDICTIVE MODEL RECOMMENDATIONS

Analysis of the results and conclusions of the FRT-II experiment has led to a better understanding of the significant parameters associated with ANP safety predictions. Certain of these parameters have been verified with previous experiments, although others still require further consideration. It is therefore suggested that the ANP safety predictive techniques (Ref. 2) be modified, where stated, in accordance with the following recommendations:

1. The isotopic release fractions used in ANP predictions, as modified by FRT I, and verified by the FRT-II measurements, should be used until further experimental data are obtained, e.g., release percentage dependence upon temperature.

2. Since the FRT-II and FRT-I experiments have definitely characterized the fission-productseffluent as aerosol, i.e., less than 10 microns, further studies should be undertaken to determine the particulate size spectrum between the 0.1-micron and 1-micron range because of biological significance.

3. Since the average inversion parameters as determined from the analysis of Stanford and Project Prairie Grass diffusion data generally predict the measured FRT-II isotopic centerline concentrations out to 20 miles, they should be used in future ANP safety predictions until other data are available. Also, the trend to underestimate concentrations at distances less than 10 miles and to overestimate concentrations between 10 and 20 miles should be evaluated so that, if possible, a set of diffusion parameters for different distances from the release point can be determined.

4. The FRT-II measured deposition velocities on grass during inversion conditions - 1.5 cm/sec for I^{131} and 0.2 cm/sec for the other isotopes - should be

used for all ANP predictions until further data are obtained either under strong lapse conditions or varying wind velocities. FRT-I experimental data indicated no significant dependence of deposition velocities on lapse rate.

5. Since previous gummed-paper deposition velocities may not be valid due to strong dependence of collection efficiency upon relative humidity, predictions based on these values are regarded as unreliable and further use is not recommended.

6. Because neither FRT II nor other related experiments have provided data on the validity of the cloud depletion term associated with the Sutton Diffusion Equation, it is recommended that an experiment be designed to evaluate this phenomenan.

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APPENDIX A

SOURCE OF FISSION PRODUCTS

A-1. Fission-Products Inventories

A-1.1 Calculated

Since the fuel-element irradiation histories were fairly well defined (Table A-1), the fission-product inventories could be computed from measured flux values and nuclear parameters given in the literature (Table A-2). The flux values, measured by exposing eleven aluminum-uranium wires in each sample during the irradiation, were integrated over, then divided by, the sample volume to give the average flux shown in Table A-3. The power levels given in Table A-1 were computed by using a Maxwellian averaged fission cross section of 487 barns and the mass of U^{235} in each sample.

All isotopes listed in Table A-2 that have an accumulated inventory greater than 1 microcurie at the time of release (computed neglecting neutron absorption) are presented in Table A-4.

A-1.2 Measured

The General Electric facility at the National Reactor Testing Station (NRTS) measured the inventories of Cs^{137}, Zr^{95}, and Ce^{144} present in each sample. The activity in a small piece of each sample was measured, scaled up by the relative

TABLE A-1

FUEL-ELEMENT IRRADIATION (MTR) HISTORIES

Release	Element and Stage Numbers	Mass of U^{235} (grams)	Operating History Time in Seconds (1st entry); Power in Watts (2nd entry)									
			Cycle No. 1	Cycle No. 2	Cycle No. 3	Cycle No. 4	Cycle No. 5	Cycle No. 6	Cycle No. 7	Cycle No. 8	Cycle No. 9	Cycle No. 10
1	1-M-1 No. 3	55.63	1.57(5)* 3.08(4)	1.92(3) 0	1.17(5) 3.08(4)	1.46(6) 0						
2	1-M-1 No. 2	62.05	1.57(5) 3.63(4)	1.92(3) 0	1.17(5) 3.63(4)	2.07(6) 0						
3	1-F-34 No. 2	59.50	2.95(4) 3.10(4)	1.2(3) 0	2.94(4) 3.10(4)	1.16(5) 0	2.52(4) 3.10(4)	1.8(2) 0	9.3(3) 3.10(4)	1.82(2) 0	2.24(5) 3.10(4)	2.53(6) 0
4	1-F-34 No. 3	59.50	2.95(4) 3.17(4)	1.2(3) 0	2.94(4) 3.17(4)	1.16(5) 0	2.52(4) 3.14(4)	1.8(2) 0	9.3(3) 3.17(4)	1.82(2) 0	2.24(5) 3.17(4)	2.87(6) 0
5	1-F-34 No. 4	59.50	2.95(4) 3.65(4)	1.2(3) 0	2.94(4) 3.65(4)	1.16(5) 0	2.52(4) 3.65(4)	1.8(2) 0	9.3(3) 3.65(4)	1.82(2) 0	2.24(5) 3.65(4)	3.38(6) 0
6	1-M-1 No. 1	55.14	1.57(5) 3.23(4)	1.92(3) 0	1.17(5) 3.23(4)	5.92(6) 0						
7	1-F-34 No. 1	59.50	2.95(4) 2.87(4)	1.2(3) 0	2.94(4) 2.87(4)	1.16(5) 0	2.52(4) 2.87(4)	1.8(2) 0	9.3(3) 2.87(4)	1.82(2) 0	2.24(5) 2.87(4)	3.96(6) 0
8	1-F-35 No. 1	62.35	5.58(3) 2.63(4)	2.4(2) 0	2.14(4) 2.63(4)	3.6(3) 0	3.87(5) 2.63(4)	2.60(6) 0				
9	1-F-35 No. 5	62.35	5.58(3) 3.82(4)	2.4(2) 0	2.14(4) 3.82(4)	3.6(3) 0	3.87(5) 3.82(4)	3.41(6) 0				
10	1-F-35 No. 2	62.35	5.58(3) 3.00(4)	2.4(2) 0	2.14(4) 3.00(4)	3.6(3) 0	3.87(5) 3.00(4)	4.68(6) 0				
11	1-F-35 No. 4	62.35	5.58(3) 3.35(4)	2.4(2) 0	2.14(4) 3.35(4)	3.6(3) 0	3.87(5) 3.35(4)	4.78(6) 0				

*Read 1.57(5) as 1.57×10^5

TABLE A-2

NUCLEAR PROPERTIES OF FISSION-PRODUCTS INVENTORY

Nuclide	% Yield	Half-Life	Nuclide	% Yield	Half-Life
Zn^{72}	0.000015	49 hr	Sb^{125} $-Te^{125m}$	0.023	2.7 yr
As^{77} $-Se^{77m}$	0.0091	38.8 hr	Sb^{127}	0.25	93 hr
Se^{79}	0.04	65000 yr	Te^{127m} $-Te^{127}$	0.25	90 d
Br^{82}	0.000038	35.9 hr	Te^{129m} $-Te^{129}$	1.0	33 d
Kr^{85}	0.39	10.3 yr	Te^{131m} $-Te^{131}$	2.9	30 hr
Rb^{86}	0.000028	19.5 d	I^{131}	2.9	8.1 d
Sr^{89}	4.8	54 d	Xe^{131m}	0.03	12 d
Sr^{90} $-Y^{90}$	5.9	28 yr	Te^{132}	4.4	77 hr
Y^{91}	5.9	58 d	I^{133}	6.5	20.8 hr
Zr^{95}	6.4	63 d	Xe^{133m}	0.16	2.3 d
Nb^{95m}	0.06	90 hr	Xe^{133}	6.5	5.27 d
Nb^{95}	6.4	35 d	Cs^{136}	0.006	13 d
Zr^{97} $-Nb^{97m}$ $-Nb^{97}$	6.2	17 hr	Cs^{137} $-Ba^{137m}$	5.9	26.6 yr
Mo^{99} $-Tc^{99m}$	6.1	67 hr	Ba^{140} $-La^{140}$	6.3	12.8 d
Tc^{99}	6.1	212000 yr	Ce^{141}	6.0	32 d
Ru^{103} $-Rh^{103m}$	2.9	41 d	Ce^{143}	6.2	32 hr
Rh^{105}	0.9	36.5 hr	Pr^{143}	6.2	13.7 d
Ru^{106} $-Rh^{106}$	0.38	1 yr	Ce^{144} $-Pr^{144}$	6.1	290 d
Ag^{111}	0.018	7.6 d	Nd^{147}	2.6	11.3 d
Pd^{112}	0.011	21 hr	Pm^{147}	2.6	2.6 yr
Cd^{115m}	0.00071	43 d	Pm^{149}	1.3	54 hr
Cd^{115}	0.0098	53 hr	Pm^{151}	0.5	27.5 hr
Sn^{117m}	0.00002	14 d	Sm^{151}	0.5	93 yr
Sn^{119m}	0.01	275 d	Sm^{153}	0.15	47 hr
Sn^{121}	0.014	27.5 hr	Eu^{155}	0.031	1.7 yr
Sn^{123m}	0.0012	131 d	Eu^{156}	0.013	15.4 d
Sn^{125m}	0.012	2.7 yr			

TABLE A-3

AVERAGE THERMAL FLUX

(n/cm^2-sec)

Release	Average Flux
1	1.39×10^{13}
2	1.47×10^{13}
3	1.31×10^{13}
4	1.34×10^{13}
5	1.54×10^{13}
6	1.47×10^{13}
7	1.21×10^{13}
8	1.06×10^{10}
9	1.54×10^{13}
10	1.21×10^{13}
11	1.35×10^{13}

TABLE A-4

CALCULATED FISSION-PRODUCTS INVENTORY
(curies)

Nuclide	Release Number										
	1	2	3	4	5	6	7	8	9	10	11
Zn^{72}	*0.183(-6)	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
As^{77} - Se^{77m}	1.25(-3)	7.45(-5)	6.55(-6)	1.24(-6)	- -	- -	- -	4.61(-6)	- -	- -	- -
Se^{79}	- -	- -	- -	- -	- -	- -	- -	1.06(-6)	1.55(-6)	1.21(-6)	1.35(-6)
Br^{82}	2.93(-6)	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Kr^{85}	4.57(-2)	5.39(-2)	5.34(-2)	5.46(-2)	6.27(-2)	4.75(-2)	4.91(-2)	5.89(-2)	8.55(-2)	6.70(-2)	7.47(-2)
Rb^{86}	4.27(-4)	3.92(-4)	3.15(-4)	2.80(-4)	2.63(-4)	7.12(-5)	1.62(-4)	3.36(-4)	3.49(-4)	1.62(-4)	1.73(-4)
Sr^{89}	4.01(+1)	4.33(+1)	3.99(+1)	3.87(+1)	4.14(+1)	2.18(+1)	2.98(+1)	4.33(+1)	5.59(+1)	3.64(+1)	4.00(+1)
Sr^{90} - Y^{90}	3.31(-1)	3.89(-1)	3.87(-1)	3.95(-1)	4.54(-1)	3.46(-1)	3.57(-1)	4.26(-1)	6.19(-1)	4.87(-1)	5.43(-1)
Y^{91}	4.67(+1)	5.08(+1)	4.69(+1)	4.57(+1)	4.91(+1)	2.65(+1)	3.56(+1)	5.11(+1)	6.64(+1)	4.38(+1)	4.82(+1)
Zr^{95}	4.75(+1)	5.19(+1)	4.83(+1)	4.73(+1)	5.10(+1)	2.83(+1)	3.72(+1)	5.27(+1)	6.90(+1)	4.62(+1)	5.08(+1)
Nb^{95m}	3.03(-1)	.98(-1)	3.35(-2)	1.65(-2)	6.45(-3)	2.32(-5)	1.45(-5)	3.04(-2)	7.76(-3)	4.05(-4)	3.63(-4)
Nb^{95}	7.27(+1)	7.47(+1)	6.60(+1)	6.24(+1)	6.39(+1)	2.74(+1)	4.39(+1)	0.71(+2)	8.60(+1)	5.05(+1)	5.50(+1)
Zr^{97} - Nb^{97m} - Nb^{97}	0.97(-4)	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Mo^{99} - Tc^{99m}	1.29(+1)	2.68(0)	6.38(-1)	2.44(-1)	6.58(-2)	3.70(-5)	0.97(-2)	5.40(-1)	7.59(-2)	1.55(-3)	1.29(-3)
Tc^{99}	1.18(-5)	1.40(-5)	1.20(-5)	1.22(-5)	1.30(-5)	1.35(-5)	4.63(-5)	4.05(-5)	5.89(-5)	4.63(-5)	5.16(-5)
Ru^{103} - Rh^{103m}	2.96(+1)	3.10(+1)	2.79(+1)	2.67(+1)	2.78(+1)	1.29(+1)	1.96(+1)	3.02(+1)	3.75(+1)	2.30(+1)	2.51(+1)
Rh^{105}	7.78(-2)	3.77(-3)	2.81(-4)	4.73(-5)	3.76(-6)	- -	- -	1.93(-4)	3.80(-6)	- -	- -
Ru^{106} - Rh^{106}	5.77(-1)	6.71(-1)	6.59(-1)	6.69(-1)	7.61(-1)	5.48(-1)	5.50(-1)	0.72(0)	1.04(0)	0.79(0)	0.88(0)
Ag^{111}	2.52(-1)	1.57(-1)	0.91(-1)	6.53(-2)	4.41(-2)	2.40(-3)	1.38(-2)	0.91(-1)	5.66(-2)	1.16(-2)	1.17(-2)
Pd^{112}	3.92(-6)	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Cd^{115m}	7.02(-3)	7.39(-3)	6.69(-3)	6.41(-3)	6.70(-3)	3.21(-3)	4.73(-3)	0.72(-2)	9.05(-1)	5.62(-3)	6.15(-3)
Cd^{115}	7.94(-3)	1.04(-3)	1.73(-4)	5.14(-5)	9.47(-6)	- -	0.90(-6)	1.37(-4)	1.05(-5)	- -	- -
Sn^{117m}	3.27(-4)	2.73(-4)	2.93(-4)	1.70(-4)	1.47(-4)	2.68(-5)	0.83(-4)	2.12(-4)	1.94(-4)	7.38(-5)	7.77(-5)
Sn^{119m}	1.98(-2)	2.29(-2)	2.25(-2)	2.28(-2)	2.58(-2)	1.82(-2)	1.99(-2)	2.48(-2)	3.51(-2)	2.67(-2)	2.97(-2)
Sn^{121}	1.10(-4)	1.90(-6)	- -	- -	- -	- -	- -	- -	- -	- -	- -
Sn^{123m}	4.77(-3)	5.43(-3)	5.22(-3)	5.22(-3)	5.81(-3)	3.80(-3)	4.41(-3)	5.72(-3)	7.91(-3)	5.76(-3)	6.38(-3)
Sn^{125m}	1.87(-1)	1.31(-1)	0.84(-1)	6.51(-2)	4.86(-2)	4.39(-3)	2.33(-2)	0.87(-1)	6.20(-2)	1.68(-2)	1.72(-2)
Sb^{125} - Te^{125m}	1.32(-2)	1.35(0)	1.54(-2)	1.56(-2)	1.79(-2)	1.34(-2)	1.40(-2)	1.69(-2)	2.44(-2)	1.90(-2)	2.11(-2)
Sb^{127}	1.36(0)	4.61(-1)	1.63(-1)	8.24(-2)	3.34(-2)	1.43(-4)	0.78(-2)	1.48(-1)	4.03(-2)	2.30(-3)	2.07(-3)
Te^{127m} - Te^{127}	1.37(0)	1.54(0)	1.46(0)	1.45(0)	1.59(0)	0.97(0)	1.19(0)	1.60(0)	2.17(0)	1.52(0)	1.68(0)
Te^{129m} - Te^{129}	1.17(+1)	1.19(+1)	1.05(+1)	0.98(+1)	1.00(+1)	4.18(0)	6.88(0)	1.13(+1)	1.35(+1)	0.78(+1)	8.51(0)
Te^{131m} - Te^{131}	5.20(-2)	1.28(-3)	5.59(-5)	6.41(-6)	- -	- -	- -	3.48(-5)	- -	- -	- -
I^{131}	4.20(+1)	2.72(+1)	1.63(+1)	1.19(+1)	8.27(0)	5.23(-1)	3.64(0)	1.64(+1)	1.06(+1)	2.37(0)	2.38(0)
Xe^{131m}	4.92(-1)	3.88(-1)	2.75(-1)	2.24(-1)	1.85(-1)	2.66(-2)	0.98(-1)	2.85(-1)	2.41(-1)	0.81(-1)	8.50(-2)
Te^{132}	1.45(+1)	3.80(0)	1.09(0)	4.74(-1)	1.54(-1)	2.21(-4)	2.82(-2)	0.96(0)	1.82(-1)	5.97(-3)	5.16(-3)
I^{133}	2.04(-3)	9.07(-6)	- -	- -	- -	- -	- -	- -	- -	- -	- -
Xe^{133m}	1.56(-1)	2.26(-2)	4.0(-3)	1.24(-3)	2.48(-4)	- -	2.56(-5)	3.22(-3)	2.75(-4)	2.61(-6)	2.05(-6)
Xe^{133}	6.22(+1)	2.93(+1)	1.35(+1)	8.23(0)	4.38(0)	7.38(-2)	1.42(0)	1.29(+1)	5.47(0)	6.23(-1)	5.95(-1)
Cs^{136}	0.98(-1)	8.02(-2)	5.82(-2)	4.81(-2)	4.04(-2)	6.58(-3)	2.21(-2)	6.06(-2)	5.33(-2)	1.91(-2)	2.00(-2)
Cs^{137} - Ba^{137m}	3.48(-1)	4.09(-1)	4.07(-1)	4.15(-1)	4.78(-1)	3.63(-1)	3.76(-1)	4.40(-1)	6.52(-1)	5.12(-1)	5.71(-1)
Ba^{140} - La^{140}	1.03(+2)	8.38(+1)	6.07(+1)	5.01(+1)	4.20(+1)	6.74(0)	2.29(+1)	6.32(+1)	5.53(+1)	1.97(+1)	2.06(+1)
Ce^{141}	7.20(+1)	7.31(+1)	6.38(+1)	6.0(+1)	6.07(+1)	2.47(+1)	4.12(+1)	0.68(+2)	8.16(+1)	4.66(+1)	5.07(+1)
Ce^{143}	1.92(-1)	5.98(-3)	3.15(-4)	4.12(-5)	2.26(-6)	- -	- -	2.02(-4)	2.19(-6)	- -	- -
Pr^{143}	1.01(+2)	8.42(+1)	6.20(+1)	5.19(+1)	4.44(+1)	7.80(0)	2.48(+1)	6.49(+1)	5.83(+1)	2.19(+1)	2.29(+1)
Ce^{144} - Pr^{144}	1.14(+1)	1.33(+1)	1.31(+1)	1.32(+1)	1.50(+1)	1.06(+1)	1.16(+1)	1.44(+1)	2.04(+1)	1.55(+1)	1.73(+1)
Nd^{147}	4.24(+1)	3.26(+1)	2.25(+1)	1.81(+1)	1.46(+1)	1.88(0)	7.57(0)	2.33(+1)	1.90(+1)	6.08(0)	6.32(0)
Pm^{147}	1.55(0)	1.81(0)	1.76(0)	1.83(0)	2.10(0)	1.56(0)	1.65(0)	1.98(0)	2.86(0)	2.23(0)	2.48(0)
Pm^{149}	1.13(0)	1.54(-1)	2.62(-2)	7.95(-3)	1.51(-3)	- -	1.48(-4)	2.09(-2)	1.67(-3)	1.41(-3)	1.10(-3)
Pm^{151}	3.94(-3)	6.80(-5)	2.25(-6)	- -	- -	- -	- -	1.34(-6)	- -	- -	- -
Sm^{151}	8.44(-3)	0.99(-2)	0.99(-2)	1.01(-2)	1.16(-2)	8.84(-3)	0.91(-2)	1.09(-2)	1.59(-2)	1.25(-2)	1.39(-2)
Sm^{153}	6.52(-2)	6.48(-3)	0.85(-3)	2.15(-4)	3.11(-5)	- -	2.25(-6)	6.48(-4)	3.36(-5)	- -	- -
Eu^{155}	2.80(-2)	3.28(-2)	3.24(-2)	3.29(-2)	2.77(-2)	2.78(-2)	2.94(-2)	3.57(-2)	5.13(-2)	3.97(-2)	4.42(-2)
Eu^{156}	2.10(-1)	1.80(-1)	1.39(-1)	1.18(-1)	1.04(-1)	2.17(-2)	6.07(-2)	1.45(-1)	1.38(-1)	5.62(-2)	5.94(-2)

*Read 0.183(-6) as 0.183×10^{-6}

amount of U^{235} in the small piece, and corrected for flux depression. The flux-depression factor was obtained from the aluminum-uranium wire-activation results. Table A-5 gives, for comparison, both the measured and computed inventories of Cs^{137}, Zr^{95}, and Ce^{144}.

A-2 Furnace and Related Equipment

A-2.1 Furnace

Induction-type furnaces (Fig. A-1) with radiation (lead) shielding built into the furnace walls were used to melt the ANP metallic-type fuel elements. The lead shielding was of sufficient thickness to meet Bureau of Explosives standards, thus allowing their use as shipping casks. Fuel-element specimens were loaded in the furnace casks at NRTS and shipped by truck to the test site at Dugway Proving Ground, Utah. After the fuel elements were melted, the furnaces were sealed shut, decontaminated, and trucked back to NRTS for burial.

A-2.2 Furnace Power Supply and Coolant System

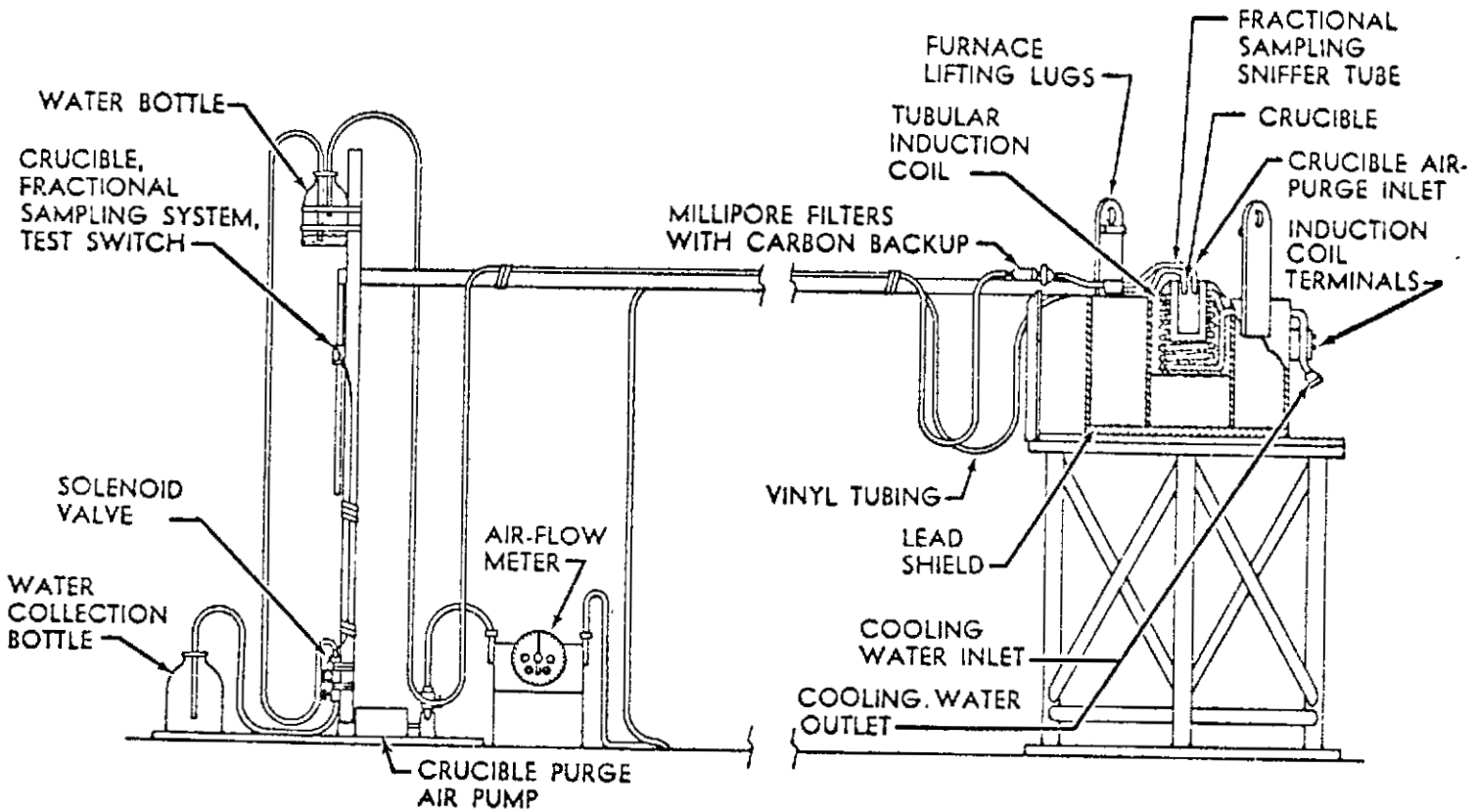
A 60-kw, air-cooled, motor-generator set was mounted in the furnace-control trailer 300 feet upwind from the furnace. The motor-generator set was serviced by a 100-kw, 440-volt, 3-phase, 60-cycle engine-driven generator. The motor-generator output (10-kc, single-phase, 440-volt maximum) was adjusted by a continuously variable field supply in the control consoles.

TABLE A-5

COMPARISON OF MEASURED AND COMPUTED INVENTORIES

(curies at release time)

Release	Cs^{137}			Zr^{95}			Ce^{144}		
	Computed	Measured	Ratio	Computed	Measured	Ratio	Computed	Measured	Ratio
1	0.348	0.293	1.19	47.5	37.9	1.25	11.5	10.2	1.13
2	0.410	0.271	1.51	51.9	40.9	1.28	13.4	10.4	1.29
3	0.407	0.189	2.15	48.3	23.6	2.04	13.1	6.57	1.99
4	0.424	0.285	1.49	47.3	37.4	1.26	13.2	10.0	1.32
5	0.478	0.570	0.84	51.0	65.9	0.77	14.9	17.6	0.85
6	0.364	0.281	1.30	28.3	26.2	1.08	10.6	9.77	1.09
7	0.376	0.280	1.34	37.2	25.1	1.48	11.6	9.18	1.28
8	0.449	0.276	1.63	52.7	37.9	1.39	14.4	9.86	1.46
9	0.652	0.399	1.63	69.0	43.3	1.59	20.4	13.2	1.55
10	0.512	0.313	1.64	46.2	27.8	1.66	15.5	9.63	1.61
11	0.571	0.466	1.23	50.9	44.6	1.14	17.3	14.9	1.16



NPC 11,994

FIGURE A-1. INDUCTION-FURNACE ASSEMBLY CROSS-SECTIONAL VIEW

The control console, located 20 feet from the motor-generator set, included (1) a push-button remote control for the motor-generator starter; (2) a continuously variable generator field supply with panel ammeter, (3) a main-line contactor for the generator-to-furnace transformer and capacitor bank; (4) panel meters for generator voltage, amperage, and power; (5) a ground detector unit, (6) switches for the two water-coolant pumps; (7) sampling-flask controls; and (8) a 110-volt service outlet.

The capacitor bank with jumpers provided 7.5- to 303.5-kvar in 7.5-kvar steps to tune the induction coil to resonance. A variable-ratio transformer provided impedance-matching between the induction coil and the motor-generator set.

A water pressure of about 30 psig was supplied by a water-coolant system for the capacitor bank, transformer, and induction coil. The warm water was returned to a 1,000-gallon tank located 50 feet from the furnace.

A-2.3 Effluent Sampling

Sampling of the effluent (excluding noble gases) during the open releases was made at a point 3 inches below the crucible rim by means of a sniffer-tube assembly (Fig. A-1). The sniffer tube was connected to (1) a Gelman filter holder containing glass wool and three millipore-type AA filters; (2) a charcoal filter; and (3) a vessel containing water. A system of valves controlled the flow rate of the water from the vessel.

The amount of displaced water determined the volume of gas sampled. The flow rate of the water, measured at the beginning and the end of the sampling cycle, varied less than 1% from changes in the head of the water. The volume of the gas sample and the purge rate of the crucible were recorded at local barometric pressure. The fraction of the effluent sampled by the sniffer-tube assembly was known to within ± 2% - a figure representing the sum of errors in the purge rate and the water-volume void (Table A-6).

Gas sampling and crucible purge were started at time zero (moment of application of power to the furnace) to ensure collection of iodine which could be evolved at a relatively low temperature of the charge (fuel element). The minimum rate of discharge of activity from the crucible occurred about 18 minutes after time zero, at which time the dummy fuel-element stages were observed to start melting. Power to the furnace was cutt off after about 31 minutes.

The time interval from application of power to start of metling of the charge was considerably longer than that for FRT I. This was because of the presence of the 1/8-inch-wall mullite crucible that served as a thermal barrier and protected the charge from reacting with the graphite crucible. The thermal barrier resulted in a high temperature of the graphite crucible and caused the Pt, Pt-Rh thermocouple in the wall of the graphite

TABLE A-6

EFFLUENT SAMPLING DATA

Release	Type	Date	Time Zero	Furnace and Stage	Purge Rate (ℓ/min)	Sampling Rate (ℓ/min)	Sampling Time (min)	Effluent Coefficient (%)
1	To arcs	Wednesday 5 Aug. 59	0002	F2-S3 (1-M-1)	17.8	0.080	23.5	0.45
2	To arcs	Monday 10 Aug. 59	2336	F7-S2 (1-M-1)	13.2	0.048	31	0.36
3	To arcs (Animals Exposed)	Tuesday 8 Sept. 59	0241	F8-S2 (1-F-34)	12.6	0.032	34	0.25
4	To arcs (Animals Exposed)	Saturday 12 Sept. 59	0143	F4-S3 (1-F-34)	11.9	0.055	29	0.46
5	To arcs	Friday 18 Sept. 59	0219	F3-S4 (1-F-34)	12.2	0.040	31.4	0.33
6	Contained	Thursday 24 Sept. 59	1300	F6-S1 (1-M-1)			35	100
7	Contained	Thursday 24 Sept. 59	1758	F9-S1 (1-F-34)			35	100
8	To arcs	Wednesday 30 Sept. 59	0207	F1-S1 (1-F-35)	11.3	0.041	31	0.36
9	Contained	Friday 9 Oct. 59	1500	F10-S5 (1-F-35)			35	100
10	To arcs	Saturday 24 Oct. 59	0735	F11-S2 (1-F-35)	17.98	0.0013	43	0.07
11	To arcs	Sunday 25 Oct. 59	0435	F15-S4 (1-F-35)	20.2	0.027	31	0.14

crucible to melt at about the time the temperature was leveling off for the 10-minute, constant-melt-temperature part of the heat cycle.

Because of broken thermocouple circuits, the temperature cycles for Releases 5, 8, 9, and 11 were controlled by power programs to the furnace. Justification for this procedure was based on the close correlation between measured temperatures and recorded power inputs observed during other releases. Detailed data on the furnace-power program are presented in Figures A-2 through A-4 and in Table A-7.

A-2.4 Total Effluent Collection

Total effluent collection was accomplished with a filter-type collector mounted on top of the furnace during the melt (Fig. A-5). The effluent was drawn up through the collector, past a series of cooling coils, stainless-steel wool, millipore filters, and stainless-steel balls coated with sodium-hydroxide. Air was forced into the furnace crucible to purge the effluent through the collector. On the exit tube, an iodine scrubber was attached to make certain that all iodine was collected. The escaping gas was monitored for beta-gamma activity to assure that the other isotopes were collected.

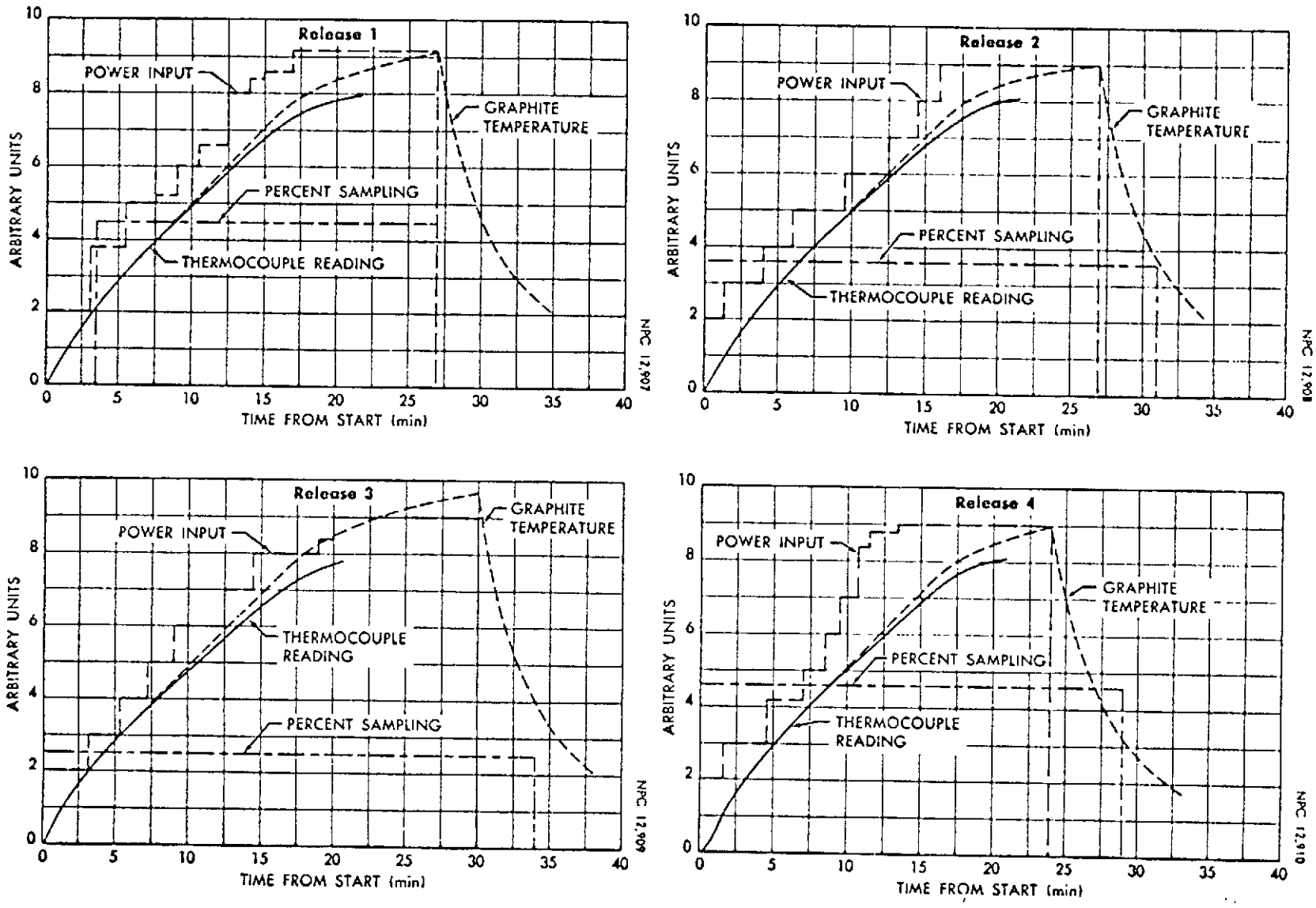


FIGURE A-2. FURNACE POWER PROGRAM: RELEASES 1, 2, 3, AND 4

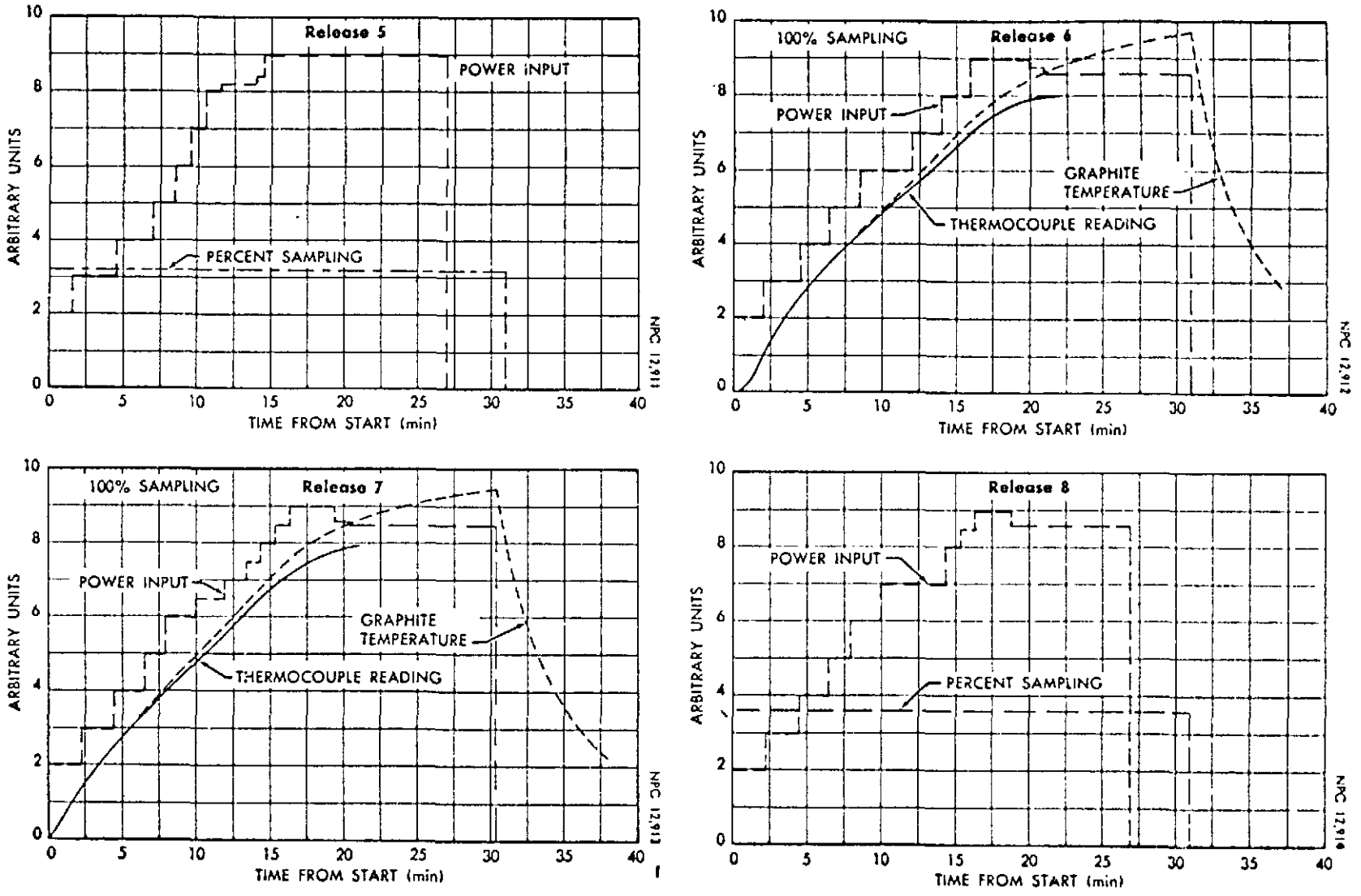


FIGURE A-3. FURNACE POWER PROGRAM: RELEASES 5, 6, 7, AND 8

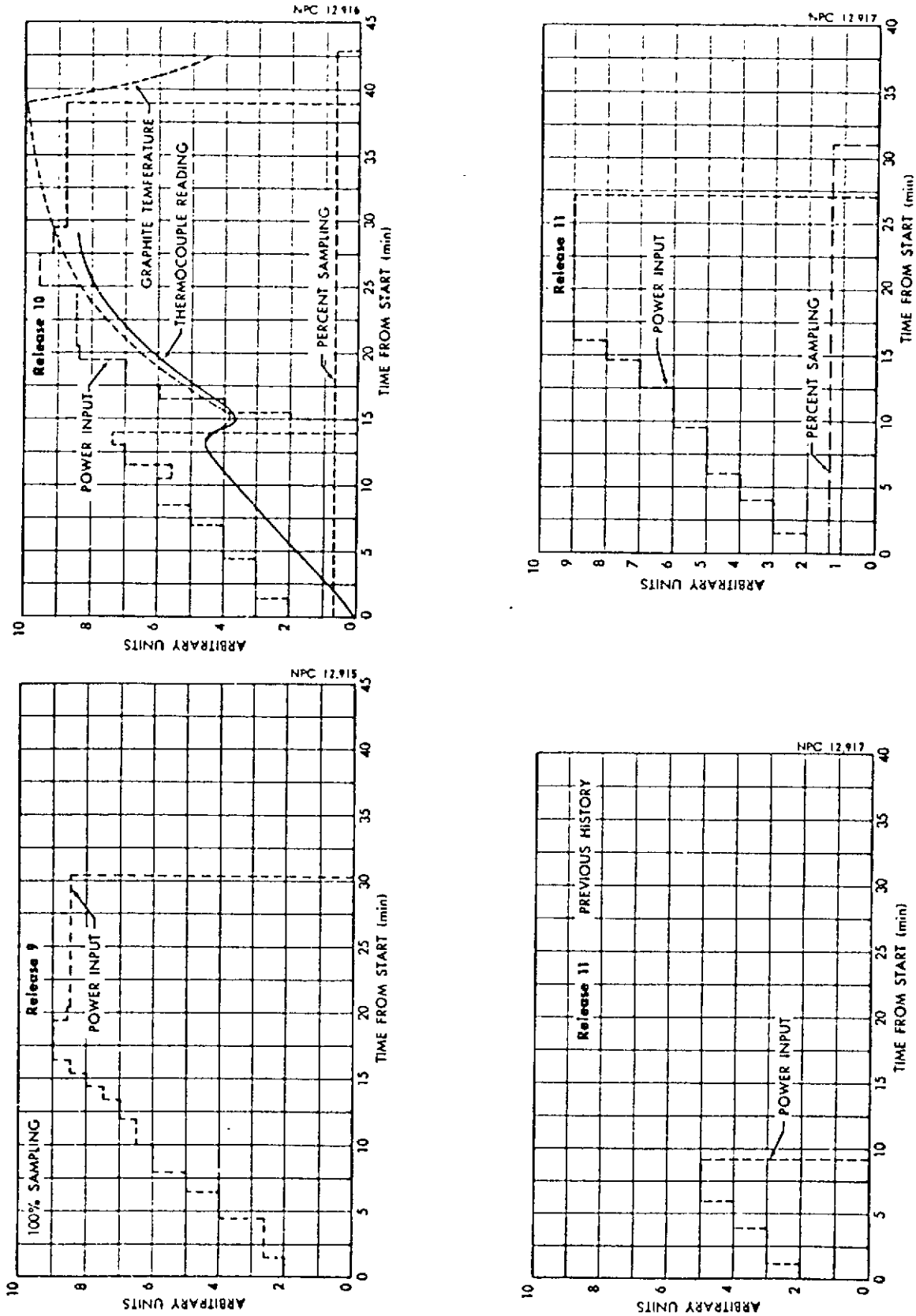


FIGURE A-4. FURNACE POWER PROGRAM: RELEASES 9, 10, AND 11

TABLE A-7

FURNACE-POWER PROGRAM

Release	Time After Power On (min)	Panel Meters: Current (amps)	Voltage (volts)	Power (kw)	Reactive Power (kvar)	Field Current (amps)
Release 1	0					
	3.0	85	230	19	-2.0	1.8
	5.5	90	230	25	-3.0	2.2
	7.5	100	250	26	-3.0	2.2
	9.0	108	313	30	-3.5	2.5
	10.5	115	310	33	-3.0	2.65
	12.5	122	340	40	-4.5	3.1
	14.0	130	340	42	-4.0	3.1
	15.0	-	342	43	-4.0	3.2
	17.0	-	-	46	-	-
	18.0	140	330	46	-2.0	3.2
	27.0	Stop power				
	31.0	Stop purging and gas-sampling				
Release 2	0	70	155	10	-1.0	1.2
	1.25	85	190	15	-1.0	1.5
	4.0	96	220	20	-2.0	1.8
	6.0	105	260	25	-2.0	2.1
	9.5	120	280	30	-3.0	2.4
	12.5	128	300	35	-3.0	2.7
	14.5	140	320	40	-4.0	2.9
	16.0	142	325	45	-4.0	3.2
	27.0	Stop power				
	31.0	Stop purging and gas-sampling				
Release 3	0	75	150	10	-1.0	1.4
	3.15	80	180	15	-2.0	1.7
	5.45	100	220	20	-2.0	2.0
	7.25	110	240	25	-4.0	2.4
	9.0	120	275	30	-4.0	2.6
	12.5	130	285	35	-5.0	2.9
	14.5	140	300	40	-6.0	3.2
	18.5					
	19.0					
	19.0	140	318	42	-6.0	3.2
	20.0	142	320	45	-6.0	3.4
	30.0	Stop power (late because of slow temperature rise)				
	34.0	Stop purging and gas-sampling				
Release 4	0	70	150	10	-1.0	1.2
	1.5	82	185	15	-2.0	1.6
	4.5	92	230	21	-2.0	2.0
	7.0	104	250	25	-2.0	2.2
	8.5	112	280	30	-3.0	2.6
	9.5	121	300	35	-4.0	2.8
	10.8	132	320	42	-4.0	3.2
	11.5	138	332	44	-4.0	3.3
	13.5	140	335	45	-4.0	3.4
	17.5	142	322	45	-4.0	3.4
	24.1	Stop power and gas purging				
	29	Stop gas-sampling				

TABLE A-7 (Cont'd)

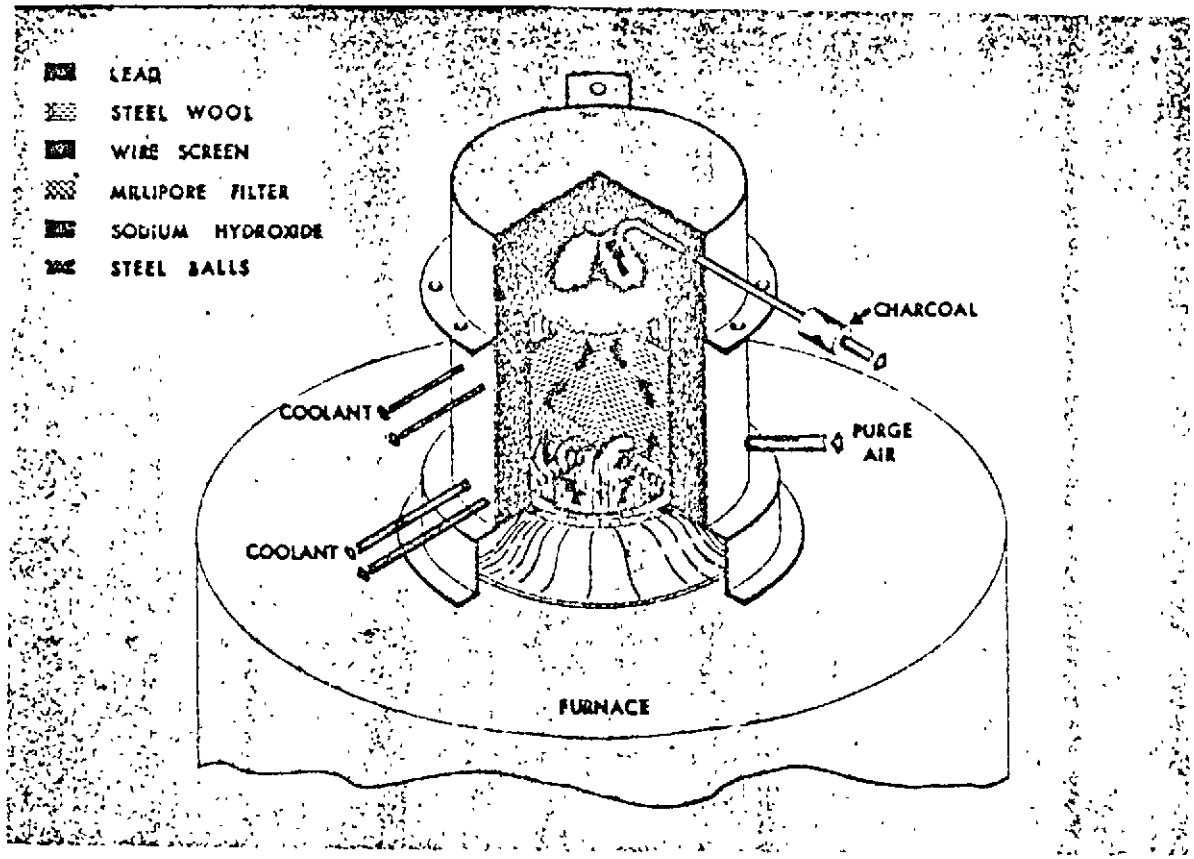
FURNACE-POWER PROGRAM

Release	Panel Meter					
	Time After Power on (min)	Current (amps)	Voltage (volts)	Power (kw)	Reactive Power (kvar)	Field Current (amps)
Release 5	0	73	150	10	-2.0	1.2
	1.5	86	190	15	-2.0	1.6
	4.5	100	210	20	-3.0	1.9
	7.0	110	240	25	-4.0	2.3
	8.5	122	260	30	-4.0	2.5
	9.5	132	290	35	-5.0	2.8
	10.5	141	300	40	-6.0	3.1
	11.5	146	300	41	-6.0	3.2
	13.0			41		
	14.5	150	320	45	-6.0	3.35
	27.0	Stop power				
	31.0	Stop purging and gas-sampling				
Release 6	0			10		
	2.0			15		
	4.5			20		
	6.5			25		
	8.5			30		
	12.0			35		
	14.0	124	340	40	-3.0	2.9
	16.0	130	360	45	-4.0	3.2
	19.0	132	355	45	-3.5	3.05
	20.0	130	350	44	-3.0	3.0
	21.0	130	345	43	-3.0	2.95
	31.0	Stop power				
	35.0	Stop purging				
Release 7	0			10.0		
	2.0	84	182	15.0	-0.5	1.5
	4.5	95	215	20.0	-0.5	1.8
	6.5	102	225	25.0	-1.0	2.1
	8.0		282	30.0	-2.0	2.4
	10.0	118	298	32.5	-2.0	2.6
	12.0	122	300	35.0	-2.0	2.7
	13.5	126	309	37.5	-2.2	2.8
	14.5	132	318	40.0	-2.2	2.95
	15.5	138	322	42.5	-2.2	3.05
	16.5	140	338	45.0	-2.4	3.2
	19.5	141	320	43.0	-2.0	3.0
	20.5	140	315	42.5	-2.0	2.95
	25.0	140	310	42.5	-1.5	2.95
	30.5	Stop power				
	35.0	Stop purging				
Release 8	0	74	140	10.0	-1	1.35
	2.0	90	162	15.0	+0.5	1.55
	4.5	100	198	20.0	+0.5	1.8
	6.5	110	220	25.0	+0.75	2.05
	8.0	125	250	30.0	+1.0	2.4
	10.0	130	260	35.0	+1.0	2.7
	12.0	139	258	35.0	+1.0	2.7
	14.5	146	282	40.0	+1.0	2.9
	15.5	150	290	42.5	+1.5	3.0
	16.5	155	290	45.0	+1.5	3.2
	19.0	156	280	43.0	+1.0	3.1
	25.0	150	260	40.0	+0.75	2.8
	27.0	Stop power				
	31.0	Stop purging and gas-sampling				

TABLE A-7 (Cont'd)

FURNACE-POWER PROGRAM

Release	Panel Meters					
	Time After Power on (min)	Current (amps)	Voltage (volts)	Power (kw)	Reactive Power (kvar)	Field Current (amps)
Release 9	0	85	138	10.0	0	1.1
	1.5	95	140	13.0	-0.5	1.3
	4.5	125	182	20.0	0.0	1.9
	6.5	132	199	25.0	+0.25	1.95
	8	110	197	30.0	+0.50	2.2
	10	112	202	32.5	+0.50	2.4
	12	118	220	35.0	+1.0	2.6
	13.5	122	222	37.5	+1.0	2.65
	14.5	128	285	40.0	+1.0	2.80
	15.5	130	293	42.5	+1.0	2.95
	16.5	138	350	45.0	+1.0	3.0
	19.5	135	335	43.0	+1.0	2.8
	20.5	135	332	42.5	+2.0	2.75
	30.5					
	35	Stop power				
	55	Stop purging and coolant pump				
Release 10	0	85	135	10.0	-1.0	1.2
	1.5	102	162	15.0	-1.5	1.5
	4.5	120	180	20.0	0	1.65
	7.0	128	200	25.0	+0.5	1.8
	8.5	140	250	30.0	+2.0	2.2
	10.5	140	220	28.0	0	2.2
	11.5	140	260	35.0	+1.5	2.0
	13	145	280	37.0	+2.0	2.23
	14					
	15					
	15.5	122	180	20.0	0	1.8
	16.5	140	240	30.0	+0.2	2.2
	17.5	135	290	35.0	+5.0	2.2
	19.5	118	380	42.0	-2.0	2.95
	20.5	120	390	42.5	-4.0	3.2
	25	180	300	48.0	+2.0	3.2
	27.5	180	280	46.0	+0.5	3.1
	29.5	180	275	44.0	0	3.2
	39	Stop power				
Note: Leak in 100-kw-generator fuel line caused generator to fluctuate, which in turn caused 10 kc motor generator to drop load several times.						
Release 11	0	75	120	10	-0.25	1.2
	1.5	92	162	15	-0.25	1.6
	4.0	102	198	20	0	1.8
	6.0	112	220	25	+0.25	2.0
	9.5	125	242	30	+0.25	2.4
	12.5	137	263	35	+0.25	2.7
	14.5	145	280	40	0	2.95
	16.0	152	300	45	+0.2	3.2
	27.0	Stop power				
	31.0	Stop purging and sampling				



NPC 12,598

FIGURE A-5. TOTAL EFFLUENT COLLECTOR - INTERNAL VIEW

APPENDIX B

RELEASE PERCENTS

During FRT II, two methods were used to determine release percents for the biologically hazardous isotopes released from ANP-type metallic fuel elements under slow-meltdown conditions. One method involves fractional sampling and the other, network arc integrals. Direct measurements of release percents were obtained by analyzing fractional samples of the radioactive effluent; estimates of release percents were made on the basis of network arc integrals.

Details of these two methods, along with tabulated data, are given in Sections B-1 and B-2.

B-1. Fractional Sampling

Samples obtained by total and partial sampling of the effluent were radiochemically analyzed in the hot-cell facilities of Phillips Petroleum Company at NRTS. The methods used in the determination of the various element can be found in the Phillips Petroleum Company Idaho Operations Office reports listed below:

ID014315 "The Determination of Barium and Strontium."

ID014315 "The Determination of Cerium."

ID014315 "The Determination of Total Rare Earths."

ID014481 "The Heterogeneous Isotopic Exchange."

ID014316 "Pellet Fluorophotometric Determination of Uranium with Preliminary Liquid-Liquid Extraction." (U-Fluor-1, Mod. 3)

ID014495 "Gamma Spectral Analysis."

Table B-1 gives the original results that were sent to Convair from Phillips Petroleum Company (Ref. 6). All analyses were made between 0800 and 1630 on the dates indicated and are reported as disintegrations per minute (d/min) for each nuclide in the total sample. The following techniques were employed in finding the disintegration rates:

Strontium was beta-counted and the disintegration rate calculated; a correction was made for self-absorption.

After the barium was separated, it was allowed to stand until the lanthanum had grown in and equilibrium was reached. The sample was then scanned on a gamma spectrometer, and the disintegration rate calculated from the 1.6-Mev lanthanum gamma.

Total rare earth (TRE) samples were beta-counted two hours after the time of final separation. The efficiency factor used to convert counts to disintegrations was that used for a 0.7-Mev beta. Since many betas could be involved, one considered to be of average energy was selected.

Cerium and iodine were separated and scanned on a gamma spectrometer. Their activities were calculated by using their respective index photopeaks for area determinations.

The fission-products inventories calculated from the fuel-element irradiation histories, combined with the results in Table B-1, give the release percents presented in Table B-2. The standard deviations for the average release percents indicate the wide range of the results, which are, nevertheless, felt to

TABLE B-1

ISOTOPIC INVENTORIES IN THE FRACTIONAL EFFLUENT COLLECTORS
(d/min)

Isotope	Method Date	RELEASE NUMBER 1	2	3	4	5	6	7	8	9	10	11
I^{131}	Chem. Date	2.24(+7)* 10-28	5.00(+6) 10-28	1.23(+8) 10-29	5.89(+8) 10-29	5.08(+7) 10-29	3.07(+8) 12-11	3.04(+9) 12-14	2.87(+8) 11-17	1.02(+10) 12-14	1.90(+8) 11-17	1.20(+8) 11-17
	PHA Date	< 2(+6) 12-23	< 1(+6) 11-25	< 5(+6) 12-16	~2(+7) 12-5	< 3(+6) 12-3	1.56(+8) 12-17	3.15(+9) 12-17	7.12(+7) 12-3	6.75(+9) 12-17	< 3(+7) 12-3	< 2(+7) 12-3
	(Carbon Filter) Date	4.61(+5) 10-28	4.41(+5) 10-28	1.11(+7) 10-30	7.83(+6) 10-30	4.76(+4) 10-30	3.66(+6) 12-16	7.26(+7) 12-16	1.53(+5) 12-16	8.89(+6) 12-16	1.81(+4) 12-16	1.20(+4) 12-16
Cs^{137}	PHA Date	7.66(+8) 12-3	1.05(+8) 12-3	1.14(+9) 12-3	6.68(+8) 12-3	1.18(+7) 12-3	8.04(+10) 12-17	3.99(+10) 12-17	1.16(+8) 12-3	4.14(+10) 12-10	8.21(+8) 12-3	1.19(+9) 12-3
	(Carbon Filter) Date	- - - - - -	- - - - - -	8.80(+5) 10-30	- - - - - -	- - - - - -	2.49(+6) 12-16	3.52(+7) 12-16	- - - - - -	- - - - - -	- - - - - -	- - - - - -
Zr^{95}-Nb^{95}	PHA Date	- - - - - -	- - - - - -	- - - - - -	- - - - - -	- - - - - -	1.40(+10) 12-17	2.72(+9) 12-17	1.10(+9) 12-3	6.40(+10) 12-10	- - - - - -	1.68(+8) 12-3
	(Carbon Filter) Date	- - - - - -	- - - - - -	- - - - - -	- - - - - -	- - - - - -	- - - - - -	- - - - - -	1.59(+4) 12-16	- - - - - -	1.81(+4) 12-16	1.20(+4) 12-16
$Ce^{141-144}$	Chem. Date	< 2(+5) 11-19	< 2(+5) 11-19	< 2(+6) 11-19	< 2(+6) 11-20	< 2(+5) 11-20	2.36(+9) 12-17	6.41(+8) 12-17	1.35(+8) 12-18	1.26(+10) 12-17	< 2(+6) 11-24	< 2(+6) 11-23
	PHA Date	- - - - - -	- - - - - -	- - - - - -	- - - - - -	- - - - - -	2.02(+9) 12-17	1.66(+8) 12-17	2.03(+8) 12-17	1.46(+10) 12-10	- - - - - -	- - - - - -
Ba^{140}-La^{140}	Chem. Date	1.43(+5) 10-26	3.80(+4) 10-28	9.93(+4) 12-17	1.69(+4) 12-17	1.16(+5) 12-2	2.76(+7) 12-17	1.83(+7) 12-17	4.37(+6) 12-17	1.13(+9) 12-17	2.30(+5) 12-17	8.93(+5) 12-17
	PHA Date	- - - - - -	- - - - - -	- - - - - -	- - - - - -	- - - - - -	- - - - - -	- - - - - -	- - - - - -	1.30(+9) 12-17	- - - - - -	- - - - - -
$Ru^{103-106}$	PHA Date	8.23(+7) 12-3	1.00(+8) 12-3	4.03(+8) 12-3	1.63(+8) 12-3	1.72(+7) 12-3	1.78(+10) 12-17	7.22(+9) 12-17	3.32(+8) 12-3	4.06(+9) 12-10	1.61(+9) 12-3	1.40(+9) 12-3
Sr^{89-90}	Chem. Date	1.19(+5) 11-5	7.78(+4) 11-6	4.25(+6) 11-10	8.89(+5) 11-10	3.14(+5) 11-11	8.15(+8) 12-3	8.10(+8) 12-9	1.06(+8) 11-25	1.31(+10) 12-10	8.12(+5) 11-30	1.54(+7) 11-30
Total Rare Earths	Chem. Date	< 5(+5) 12-22	< 2(+5) 12-22	< 3(+6) 12-22	< 2(+6) 12-22	< 1(+5) 12-22	5.6(+9) 12-22	1.27(+9) 12-22	9.96(+7) 12-22	2.65(+10) 12-22	< 6(+6) 12-22	< 9(+6) - - -
Uranium (grams)	Chem. Date	3.4(-5) - - -	< 2(-5) - - -	1.3(-4) - - -	< 2(-5) - - -	< 2(-5) - - -	8.1(-3) - - -	< 5(-4)	2.6(-5)	8.7(-3) - - -	4.1(-5)	2.9(-4)

*Read 2.24(+7) as 2.24×10^7

TABLE B-2

ISOTOPIC RELEASE PERCENTS FROM FRACTIONAL SAMPLING

Release	U^{235}	I^{131}		Cs^{137}	$Ru^{103-106}$	Sr^{89-90}	$Ce^{141-144}$		$Ba^{140}-La$	% of Effluent Analyzed
	Chem.	Chem	PHA	PHA	PHA	Chem.	Chem.	PHA	Chem.	
1	0.013	8	–	22	0.2	0.00009	<0.0001	– –	0.001	0.45
2	<0.013	2	5	3	0.3	0.00006	<0.001	– –	0 0004	0.36
3	0.082	11	27	51	0.1	0.004	<0.001	– –	0.007	0.25
4	<0.007	28	22	16	0.2	0.0005	<0.0007	– –	0.0006	0.46
5	<0.01	3	4	0.3	0.03	0.0002	<0.00009	– –	0.002	0.33
6*	0.014	22	19	10	0.2	0.004	0.008	0.007	0.02	100.00
7*	<0.0008	33	45	4	0.05	0.003	0.001	0.0004	0.003	100.00
8	0.011	14	14	32	0.3	0.06	0.07	0.10	0.06	0.36
9*	0.013	13	11	3	0.01	0.02	0.02	0.02	0.04	100.00
10	0.088	41	24	100	0.08	0.001	<0.003	– –	0.01	0.07
11	0.31	12	8	67	3	0.02	<0.001	– –	0.02	0.14
Average No. of Determinations	0.076±0.109 [7]	16 ± 11 [19]		28 ± 32 [11]	0.49±1.0 [11]	0.010±0.018 [11]	0.025±0.035 [9]		0.015±0.019 [11]	

*Contained Releases (100% Sampling)
Health Physics survey of furnace pad area indicated that activity escaped total collector during Contained Release 9.

be valid. For the case of I^{131}, wet-chemistry (chem.) and pulse-height analysis (PHA) results are in general agreement – the average difference being less than 28%.

Comments taken from the FRT-II log book regarding furnace operation anomalies that may have affected the release percents are:

- Release 11 had a prior partial melt history that may have caused the lower release percentage of I^{131}.
- Releases 5, 8, 9, and 11 were temperature-controlled by programming the power input to be similar to previous releases.
- Release 10 was taken up to power and the furnace power accidentally cut off at t_o + 14 minutes. The power was restored at t_o + 15 minutes and may have resulted in a temperature excursion.
- The crucible cracked on Release 8. About 1/4 cup of Pb shielding ran out of the front of the furnace. Flames and sparks issued from the crucible to a height of about 18 inches above the furnace.

B-2. Network Arc Integrals

The arc integral of the time-integrated air concentration of activity, given in Table B-3, is:

$$A_k = I_k R_k x$$

where I_k is the isotopic fuel-element inventory

R_k is the isotopic release percent

x is the atmospheric depletion factor.

TABLE B-3

ISOTOPIC ARC INTEGRALS
(curie-sec/meter^2)

Isotope	Arc	Release Number 1	2	5	8	10	11
I^{131}	100m	- - -	- - -	- - -	- - -	6.62(-2)	1.23(-3)
	1000m	4.17(-1)*	2.99(-1)	8.95(-2)	6.21(-1)	4.63(-2)	2.05(-2)
	2000m	2.27(-1)	2.07(-1)	5.43(-2)	5.51(-1)	3.48(-2)	2.54(-2)
	4000m	- - -	2.59(-1)	4.94(-2)	3.55(-1)	2.01(-2)	2.08(-2)
	8000m	9.63(-2)	2.07(-2)	4.22(-3)	2.67(-2)	1.08(-2)	- - -
	16000m	1.65(-1)	1.50(-2)	6.32(-3)	6.37(-2)	8.63(-3)	5.06(-3)
	32000m	5.07(-2)	5.18(-2)	6.33(-3)	1.17(-2)	- - -	- - -
Cs^{137}	100m	- - -	- - -	- - -	- - -	1.15(-2)	4.83(-3)
	1000m	1.28(-3)	1.53(-3)	2.09(-3)	5.02(-3)	7.75(-3)	3.86(-3)
	2000m	8.7(-4)	1.35(-3)	8.04(-4)	7.87(-3)	6.31(-3)	4.64(-3)
	4000m	- - -	8.31(-4)	6.44(-4)	5.22(-3)	4.05(-3)	2.97(-3)
	8000m	2.85(-4)	1.70(-4)	6.73(-5)	1.46(-4)	1.09(-3)	- - -
	16000m	7.55(-4)	1.18(-4)	6.64(-5)	8.21(-4)	2.17(-3)	1.08(-3)
	32000m	2.15(-4)	5.39(-4)	7.54(-5)	5.16(-5)	- - -	- - -
Ru^{103}	100m	- - -	- - -	- - -	- - -	4.20(-2)	2.04(-2)
	1000m	1.88(-3)	2.24(-3)	1.52(-3)	2.96(-2)	2.25(-2)	1.52(-2)
	2000m	1.23(-3)	1.69(-3)	5.63(-4)	4.54(-2)	2.08(-2)	1.46(-2)
	4000m	- - -	6.97(-4)	2.98(-4)	2.31(-2)	1.34(-2)	5.51(-3)
	8000m	4.04(-4)	3.42(-4)	4.77(-5)	1.33(-3)	3.45(-3)	- - -
	16000m	1.01(-3)	1.93(-4)	1.21(-4)	4.67(-3)	4.67(-3)	3.46(-3)
	32000m	2.88(-4)	1.18(-3)	8.87(-5)	1.43(-4)	- - -	- - -
Te^{127m}	1000m	1.38(-4)					
Te^{129m}	1000m	2.92(-3)					

*Read 4.17(-1) as 4.17 x 10

To obtain a relative release percent for isotope i, assume isotope k has a given release percent R; then the relative release percent of isotope i is

$$R_i = \frac{A_i I_k R}{A_k I_i}$$

Release percents normalized to a 24% release of I^{131} are presented in Table B-4 for Cs^{137}, Ru^{103}, Te^{127m}, and Te^{129m}.

TABLE B-4

RELATIVE RELEASE PERCENTS BASED ON ARC INTEGRALS
(Normalized to 24% Release of I^{131})

Isotope	Release Number	100-Meter Arc	1000-Meter Arc	2000-Meter Arc	4000-Meter Arc	8000-Meter Arc	16000-Meter Arc	32000-Meter Arc
Cs^{137} ($\bar{x}$=12±6)*	1		9.1	11		8.6	13	12
	2		8.1	10	5.3	13	12	16
	5		9.6	6.2	5.3	6.7	4.3	4.8
	8		7.2	12	13	4.8	12	13.8
	10	19	19	20	22	11	28	
	11		19	18	14	21		
Ru^{103} ($\bar{x}$=.67± 0.57)*	1		0.15	0.18		0.14	0.21	0.19
	2		0.16	0.17	0.058	0.35	0.27	0.48
	5		0.12	0.086	0.043	0.081	0.14	0.10
	8		0.62	1.05	0.86	0.67	0.96	1.6
	10	1.6	1.2	1.5	1.6	0.77	1.3	
	11		1.7	1.3	0.62		1.5	
Te^{127m}	1		0.24					
Te^{129m}	1		0.61					

* $\bar{x}$ = Mean ± σ for all arcs and all releases

APPENDIX C

PARTICLE SIZE

Two methods were used to obtain information on particle sizes of released fission products. One method utilized an Andersen sampler with a carbon-millipore backup: each of the six stages of this cascade-type sampler has a unique size range associated with it. The second method, applicable only to iodine-particle sizing, determined the percent of effluent that passed through a prefilter and was collected on a backup carbon cartridge. Data obtained by these methods on the three isotopes of major concern - I^{131}, Cs^{137}, and Ru^{103} - are discussed below.

Iodine 131

Every field sampler contained a backup filter that was 100% efficient in the collection of iodine. Prefilters of two types were used: the millipore filter, which has a collection efficiency of 99% for particles larger than 0.05 microns; and the pleated filter, which has a collection efficiency of 99.98% for particles larger than 0.3 microns.

Millipore prefilters were used on all arcs during Releases 1 and 2, and pleated filters were used on the 0.1-, 16-, and 32-kilometer arcs during Releases 3, 4, 5, 8, 10, and 11. The results for the 16- and 32-kilometer arcs (Table C-1) indicate that pleated

TABLE C-1

PERCENT OF I^{131} COLLECTED ON THE CARBON CARTRIDGE

Release	100-Meter Arcs	1000-Meter Arcs	2000-Meter Arcs	4000-Meter Arcs	8000-Meter Arcs	16000-Meter Arcs	32000-Meter Arcs
1	-	62±3 [4]	53±9 [10]	55±17 [2]	65±10 [10]	50±19 [23]	41±9 [16]
2	-	61±9 [8]	52±9 [7]	53±7 [13]	57±10 [13]	51±7 [15]	32±8 [24]
3	-	76±5 [22]	-	-	-	-	-
4	-	65±4 [21]	-	-	-	-	-
5	-	59±9 [16]	63±12 [28]	66±7 [15]	81±8 [10]	30±5 [11]	24±9 [16]
8	-	77±13 [5]	76±19 [10]	72±6 [7]	82±3 [4]	19±8 [15]	24±3 [5]
10	16±19 [11] *	71±4 [13]	70±5 [20]	61±6 [15]	76±6 [8]	18±6 [11]	14±5 [6]
11	-	81±8 [6]	-	-	-	19±8 [7]	-
Averages	16±19 [11]	68±10 [95]	64±13 [75]	61±9 [52]	70±13 [45]	35±19 [82]	30±11 [67]

[ ] Number of determinations.

filters have a higher iodine-collection efficiency than the millipore filters. These findings do not agree with the manufacturer's specified collection efficiencies, but the anomoly may be caused by the higher flow rate through, of the denser path offered by, the pleated filters. The average network flow rates are given in Table C-2.

TABLE C-2

AVERAGE FLOW RATES OF SAMPLERS

Sampler	Location	Flow Rate (m^3/sec)
Andersen Samplers	Charged Wire Locations and 100-Meter Arc	$(7.0\pm0.6)\times10^{-4}$ [35] *
Pleated Filter	100-Meter Arc	$(8.9\pm0.9)\times10^{-3}$ [30]
Millipore Filter	1000-, 2000-, 3000-Meter Arcs	$(6.8\pm0.7)\times10^{-4}$ [363]
Millipore Filter	8000-Meter Arc	$(1.7\pm0.2)\times10^{-3}$ [162]
Millipore Filter	16000- and 32000-Meter Arcs	$(5.9\pm0.5)\times10^{-3}$ [150]
Pleated Filter	16000- and 32000-Meter Arcs	$(9.0\pm1.2)\times10^{-3}$ [271]

*Number of Determinations

Andersen-sampler results show that, on the average, about 84% of the iodine collected was smaller than the 1-micron median diameter (Fig. C-1). The data obtained from Release 11, in which iodine was released into JP4 jet-fuel smoke, indicate that about 50% more iodine was collected in the earlier stages of the samplers, implying that some scavenging occurred (Table C-3).

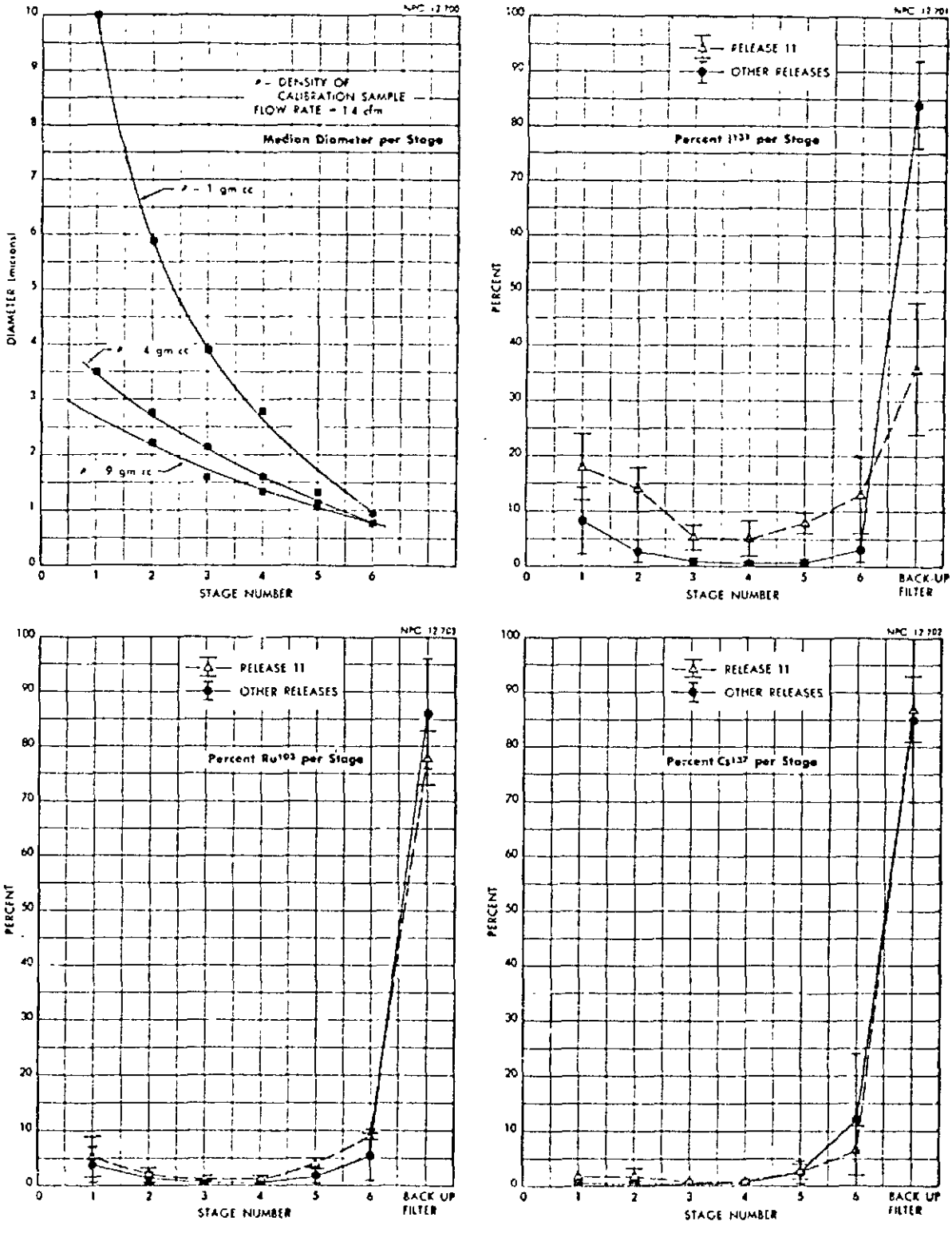


FIGURE C-1. ANDERSEN SAMPLER DATA

TABLE C-3

PERCENT OF I^{131} COLLECTED BY ANDERSEN SAMPLERS
(Atmospheric Releases)

Sampler Stage Number	Percent Collected						Average	Atmospheric Release with JP4-Fuel Smoke		Average
1	-	13.98	2.29	12.07	9.84	10.98	8.2 ± 6.0	22.25	13.87	18±6
2	-	4.60	0.26	3.41	3.73	4.21	2.7 ± 2.0	11.54	17.17	14±4
3	-	1.83	0.17	0.95	0.98	1.26	0.87±.68	3.86	6.94	5.4±2.2
4	1.27	0.71	0.11	0.46	0.49	0.49	0.59±.39	2.71	7.25	5.0±3.2
5	0.93	1.28	0.07	0.73	-	1.22	0.71±.56	6.48	9.15	7.8±1.8
6	2.31	1.22	0.08	5.58	3.91	5.02	3.0 ± 2.2	7.98	18.25	13±7
Backup Filter Chain	95.50	76.65	97.00	76.80	81.06	76.83	84±8	45.18	27.76	36±12

Original data on the percent of iodine activity collected on the carbon cartridge are given in Table C-4. These results are included to show how the percentages changed from station to station on all releases.

Cesium 137

About 85% of the cesium activity was associated with particles having a median diameter smaller than 1 micron (Fig. C-1). No scavenging due to the JP4 smoke is apparent (Table C-5).

Ruthenium 103

About 86% of the ruthenium activity was collected on the backup filter chain, implying that the majority of the released ruthenium was associated with particles having median diameters smaller than 1 micron (Table C-6).

TABLE C-4

PERCENT IODINE-131 ON CARBON CARTRIDGE
AT EACH STATION

Percent I^{131} on Carbon Cartridge: Release 1

Arc Degree	100-m Arc	1000-m Arc	2000-m Arc	4000-m Arc	8000-m Arc	16000-m Arc	32000-m Arc
1							
2							
3							
4							
5							
6							
7					73.3		
8					58.7	3.25	
9				67.7		7.05	
10					57.1	48.7	
11			45.2	43.2	58.5	67.8	
12			51.3		60.3		53.5
13			44.4		64.6	80.3	53.7
14			51.3		87.0	50.8	34.2
15		62.7	63.3		57.0	47.7	58.4
16			60.9		60.8	54.2	38.8
17		64	33.6		69.1	50.6	42.2
18			60.1			90.7	38.2
19		63.5	57.4			52.9	
20			57.6				44.4
21		56.5				31.7	41.4
22						48.3	50.1
23						53.4	
24						41.1	31.5
25						46.0	30.9
26						46.9	36.4
27							31.9
28						51.7	32.1
29						49.3	35.8
30						48.4	
31						68.5	
32						61.5	
33						57.8	
34							
35							
36							
Average		61.6	52.5	55.4	64.6	50.3	40.8

TABLE C-4 (cont'd)

Percent I^{131} on Carbon Cartridge: Release 2

Arc Degree	100-m Arc	1000-m Arc	2000-m Arc	4000-m Arc	8000-m Arc	16000-m Arc	32000-m Arc
21							30.1
22							
23							33.7
24							29.3
25							33.7
26							40.9
27							29.8
28							33.9
29							30.6
30					30.2		32.9
31					48.0		36.4
32					74.0		35.3
33					58.8		38.2
34					60.1	52.3	38.5
35					54.7	58.8	46.7
36					59.9	58.7	7.22
37					61.4	52.9	29.8
38					61.1	61.0	34.9
39					57.8	53.4	25.9
40					63.2	49.1	27.3
41						48.9	27.2
42					58.2		23.3
43					55.6		29.4
44						48.4	38.6
45		67.9		46.8		46.6	24.4
46				49.7		45.8	
47		63.2		54.0			
48				49.6		35.7	
49		77.4		47.8		53.6	
50				52.0		51.5	
51		61.0		57.0		41.5	
52				50.1			
53		53.5	33.0	57.3			
54			50.8	41.1			
55		55.1	55.6	68.0			
56			51.7	58.2			
57		50.3	56.7	55.2			
58			57.9				
59		56.7					
60			61.3				
61							
Average		60.6	52.4	52.8	57.1	50.5	31.6

TABLE C-4 (cont'd)

Percent I^{131} on Carbon Cartridge: Release 3

Arc Degree	100-m Arc	1000-m Arc	2000-m Arc	4000-m Arc	8000-m Arc	16000-m Arc	32000-m Arc
1		77.9					
3		72.7					
5		77.2					
7		75.2					
9		77.3					
11		77.7					
13		76.9					
15		77.3					
17		75.9					
19							
21		74.6					
23							
25							
27							
29		74.3					
31		76.8					
33		75.5					
35		75.0					
37		77.4					
39		77.1					
41		76.0					
43		86.3					
45		89.6					
47		72.0					
49		73.6					
51							
53							
55							
57		61.5					
59							
61							
Average		76.2					

TABLE C-4 (cont'd)

Percent I^{131} on Carbon Cartridge: Release 4

Arc Degree	100-m Arc	1000-m Arc	2000-m Arc	4000-m Arc	8000-m Arc	16000-m Arc	32000-m Arc
1		65.6					
3		62.3					
5		62.5					
7		64.9					
9		55.6					
11		61.0					
13		72.8					
15		67.3					
17		60.8					
19		69.9					
21		60.6					
23							
25							
27		66.0					
29		60.6					
31		61.4					
33		65.0					
35		69.7					
37		66.0					
39		61.7					
41							
43		65.5					
45							
47							
49							
51							
53		67.4					
55							
57		68.0					
59							
61							
Average		64.5					

TABLE C-4 (cont'd)

Percent I^{131} on Carbon Cartridge: Release 5

Arc Degree	100-m Arc	1000-m Arc	2000-m Arc	4000-m Arc	8000-m Arc	16000-m Arc	32000-m Arc
11							
12							
13		67.5					
14							
15		66.0	65.1				12.9
16			73.1				
17		52.0	68.8				44.8
18							13.8
19		73.2	71.8	68.4			21.1
20			71.6	65.4		30.4	
21			68.5	70.5		25.9	30.8
22			69.0	68.3		27.9	39.7
23			69.2			23.3	
24			61.1				22.5
25			73.1	69.4		24.9	26.7
26			67.9	69.2		36.3	18.3
27		67.3	68.9	68.9			22.6
28			68.3	69.6			19.5
29		67.3	67.2	67.8		40.5	16.3
30				70.4	77.3	26.6	20.7
31		67.4	67.7	66.8	75.1	32.8	17.5
32			65.7		74.7	28.5	22.0
33		64.1	67.7	43.7	70.6		
34			65.7	60.1	83.7	29.0	34.6
35		53.3	53.6	63.6	90.9		
36			66.2	60.4	92.6		
37		59.2	26.0		86.3		
38			66.7		86.0		
39		59.2			69.4		
40			59.2				
41		61.5	75.4				
42			63.3				
43		52.7					
44			31.6				
45		44.8					
46			52.7				
47		48.2	49.1				
48							
49		42.8					
50							
Average		59.1	63.3	65.5	80.6	29.6	23.3

TABLE C-4 (cont'd)

Percent I^{131} on Carbon Cartridge: Release 8

Arc Degree	100-m Arc	1000-m Arc	2000-m Arc	4000-m Arc	8000-m Arc	16000-m Arc	32000-m Arc
1		88.0			79.0		25.0
2		80.0	95.0		85.0		20.0
3		83.0	95.0	62.0	79.0	21.0	26.0
4			91.0	69.0	84.0	14.0	26.0
5		82.0	78.0	76.0		19.0	25.0
6			76.0	79.0		42.0	
7		54.0	81.0	78.0		17.0	
8			77.0	74.0		15.0	
9			75.0	69.0		21.0	
10			55.0			20.0	
11			35.0			25.0	
12							
13						18.0	
14							
15						16.0	
16						12.0	
17						19.0	
18						18.0	
19							
20						8.3	
Average		77.4	75.8	72.4	81.7	19.0	24.4

TABLE C-4 (cont'd)

Percent I^{131} on Carbon Cartridge: Release 10

Arc Degree	100-m Arc	1000-m Arc	2000-m Arc	4000-m Arc	8000-m Arc	16000-m Arc	32000-m Arc
1	10.0						16.5
2							
3	3.0	65.6					15.5
4			70.0				
5	9.5	67.6	70.2				15.0
6			73.9	69.0			11.0
7	5.5	72.6	67.7				7.0
8			72.1	73.6			
9	7.3	67.8	73.3	60.0			
10			62.1	54.7			
11	6.0	80.1	77.0				20.3
12				59.8			
13	9.0	74.1	71.0	63.3	80.4		
14			69.0	66.6			
15	11.0	72.6	73.0	49.2	69.7	19.5	
16			66.7	56.3			
17	6.6	73.8	71.2	56.3		16.6	
18				63.4			
19	67.0	71.4	73.0	62.7	87.4	11.7	
20			71.6	61.9			
21	36.5	67.3	74.3	57.4	69.0	17.4	
22			68.7	54.9			
23			75.0		71.3	19.2	
24			63.8				
25					72.3	18.1	
26			58.3				
27		70.0			74.6	17.5	
28							
29		66.5			80.5	4.95	
30							
31		67.1				17.0	
32							
33						21.9	
34							
35						29.0	
Average	15.5	70.4	70.1	60.6	75.6	17.5	14.2

TABLE C-4 (cont'd)

Percent I^{131} on Carbon Cartridge: Release 11

Arc Degree	100-m Arc	1000-m Arc	2000-m Arc	4000-m Arc	8000-m Arc	16000-m Arc	32000-m Arc
1							
2							
3							
4							
5		73.3					
6							
7		80.0				23.6	
8							
9						18.1	
10							
11						17.2	
12							
13		95.8				14.0	
14							
15		76.5				14.0	
16							
17		77.1				12.4	
18							
19		81.9					
20							
21						35.0	
22				78.0			
23							
24							
25							
Average		80.7		78.0		17.2	

TABLE C-5

PERCENT OF Cs^{137} COLLECTED BY ANDERSEN SAMPLERS
(Atmospheric Releases)

Sampler Stage Number	Percent Collected							Average	Atmospheric Release with JP4-Fuel Smoke		Average
1	-	-	-	2.10	-	0.24	0.15	0.36±0.78	-	1.82	1.8
2	-	0.08	-	0.76	-	0.14	0.13	0.16±0.27	2.47	1.29	1.9±0.8
3	0.89	0.53	-	0.23	-	0.21	0.22	0.30±0.32	0.77	0.53	0.65±0.17
4	1.95	0.48	0.25	0.72	0.27	0.25	0.16	0.58±0.63	1.06	0.65	0.86±0.29
5	6.67	3.12	2.95	2.23	1.03	1.24	0.47	2.5 ± 2.1	1.73	3.51	2.6 ±1.3
6	36.69	10.49	11.11	15.83	3.47	2.26	1.07	12 ± 12	3.34	9.44	6.4 ±4.3
Backup Filter Chain	53.80	85.30	85.69	78.14	95.22	95.66	97.80	85 ± 15	90.63	82.76	87 ± 6

TABLE C-6

PERCENT OF Ru^{103} COLLECTED BY ANDERSEN SAMPLERS
(Atmospheric Releases)

Sampler Stage Number	Percent Collected							Average	Atmospheric Release with JP4-Fuel Smoke		Average
1	6.44	4.61	6.71	7.44	-	0.87	0.72	3.8 ± 3.2	7.80	2.54	5.2±3.7
2	2.38	1.48	2.32	2.19	-	0.30	0.18	1.3 ± 1.1	2.79	1.03	1.9±1.2
3	1.11	0.65	0.27	0.92	-	0.29	0.19	0.49±0.41	1.46	0.75	1.1±0.5
4	1.46	0.56	0.74	0.72	0.28	0.32	0.23	0.62±0.43	1.36	0.81	1.1±0.4
5	4.13	1.73	1.58	1.95	1.23	0.77	0.37	1.7 ± 1.2	3.74	4.68	4.2±0.7
6	14.12	5.92	4.49	8.55	4.34	1.44	0.68	5.6 ± 4.6	8.59	9.38	9.0±0.6
Backup Filter Chain	70.35	85.04	83.89	78.22	94.16	96.01	97.62	86 ± 10	74.27	80.80	78±5

APPENDIX D

METEOROLOGICAL TEST PROGRAM

The primary function of the meteorological program was that of support to the Field Release Test series. Micrometeorological measurements were made of wind direction and velocity, and of temperature and humidity from 1 meter below the surface to 32 meters above. These measurements were made and recorded at three towers that were located at the Apex and along the centerline of the test grid on the 16-km and 32-km arcs. The data thus obtained were applied in a parametric evaluation of the factors affecting the dispersal and deposition of the fission-products effluent. Air Weather Service forecasts were utilized in planning release operations and schedules.

D-1 Area of Meteorological Interest

The area of meteorological interest covered approximately 2500 square miles bounded on the west by the Utah-Nevada border, on the north by U. S. Highway 40, on the east by the Cedar Mountains, and on the south by the Vernon-Callao road (about sixty miles south of U. S. Highway 40). The largest portion of this region is in the Great Salt Lake Desert, an area of salt flats and silty-clay flats having scarcely any vegetation.

The test grid was located in the heart of the salt-flat area where the density of vegetation, mainly pickleweed, is approximately 100 plants per square mile. Directly under the soil surface,

the moisture gradient increases rapidly to a point of saturation at 12 to 18 inches. During wet seasons, travel is very difficult because the impervious soil forms a slick, sticky mud. Normally, the area has dried from the winter's precipitation by the end of June, and a vehicle can travel almost anywhere with little difficulty. However, during 1959, abnormally large amounts of rainfall occurred in August and September, as shown in Figure D-1.

The test area exerted a significant influence on the climatological aspects of the program. The vastness of the area, the general uniformity of the terrain, and the character of the soil helped to define the low-level circulation patterns, temperature gradients, and the net heat transfer.

The test area is influenced by two types of wind regimes: (1) the synoptic wind, associated with migratory pressure systems; and (2) the local wind, experienced under a stagnant, or stationary, pressure system. The synoptic wind is usually of moderate speed, and the prevailing direction is southeasterly to southwesterly except during a period of a few hours following a frontal passage when the winds become northeasterly to north-northeasterly. Under a weak pressure gradient, with winds less than 10 mph, the synoptic daytime wind generally has a cross-isobaric flow. The local wind is an interbasin circulation set up by the temperature difference between the Salt Flats and the Sevier Basin (about 40 miles to the south). Optimum atmospheric conditions for the tests are a result of the stationary pressure system.

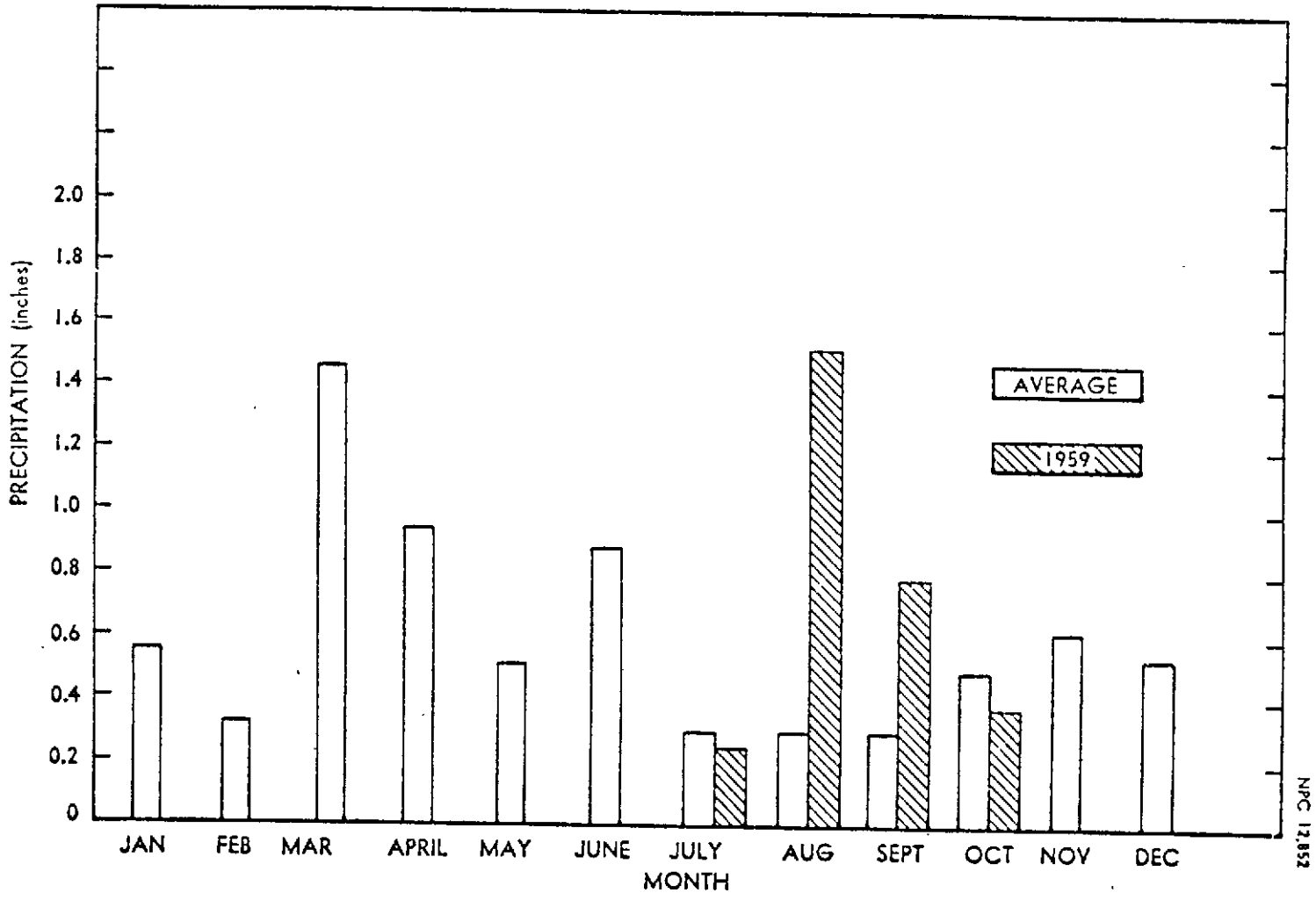


FIGURE D-1. RAINFALL AT DUGWAY PROVING GROUND: COMPARISON OF AVERAGE WITH SUMMER 1959

The Salt Flats are highly reflective. Generally, the area receives a relatively high percentage of insolation because of the characteristically clear atmosphere; consequently, there is a high nocturnal radiation from the soil. The soil-to-atmosphere heat budget shows a rather wide range of diurnal heat flux. The daytime lapse normally varies from 3 to 6°F per 1000 feet, with a maximum of 8 to 10°F on hotter days. The nighttime inversions frequently range between 3 and 6°F; however, a gradient as great as 12°F has been observed. The strong temperature gradients during inversion conditions occur between the 0.5- and 4.0-meter levels.

The barren hills are ideal for daytime heating, and the resulting convection and upslope winds are instrumental in the formation of the local atmospheric circulation between the Salt Flats and the Sevier Basin. During the night, the opposite situation exists; the mountains cool rapidly and the air settles. This condition is known as "drainage" and is the cause of another interbasin circulation in which the cooled air from the Sevier Basin underruns the air on the Salt Flats. The FRT-II test site lies in the path of one of the drainage channels between the two basins, and therefore was subjected to northwcaterly upslope winds during the daytime and southeasterly drainage winds during the night.

Under neutral synoptic winds, the drainage is usually well established by one or two hours after sundown and continues until heating takes over the following morning. Under ideal radiative conditions, drainage winds will attain speeds of 6 to 8 mph;

however, a synoptic north wind of about 15 mph will completely override the drainage influence. It is noteworthy that during the 3-month test period conditions appropriate for testing occurred only ten times. The limitations on testing resulted, in part, from the desirability to have a 2-hour persistence of on-grid winds as a minimum requirement for a release. Other limitations involved lapse-rate requirements, wind-velocity requirements, and network accessibility.

D-2 Release Conditions

D-2.1 Wind and Thermal Conditions

Data on wind and thermal conditions for the 11 releases are summarized in Tables D-1 through D-4. The change in temperature from 0 or 1 to 16 or 32 meters is noted on the tables, a "minus" temperature indicating cooler air near the ground. All atmospheric releases were made under inversion conditions. Releases 6, 7, and 9 were contained.

D-2.2 Temperature Measurements

Basic temperature-profile data for each release, along with other pertinent data, are tabulated in Table D-5. The thermal-gradient profiles are plotted in Figures D-2, D-3, and D-4 for Releases 1, 2, 3, 4, 5, 8, 10 and 11. The profiles for Releases 1 and 2 are based on data obtained from the Apex tower; the profiles for Releases 3 and 4 are based on data from both the Apex and the 16-kilometer towers; and the profiles for Releases 5, 8, 10, and 11, on data from all three towers. In all cases, except Releases 1 and 2, surface and ground temperatures are included in the thermal-gradient profiles for purposes of comparison.

TABLE D-1

WIND AND THERMAL CONDITIONS AT THE APEX TOWER
Period: t_o to t_o + 60 Min

Release Date	Time (MST)* t_o	Time (MST)* t_{16}	Tower Height (meters)	Wind Direction Grid Centerline at 170° Min	Wind Direction Grid Centerline at 170° Mean	Wind Direction Grid Centerline at 170° Max	Wind Velocity (meters/sec) Min	Wind Velocity (meters/sec) Mean	Wind Velocity (meters/sec) Max	Temp. Differential Tower Ht. (meters)	Temp. Differential ΔT (°C)
1 5 Aug	0000	0053	2-16 2	145 145	154 157	166 168	2.6 2.6	5.0 4.2	7.4 5.6	0-32 1-32	No Data -2.4
2 10 Aug	2336	0040	2-16 2	172 172	183 181	198 198	2.8 2.8	4.2 3.4	5.7 4.1	0-32 1-32	No Data -5.0
3 8 Sept	0241	0404	2-16 2	107 112	173 173	218 218	1.2 1.2	3.2 2.4	6.2 3.7	0-32 1-32	-5.0 -1.6
4 12 Sept	0143	0337	2-16 2	116 118	170 172	225 224	0.5 0.5	2.4 1.8	7.1 3.3	0-32 1-32	-4.7 -3.1
5 18 Sept	0219	0319	2-16 2	149 150	168 166	185 184	2.9 2.9	4.4 3.6	6.1 4.5	0-32 1-32	-2.2 -1.1
6 24 Sept	1300	Contained Release									
7 24 Sept	1758	Contained Release									
8 30 Sept	0207	0346	2-16 2	139 139	150 149	158 155	1.5 1.7	2.7 2.0	4.1 2.7	0-32 1-32	-1.5 -1.5
9 9 Oct	1330	Contained Release									
10 24 Oct	0735	0918	1-32 2	134 134	171 155	202 176	0.5 0.9	2.6 1.9	5.0 2.8	0-32 1-32	-2.9 -1.3
11 25 Oct	0435	0536	1-32 2	149 149	165 159	192 172	1.8 2.1	4.4 3.2	7.4 4.0	0-32 1-32	-6.7 -6.4

*t_o = release time; t_{16} = eta of leading edge of cloud at 16-km arc.

TABLE D-2

WIND AND THERMAL CONDITIONS AT THE 16-KM TOWER

Period: t_{16} to t_{16} + 60 Min

Release Date	Time (MST)* t_o	Time (MST)* t_{16}	Tower Height (meters)	Wind Direction Grid Centerline at 170° Min	Wind Direction Mean	Wind Direction Max	Wind Velocity (meters/sec) Min	Wind Velocity Mean	Wind Velocity Max	Temp. Differential Tower Ht. (meters)	Temp. Differential ΔT (°C)
1 5 Aug	0053	0200	2-16	139	162	227	2.0	4.0	6.6	Non Operational	
2 10 Aug	0040	0233	2-16	130	166	212	0.1	2.4	5.1	Non Operational	
3 8 Sept	0404	0509	2-16	153	165	182	1.8	4.6	7.3	1-16 1-32	-3.4
4 12 Sept	0337	0607	2-16	97	185	260	0.2	1.8	3.4	1-16 1-32	-1.6 -6.6
5 18 Sept	0319	0431	2-16	152	167	191	2.8	3.7	5.6	1-16 1-32	-1.1 -6.1
6 24 Sept					Contained Release						
7 24 Sept					Contained Release						
8 30 Sept	0345	0634	2-16	95	107	151	0.3	1.3	2.2	1-16 1-32	-0.7
9 9 Oct					Contained Release						
10 24 Oct	0918	1105	1-32	139	163	220	1.2	2.5	3.7	1-16 1-32	+0.6 +0.7
11 25 Oct	0536	0709	1-32	90	147	170	0.9	2.9	6.4	1-16 1-32	-2.1 -3.7

* t_{16} = eta of leading edge of cloud at 16-km arc.

t_{32} = eta of leading edge of cloud at 32-km arc.

TABLE D-3

WIND AND THERMAL CONDITIONS AT THE 32-KM TOWER
Period: t_{32} to t_{32} + 60 Min

Release Date	Time (MST)* t_{32}	Tower Height (meters)	Wind Direction Grid Centerline at 170° Min	Mean	Max	Wind Velocity (meters/sec) Min	Mean	Max	Temp. Differential Tower Ht. (meters)	ΔT (°C)
1 5 Aug	0200		Non Operational							
2 10 Aug	0233		Non Operational							
3 6 Sept	0509	2-16	163	191	218	1.4	3.7	7.8	Non Operational	
4 12 Sept	0507	2-16	148	164	185	0.1	1.4	2.4	Non Operational	
5 18 Sept	0431	2-16	122	139	161	1.5	2.7	4.2	1-16 1-32	-0.4 -0.5
6 24 Sept			Contained Release							
7 24 Sept			Contained Release							
8 30 Sept	0634	2-16	10	45	90	0.7	1.7	3.6	1-16 1-32	-1.1 -1.8
9 9 Oct			Contained Release							
10 24 Oct	1105	1-32	146	170	190	0.6	3.7	5.2	1-16 1-32	+0.9 +0.8
11 25 Oct	0709	1-32	20	90	158	0.9	2.4	5.6	1-16 1-32	-5.0 -7.1

* t_{32} = eta of leading edge of cloud at the 32-km arc.

TABLE D-4

WIND DIRECTIONS AT 2-KM STATION
2-Meter Level - Period: t_2 to t_2 + 60 Min

Release Number	Date 1959	Time (MST) t_o	Time (MST) t_2	Wind Direction (deg) Min	Mean	Max
1	5 Aug	0000	Non Operational			
2	10 Aug	2336	Non Operational			
3	8 Sept	0241	0255	120	149	170
4	12 Sept	0143	0201	133	169	225
5	18 Sept	0219	0229	148	163	185
6	24 Sept	1300	Contained Release			
7	24 Sept	1758	Contained Release			
8	30 Sept	0207	0219	124	145	155
9	9 Oct	1330	Contained Release			
10	24 Oct	0735	0754	152	156	163
11	25 Oct	0435	0446	130	155	167

* t_2 = eta of leading edge of cloud at 2-km arc.

TABLE D-5

TEMPERATURE PROFILE DATA

Release 1: Apex Tower*

t_o (release time) - 0000, 5 Aug

Temperature - 75°F (1.5m)

Rel. Humidity - 47%

Bar. Pressure - 25.52 in. Hg

Wind

Direction (deg)			Velocity (m/sec)		
Min	Mean	Max	Min	Mean	Max
145	154	166	2.6	5.0	7.4

Clear Skies

Height	t_o	t_o+15	t_o+30
32m	24.8°C	24.8°C	25.0°C
16	24.8	24.5	24.9
8	24.4	23.6	23.9
4	23.9	23.4	23.6
2	23.6	23.8	23.1
1	23.4	22.6	22.8

Release 2: Apex Tower

t_o (release time) - 2336, 10 Aug

Temperature - 78°F (1.5m)

Rel. Humidity - 37%

Bar. Pressure - 25.46 in. Hg

Wind

Direction (deg)			Velocity (m/sec)		
Min	Mean	Max	Min	Mean	Max
172	183	198	1.8	4.2	5.7

Clear Skies

Height	t_o	t_o+15	t_o+30
32m	30.0°C	29.3	31.1
16	28.1	28.1	28.4
8	26.2	26.3	26.6
4	25.8	25.9	26.1
2	25.1	25.0	25.5
1	25.1	24.8	25.4

*16- and 32-km thermal instrumentation nonoperational

TABLE D-5 (Cont'd)

TEMPERATURE PROFILE DATA

Release 3: Apex Tower

t_o (release time) - 0241, 8 Sept

Temperature - 68°F (1.5m)

Rel. Humidity - 31%

Bar. Pressure - 25.37 in. Hg

Wind

Direction (deg)			Velocity (m/sec)		
Min	Mean	Max	Min	Mean	Max
107	173	218	1.2	3.2	6.2

Scattered high clouds

Height	t_o	t_o+15	t_o+30
32m	21.6°C	21.7	22.8
16	21.7	21.4	21.7
8	21.1	20.6	21.0
4	21.2	20.7	20.8
2	20.6	20.0	20.3
1	20.2	20.1	20.1
0	17.8	17.2	17.7
-1	22.3	22.3	22.3

Release 3: 16-km Tower

t_{16}(eta) - 0404, 8 Sept

Temperature - 68.6°F

Wind

Direction (deg)			Velocity (m/sec)		
Min	Mean	Max	Min	Mean	Max
153	165	182	1.8	4.6	7.3

Scattered high clouds

Height	t_{16}	t_{16}+15	t_{16}+30
16m	22.7°C	23.2	23.2
8	21.7	21.4	21.1
4	21.2	21.9	20.4
2	20.5	20.4	20.0
1	20.4	20.0	19.7
0.5	19.9	19.4	19.2

TABLE D-5 (Cont'd)

TEMPERATURE PROFILE DATA

Release 4: Apex Tower

t_o (release time) - 0143, 12 Sept

Temperature - 69°F

Rel. Humidity - 60%

Bar. Pressure - 25.70 in Hg

Wind

Direction (deg)			Velocity (m/sec)		
Min	Mean	Max	Min	Mean	Max
116	170	225	0.5	2.4	7.1

Height	t_o	t_o+15	t_o+30
32m	23.6°C	23.8	23.9
16	23.9	23.6	23.1
8	23.1	22.8	22.7
4	22.2	22.2	22.6
2	21.2	20.8	22.8
1	21.0	20.5	20.6
0	19.1	18.6	18.8
-1	22.3	22.4	22.6

Release 4: 16-km Tower

t_{16} (eta) - 0337, 12 Sept

Temperature - 66.5°F

Wind

Direction (deg)			Velocity (m/sec)		
Min	Mean	Max	Min	Mean	Max
97	185	260	0.2	1.8	3.4

Height	t_{16}	t_{16}+15	t_{16}+30
16m	20.7°C	20.2	19.8
8	19.8	19.9	19.2
4	19.8	19.4	19.0
2	19.3	19.0	18.6
1	19.6	18.9	18.1
0.25	19.2	18.9	18.1
-1	22.9	22.8	22.7

TABLE D-5 (Cont'd)

TEMPERATURE PROFILE DATA

Release 5: 32-km Tower

t_{32} (eta) - 0431, 18 Sept

Temperature - 56°F

Wind

Direction (deg)			Velocity (m/sec)		
Min	Mean	Max	Min	Mean	Max
122	139	161	1.5	2.7	4.2

Data questionable due to improper range setting on recorder.

Height	t_{32}	$t_{32}+30$	$t_{32}+90$
32m	14.7°C	15.7	16.3
16	14.4	15.4	16.2
8	13.9	15.1	15.5
4	13.7	15.0	15.4
2	13.7	14.8	15.2
1	13.2	14.3	15.0
-1	22.2	22.2	22.4

Release 8: Apex Tower

t_o (release time) - 0207, 30 Sept

Temperature - 41°F

Rel. Humidity - 62%

Bar. Pressure - 25.42 in. Hg

Wind

Direction (deg)			Velocity (m/sec)		
Min	Mean	Max	Min	Mean	Max
139	149	155	1.7	2.0	2.7

Clear Skies

Height	t_o	t_o+15	t_o+30
32m	7.0°C	7.1	6.8
16	7.0	6.9	7.1
8	6.6	6.4	6.9
4	6.4	5.8	6.4
2	6.1	5.8	6.1
1	6.1	5.7	6.1
0	5.5	5.5	5.5
-1	20.7	20.7	20.7

TABLE D-5 (Cont'd)

TEMPERATURE PROFILE DATA

Release 8: 16-km Tower

t_{16} (eta) - 0346, 30 Sept

Temperature - 42°F

Wind

Direction (deg)			Velocity (m/sec)		
Min	Mean	Max	Min	Mean	Max
095	107	151	0.3	1.3	2.2

Height	t_{16}	t_{16}+15	t_{16}+30
16m	5.8°C	5.4	5.1
8	5.6	4.9	5.1
4	5.2	4.8	4.7
2	4.9	4.6	4.6
1	4.8	4.6	4.5
.25	4.7	4.5	4.2
-.03	9.6	9.5	9.5
- 1	21.0	21.0	21.0

Release 8: 32-km Tower

t_{32} (eta) - 0634, 30 Sept

Temperature - 40°F

Wind

Direction (deg)			Velocity (m/sec)		
Min	Mean	Max	Min	Mean	Max
010	045	090	0.7	1.7	3.6

Height	t_{32}	t_{32}+30	t_{32}+60	t_{32}+90
32m	6.1°C	9.0	8.5	8.7
16	5.6	7.8	8.5	8.4
8	5.2	7.4	8.2	8.0
4	4.8	7.0	7.8	7.9
2	4.5	7.0	7.9	7.8
1	4.4	6.8	7.5	7.7
.50	3.8	7.4	7.3	7.3
-.03	N.O.	N.O.	9.4	9.5
-.12			15.0	14.8
- 1			21.0	21.0

TABLE D-5 (Cont'd)

TEMPERATURE PROFILE DATA

Release 5: Apex Tower

t_o (release time) - 0219, 18 Sept

Temperature - 57°F

Rel. Humidity - 61%

Bar. Pressure - 25.49 in. Hg

Wind

Direction (deg)			Velocity (m/sec)		
Min	Mean	Max	Min	Mean	Max
150	166	184	2.9	3.6	4.5

Partly Cloudy

Height	t_o	t_o+15	t_o+30
32m	15.6°C	15.1	14.8
16	15.4	15.2	14.9
8	14.7	14.8	14.7
4	14.3	14.8	14.2
2	14.2	14.4	13.7
1	14.2	13.9	13.6
0	13.1	13.0	12.8
-1	22.2	22.2	22.2

Release 5: 16-km Tower

t_{16} (eta) - 0319, 18 Sept

Temperature - 55°F

Wind

Direction (deg)			Velocity (m/sec)		
Min	Mean	Max	Min	Mean	Max
152	167	191	2.8	3.7	5.6

Height	t_{16}	t_{16}+15	t_{16}+30
32m	22.1°C	22.2	22.4
16	13.5	13.6	14.2
8	12.9	12.8	13.7
4	12.9	13.1	13.5
2	12.4	12.5	13.3
1	12.4	12.6	13.2
.25	12.3	12.4	12.9
-.03	11.4	11.4	11.8
- 1	22.3	22.3	22.3

TABLE D-5 (Cont'd)

TEMPERATURE PROFILE DATA

Release 10: Apex

t_o (release time) - 0735, 24 Oct

Temperature - 47°F

Rel. Humidity - 72%

Bar. Pressure - 25.80 in. Hg

Wind

Direction (deg)			Velocity (m/sec)		
Min	Mean	Max	Min	Mean	Max
134	155	176	0.9	1.9	2.8

Clear Skies

Height	t_o	t_o+15	t_o+30
32m	9.8°C	10.4	9.4
16	9.4	10.3	9.8
8	8.7	9.3	8.9
4	8.5	9.2	8.6
2	8.4	9.4	8.6
1	8.3	8.9	8.3
0	6.5	7.2	6.7
-.03	7.8	7.8	7.7
- 1	16.1	16.1	16.1

Release 10: 16-km Tower

t_{16} (eta) - 0918, 24 Oct.

Temperature - 53°F

Wind

Direction (deg)			Velocity (m/sec)		
Min	Mean	Max	Min	Mean	Max
139	163	220	1.2	2.5	3.7

Height	t_{16}	t_{16}+15	t_{16}+30	t_{16}+60
32m	11.4°C	12.2	14.4	15.7
16	11.6	12.0	14.4	15.8
8	11.8	12.6	14.5	16.0
4	13.1	13.6	15.3	15.3
2	11.9	12.6	14.5	15.8
1	11.9	12.9	15.0	15.8
.5	12.1	13.0	14.8	16.0
.25	12.0	12.8	14.7	16.3
-.03	11.6	11.6	12.3	12.7
-.06	12.8	12.7	12.9	12.9
- 1	16.1	16.1	16.1	16.2

TABLE D-5 (Cont'd)

TEMPERATURE PROFILE DATA

Release 10: 32-km Tower

t_{32} (eta) - 1105, 24 Oct.

Temperature - 64°F

Wind

Direction (deg)			Velocity (m/sec)		
Min	Mean	Max	Min	Mean	Max
146	170	190	0.6	3.7	5.2

Height	t_{32}	t_{32}+25	t_{32}+55
32m	18.1°C	18.7	19.9
16	17.8	18.7	19.9
8	17.9	18.9	19.8
4	17.7	18.7	19.7
2	17.9	19.2	20.0
1	19.3	19.6	20.2
.50	18.7	20.0	20.6
-.03	13.1	14.1	15.1
-.06	11.1	11.3	11.5
-.12	13.1	13.3	13.2
- 1	16.2	16.2	16.2

Release 11: Apex

t_o (release time) - 0435, 25 Oct

Temperature - 49°F

Rel. Humidity - 68%

Bar. Pressure - 25.80 in. Hg

Wind

Direction (deg)			Velocity (m/sec)		
Min	Mean	Max	Min	Mean	Max
149	159	172	2.1	3.2	4.0

Clear Skies

Cold front passed station at 0718 with northeasterly winds.

Height	t_o	t_o + 15	t_o + 30
32m	15.9°C	15.6	16.7
16	14.6	14.7	15.0
8	11.3	12.1	11.9
4	10.4	11.2	10.7
2	9.6	9.6	9.5
1	9.5	9.5	9.4
.50	9.0	9.1	9.0
0	7.7	7.9	7.8
-.03	10.0	10.0	10.0
- 1	16.7	16.7	16.7

TABLE D-5 (Cont'd)

TEMPERATURE PROFILE DATA

Release 11: 16-km Tower

t_{16} (eta) - 0536, 25 Oct

Temperature - 48°F

Wind

Direction (deg)			Velocity (m/sec)		
Min	Mean	Max	Min	Mean	Max
090	147	170	0.9	2.9	6.4

Cold front passed station 0650 with northeasterly winds.

Height	t_{16}	t_{16}+15	t_{16}+30
32m	11.7°C	12.8	12.7
16	10.9	10.2	10.6
8	9.6	9.4	9.3
4	9.2	9.0	8.8
2	8.9	8.8	8.6
1	8.7	8.6	8.2
.50	8.5	8.4	8.1
.25	8.1	8.2	7.9
-.03	10.8	10.7	10.7
-.06	12.6	12.6	12.5
- 1	16.0	16.0	16.0

Release 11: 32-km Tower

t_{32} (eta) - 0709, 25 Oct

Temperature - 46°F

Wind

Direction (deg)			Velocity (m/sec)		
Min	Mean	Max	Min	Mean	Max
020	090	158	0.9	2.4	5.6

Cold front passed station at 0625 with northeasterly winds.

Height	t_{32}	t_{32}+30	t_{32}+60
32m	12.0°C	16.8	16.4
16	11.2	14.7	13.6
8	9.4	12.1	11.8
4	8.9	10.2	11.7
2	8.2	9.4	9.3
1	8.0	9.3	8.9
.50	7.6	8.9	11.2
.25	7.9	8.9	11.1
-.03	9.7	9.4	9.1
-.06	12.4	12.1	11.6
-.12	13.5	13.6	13.5
- 1	16.4	16.4	16.4

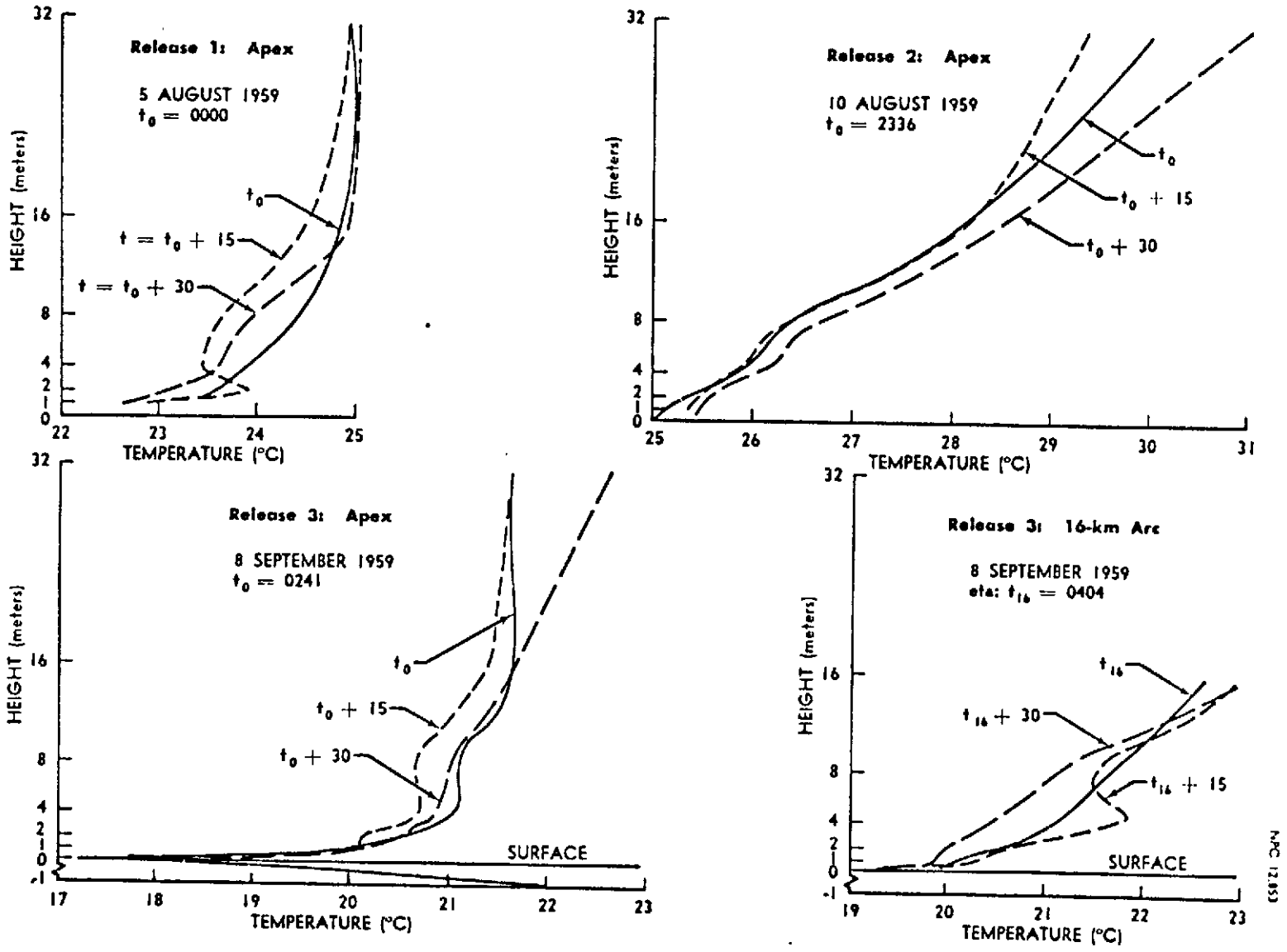


FIGURE D-2. THERMAL-GRADIENT PROFILES AT METEOROLOGICAL TOWERS: RELEASES 1, 2, AND 3

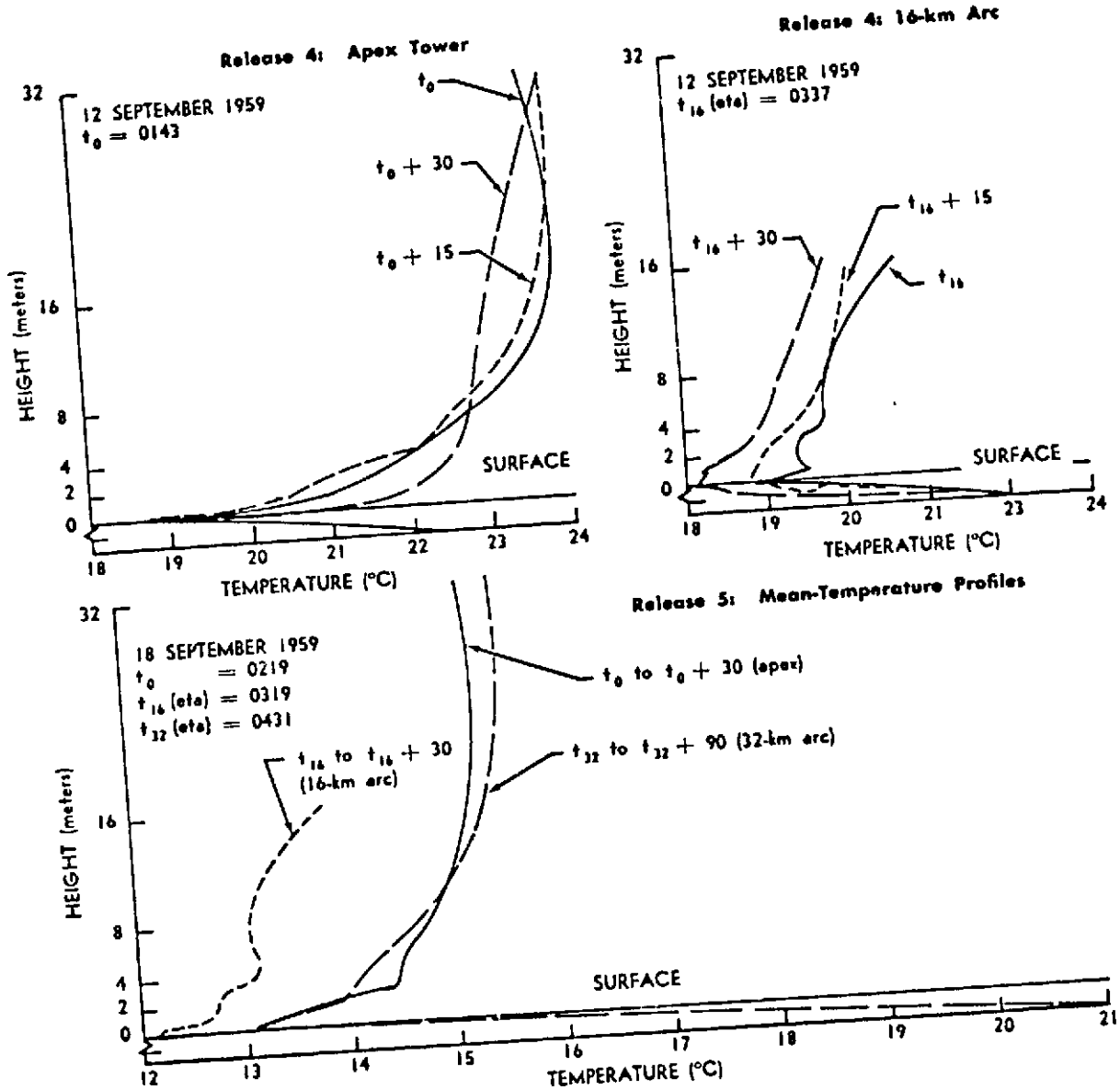
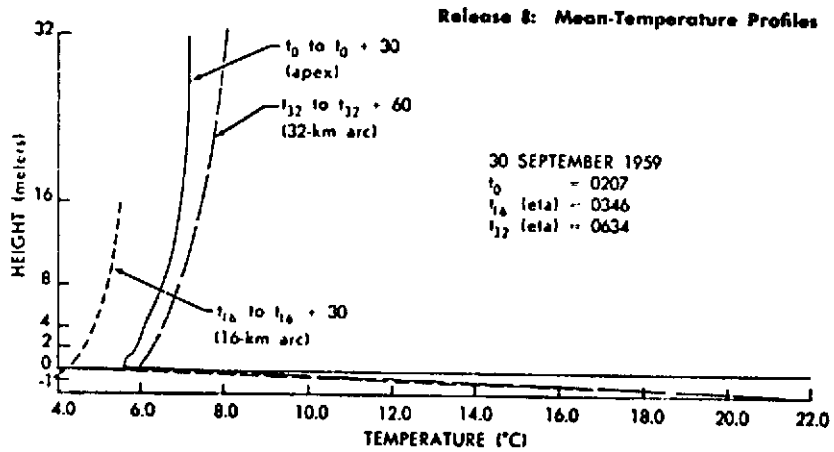
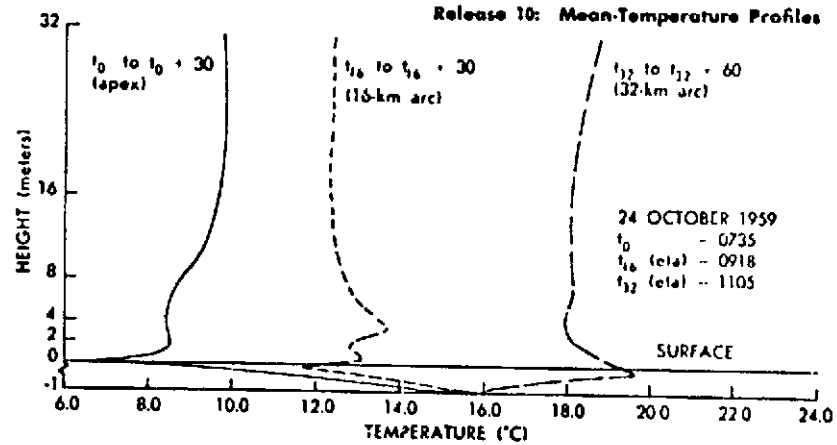


FIGURE D-3. THERMAL-GRADIENT PROFILES AT METEOROLOGICAL TOWERS: RELEASES 4 AND 5





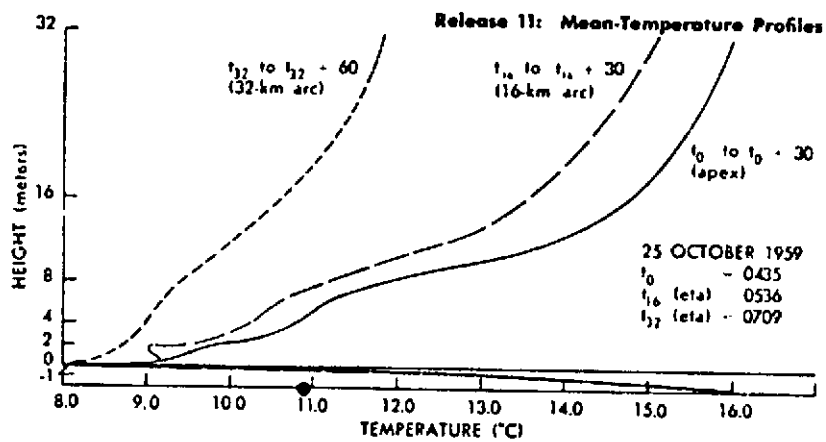


FIGURE D-4. THERMAL GRADIENT PROFILES AT METEOROLOGICAL TOWERS: RELEASES 8, 10, AND 11

NPC 12555

D-2.3 Air-Flow Measurements

At each of the three stations, measurements of wind direction and velocity were recorded from instruments located at six positions (1, 2, 4, 8, 16 and 32 meters) on the meteorological tower. The minimum, mean, and maximum values are presented in Table D-6 for Releases 1, 2, 3, 4, 5, 8, 10, and 11.

The frequency of nighttime surface-wind directions are given in Table D-7. The mean hourly wind direction for the period 2000 to 0600 hours at the Apex area (2-meter level) are given in terms of occurrence. These data are compared with wind data for 1957 and 1958 taken from the Mud Hen station two miles west of the Apex.

D-2.4 Lapse Rate

Figures D-5 through D-12 show the recorded temperature and recording positions for each release. The temperature profiles show considerable variation in lapse rate during the fuel-element melting cycle, during passage of the cloud over the grid, and at synoptic times for each of the three tower stations.

D-3 Heat-Budget Measurements

Heat-budget measurements were made during FRT II for four principal reasons:

1. To provide a more complete documentation of meteorological conditions existing during each atmospheric release.
2. To provide a source of data where others may check their theories against actual experimental results.
3. To develop a practical skill for measuring and analyzing heat-budget information.
4. To search for fundamental relationships between measured meteorological conditions and actual diffusion.

TABLE D-6

AIR-FLOW SUMMARY

Release 1

Apex Tower						
t_o to t_o+30 min				t_o = 0000, 5 Aug		
Height (meters)	Wind Direction, Grid CL at 170°			Wind Velocity(m/sec)		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
32	167	169	171	8.0	8.4	9.0
16	158	159	164	Non Operational		
8	-	-	-	5.7	6.6	7.4
4	-	-	-	4.9	5.9	6.8
2	158	162	168	4.0	4.9	5.6
1	-	-	-	3.8	4.8	5.7

16-km Tower						
t_{16} to t_{16}+60 min				t_{16} = 0053, 5 Aug		
Height (meters)	Wind Direction, Grid CL at 170°			Wind Velocity(m/sec)		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
32	140	159	205	Non Operational		
16	Non Operational			4.6	4.9	6.6
8	-	-	-	Non Operational		
4	-	-	-	Non Operational		
2	138	163	227	2.0	3.1	4.5
1	-	-	-			

* Centerline of grid coincides with 170° wind direction

t_{16} = eta of cloud at 16-km arc

2- and 32-km stations were non operational

TABLE D-6 (Cont'd)

AIR-FLOW SUMMARY

Release 2

Apex Tower						
t_o to t_o+30 min				t_o = 2336, 10 Aug		
Height (meters)	Wind Direction, Grid CL at 170°			Wind Velocity (m/sec)		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
32	200	205	209	7.5	8.0	8.7
16	176	185	189	3.9	4.7	5.1
8	-	-	-	4.1	4.8	5.7
4	-	-	-	3.3	3.9	4.8
2	172	179	198	2.8	3.3	4.1
1	-	-	-	2.5	3.1	3.8

16-km Tower						
t_{16} to t_{16}+60 min				t_{16} = 0040, 11 Aug		
Height (meters)	Wind Direction, Grid CL at 170°			Wind Velocity (m/sec)		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
32	140	159	212	Non Operational		
16	130	160	212	0.7	2.7	5.1
8	-	-	-	0.3	2.6	4.7
4	-	-	-	0.1	2.3	4.5
2	130	163	193	0.5	1.9	3.7
1	-	-	-	1.1	2.2	3.0

TABLE D-6 (Cont'd)

AIR-FLOW SUMMARY

Release 3

t_o to t_o+30 min	Apex Tower			t_o = 0241, 8 Sept		
Height (meters)	Wind Direction, Grid CL at 170°			Wind Velocity (m/sec)		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
32	180	189	227	3.6	5.9	7.3
16	164	173	218	3.6	4.9	6.2
8	-	-	-	2.1	3.0	3.9
4	-	-	-	1.3	2.1	3.0
2	167	172	218	1.2	2.0	2.7
1	-	-	-	1.3	2.2	3.8

t_2 to t_2+30 min	2-km Tower			t_2 = 0255, 8 Sept		
Height (meters)	Wind Direction, Grid CL at 170°			Wind Velocity (m/sec)		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
2	120	149	170	-	-	-

t_{16} to t_{16}+60 min	16-km Tower			t_{16} = 0404, 8 Sept		
Height (meters)	Wind Direction, Grid CL at 170°			Wind Velocity (m/sec)		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
32	161	167	170	6.5	7.8	8.8
16	158	163	166	3.3	5.8	7.3
8	-	-	-	2.8	4.6	6.1
4	-	-	-	Non Operational		
2	152	167	182	1.8	3.2	4.5
1	-	-	-	Non Operational		

t_{32} to t_{32}+60 min	32-km Tower			t_{32} = 0509, 8 Sept		
Height (meters)	Wind Direction, Grid CL at 170°			Wind Velocity (m/sec)		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
32	169	174	184	3.4	4.9	6.0
16	164	183	199	5.0	5.5	6.8
8	-	-	-	Non Operational		
4	-	-	-	Non Operational		
2	163	199	218	1.4	1.9	2.8
1	-	-	-	1.0	1.6	2.4

TABLE D-6 (Cont'd)

AIR-FLOW SUMMARY

Release 4

t_o to t_o+30 min	Apex Tower			t_o = 0143, 12 Sept		
Height (meters)	Wind Direction, Grid CL at 170°			Wind Velocity(m/sec)		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
32	183	236	276	1.9	2.2	2.4
16	173	189	216	1.7	2.2	3.0
8	-	-	-	1.2	1.7	2.6
4	-	-	-	0.6	1.4	2.3
2	178	197	224	0.8	1.3	2.2
1	-	-	-	0.5	1.0	1.6

t_2 to t_2+30 min	2-km Tower			t_2 = 0201, 12 Sept		
Height (meters)	Wind Direction, Grid CL at 170°			Wind Velocity(m/sec)		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
2	133	169	225	-	-	-

t_{16} to t_{16}+60 min	16-km Tower			t_{16} = 0337, 12 Sept		
Height (meters)	Wind Direction, Grid CL at 170°			Wind Velocity(m/sec)		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
32	169	195	224	2.8	3.5	4.4
16	166	191	232	1.2	2.7	3.4
8	-	-	-	1.0	2.0	2.8
4	-	-	-	0.2	1.4	1.9
2	77	180	260	0.2	1.2	1.8
1	-	-	-	0.4	1.0	1.4

t_{32} to t_{32}+60 min	32-km Tower			t_{32} = 0607, 12 Sept		
Height (meters)	Wind Direction, Grid CL at 170°			Wind Velocity(m/sec)		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
32	125	148	164	Non Operational		
16	155	166	179	0.2	1.7	2.0
8	-	-	-	1.2	1.8	2.4
4	-	-	-	Non Operational		
2	148	162	185	0.4	0.7	1.0
1	-	-	-	0.4	0.7	1.0

TABLE D-6 (Cont'd)

AIR-FLOW SUMMARY

Release 5

t_o to t_o+30 min	Apex Tower			t_o = 0219, 18 Sept		
Height (meters)	Wind Direction, Grid CL at 170°			Wind Velocity (m/sec)		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
32	169	174	185	4.7	5.5	6.3
16	163	170	183	5.0	5.6	6.0
8	-	-	-	3.8	4.6	5.4
4	-	-	-	3.0	4.6	4.3
2	155	166	177	2.9	3.4	.42
1	-	-	-	2.6	3.2	4.1

t_2 to t_2+30 min	2-km Tower			t_2 = 0229, 18 Sept		
Height (meters)	Wind Direction, Grid CL at 170°			Wind Velocity (m/sec)		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
2	148	163	185	-	-	-

t_{16} to t_{16}+60 min	16-km Tower			t_{16} = 0319, 18 Sept		
Height (meters)	Wind Direction, Grid CL at 170°			Wind Velocity (m/sec)		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
32	156	169	184	4.4	5.6	6.6
16	152	163	170	3.6	4.3	5.6
8	-	-	-	3.2	3.6	4.4
4	-	-	-	2.8	3.2	3.8
2	154	171	191	Non Operational		
1	-	-	-	2.1	2.7	3.4

t_{32} to t_{32}+60 min	32-km Tower			t_{32} = 0431, 18 Sept		
Height (meters)	Wind Direction, Grid CL at 170°			Wind Velocity (m/sec)		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
32	130	149	163	Non Operational		
16	126	139	155	2.6	3.5	4.1
8	-	-	-	2.5	3.3	4.2
4	-	-	-	1.6	2.2	2.9
2	122	139	161	1.5	2.0	2.6
1	-	-	-	1.3	1.8	2.4

TABLE D-6 (Cont'd)

AIR-FLOW SUMMARY

Release 8

t_o to t_o+30 min	Apex Tower			t_o = 0207, 30 Sept		
Height (meters)	Wind Direction, Grid CL at 170°			Wind Velocity (m/sec)		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
32	152	159	176	Non Operational		
16	146	151	158	3.2	3.6	3.9
8	-	-	-	2.2	2.6	2.8
4	-	-	-	1.5	1.8	2.0
2	147	149	155	1.7	1.8	1.9
1	-	-	-	1.4	1.6	1.8

t_2 to t_2+30 min	2-km Tower			t_2 = 0219, 30 Sept		
Height (meters)	Wind Direction, Grid CL at 170°			Wind Velocity (m/sec)		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
2	124	145	155	-	-	-

t_{16} to t_{16}+60 min	16-km Tower			t_{16} = 0346, 30 Sept		
Height (meters)	Wind Direction, Grid CL at 170°			Wind Velocity (m/sec)		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
32	98	128	169	0.9	2.5	4.0
16	95	104	139	0.8	1.2	2.0
8	-	-	-	0.5	1.5	2.4
4	-	-	-	0.3	1.2	2.0
2	95	109	151	Non Operational		
1	-	-	-	0.1	1.0	2.0

t_{32} to t_{32}+60 min	32-km Tower			t_{32} = 0634, 30 Sept		
Height (meters)	Wind Direction, Grid CL at 170°			Wind Velocity (m/sec)		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
32	25	59	80	1.3	2.0	3.2
16	30	57	90	0.7	1.6	3.0
8	-	-	-	1.1	1.8	3.6
4	-	-	-	1.0	1.7	2.4
2	10	33	50	1.0	1.7	2.4
1	-	-	-	Non Operational		

TABLE D-6 (Cont'd)

AIR-FLOW SUMMARY

Release 10

t_o to t_o+30 min	Apex Tower			t_o = 0735, 24 Oct		
Height (meters)	Wind Direction, Grid CL at 170°			Wind Velocity(m/sec)		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
32	197	200	202	3.3	4.0	4.8
16	177	183	185	2.1	3.1	4.0
8	-	-	-	1.1	1.8	2.8
4	-	-	-	0.5	1.1	1.9
2	151	165	176	0.9	1.5	2.1
1	-	-	-	0.5	1.1	1.6

t_2 to t_2+30 min	2-km Tower			t_2 = 0754, 24 Oct		
Height (meters)	Wind Direction, Grid CL at 170°			Wind Velocity(m/sec)		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
2	152	156	163	-	-	-

t_{16} to t_{16}+60 min	16-km Tower			t_{16} = 0918, 24 Oct		
Height (meters)	Wind Direction, Grid CL at 170°			Wind Velocity(m/sec)		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
32	139	159	207	2.2	3.0	3.7
16	155	165	210	1.5	2.6	3.2
8	-	-	-	1.4	2.6	3.3
4	-	-	-	1.2	2.2	2.8
2	145	165	220	2.0	2.4	2.8
1	-	-	-	1.3	2.1	2.6

t_{32} to t_{32}+60 min	32-km Tower			t_{32} = 1105, 24 Oct		
Height (meters)	Wind Direction, Grid CL at 170°			Wind Velocity(m/sec)		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
32	150	163	180	Non Operational		
16	150	174	190	Non Operational		
8	-	-	-	Non Operational		
4	-	-	-	Non Operational		
2	146	174	190	2.0	3.1	3.9
1	-	-	-	0.6	2.1	3.0

TABLE D-6 (Cont'd)

AIR-FLOW SUMMARY

Release 11

t_o to t_o+30 min	Apex Tower			t_o = 0435, 25 Oct		
Height (meters)	Wind Direction, Grid CL at 170°			Wind Velocity(m/sec)		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
32	165	169	172	4.6	6.1	7.0
16	157	162	166	5.7	6.5	7.4
8	-	-	-	4.1	4.8	5.2
4	-	-	-	3.1	3.4	3.9
2	152	157	165	3.1	3.3	3.7
1	-	-	-	2.4	2.9	3.3

t_2 to t_2+30 min	2-km Tower			t_2 = 0446, 25 Oct		
Height (meters)	Wind Direction, Grid CL at 170°			Wind Velocity(m/sec)		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
2	130	155	167	-	-	-

t_{16} to t_{16}+60 min	16-km Tower			t_{16} = 0536, 25 Oct		
Height (meters)	Wind Direction, Grid CL at 170°			Wind Velocity(m/sec)		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
32	136	158	170	3.2	5.4	6.4
16	110	142	157	1.8	3.7	5.2
8	-	-	-	2.0	2.9	3.9
4	-	-	-	1.3	2.2	3.1
2	90	141	162	1.3	1.9	3.0
1	-	-	-	0.9	1.5	2.5

t_{32} to t_{32}+60 min	32-km Tower			t_{32} = 0709, 25 Oct		
Height (meters)	Wind Direction, Grid CL at 170°			Wind Velocity(m/sec)		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
32	35	73	92	2.2	3.2	4.4
16	43	87	137	2.5	3.5	5.6
8	-	-	-	2.0	2.9	4.9
4	-	-	-	1.4	2.0	3.1
2	20	110	158	1.3	1.6	2.5
1	-	-	-	0.9	1.3	1.8

TABLE D-7

NUMBER OF HOURS OF NIGHTTIME SURFACE WIND DIRECTION
AND NUMBER OF RELEASES POSSIBLE*

Apex Area (2-meter level)

2000 - 0600 Hours

For

August, September, October 1957-8-9

Year	Wind Direction Range (degrees)			
	150 - 190 CL at 170	140 - 200 CL at 170	130 - 190 CL at 160	135 - 195 CL at 165
1957**	195 12.8*	246 16.2	249 16.4	256 16.9
1958**	109 7.2	142 9.4	131 8.6	135 8.9
1959	122 8	216 14.1	204 13.4	225 14.8
3-Year Average	142 9.3	201 13.3	194 12.8	205 13.5

CL - Centerline

* - No. of releases relative to the eight releases made in 1959.

** - Wind data for 1957-8 taken from Mud Hen.

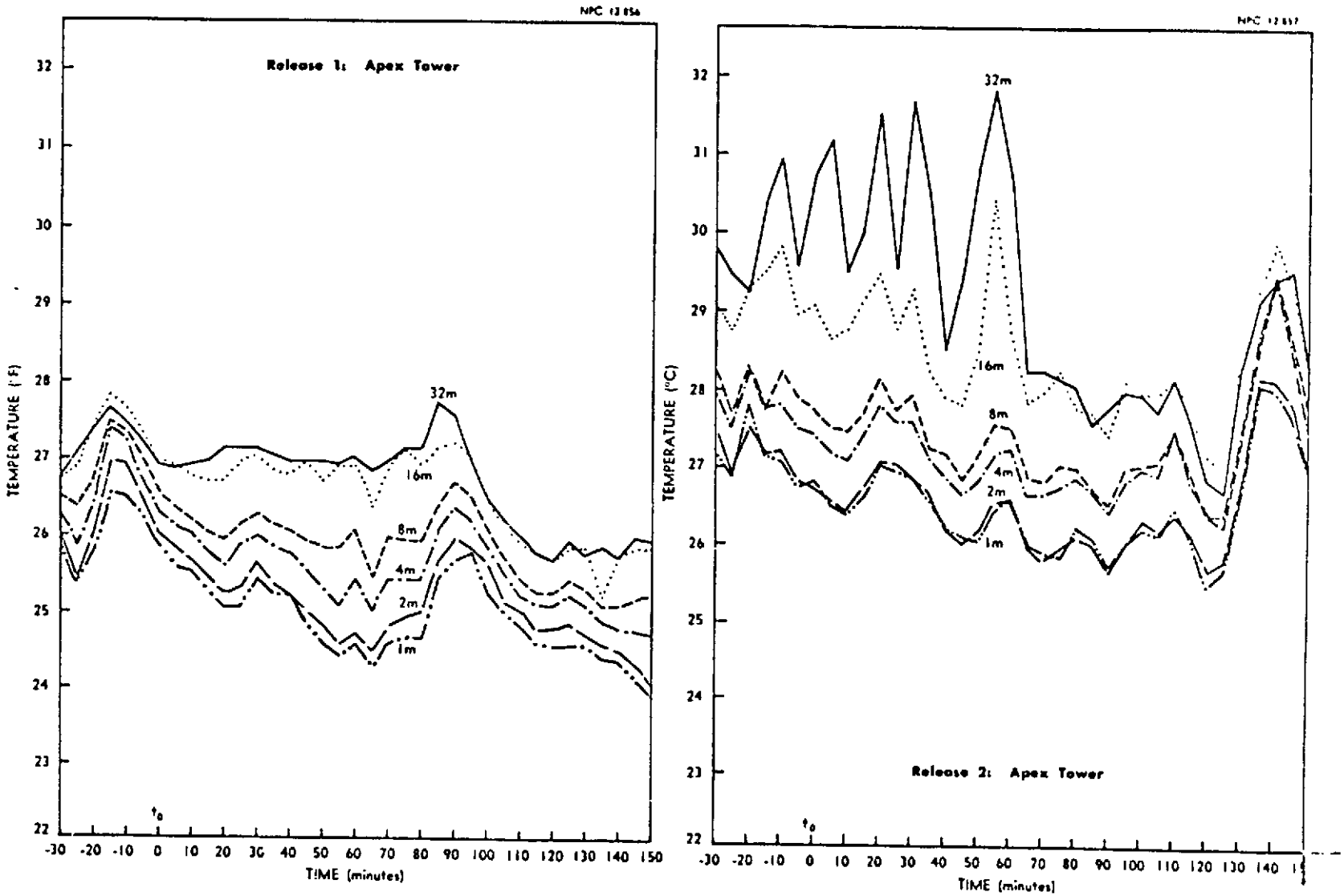


FIGURE D-5. TEMPERATURE PROFILES FOR RELEASES 1 AND 2: APEX TOWER

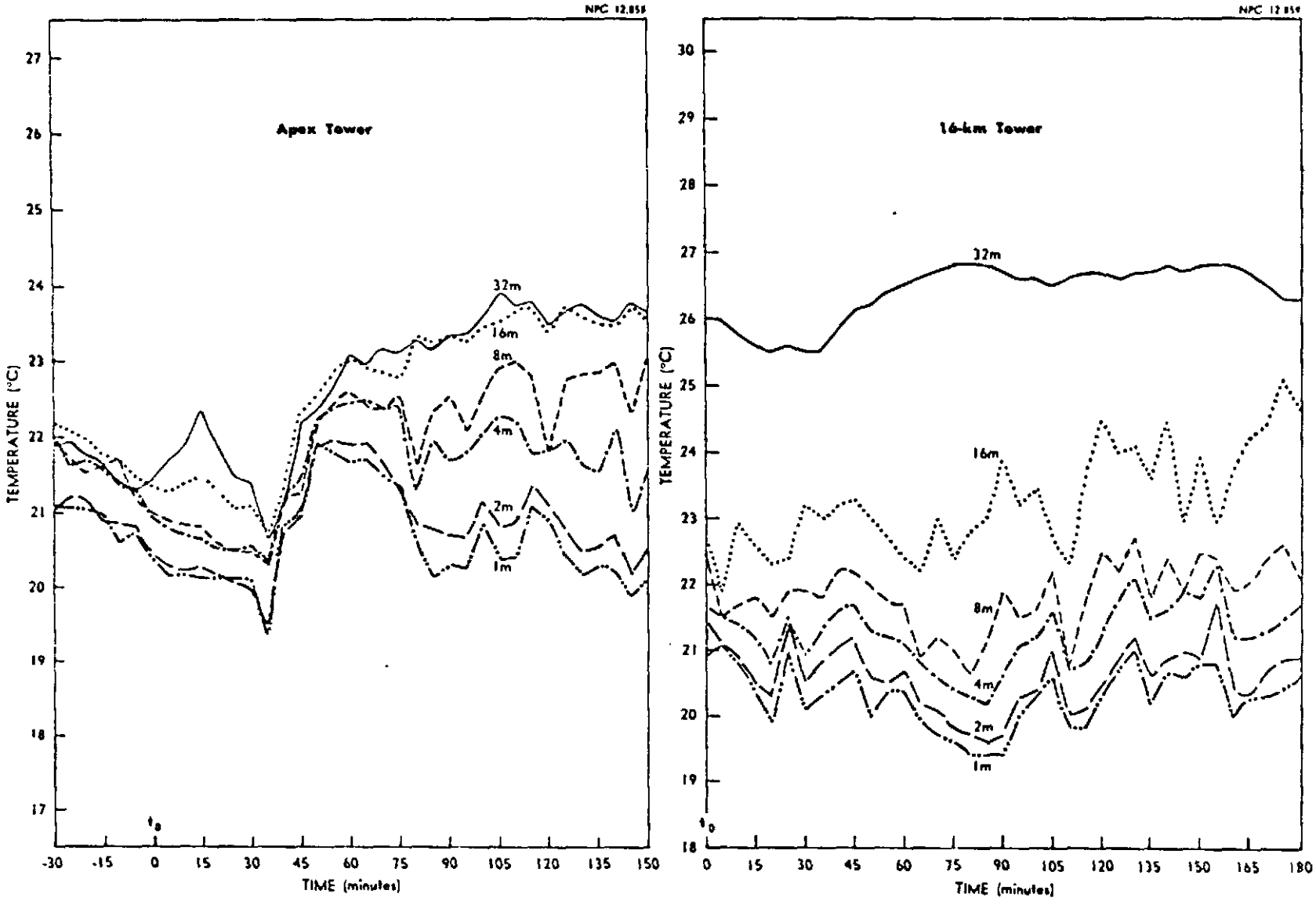


FIGURE D-6. TEMPERATURE PROFILES FOR RELEASE 3: APEX AND 16-KM TOWERS

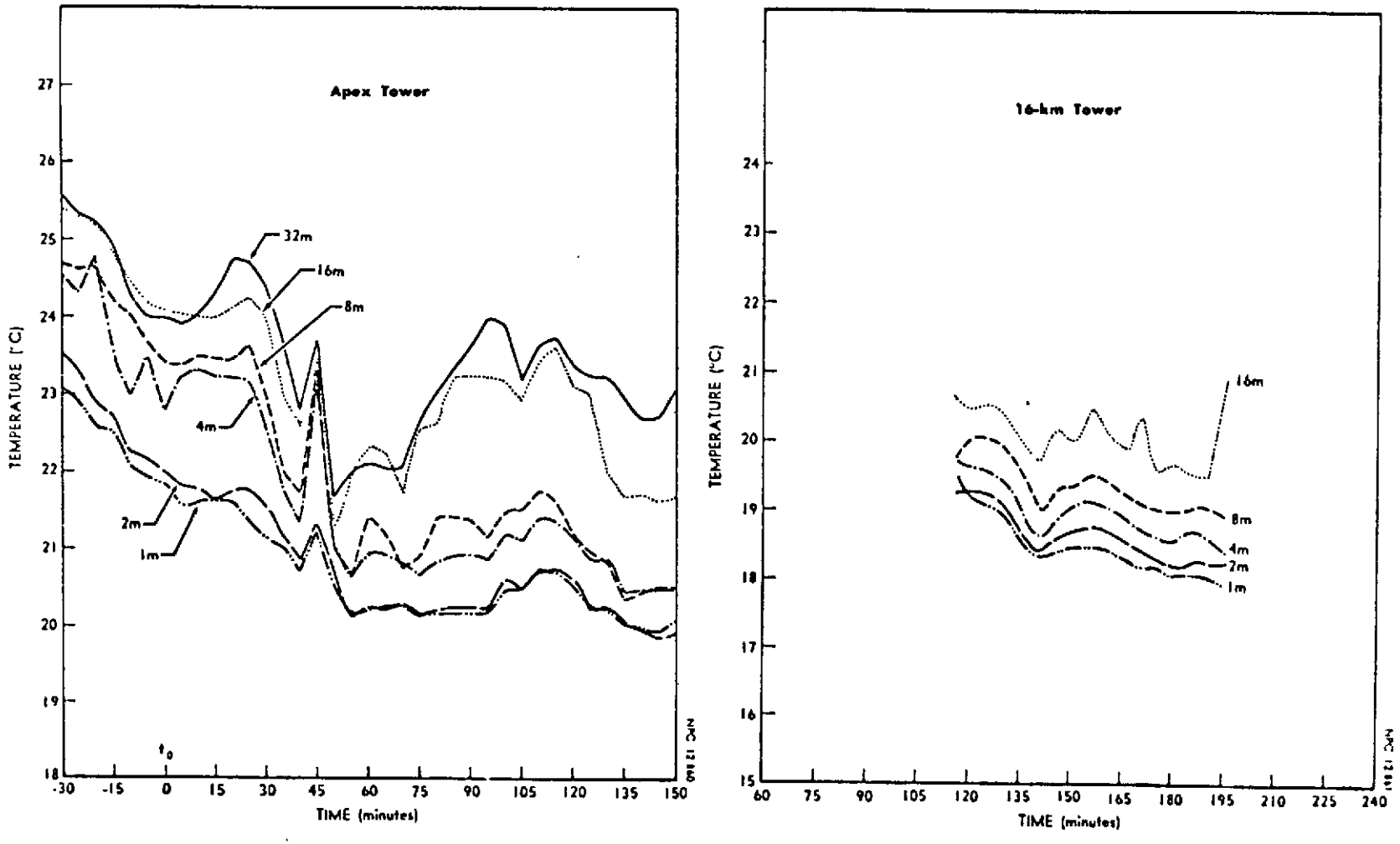


FIGURE D-7. TEMPERATURE PROFILES FOR RELEASE 4: APEX AND 16-KM TOWERS

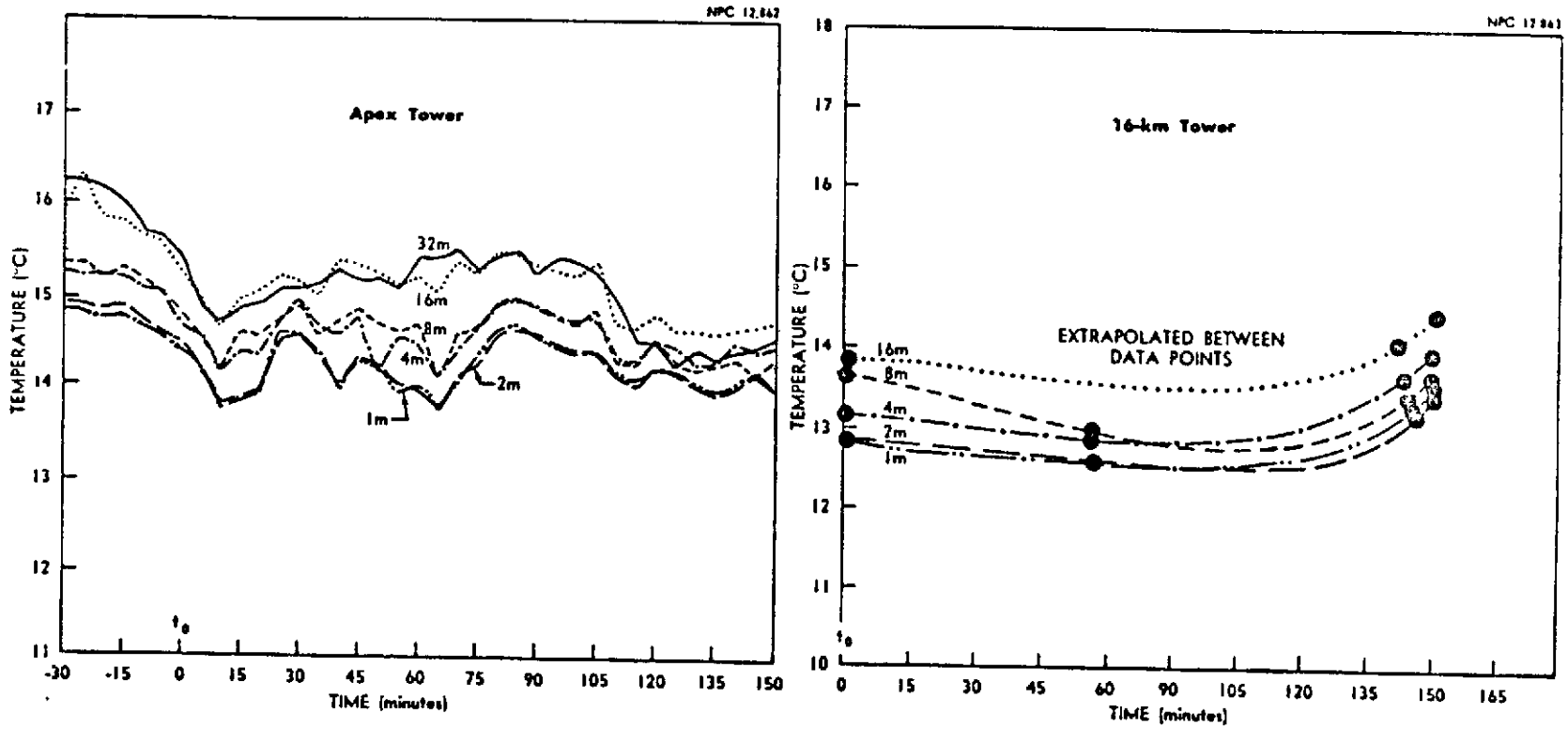


FIGURE D-8. TEMPERATURE PROFILES FOR RELEASE 5: APEX AND 16-KM TOWERS

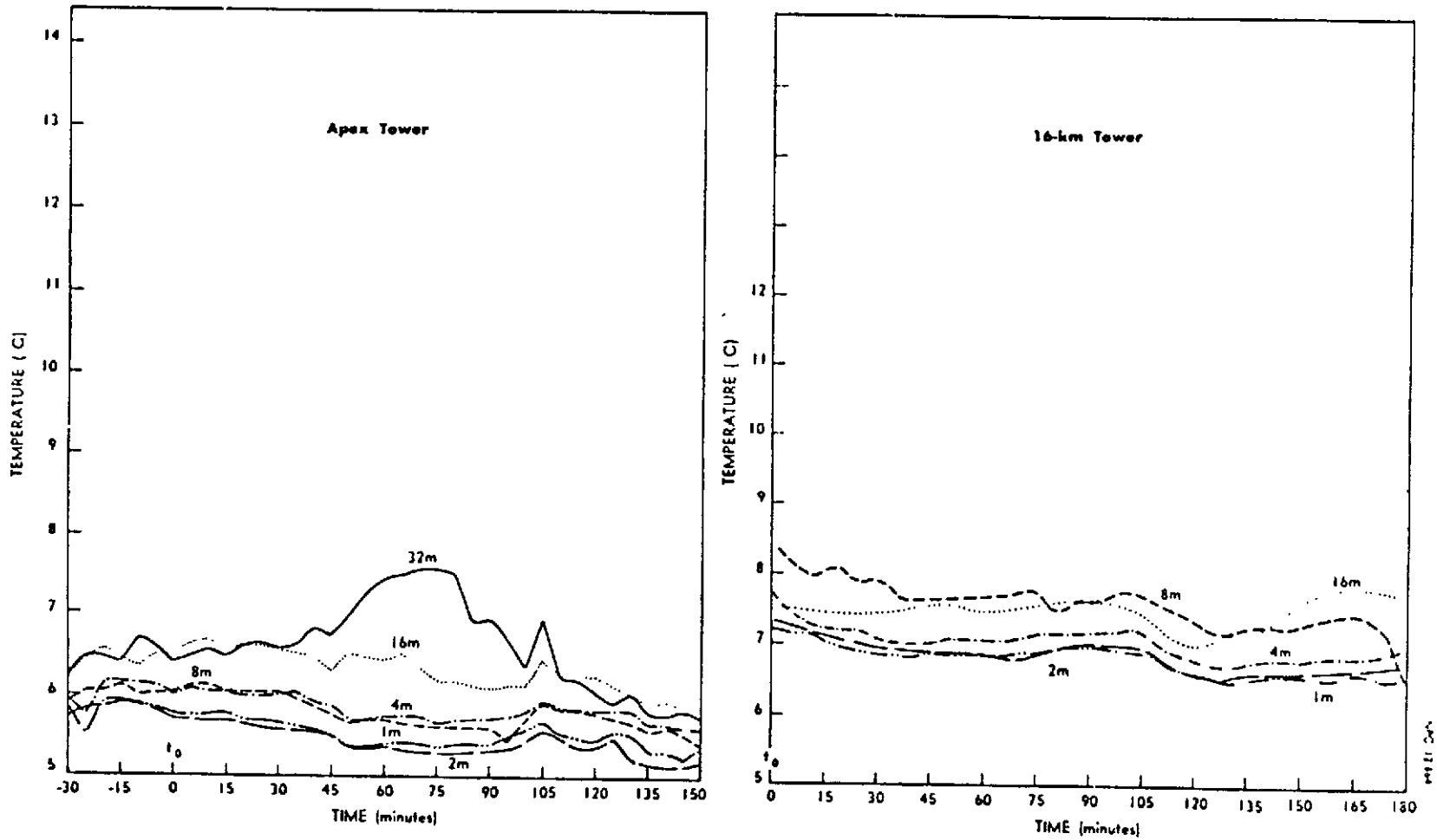


FIGURE D-9. TEMPERATURE PROFILES FOR RELEASE 8: APEX AND 16-KM TOWERS

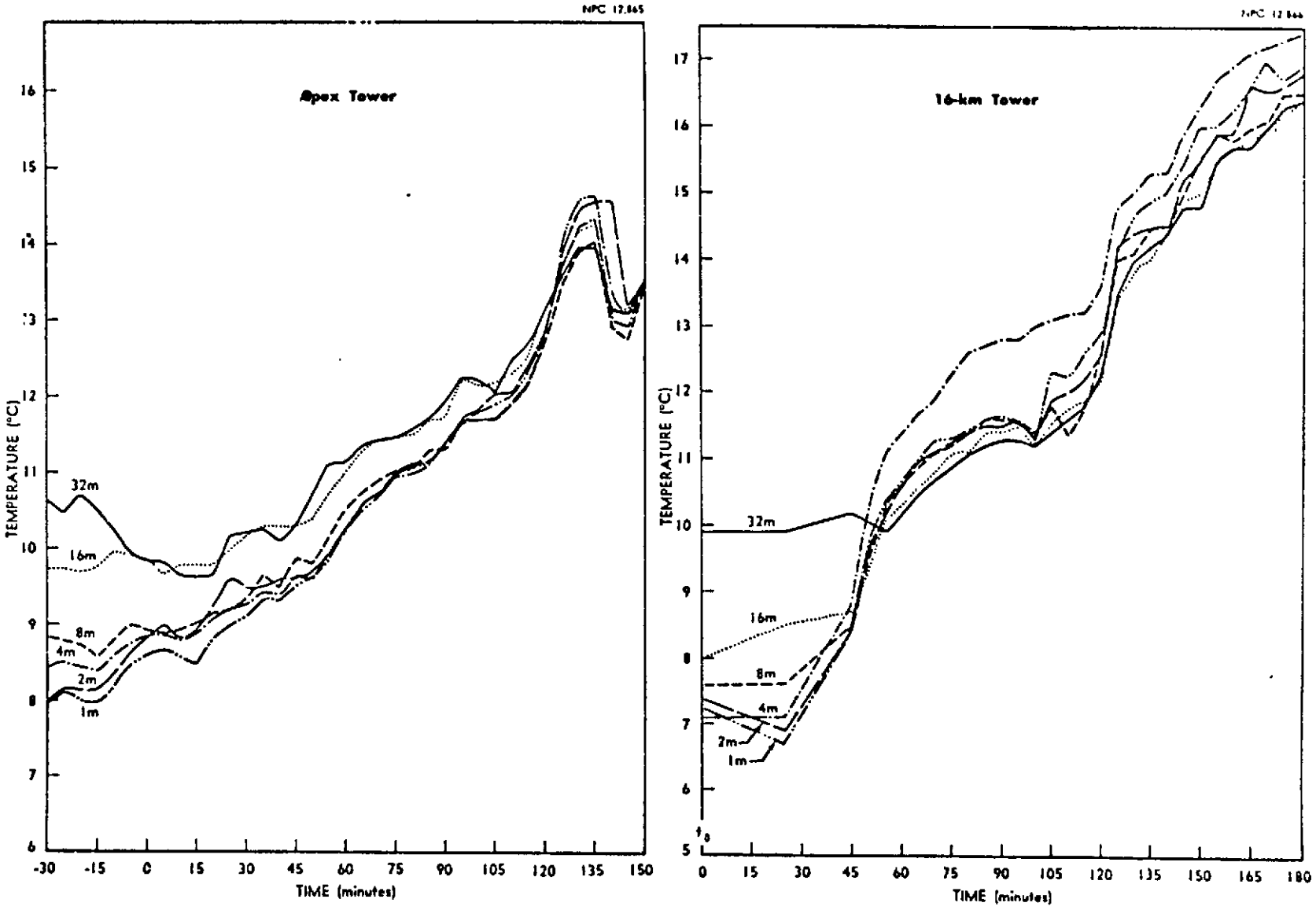


FIGURE D-10. TEMPERATURE PROFILES FOR RELEASE 10: APEX AND 16-km TOWERS

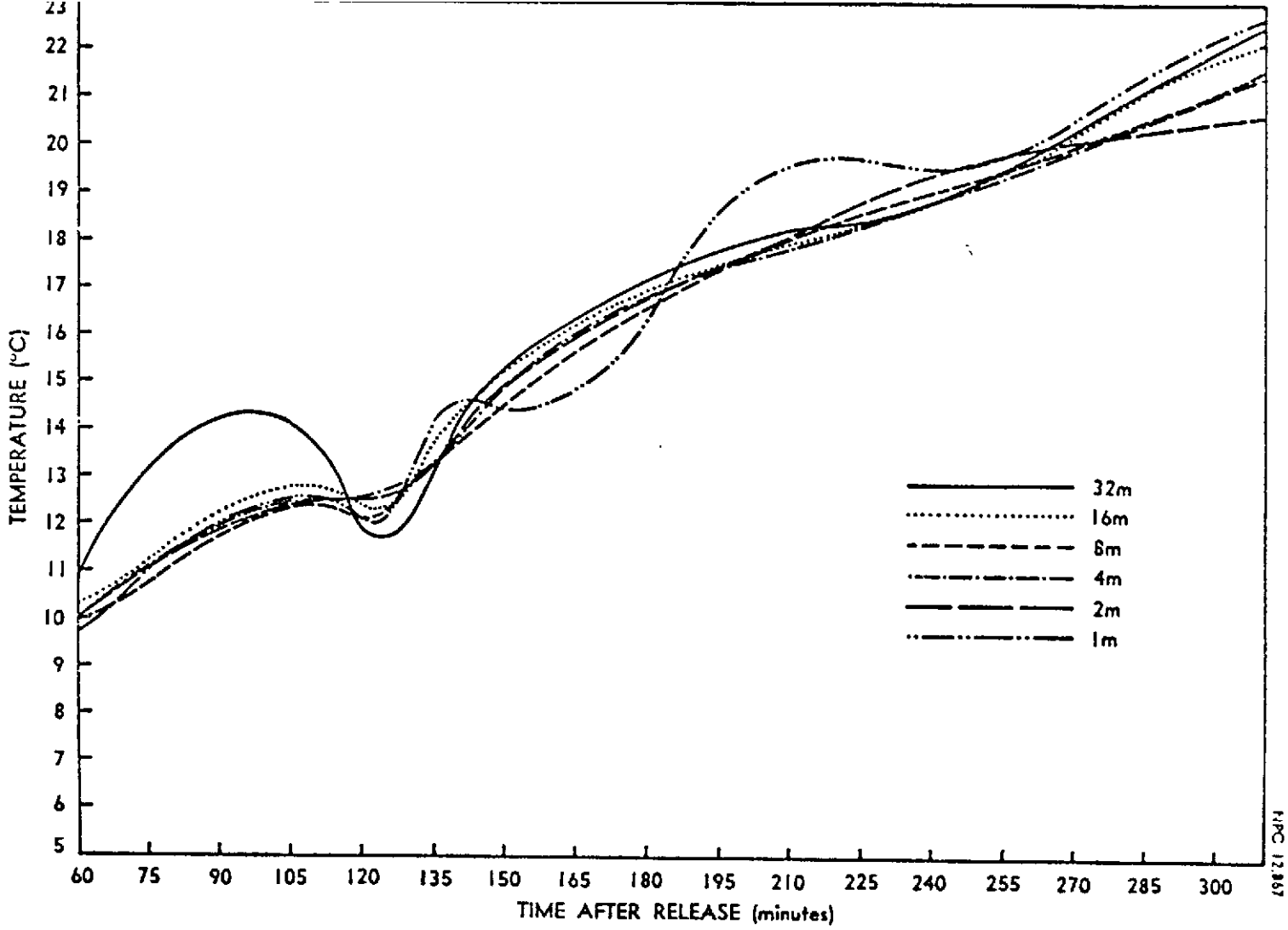


FIGURE D-11. TEMPERATURE PROFILES FOR RELEASE 10: 32-KM TOWER

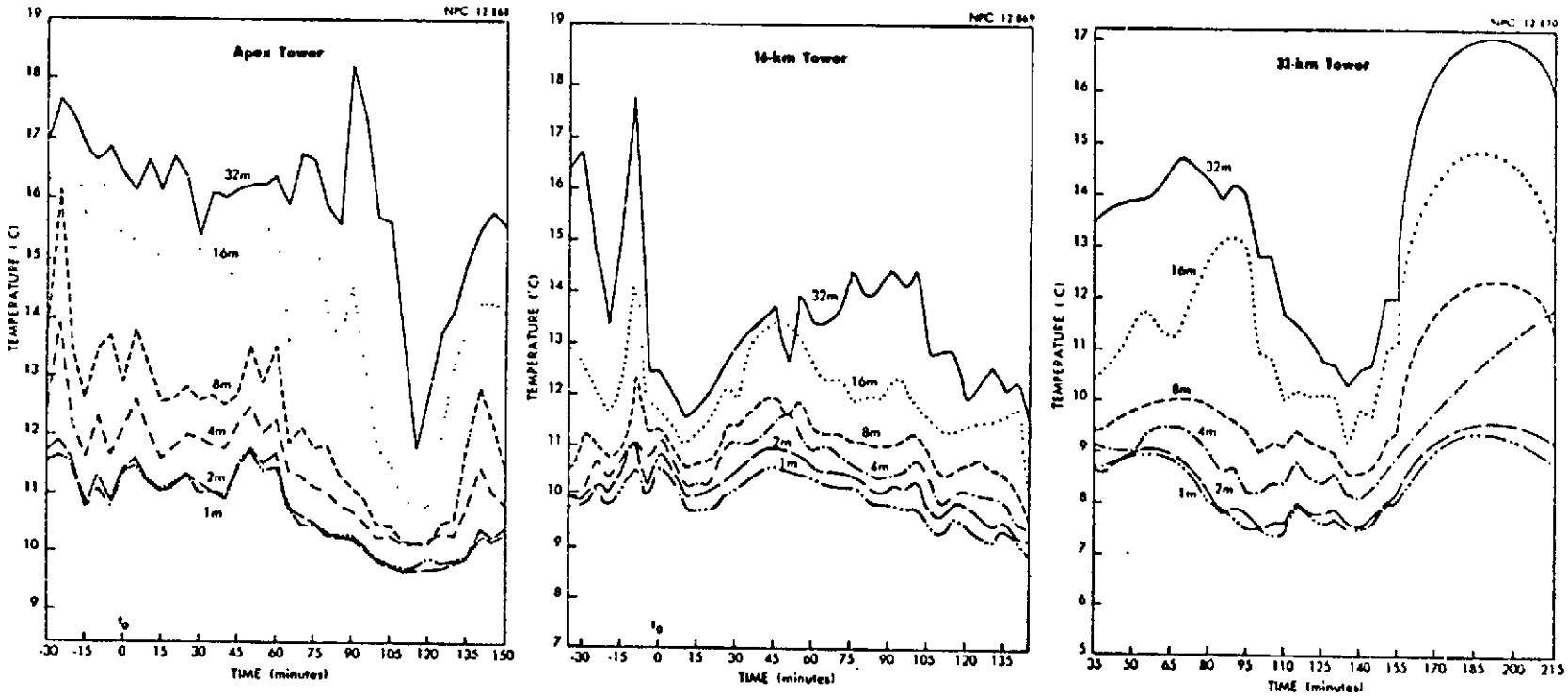


FIGURE D-12. TEMPERATURE PROFILES FOR RELEASE 11: APEX, 16-KM, AND 32-KM TOWERS

At any given instance, it is theoretically possible to determine the energy transport at any given point in the atmosphere. Means of transferring energy in the atmosphere are discussed in the sections following.

Radiation Transmission. Electromagnetic radiation moves through the atmosphere at the velocity of light in the medium. It can be reflected, refracted, or absorbed by the constituents of the atmosphere. The energy associated with such radiation is given by:

$$E = \frac{hc}{\lambda} \text{ (ergs)}$$

where h is Planck's constant = 6.62×10^{-27} erg-sec,

c is the velocity of light = 1.998×10^{10} cm/sec

λ is the wave length of the radiation in cm.

The primary source of heat to the atmosphere is the sun, which provides about 1.35×10^{6} ergs/cm^2-sec (1.94 cal/in.^{2}-min) at the distance of the earth (neglecting atmospheric absorption). The solar radiation is primarily restricted to wave lengths lying between 3000 and 20000 angstroms, having many absorption lines caused by the constituents in the earth or solar atmospheres. For practical purposes, the sun may be assumed to be a black body at 5800°K having an intensity of

$$W(\lambda, T) = \frac{C_1 \lambda^{-5}}{e^{C_2/\lambda T} - 1} \quad \frac{\text{watts}}{\text{steradian-cm}^3} ,$$

where $C_1 = 1.177 \times 10^{-12}$ cm^2-watts/steradian

$C_2 = 1.432$ cm-$^\circ$K

$T \approx 5800^\circ$K

Secondary emissions from the earth may, on the average, be considered to be coming from a black-body radiator at about 250°K. The average solar balance on the earth, neglecting any net gain or loss of energy, is as follows:

Of 100% incoming radiation,

27% is reflected back by the atmosphere
9% is scattered back by the atmosphere
36% = Albedo

32% reaches the earth directly
19% reaches the earth by scattering
51% reaches the earth
13% is absorbed in the atmosphere
64% absorbed by the atmosphere

17% leaves the earth and its atmosphere from earth
47% leaves from the atmosphere
64%

In the lower atmosphere, variables such as cloud cover, atmospheric moisture, atmospheric dusts, types of surfaces, the inclination of the sun, and diurnal insolation cause problems in creating similar heat balances.

Conduction. Energy can move through a substance without the visible motion of any part of the substance. Such motion may be described by the heat-conduction equation ($u_t = \nabla^2 u$) which can readily be solved for a given set of boundary conditions.

Convection. Conduction satisfactorily describes the observed heat flow in solids but cannot explain the higher than expected heat transfer in gases or fluids. The more rapid heat transfer is due to the physical motion in the fluid caused by temperature and density gradients. In the atmosphere, conductive heat transfer can generally be neglected as compared to convective heat transfer.

Latent Energy Transfer. Energy can be absorbed or liberated in a medium by causing changes of the state, such as the evaporation of ice or the condensation of vapor. Evaporation, for instance, removes sensible heat from the atmosphere and retains it in a potential state until condensation again returns the heat. Such an energy transport mechanism can fool thermal-heat sensing devices and can only be detected through careful measurements of atmospheric moisture content.

In micrometeorology, it is reasonable to assume that if the mechanisms of atmospheric dispersal are to be understood, the place to start is with the atmospheric energy transport. Many investigators (Refs. 7 through 14), have contributed to the understanding of atmospheric diffusion. Because of their contributions, it is possible to predict atmospheric dispersal by knowing such measurable quantities as the variations of temperature, humidity, and wind velocity (vector components) with height. These are caused by surface terrain, surface moisture, variations in daily cloud cover, surface albedos,

and general atmospheric circulation patterns, to mention a few. All of these considerations are an important aspect of heat-budget studies. An instantaneous heat balance is a measure of merit as to how well all the components are known.

At the surface of the earth a heat balance exists if

$$E(3) + S(3) + L(3) + B(3) + W(3) = 0 \quad \text{when } z = 0,$$

where $E(z)$ is the short-wave flux,

$S(z)$ is the long-wave flux,

$L(z)$ is the eddy diffusion heat-transfer flux,

$B(z)$ is the conducted flux,

$W(z)$ is the transfer of heat through phase transformation.

These components are more fully defined in Reference 7 , and may be further resolved by consulting the literature.

D-3.1 Instruments Used for Heat-Budget Measurements

Net Radiometer. A Beckman and Whitley Model N188 radiometer was used for measuring the net atmosphere-ground heat exchange. The instrument was mounted two meters above the ground over an area fairly typical of the salt flats. The electrical impulses generated as a result of the heat flux were telemetered to a recorder located in the meteorological trailer. The sensing element was composed of silver-constantan thermopiles arranged in a thin phenolic resin plate. The thermopiles consisted of a series of thermcouples that were positioned so that one set of junctions ("hot" junctions) were in a plane

adjacent and parallel to one face of the plate, and the other set of junctions ("cold" junctions) were in a plane parallel and adjacent to the other face of the plate. Heat flow through the plate generated an EMF due to the difference in temperatures between the "hot" and "cold" junctions of the thermopile. The free-air temperature was measured by thermocouples mounted two meters above the ground.

Soil Heat-Flow Measurement. A soil heat-flux determination was made by use of a Beckman and Whitley heat-flow transducer installed approximately 0.5 centimeter below the surface in normalized soil. The signal output (mv/gm-cal/cm^2/min) at a specific transducer temperature was recorded on a millivolt potentiometer. The transducer temperature was recorded on a potentiometer calibrated for the copper-constantan thermocouple embedded in the heat-flow transducer.

Further confirmation of heat flow was made by copper-constantan thermocouples buried at various depths to determine the soil heat gradient. Recording of these temperatures was made on a recording potentiometer calibrated for Cu/Cn thermocouples.

Pyrheliometer. Solar-radiation measurements were made at Apex with an Eppley-type pyrheliometer mounted upright two meters above the ground. Reflected radiation (from the ground) was measured with an inverted Eppley mounted at the

two-meter level at or near the focal point of a parabolic reflector. It was not feasible to calibrate this instrument at the test site; hence, the data were not applied to the heat-budget studies.

The pyrheliometer, a 50-junction type, consisted of a thermopile with two concentric rings enclosed in a glass globe. When exposed to solar radiation, the two rings developed a marked temperature difference and the voltage of the resulting current was nearly proportional to the intensity of solar radiation. A strip-chart recorder registered both duration and intensity of solar radiation.

The instrument was not operated continuously because of daytime electrical-power shut-offs. A few days of insolation data were obtained, which compared favorably with the solar-radiation data taken at Salt Lake City Airport.

Barograph. Atmospheric pressure at the release site was recorded continuously by a Taylor Instruments barograph. The instrument was calibrated during a ten-day period at the USAF Weather Station, then was moved to the instrument shelter near Apex. The barograph exhibited a sensitivity of ± 0.03 inches of mercury. Atmospheric pressure was recorded throughout the test period of FRT II.

Aspirated Thermocouples. Each of the three meteorological towers was instrumented with aspirated thermocouples to obtain temperature profiles of the free-ambient air. The

copper-constantan thermocouples on each tower yielded a sensitivity of $\pm 0.1^{\circ}C$, penned out on a Brown Electronix Multipoint Recorder. Temperature gradients were recorded continuously for a few hours prior to release and during the period the cloud was over the network.

Pibal Stations. Winds aloft over the salt flats were measured with 100-gram helium-filled pilot balloons and theodolites. Four teams, each comprised of two USAF Weather Service airmen, were stationed at Knolls, Callao, Black Rock, and Apex (Fig. 18) to obtain wind speeds and directions at every 500-foot level up to and including 3000 feet. The Pibal runs were started a few hours in advance of release time and continued until the radioactive cloud had cleared the grid. The data, radioed or telephoned to Apex station, were used to determine air flow over the salt flats during release and aided in predicting the meteorological conditions for a release.

Psychrometer. Air moisture at 1.5 meters was measured with a U. S. Weather Bureau-type sling psychrometer. Two carefully matched thermometers were mounted on a stainless-steel backing with a handle attached for whirling. A cotton "sock" was used on the "wet bulb" thermometer. This instrument was used to calibrate and check other air-moisture-measuring instrumentation.

Hygrothermograph. Air-temperature and moisture measurements at the 1.5-meter level were also made with a U. S. Weather Bureau-type hygrothermograph. This instrument, located in a U. S. Weather Bureau-type shelter, recorded both temperature and relative humidity on the same chart. The temperature-sensitive element was a highly-polished, gold-plated, Bourbon tube; the humidity element was a multiple strand of specially treated, hygroscopic human hairs. The accuracy of relative humidity measurements was within 2% in the range of from 15 to 90% R.H. The accuracy of temperature measurement was $\pm 0.5^{o}F$. The measurements were recorded continuously during the FRT-II test period.

D-3.2 Measurements Made at Release Times

General information needed to make certain estimates on the over-all heat budget of the environment are contained in this section. Table D-8 lists the results of a mechanical and chemical analysis of soil samples as performed by the University of Utah in 1953. The area sampled was not part of the specific test area of FRT II, but the amount of salts and moisture would be higher in the Salt Flats, particularly near the surface, than those percentages shown.

The average daily totals of solar radiation, consisting of (1) computed insolation for latitude $40^{o}N$ outside the atmosphere; (2) computed insolation received at the ground with

TABLE D-8

ANALYSIS OF SOIL IN PICKLEWEED AREA AT THE EDGE OF SALT FLATS

Mechanical Analysis (% Dry Weight of Sample)						
Depth (in.)	20 Mesh Screen	40 Mesh Screen	60 Mesh Screen	80 Mesh Screen	100 Mesh Screen	% particles too large to pass through 20 Mesh Screen
Surface	0.4	8.6	17.1	7.6	10.4	55.9
12	0.1	0.4	1.0	0.9	1.0	96.6
24	0.0	0.2	0.3	1.3	3.1	95.1
36	0.0	0.1	00.4	0.8	1.8	96.9

Chemical Analysis							
			Salts (% Dry Weight of Sample)				
Depth (in.)	pH	Moisture %	NaCl	Na_2SO_4	Na_2CO_3	$NaHCO_3$	Total
Surface	8.4	4.4	20.80	0.842	0	0.018	21.600
12	8.4	21.7	4.90	0.204	0.021	0.087	5.300
24	8.4	22.1	4.05	0.275	0.037	0.081	4.240
36	8.6	28.7	5.40	0.204	0.023	0.070	5.470

clear skies, latitude 40°N; (3) insolation observed at Dugway Proving Ground; and (4) insolation observed at Washington, D.C., are plotted in Figure D-13. The average daily totals of solar radiation for Dugway Proving Ground, Salt Lake City, and Fort Worth are shown in Figure D-14. The daily total radiation at Salt Lake City for 1959 is shown in Figure D-15.

The net heat exchange between the soil and the atmosphere (two-meter level) for Releases 3, 4, 5, 8, 10, and 11 are plotted in terms of g-cal/cm^2 per minute versus time in Figures D-16 through D-27. The air and surface temperatures are plotted over a period of several hours, but the temperature differentials are plotted for a shorter period of time. By plotting the temperature differentials, slight fluctuations can be detected.

D-3.3 Summary of Heat-Budget Results

The remarks herewith are intended to provide perspective and guidance in the application of heat-energy data to the evaluation and prediction of effluent dispersal. Summaries of heat-budget components and related meteorological parameters measured for each of the releases are presented in Tables D-9 and D-10. Certain of these components and elements, such as net heat exchange versus wind speed and net heat exchange versus temperature-profile parameter n, do not show any acceptable correlation. On the other hand, it is readily

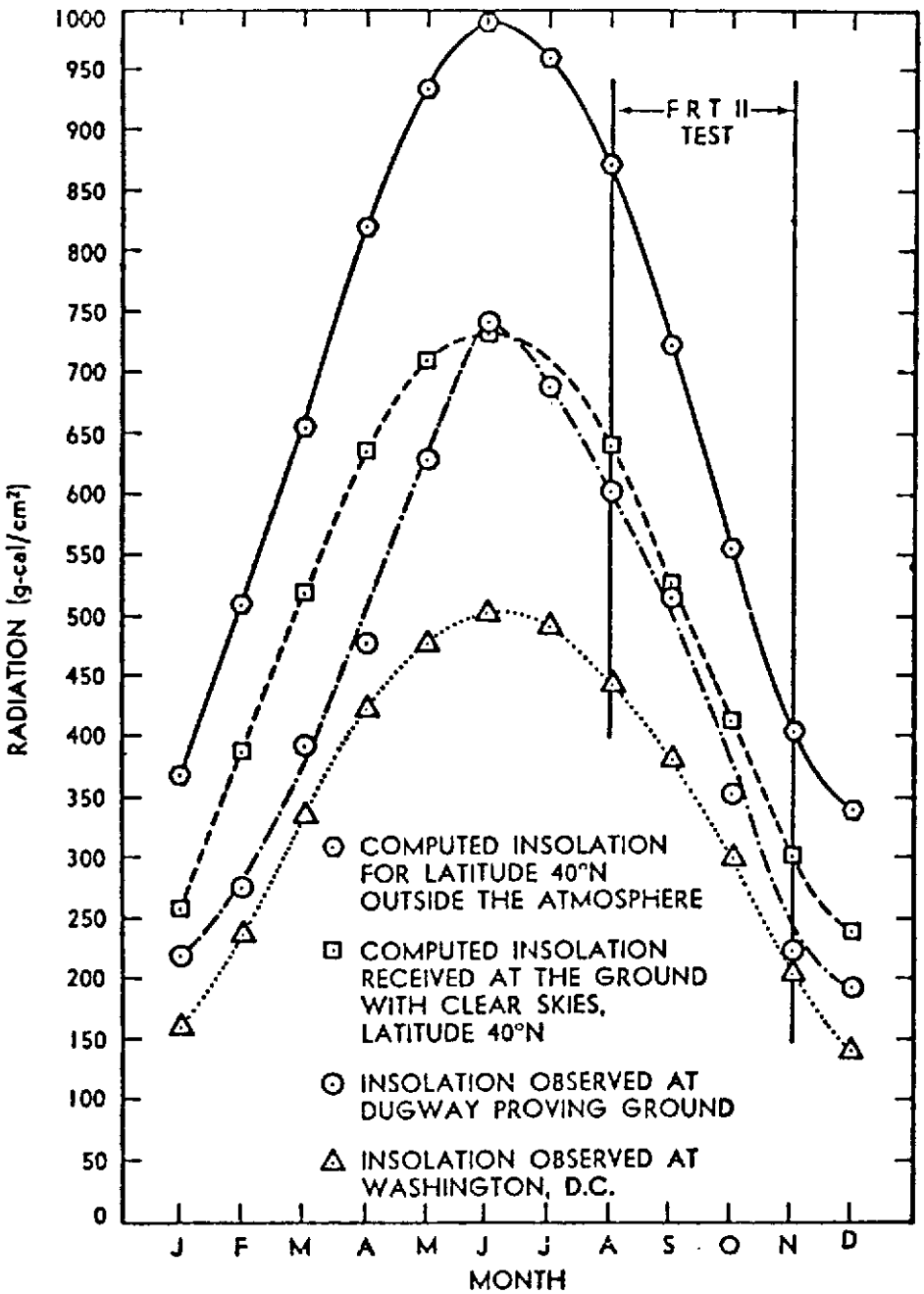


FIGURE D-13. AVERAGE DAILY TOTALS OF SOLAR RADIATION: GEOGRAPHICAL COMPARISON

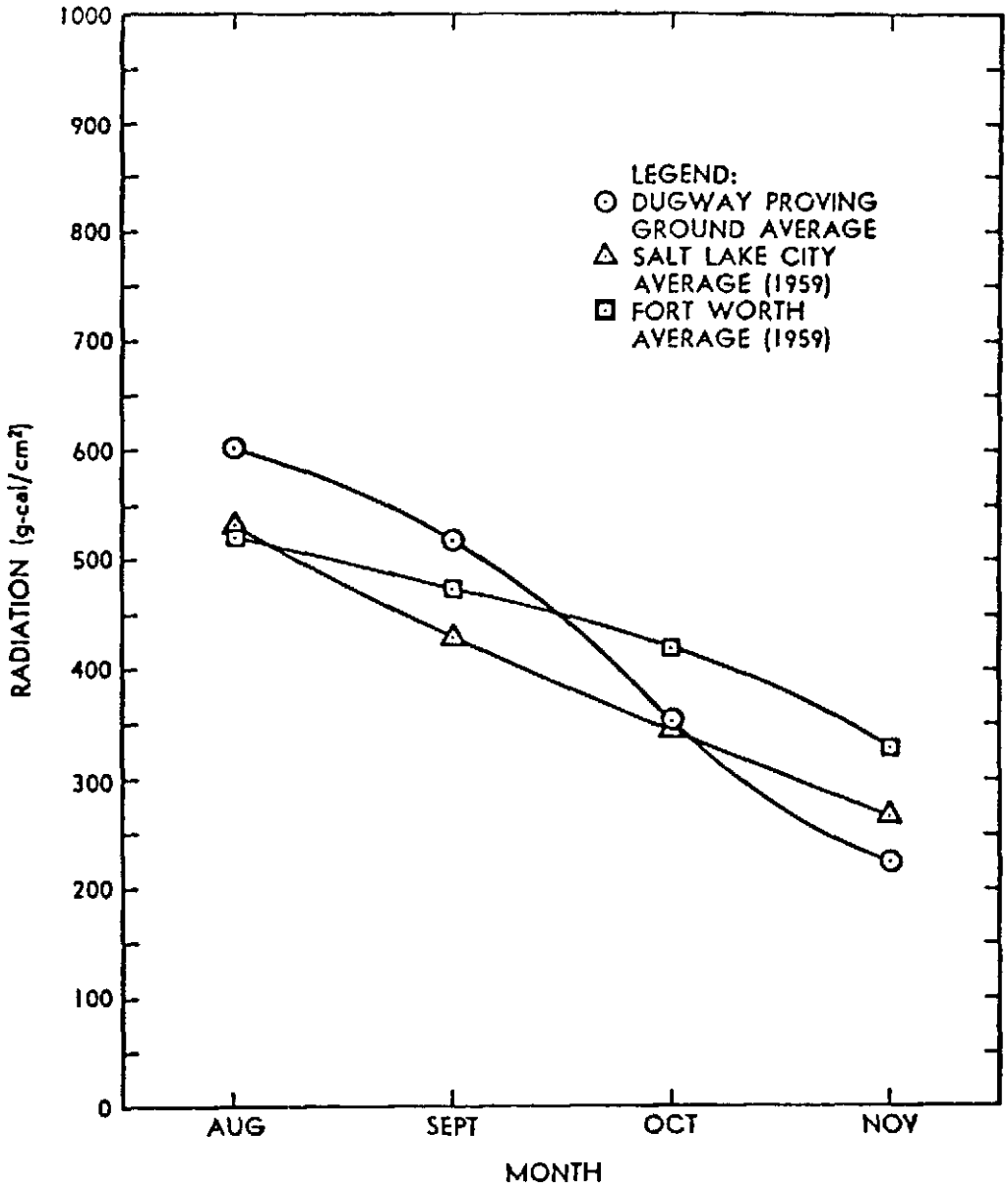


FIGURE D-14. AVERAGE DAILY TOTALS OF SOLAR RADIATION: DUGWAY, SALT LAKE CITY, AND FORT WORTH

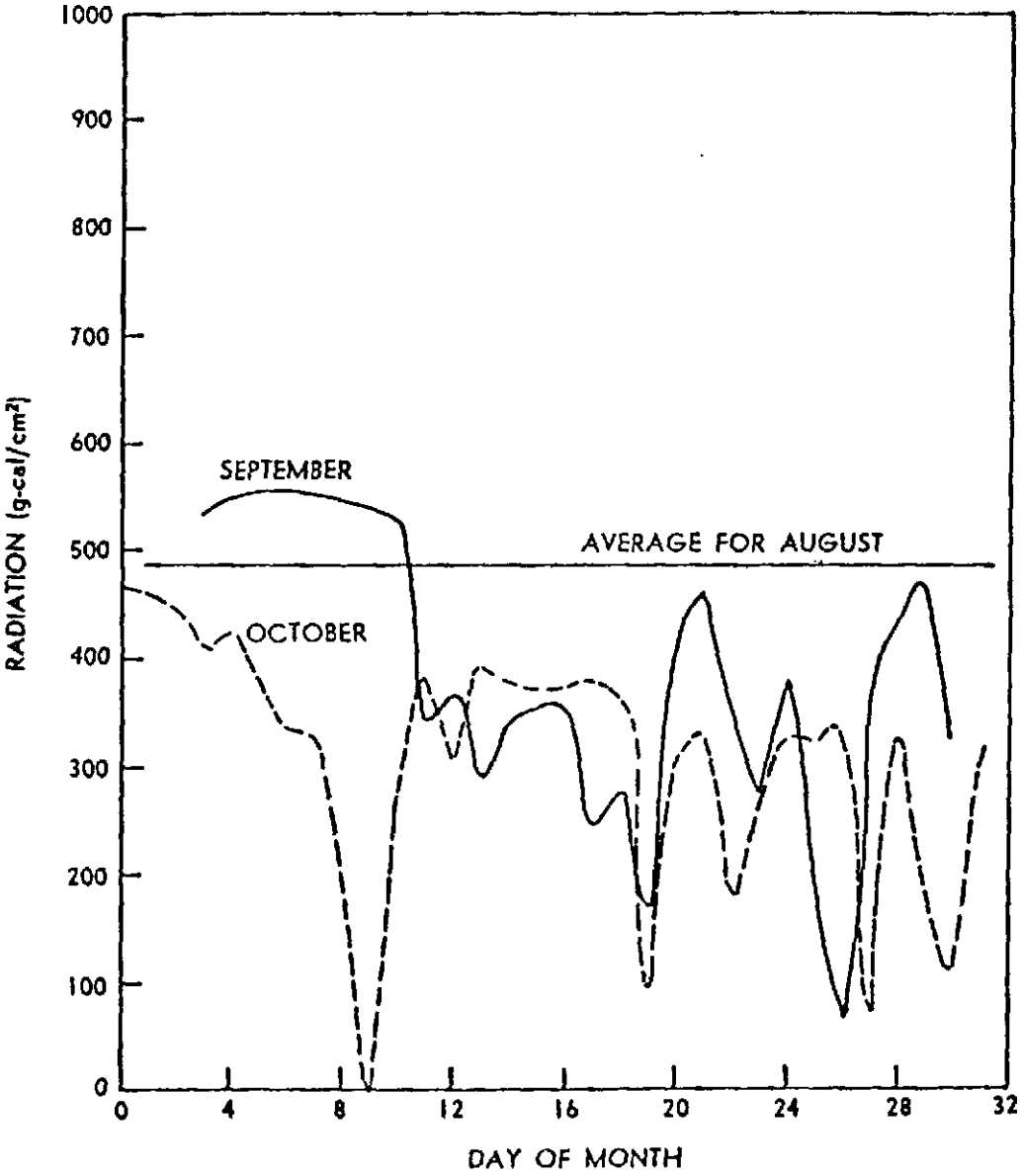


FIGURE D-15. DAILY TOTAL SOLAR RADIATION: SALT LAKE CITY, 1959

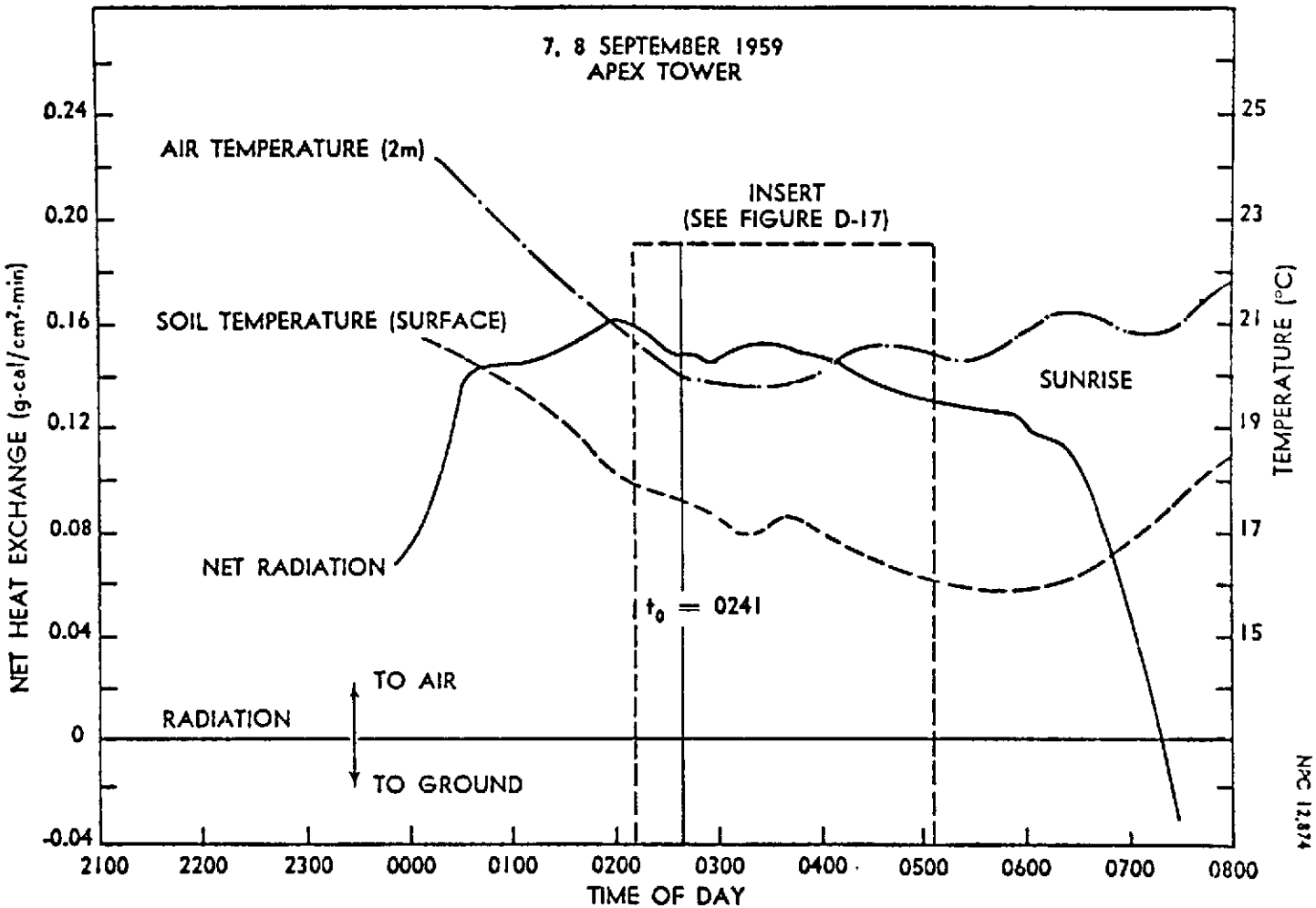


FIGURE D-16. NET HEAT EXCHANGE BETWEEN SOIL AND AIR: RELEASE 3

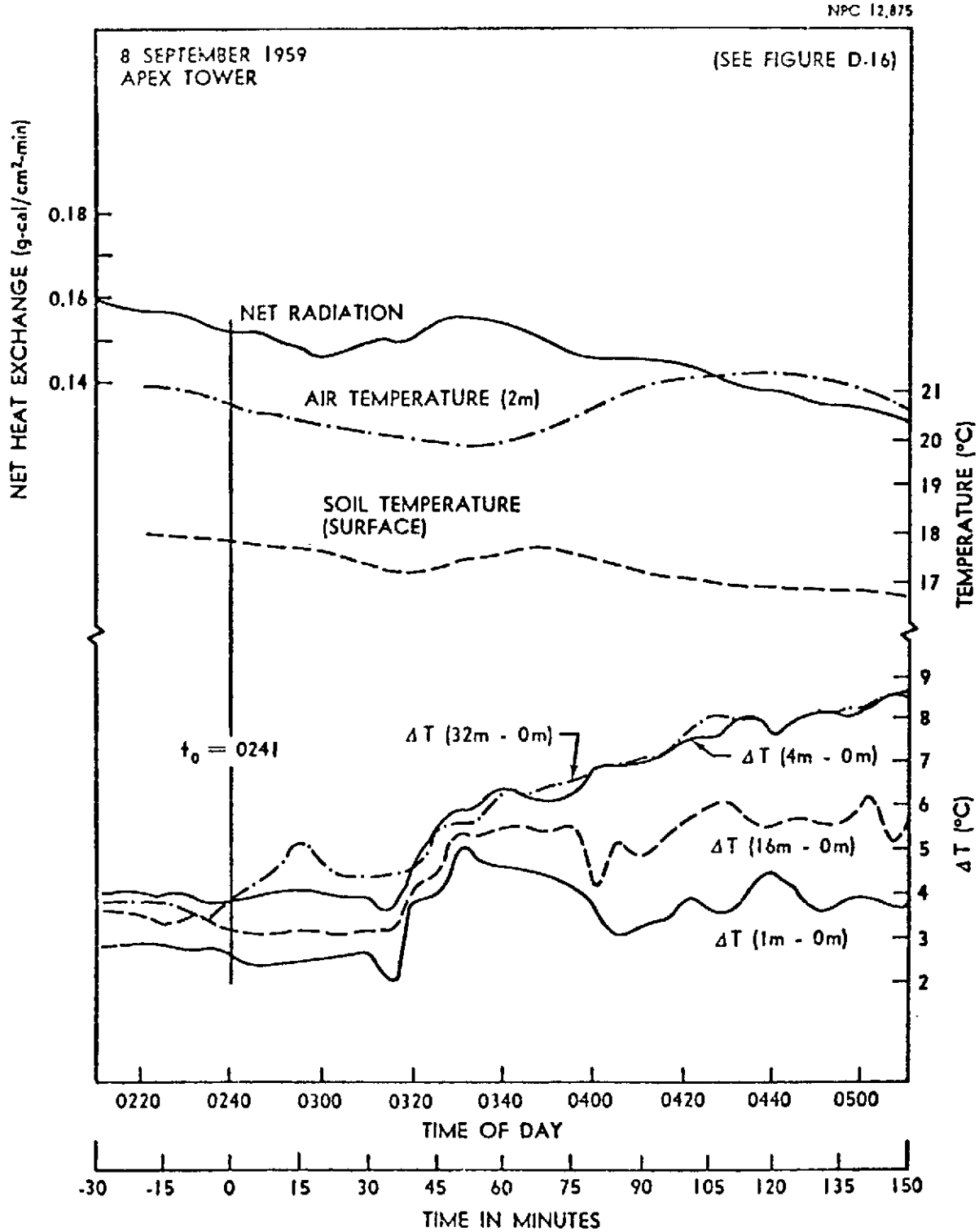


FIGURE D-17. NET HEAT EXCHANGE AND TEMPERATURE DIFFRENTIALS: RELEASE 3

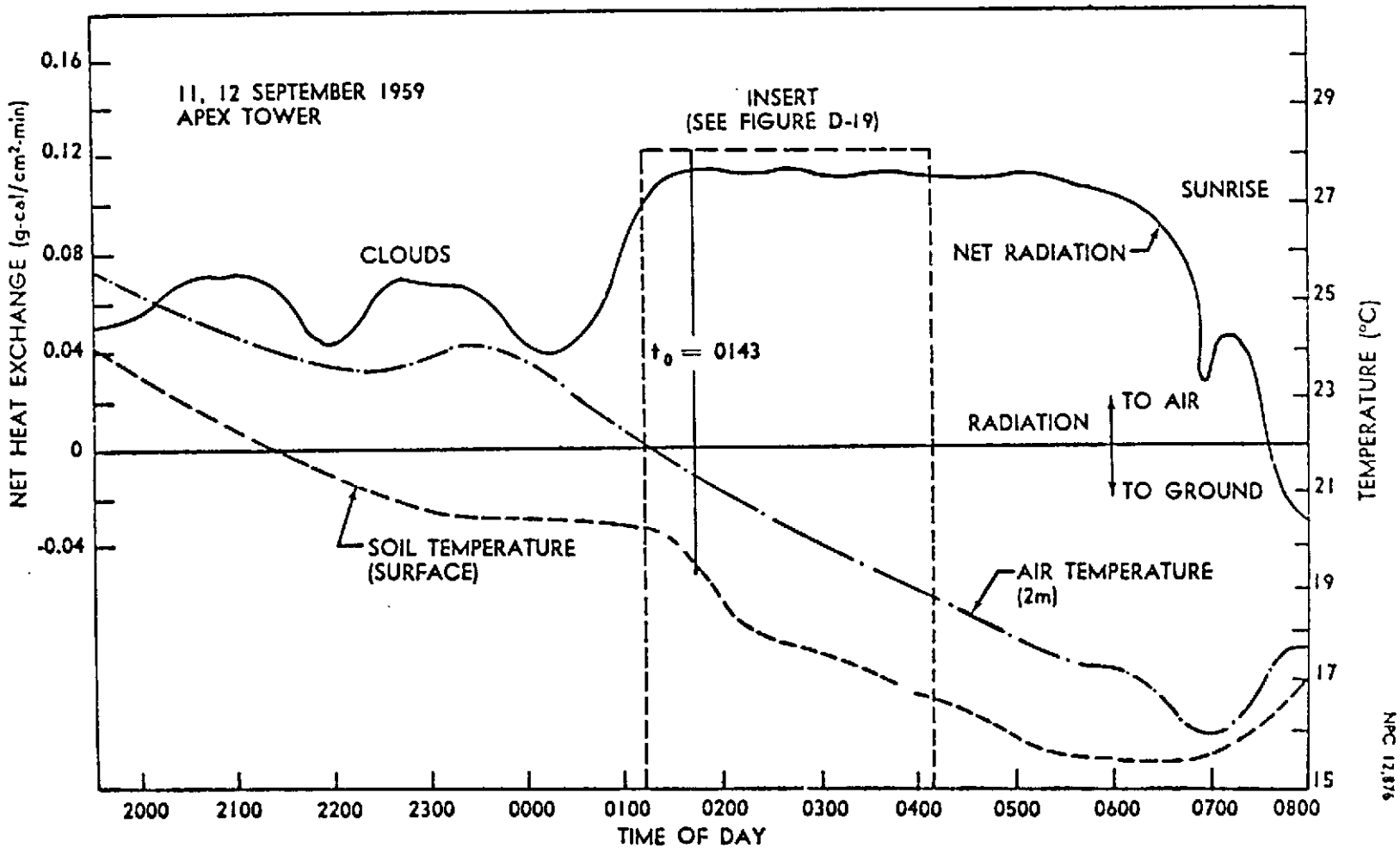


FIGURE D-18. NET HEAT EXCHANGE BETWEEN SOIL AND AIR: RELEASE 4

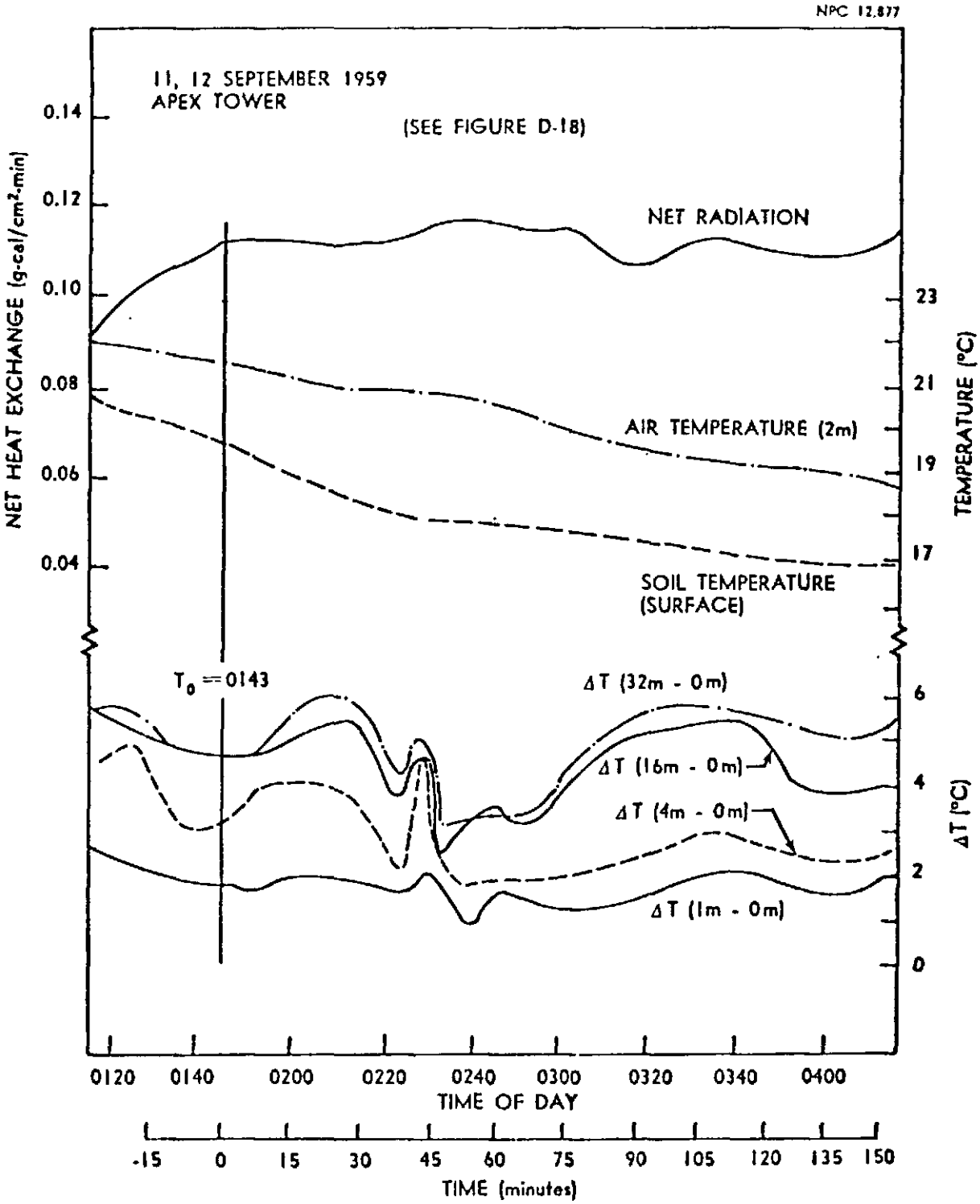


FIGURE D-19: NET HEAT EXCHANGE AND TEMPERATURE DIFFERENTIALS: RELEASE 4

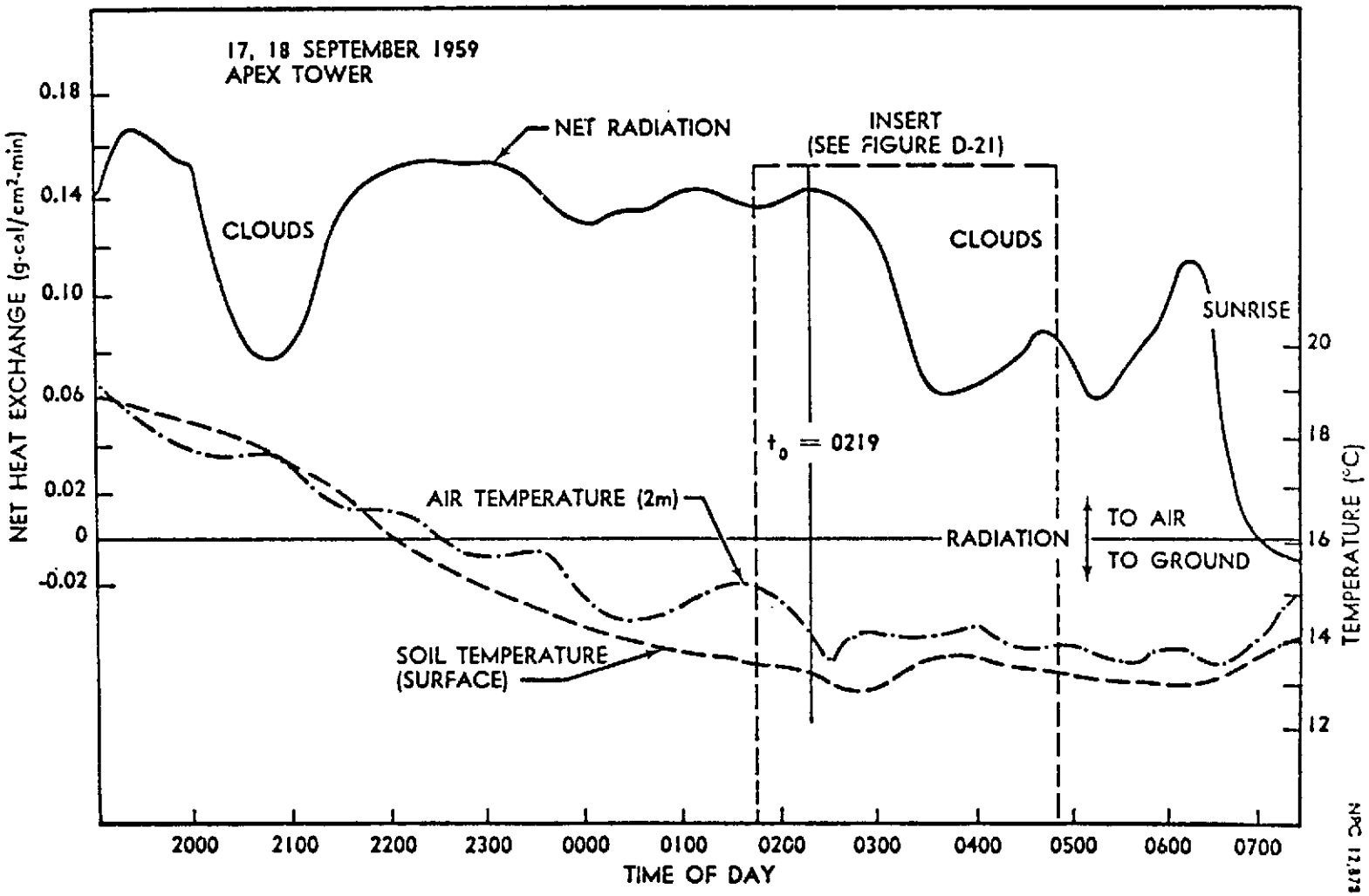


FIGURE D-20. NET HEAT EXCHANGE BETWEEN SOIL AND AIR: RELEASE 5

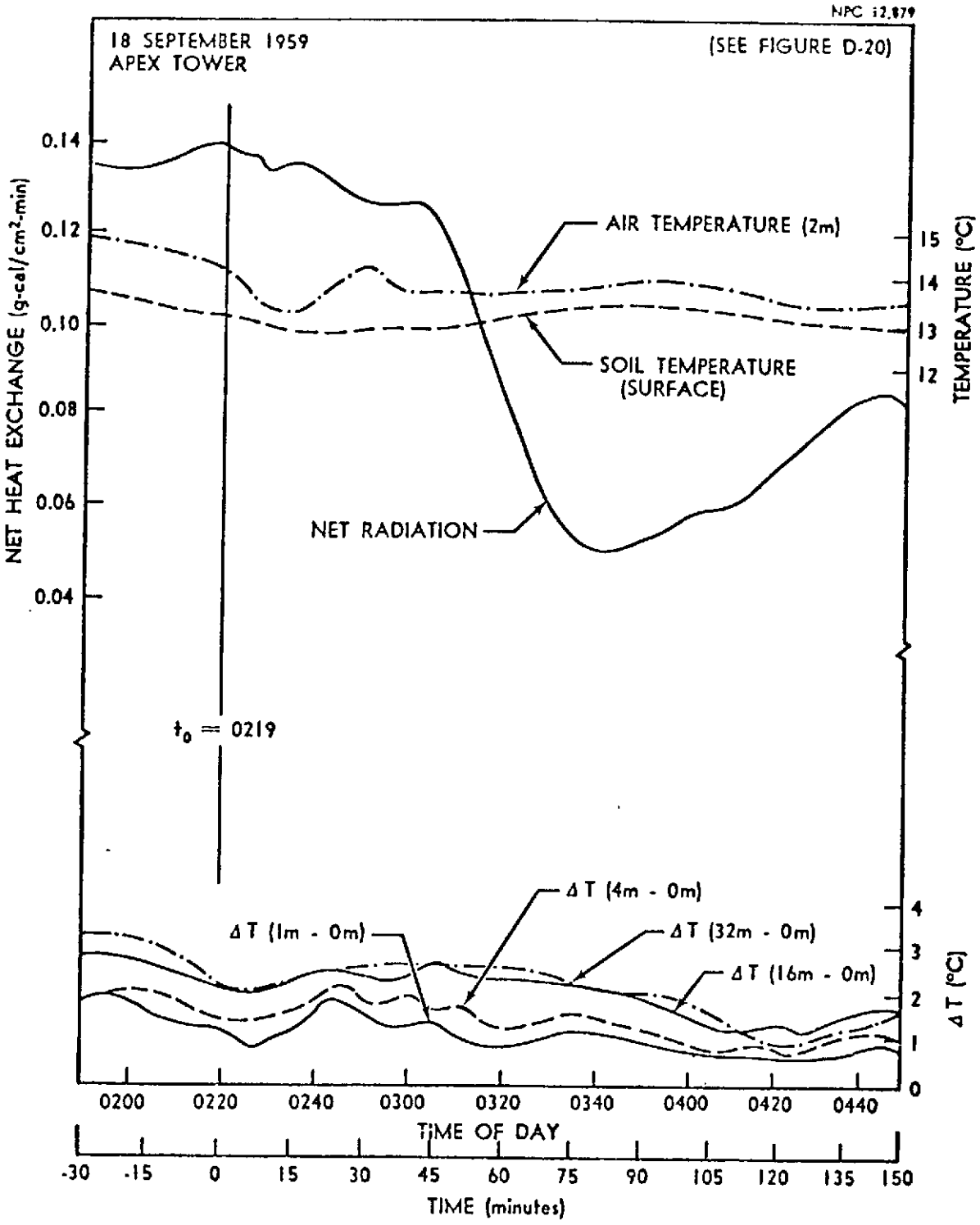


FIGURE D-21. NET HEAT EXCHANGE AND TEMPERATURE DIFFERENTIALS: RELEASE 5

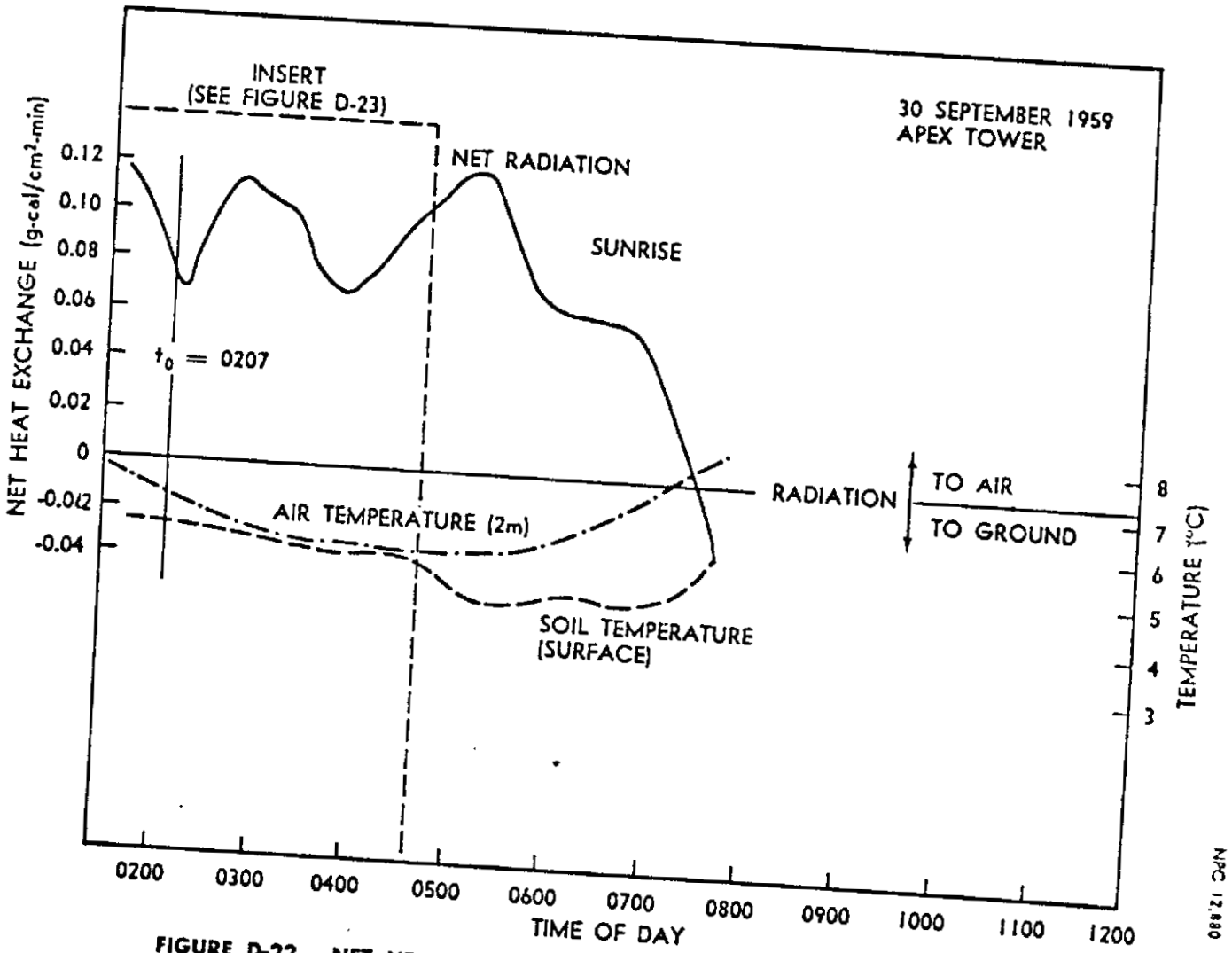


FIGURE D-22. NET HEAT EXCHANGE BETWEEN SOIL AND AIR: RELEASE 8

NPC 12,880

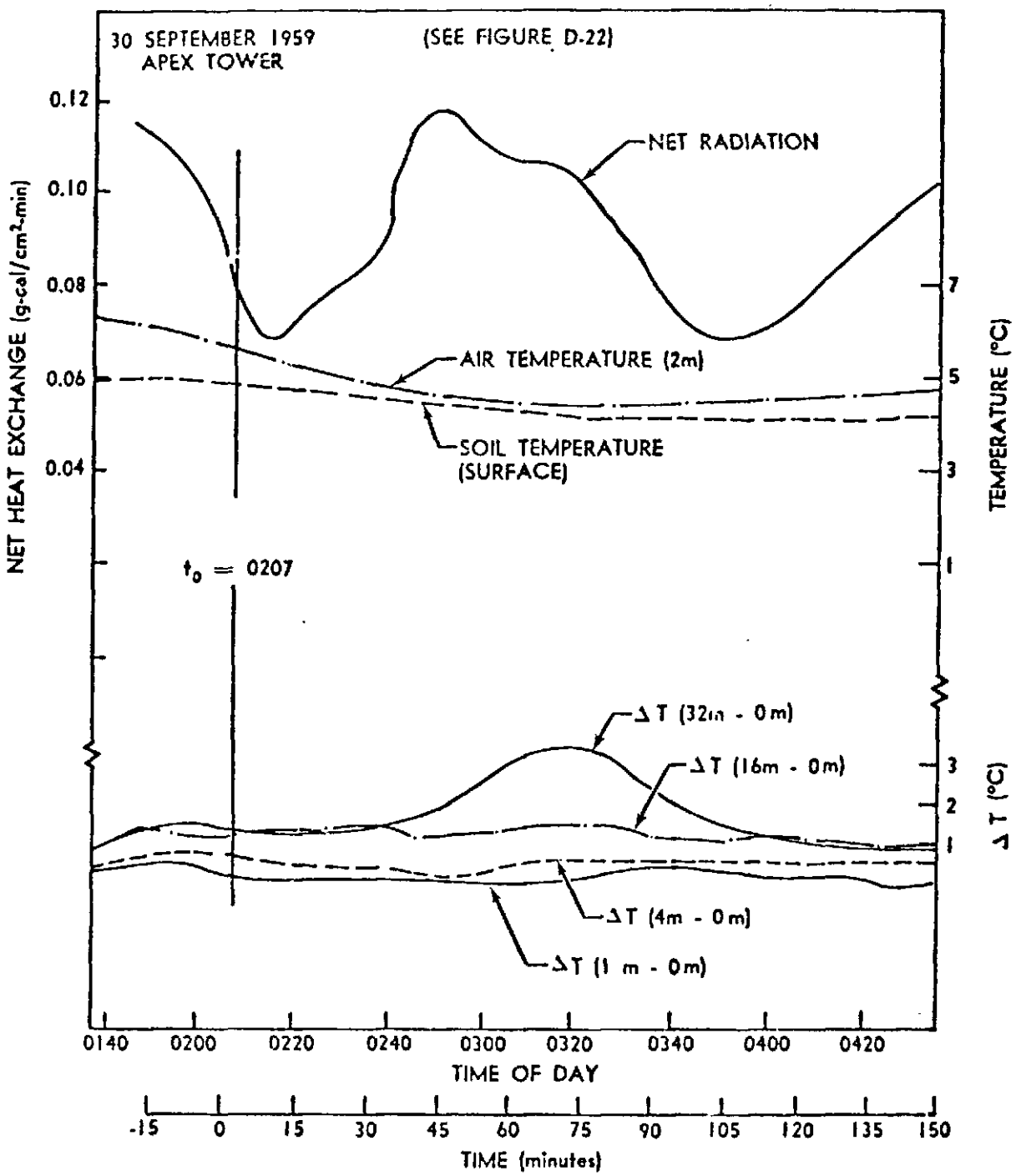


FIGURE D-23. NET HEAT EXCHANGE AND TEMPERATURE DIFFERENTIALS: RELEASE 8

NPC 12,882

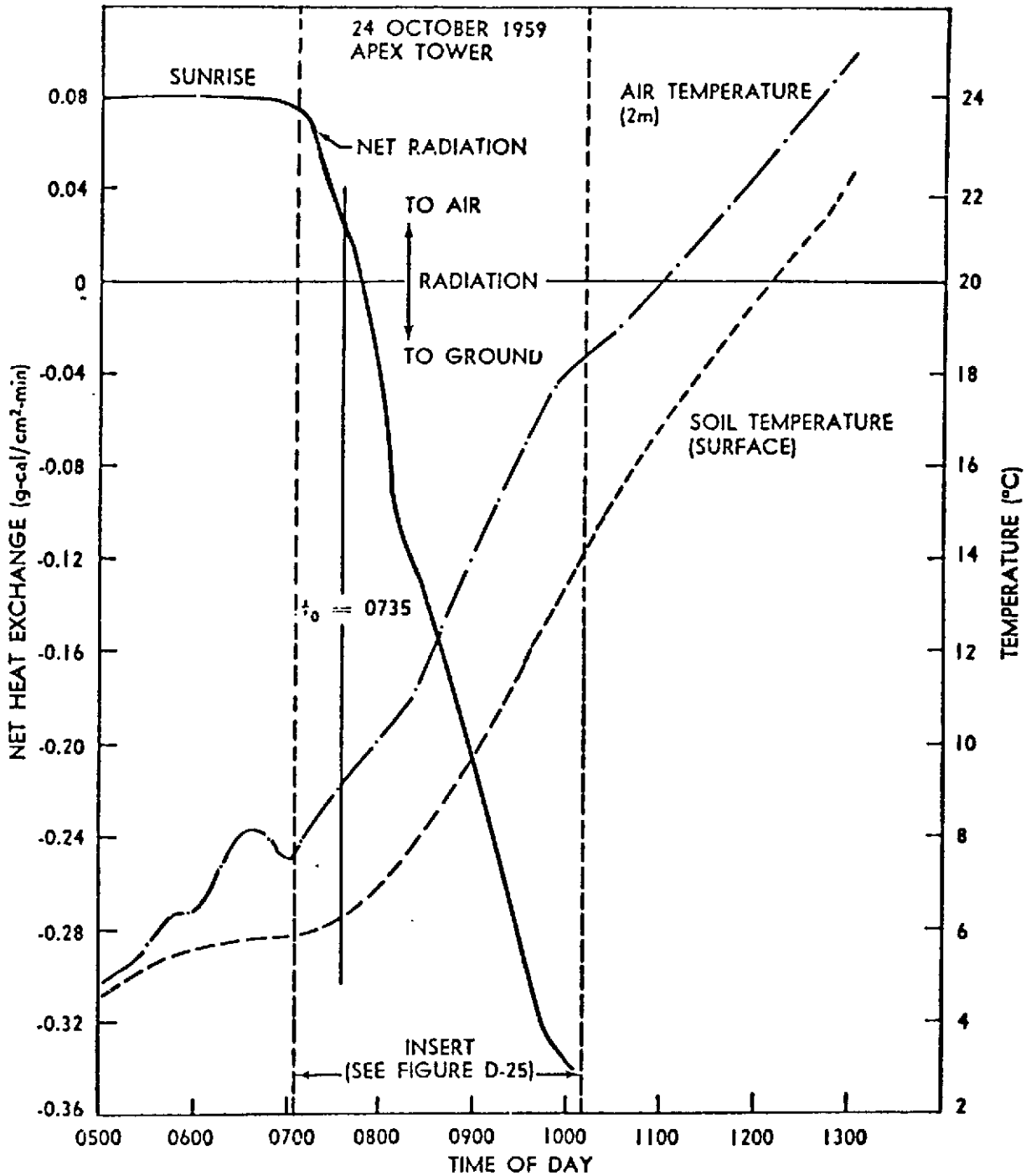


FIGURE D-24. NET HEAT EXCHANGE BETWEEN SOIL AND AIR: RELEASE 10

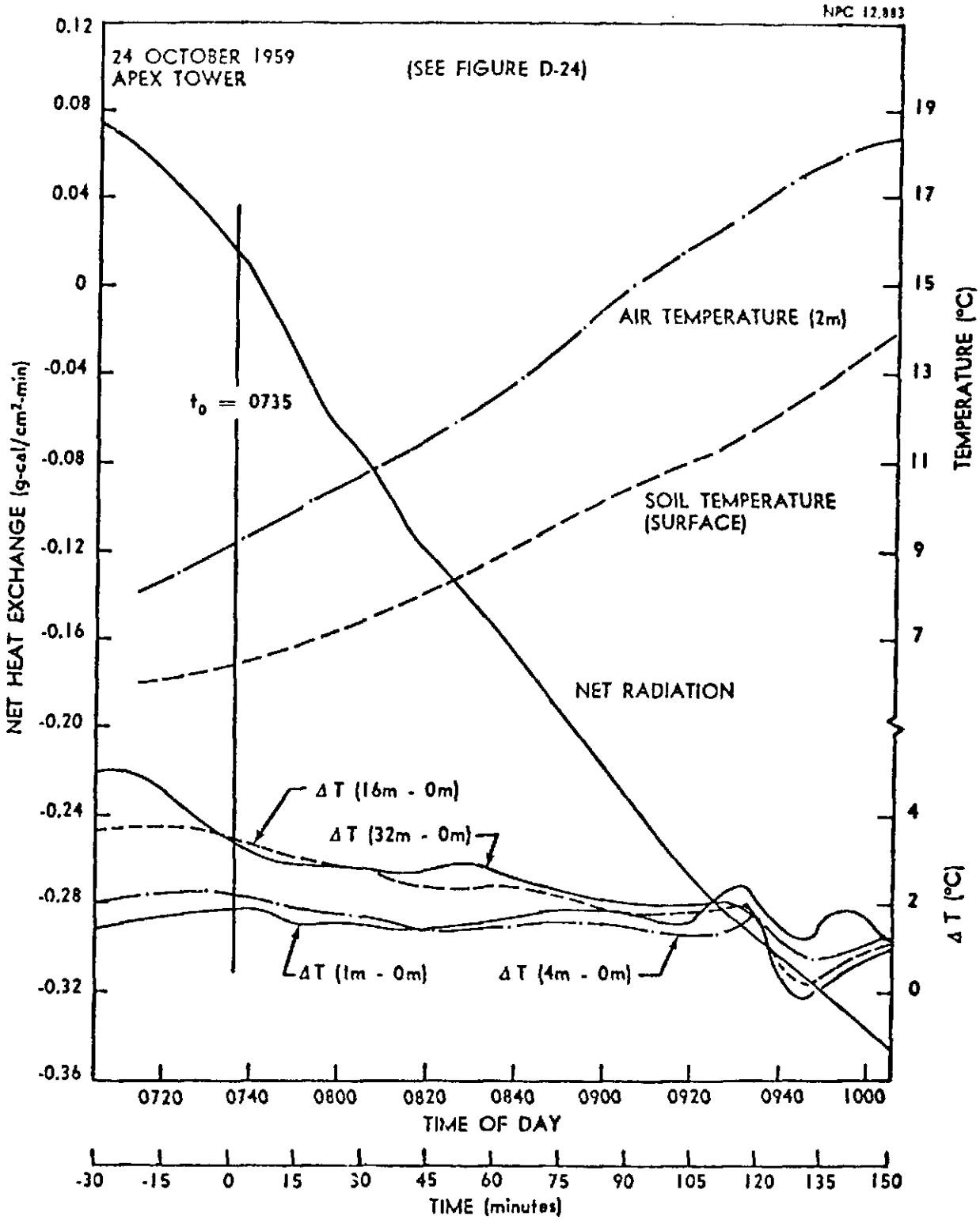


FIGURE D-25. NET HEAT EXCHANGE AND TEMPERATURE DIFFERENTIALS: RELEASE 10

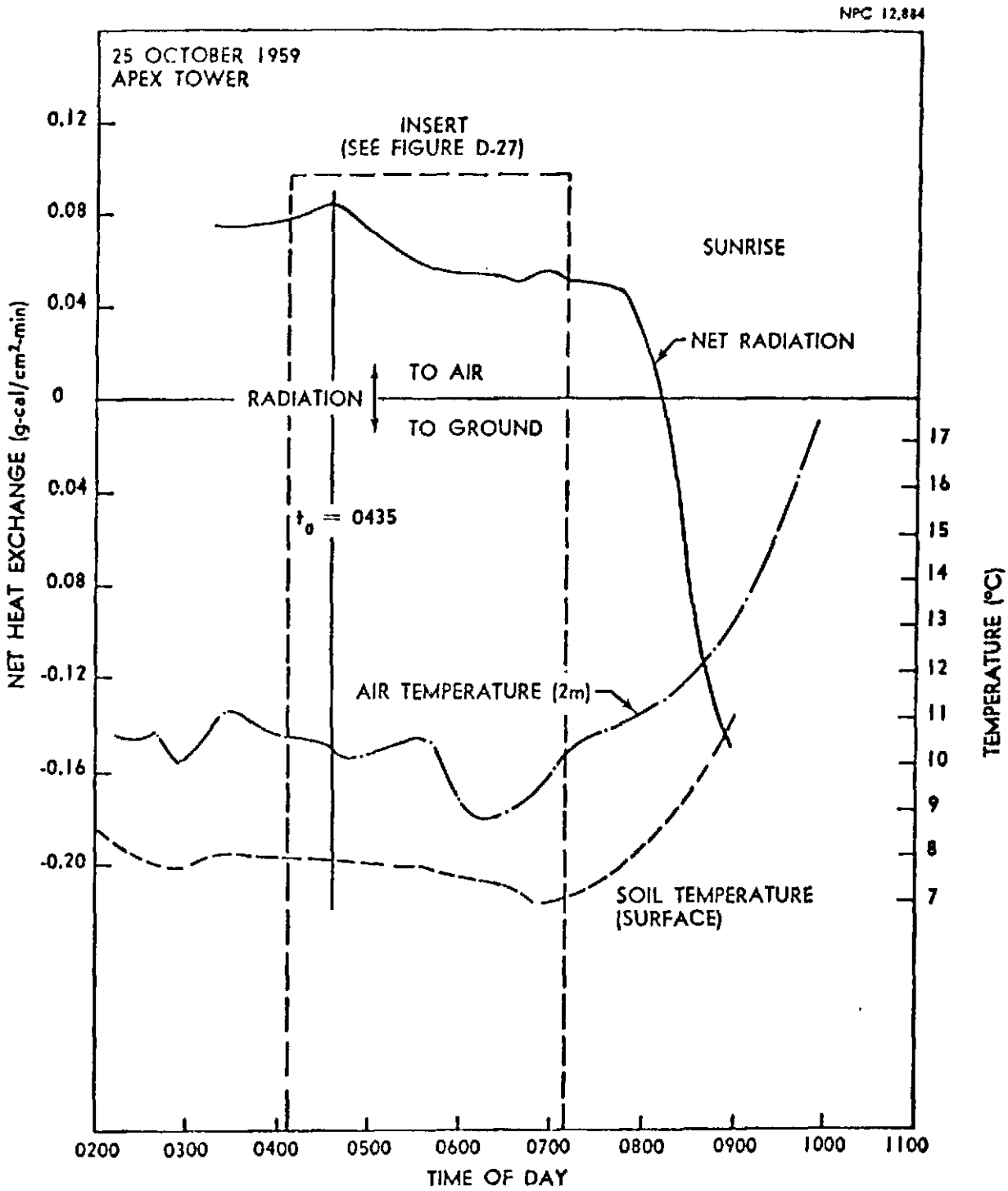


FIGURE D-26. NET HEAT EXCHANGE BETWEEN SOIL AND AIR: RELEASE 11

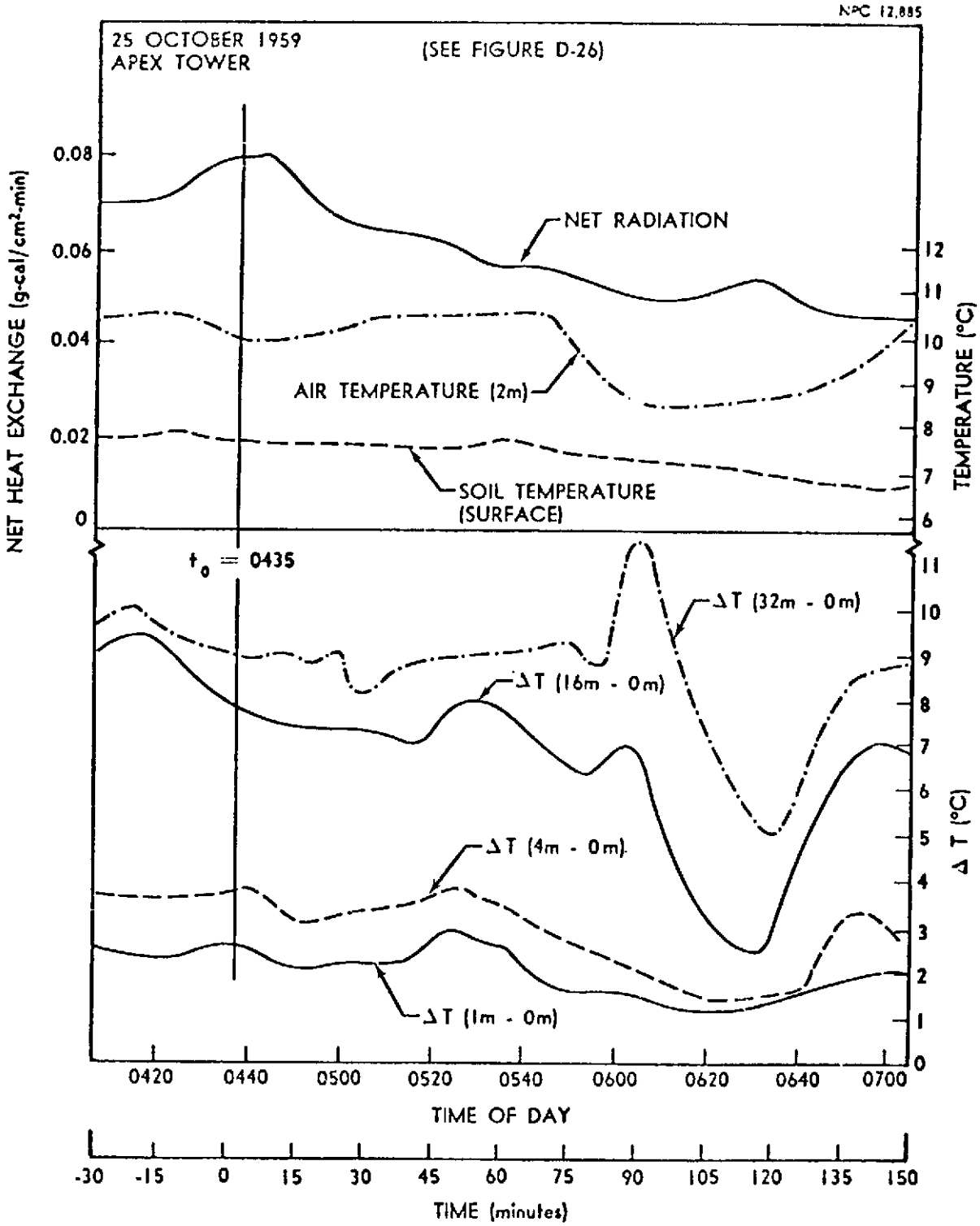


FIGURE D-27. NET HEAT EXCHANGE AND TEMPERATURE DIFFERENTIALS: RELEASE 11

Table D-9

AVERAGE TEMPERATURE AND WIND VELOCITY AT APEX
FOLLOWING EACH RELEASE

Height	Temperature (°C)							
	Release No.							
	1	2	3	4	5	8	10	11
32m	24.8	30.1	22.0	23.8	15.2	7.0	9.9	16.1
16	24.7	28.2	21.6	23.5	15.2	7.0	9.8	14.8
8	24.0	26.4	20.9	22.9	14.7	6.6	9.0	11.8
4	23.6	25.9	20.9	22.3	14.4	5.9	8.8	10.8
2	23.5	25.2	20.3	21.6	14.1	6.0	8.8	9.6
11	22.9	25.1	20.1	20.7	13.9	6.0	8.5	9.5
0.50								9.0
0			17.6	18.8	13.0	5.5	6.8	7.8
- .03							7.8	10.0
-1.0			22.3	22.4	22.2	20.7	16.1	16.7
	Wind Velocity (m/sec)							
32	8.4	8.0	5.9	2.2	5.5		4.0	6.1
16		4.7	4.9	2.2	5.6	3.6	3.1	6.5
8	6.6	4.8	3.0	1.7	4.6	2.6	1.8	4.8
4	5.9	3.9	2.1	1.4	4.6	1.8	1.1	3.4
2	4.9	3.3	2.0	1.3	3.4	1.8	1.5	3.3
1	4.8	3.1	2.2	1.0	3.2	1.6	1.1	2.9

Table D-10

HEAT-BUDGET COMPONENTS MEASURED AT APEX FOR EACH RELEASE

Release	1	2	3	4	5	8	10	11
$\bar{u}$ (m/sec)	5.0	4.2	3.2	2.4	4.4	2.7	2.6	4.4
ΔT(°C) 0-32m	--	--	-5.0	-4.7	-2.2	-1.5	-2.9	-6.7
ΔT(°C) 1-32m	2.4	-5.0	-1.6	-3.1	-1.1	-1.5	-1.3	-6.4
Relative Humidity*	47	37	31	60	61	62	72	68
Pressure* (in.of Hg)	25.52	25.46	25.37	25.70	25.49	25.42	25.80	25.80
Temp (°F)*	75	78	68	69	57	41	47	64
B**	0.172	0.245	0.322	0.236	0.168	0.298	0.374	0.253
N***	0.0241	0.0473	0.0249	0.0399	0.0249	0.0482	0.0320	0.01620
T(°C)****	--	--	4.7	3.6	9.2	15.2	9.3	8.9
S(0) g-cal/cm^2-min	--	--	0.578	0.587	0.542	0.487	0.497	0.503
Surface Temp (°C)	--	--	17.6	18.8	13.0	5.5	6.8	7.8
Net Heat Exchange (g/cal/cm^2-min)	--	--	0.151	0.114	0.138	0.078	0.032	0.072
Stability Index $S = 1/n$	--	--	--	--	3.48	2.18	1.84	2.48

* Measurements made at 1.5 meters above ground level.

** $B = \frac{n}{2-N}$, n as applied to Sutton's Equation.

*** N obtained from power law fit to atmospheric temperature gradient (0-32 meters)

**** Temperature increase from ground level to 1 meter below ground level.

seen that a close relationship exists between the net heat-exchange rate and the value of the stability parameter n, used in Sutton's diffusion equation. This can be observed in Figure D-28 where the heat-exchange rate is plotted versus the stability index S ($S = 1/n$). This feature is significant in that inversion intensity (air stability at low levels) and nocturnal radiation have a direct relationship and can be measured by use of a single instrument, the net radiometer. The measurements can be easily translated to a corresponding value of n in the diffusion equation. Further, there exists for each release an acceptable correlation between lapse rate and net heat exchange. The rate of the net heat exchange (soil-atmosphere) appears to be an important tool in evaluating the diffusive capacity of the air.

Tables D-11 and D-12 show a normalized tabulation of measured centerline maximum concentrations and arc integral concentrations. These can be compared with the values in Table D-10 to determine the influence of heat-flux components on atmospheric depletion.

D-3.4 Other Heat Budget Data

Heat-flux-radiation conditions were recorded between 0600 on 28 August and 1800 on 29 August 1959, and between 0600 and 1800 on 23 October 1959. Heat-transfer data for these dates are shown in Figures D-29, D-30, and D-31. Figures D-32

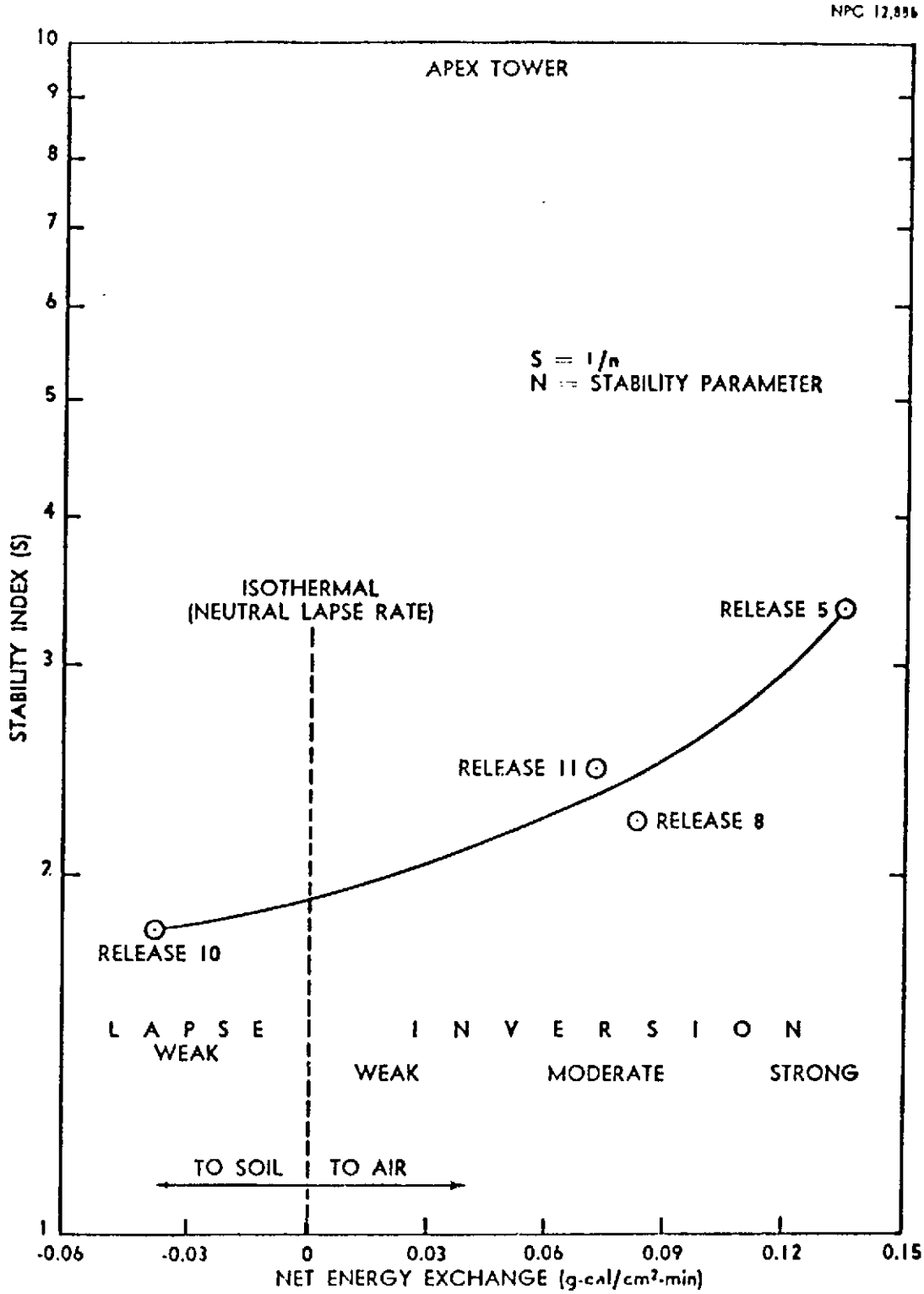


FIGURE D-28. COMPARISON OF AIR-STABILITY INDEX WITH THE AIR-SOIL NET HEAT EXCHANGE

Table D-11

MAXIMUM CENTERLINE CONCENTRATION DEPLETION FACTOR

$$\left[\left(F\alpha \left(\frac{x}{1000} \right)^{m_y + m_z} \right] \right.$$

Isotope	Arc (meters)	Release Number					
		1	2	5	8	10	11
I^{131}	100	--	--	--	--	1.75	0.578
	1000	1.000	1.000	1.00	1.00	1.00	1.0
	2000	0.368	0.394	0.707	0.708	0.350	0.6225
	4000	--	0.243	0.208	0.164	0.195	0.3140
	8000	0.0582	0.0728	0.00735	0.0391	0.0375	--
	16000	0.0405	0.0170	0.00255	0.0200	0.0175	0.400
	32000	0.00304	0.00485	0.00130	0.0050	--	--
Cs^{137}	100	--	--	--	--	11.6	4.84
	1000	1.000	1.000	1.00	1.00	1.00	1.00
	2000	0.333	0.500	0.497	0.720	0.732	0.548
	4000	--	0.215	0.0947	0.210	0.314	0.274
	8000	0.0433	0.0901	0.00513	0.011	0.0433	--
	16000	0.0556	0.0240	0.02285	0.004	0.0280	0.645
	32000	0.00217	0.0600	0.00153	0.0003	--	--
Ru^{103}	100	--	--	--	--	7.69	5.91
	1000	1.000	1.000	1.00	1.00	1.00	1.00
	2000	0.444	0.60	0.526	0.882	0.631	.500
	4000	--	0.150	0.147	0.162	0.269	.118
	8000	0.0315	0.016	0.0065	0.00382	0.0346	--
	16000	0.0444	0.0045	0.00463	0.00279	0.0215	.0059
	32000	0.0241	0.01	0.00316	0.000882	--	--

TABLE D-12

ARC-INTEGRAL DEPLETION FACTORS

$F_q C \left(\frac{x}{1000}\right)^{m_z}$

Isotope	Arc (meters)	Release Number 1	2	5	8	10	11
I^{131}	100	--	--	--	--	1.425	--
	1000	1.00	1.00	1.00	1.00	1.00	1.00
	2000	0.534	0.692	0.620	0.887	0.751	1.240
	4000	--	0.868	0.565	0.572	0.434	0.982
	8000	0.02304	0.00692	0.0482	0.04305	0.233	--
	16000	0.3958	0.00502	0.0722	0.0974	0.0186	0.0406
	32000	0.01214	0.01733	0.0724	0.0189	--	--
Cs^{137}	100	--	--	--	--	1.482	1.255
	1000	1.00	1.00	1.00	1.00	1.00	1.00
	2000	0.629	0.882	0.0384	1.561	0.815	1.210
	4000	--	0.0543	0.0308	1.018	0.523	0.770
	8000	0.0223	0.0115	0.00322	0.00290	0.141	--
	16000	0.0590	0.00772	0.00318	0.0163	0.280	0.280
	32000	0.0168	0.0353	0.00361	0.00102	--	--
Ru^{103}	100	--	--	--	--	1.863	1.345
	1000	1.00	1.00	1.00	1.00	1.00	1.00
	2000	0.665	0.754	0.0436	1.539	0.927	0.961
	4000	--	0.0311	0.0196	0.780	0.595	0.0363
	8000	0.0215	0.0153	0.00314	0.00450	0.01535	--
	16000	0.537	0.00869	0.00797	0.0158	0.02075	0.0228
	32000	0.01535	0.00526	0.00589	0.000483	--	--

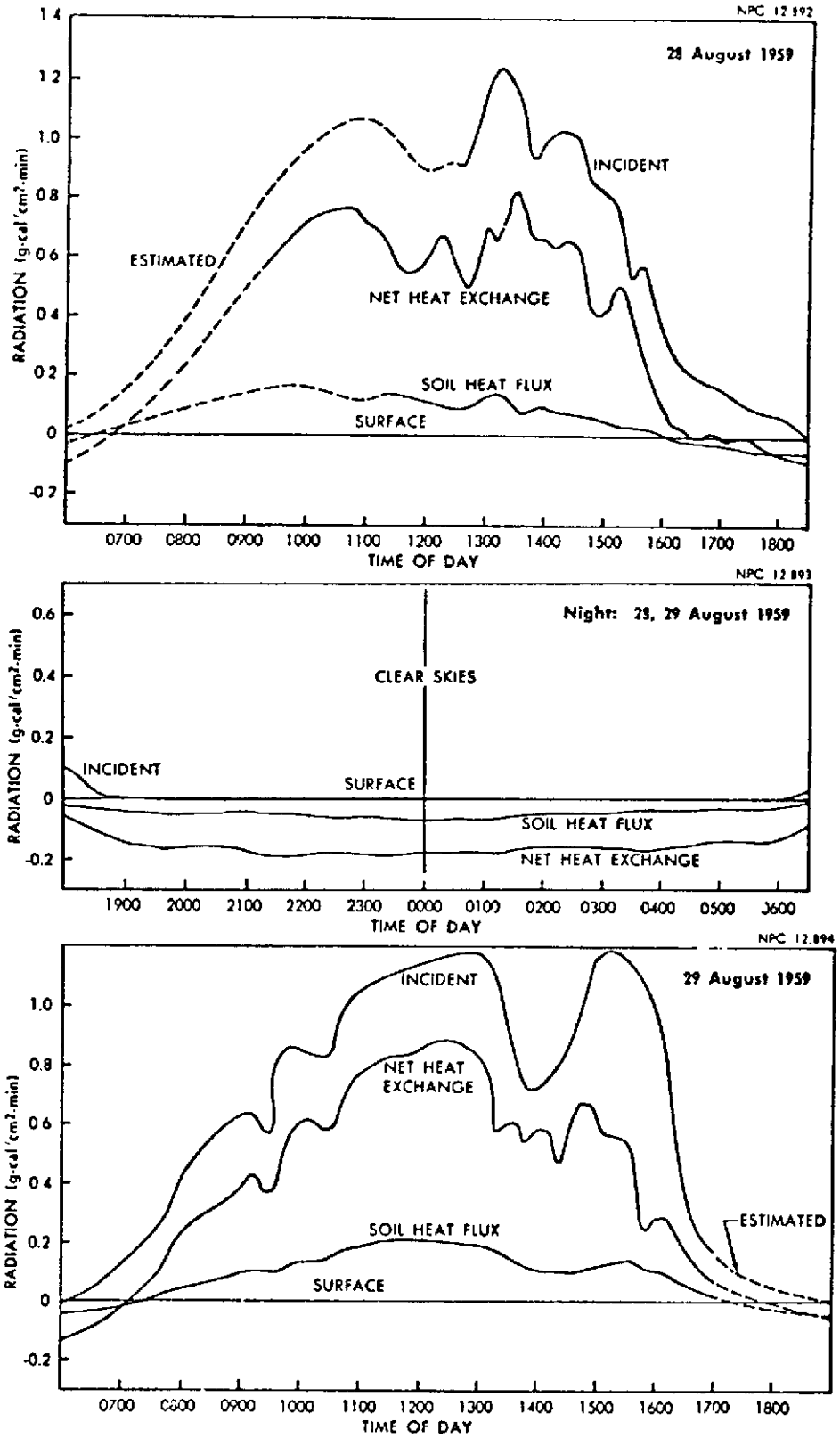


FIGURE D-29. RATE OF HEAT TRANSFER AT APEX: 28, 29 AUGUST 1959

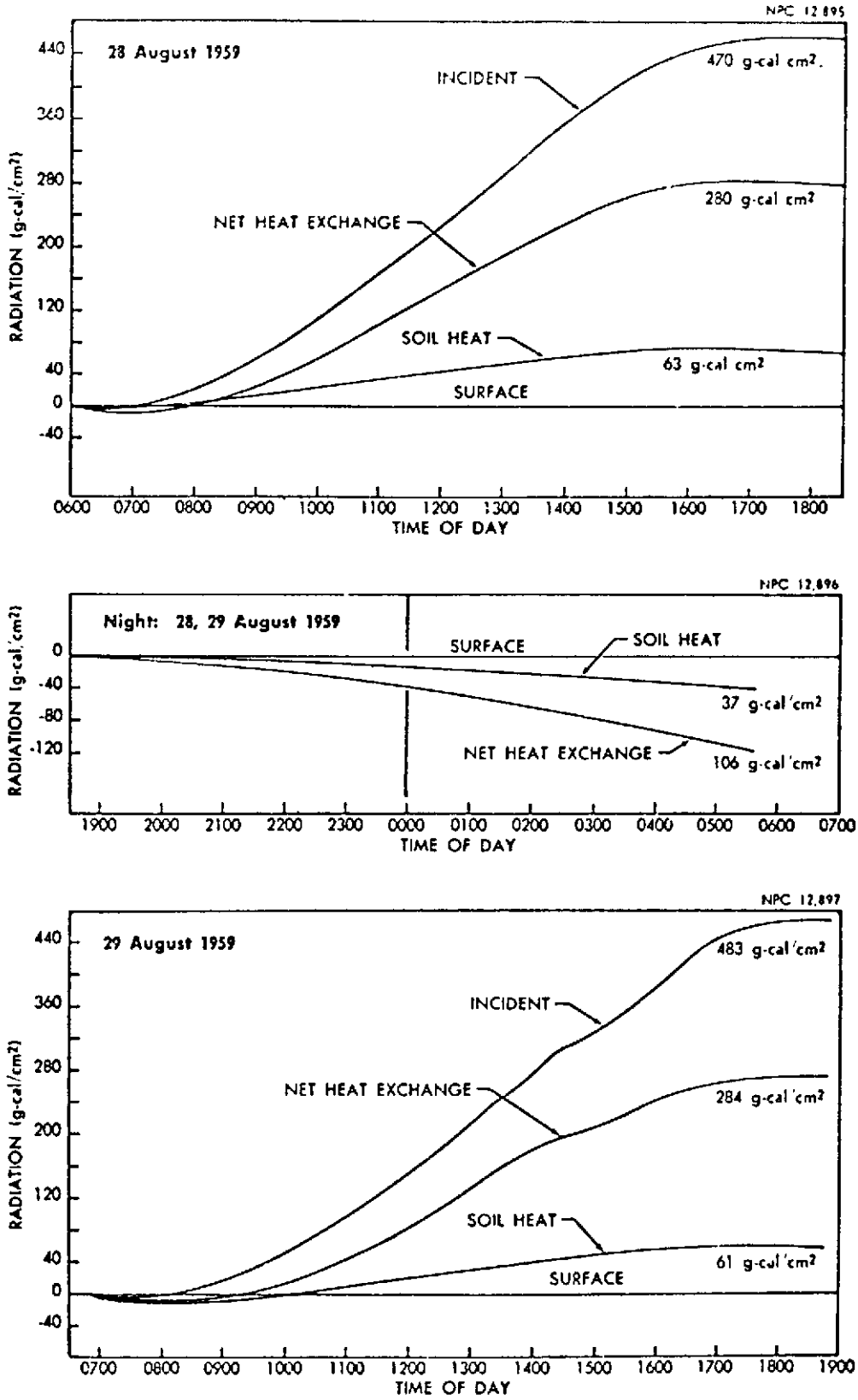
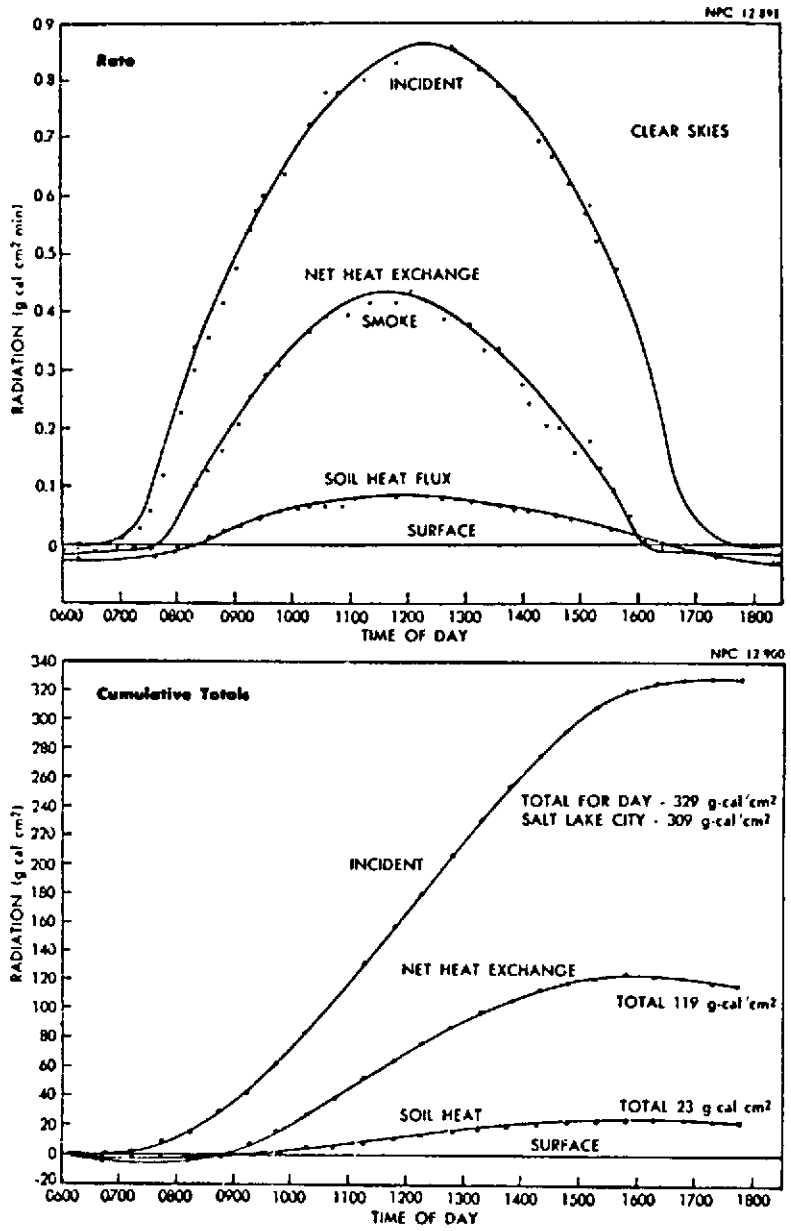


FIGURE D-30. CUMULATIVE HEAT TRANSFER AT APEX: 28, 29 AUGUST 1959



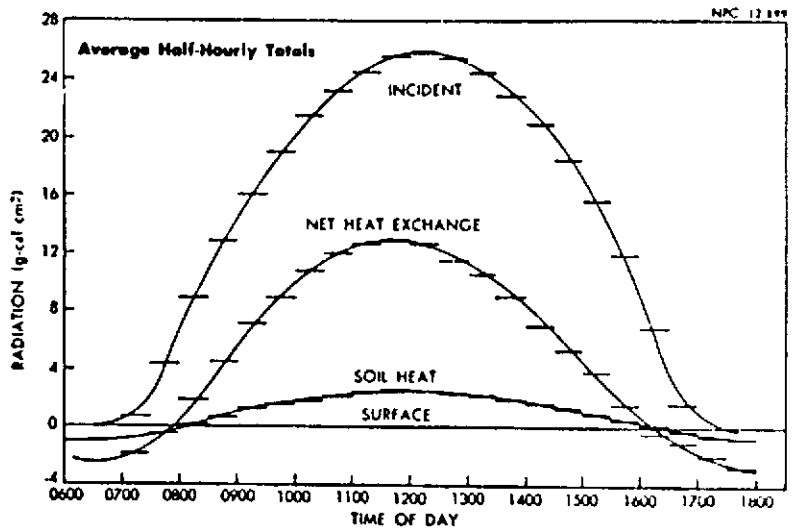


FIGURE D-31. HEAT TRANSFER AT APEX: 23 OCTOBER 1959

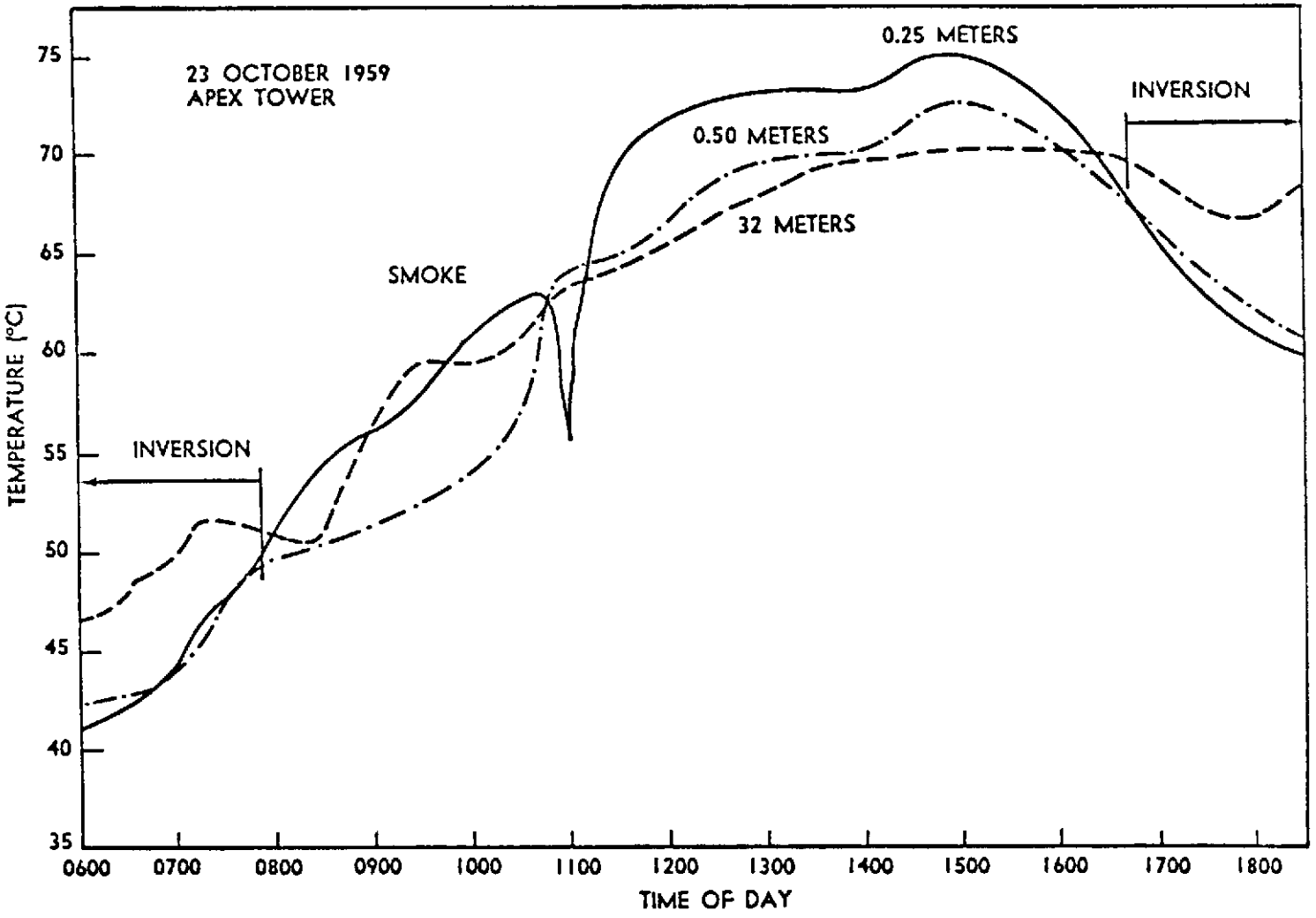


FIGURE D-32. TEMPERATURE VARIATION WITH HEIGHT AND TIME

NPC 12,901

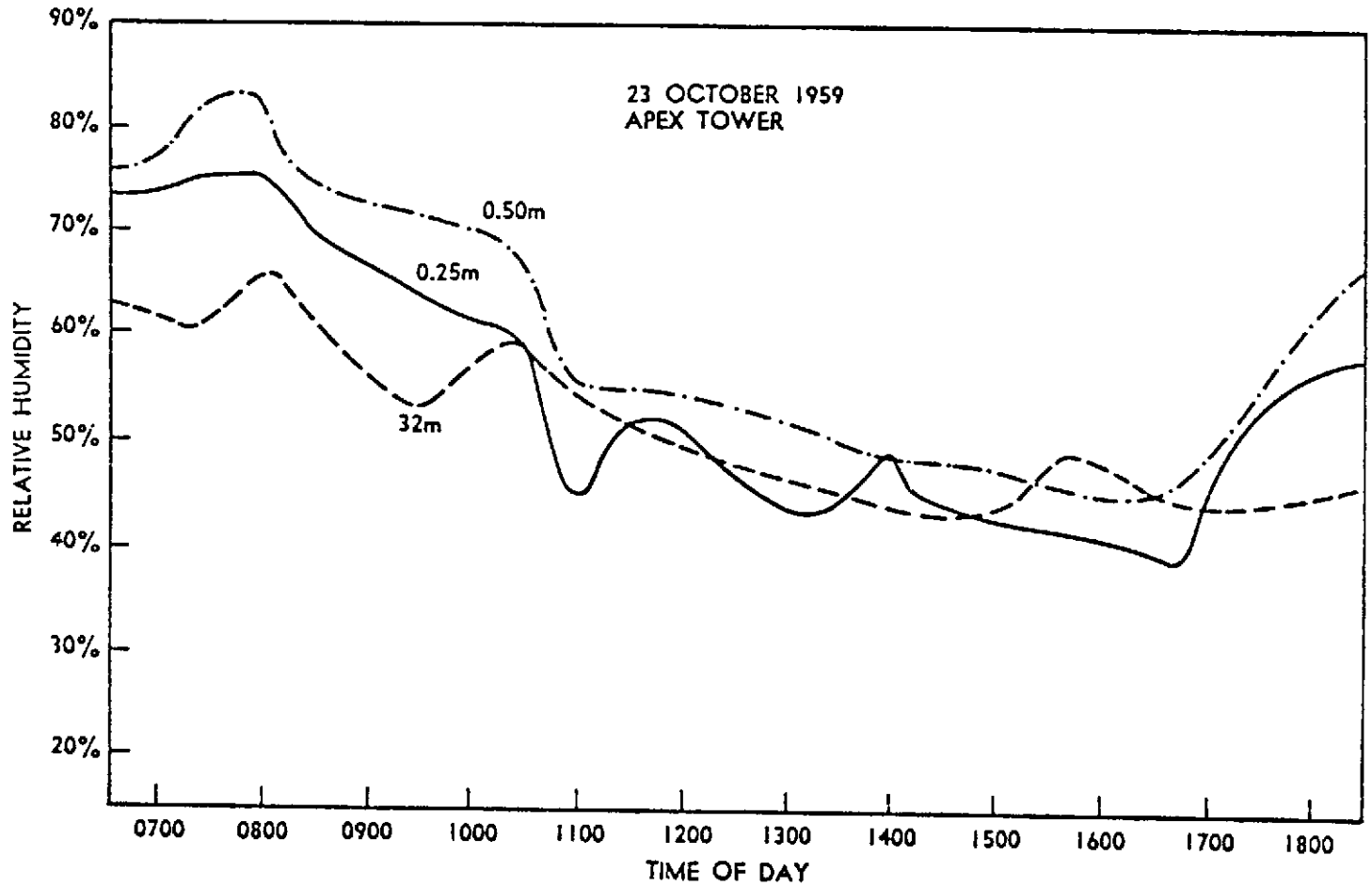


FIGURE D-33. RELATIVE-HUMIDITY VARIATION WITH HEIGHT AND TIME

NPC 12,902

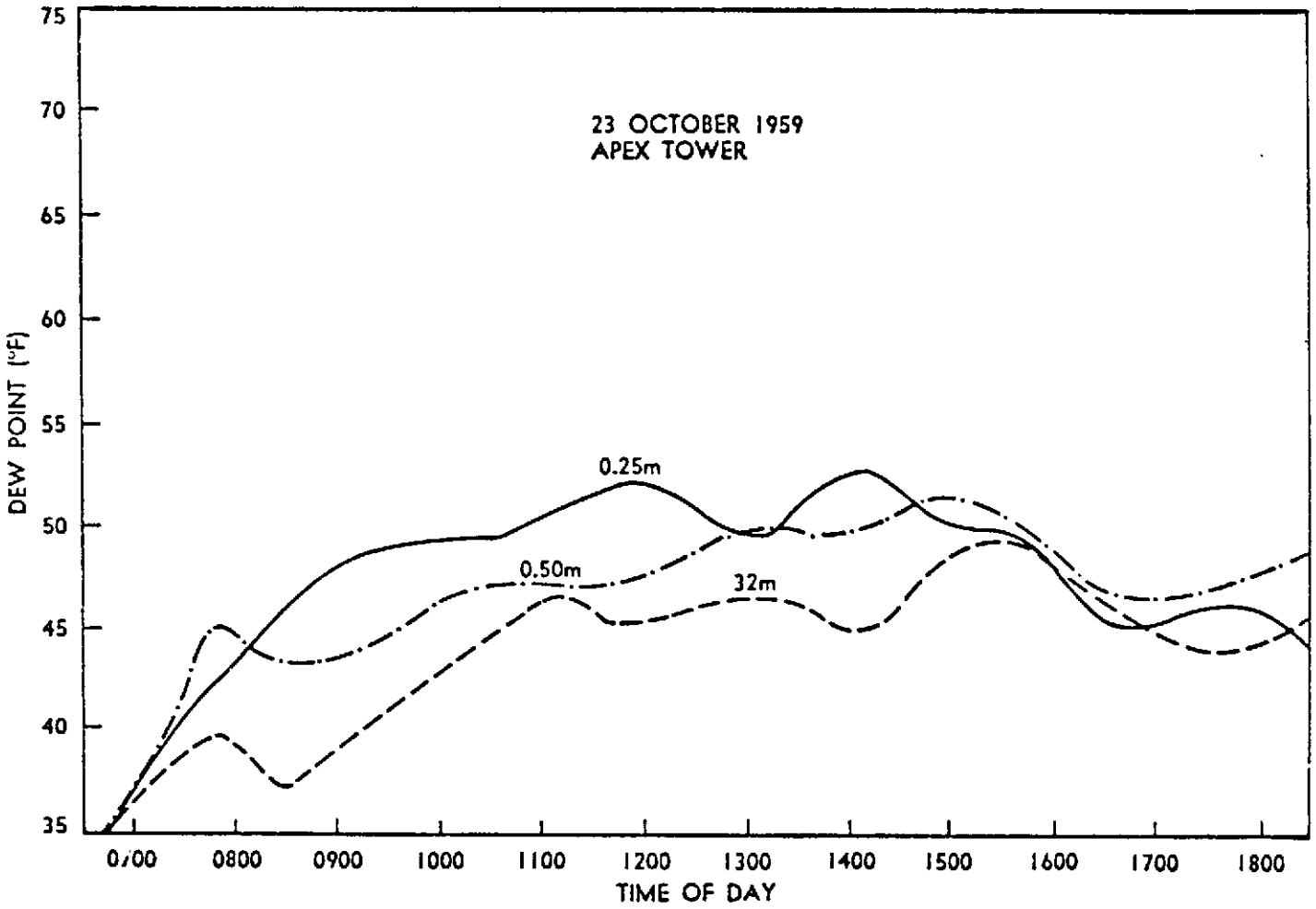
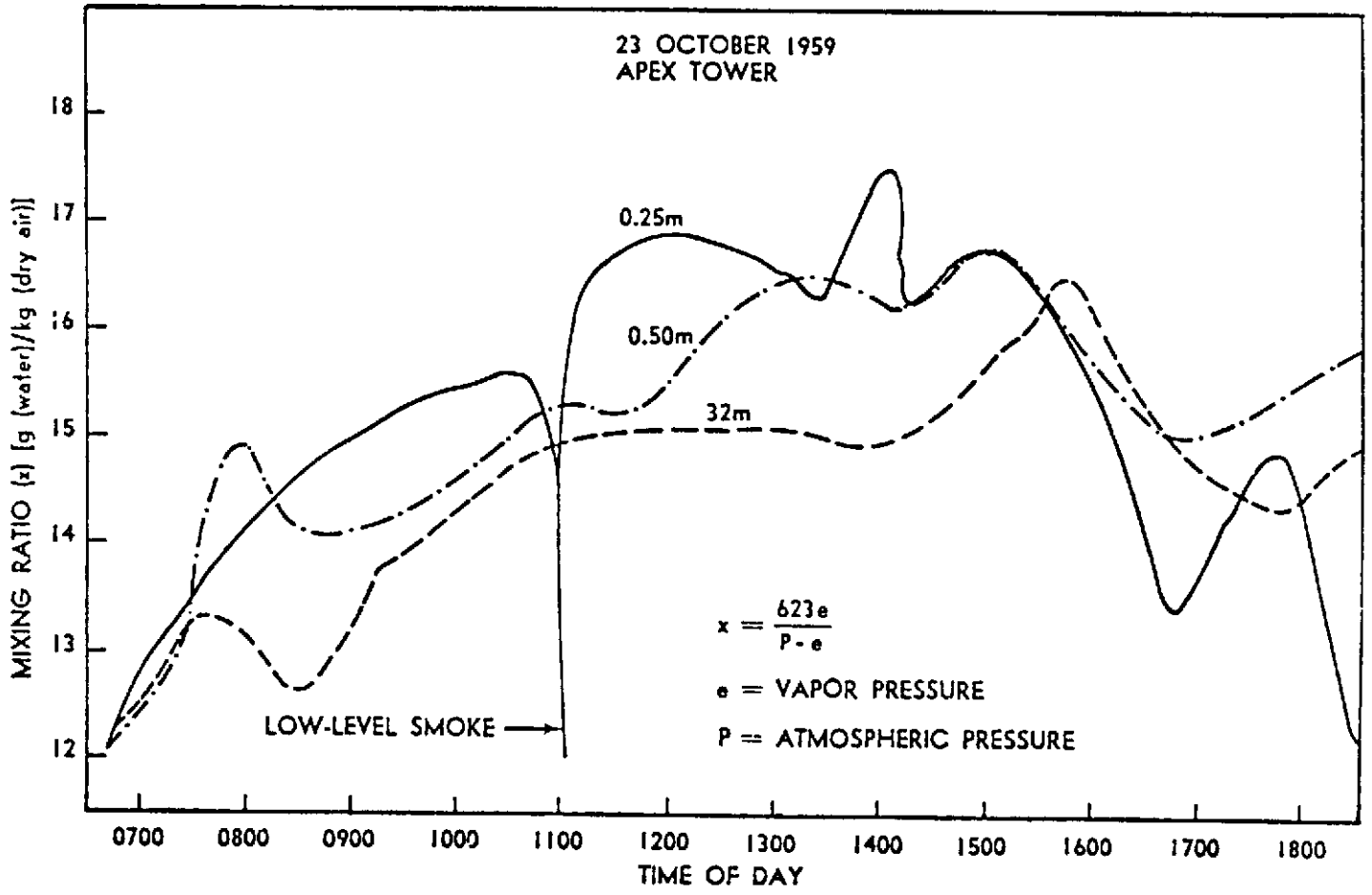


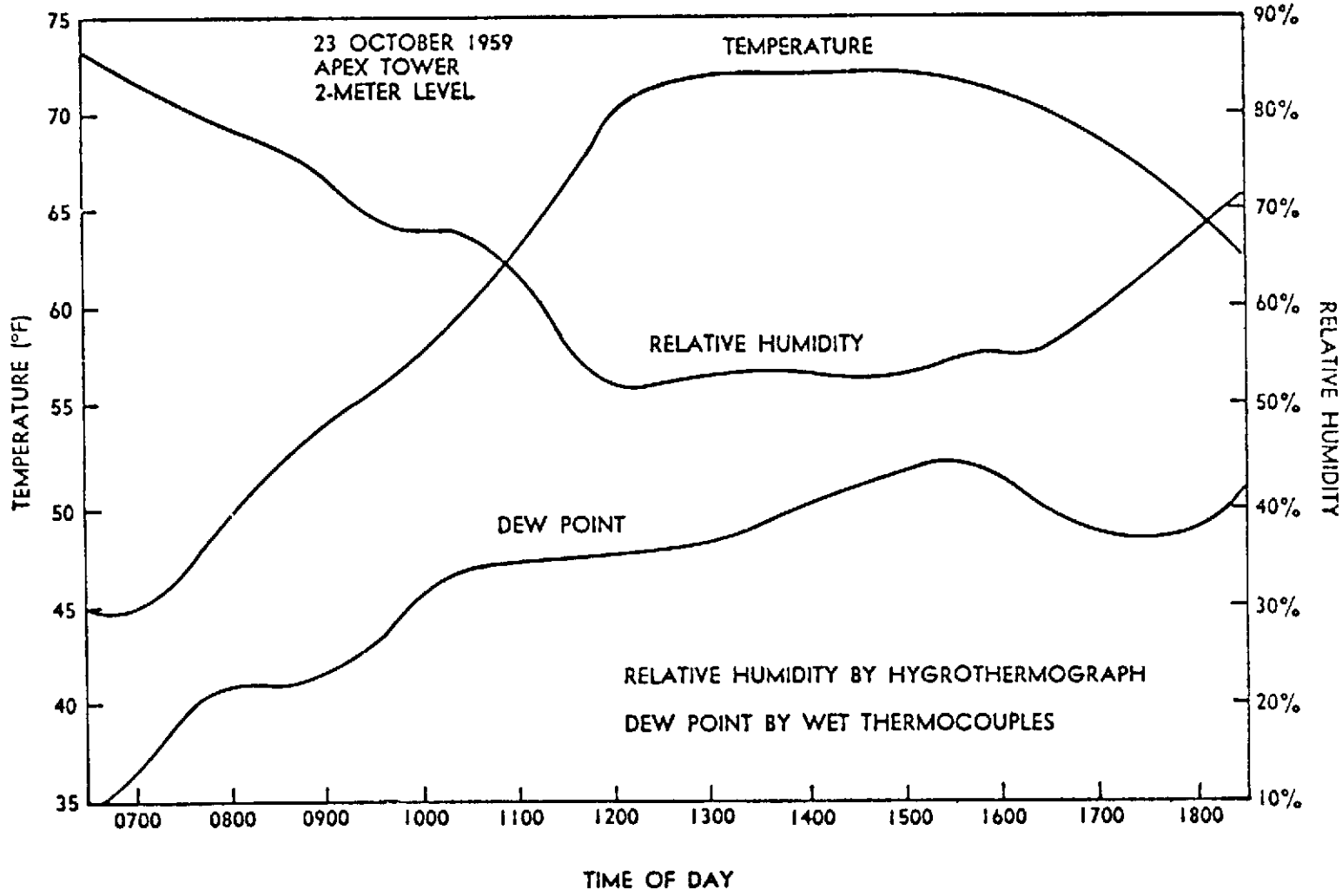
FIGURE D-34. DEW-POINT VARIATION WITH HEIGHT AND TIME

NPC 12,903



NPC 12,964

FIGURE D-35. MIXING-RATIO VARIATION WITH HEIGHT AND TIME



NPC 12,905

FIGURE D-36. VARIATION OF TEMPERATURE, HUMIDITY, AND DEW POINT WITH TIME

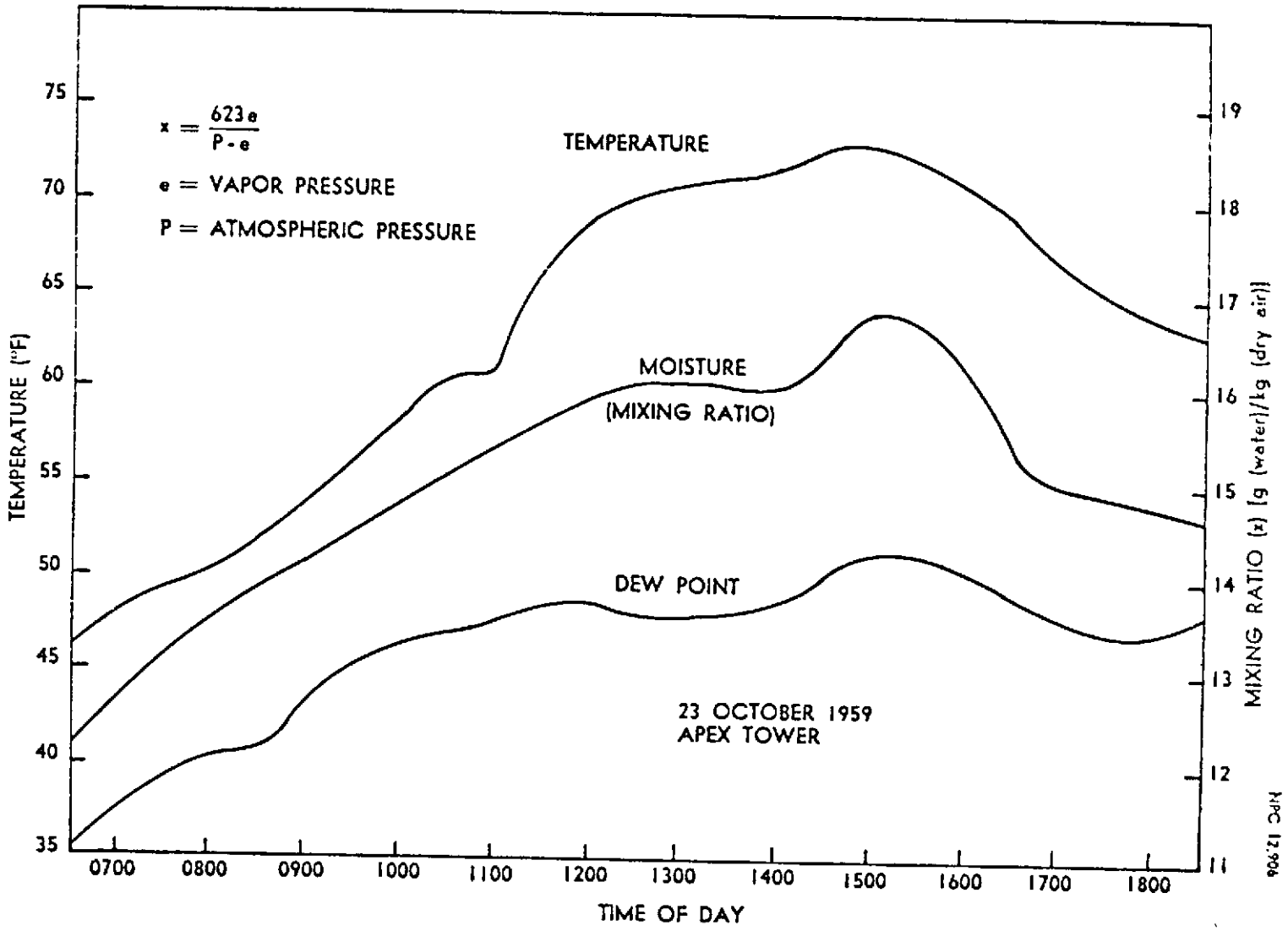


FIGURE D-37. COMPARISON OF MEAN VALUES (1-32 METERS) OF TEMPERATURE, MIXING RATIO, AND DEW POINT

through D-37 show the variations of atmospheric moisture and temperature with respect to height and time during a typical clear fall day on the Salt Flats. The data include the results of humidity measurements at the 0.25-, 0.5-, 1-, 2-, 4-, 8-, 16-, and 32-meter levels on the Apex tower. Similar humidity data were not collected during each release because of equipment trouble. The wick that was used for the wet bulb readings deteriorated after a few hours of use, probably because of the saline atmosphere. The information in these figures is applicable to the prediction of occurrence and the strength of nocturnal surface inversions.

The albedo of the grid surface was determined on the above dates by indirect means by use of the radiation data obtained with the pyrheliometer, the net radiometer, and the soil heat plate. Since it was not feasible to calibrate the inverted pyrheliometer (with parabolic reflector), it was considered that the indirect method would yield a better approximation of the reflected-to-incident radiation fraction. The albedo values (r/i) so obtained ranged from 0.35 to 0.60 for the three days when measurements were made. The skies were clear and the soil surface was fairly dry but not so arid as in July when the crystalline salts on the surface produced a reflectivity equivalent to that of snow, which has an albedo of 0.70 or more.

The albedo dropped considerably and remained low for several days following the rains. The surface was slow in drying and the silt and salt, being wet and dark, became highly absorbent of solar radiation.

During the dry seasons, the salt flats appear to yield the maximum albedo in comparison with other areas in the United States. As a consequence of this factor, the strongest surface inversions can be expected and the poorest diffusion conditions will result.

APPENDIX E

NETWORK ACTIVITY

During FRT II, crosswind profiles of encironment contamination at various distances downwind were measured by a variety of collection media. These included air-sampler filters, glass impaction plates, activated-charcoal cartridges, charged-wire collectors, grass, soil, and adhesive fallout papers. During the series of releases, approximately 2000 radioactive samples were collected and quantitatively analyzed for Zr^{95}-Nb^{95}, Cs^{137}, Ru^{103}, I^{131}, and Ce^{141}.

With the aid of a 256-channel analyzer and an IBM-704 computer, a simple and sufficiently accurate (15%) method for rapidly stripping the spectra was devised (Ref. 15). The spectra were accumulated on the 256-channel analyzer and recorded on strip charts to provide permanent visual records. The IBM-704 computer was used to solve a set of simultaneous equations based on the pulse-height analyzer output. The solution of these equations yielded the desired quantitative analysis of each isotope.

Tables E-1 through E-21 present the network-activity data derived by this method. These data were used to determine atmospheric diffusion parameters, deposition velocities, and release percents.

TABLE E-1

I^{131} GROUND-LEVEL GUMMED-PAPER CONTAMINATION: RELEASE 1

(curies/meter^2)

	A			R		C	
	15 FEET	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1							
2	3.29(-4						
3							
4	[illegible]						
5							
6							
7				1.81(-6			
8	[illegible]						
9				4.30(-		[illegible]	
10						[illegible]	
11				[illegible]		[illegible]	
12	[illegible]					[illegible]	
13		4.31(-7		2.55(-7		[illegible]	[illegible]
14						[illegible]	[illegible]
15		1.40(-5		2.29(-		[illegible]	[illegible]
16	[illegible]					[illegible]	[illegible]
17		[illegible]		4.53(-7			[illegible]
18							[illegible]
19		5.00(-6		3.33(-			
20							
21		4.04(-					
22							
23		4.21(-7				1.32(-	
24	1.22(-4						
25							
26						1.07(-8	
27							
28	3.31(-5						
29							
30							

	A			R		C	
	15 FEET	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31							
32	.11(-						
33							
34							
35							
36	2.44(-						
37							
38							
39							
40	7.07(-						
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							
51							
52							
53							
54							
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56							
57							
58							
59							
60							
61							

TABLE E-1 (Cont'd)

I^{131} GROUND-LEVEL GUMMED-PAPER CONTAMINATION: RELEASE 2

(curies/meter^2)

	A			B			C			A			B			C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5								35							
6								36							
7								37							
8								38							
9								39							
10								40							
11								41							
12								42							
13								43		1.09(-8					
14								44							
15								45		2.10(-8					
16								46							
17								47		3.02(-8					
18								48							
19								49		3.0[illegible](-9					
20								50							
21								51		1.27(-[illegible]					
22								52							
23								53		1.65(-7					
24								54							
25								55		3.27(-6					
26								56							
27								57		6.47(-[illegible]					
28								58							
29								59		8.73(-[illegible]					
30								60							
								61		7.00(-7					

TABLE E-1 (Cont'd)

I^{131} GROUND-LEVEL GUMMED-PAPER CONTAMINATION: RELEASE 3

(curies/meter^2)

	A R C								A R C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		3.57(-8						31							
2								32							
3		5.12(-8						33							
4								34							
5		7.24(-8						35		3.11(-8					
6								36							
7		1.07(-7						37							
8								38							
9		1.72(-8						39							
10								40							
11		1.01(-7						41							
12								42							
13		7.57(-8						43		8.70(-9					
14								44							
15		9.18(-8						45							
16								46							
17		7.04(-8						47							
18								48							
19		1.00(-7						49							
20								50							
21								51							
22								52							
23		7.24(-8						53							
24								54							
25								55							
26								56							
27		8.97(-8						57							
28								58							
29								59							
30								60							
								61							

TABLE E-1 (Cont'd)

^{131}I GROUND-LEVEL GUMMED-PAPER CONTAMINATION: RELEASE 4

(curies/meter^2)

	A R C								A R C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		1.01(-8						31							
2								32							
3								33		7.80(-9					
4								34							
5		1.[illegible]6(-8						35							
6								36							
7								37		5.20(-9					
8								38							
9		1.01(-8						39							
10								40							
11								41							
12								42							
13								43							
14								44							
15								45							
16								46							
17		1.[illegible](-8						47							
18								48							
19		[illegible]8(-8						49							
20								50							
21		2.81(-8						51							
22								52							
23								53							
24								54							
25		7.50(-[illegible]						55							
26								56							
27								57							
28								58							
29		1.0[illegible](-8						59							
30								60							
								61							

TABLE E-1 (Cont'd)

I^{131} GROUND-LEVEL GUMMED-PAPER CONTAMINATION: RELEASE 5

(curies/meter^2)

	A			B		C			A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31		1.60(-7		2.6[illegible](-5			
2								32							
3								33		2.12(-7		1.93(-8			
4								34							
5								35		2.15(-7		1.76(-8			
6								36							
7								37		7.93(-8		2.02(-8			
8								38							
9								39		8.62(-8		3.40(-9			
10								40							
11		5.88(-8						41		8.16(-8					
12								42							
13		[illegible].86(-8						43		1.48(-7					
14								44							
15		1.22(-6						45		2.99(-7					
16								46							
17		1.82(-6		3.76(-9				47		1.86(-7					
18								48							
19		9.27(-7		1.78(-8				49		2.95(-8					
20				1.53(-7				50							
21		2.[illegible]7(-7		1.71(-7				51							
22								52							
23		1.15(-7		5.97(-8				53							
24								54							
25		1.53(-7		3.98(-8				55							
26								56							
27		1.39(-7		2.35(-8				57							
28								58							
29		2.18(-7		3.88(-8				59							
30								60							
								61							

TABLE E-1 (Cont'd)

I^{131} GROUND-LEVEL GUMMED-PAPER CONTAMINATION: RELEASE 10

(curies/meter^2)

	A			B			C		A			B			C
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		1.78(-8						31							
2								32							
3		3.86(-8						33							
4								34							
5		4.17(-8						35							
6				7.86(-9				36							
7		6.42(-8						37							
8				5.09(-8				38							
9		7.38(-8		5.85(-8				39							
10				7.25(-8		7.22(-8		40							
11		5.50(-8		3.50(-8				41							
12				4.04(-8		3.04(-9		42							
13		7.95(-8		3.80(-8				43							
14				1.49(-8				44							
15		1.25(-7						45							
16				1.73(-8		4.45(-9		46							
17		1.34(-7						47							
18						9.02(-9		48							
19		2.24(-7						49							
20						4.20(-9		50							
21		4.32(-7						51							
22						6.32(-9		52							
23		1.63(-7						53							
24						4.33(-9		54							
25		2.53(-7						55							
26						2.21(-8		56							
27		1.39(-7						57							
28								58							
29								59							
30								60							
								61							

TABLE E-1 (Cont'd)

I^{131} GROUND-LEVEL GUMMED-PAPER CONTAMINATION: RELEASE 11

(curies/meter^2)

	A B C								A B C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5								35							
6						2.46(-9		36							
7						1.79(-9		37							
8						5.42(-9		38							
9						1.89(-8		39							
10						4.28(-9		40							
11								41							
12						2.11(-9		42							
13		4.72(-8						43							
14						3.08(-9		44							
15		5.42(-7						45							
16						3.88(-9		46							
17		1.39(-6						47							
18				2.01(-9		4.22(-9		48							
19		8.42(-7		1.52(-9		1.43(-9		49							
20				1.43(-8		2.43(-8		50							
21		1.13(-8		4.10(-8				51							
22				1.57(-7		3.49(-9		52							
23		5.93(-9		5.36(-8				53							
24				5.09(-9				54							
25		4.61(-9						55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE E-2

I^{131} ELEVATED GUMMED-PAPER CONTAMINATION: RELEASE 1

(curies/meter^2)

	A R C								A R C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5								35							
6								36							
7								37							
8								38							
9								39							
10								40							
11								41							
12								42							
13								43							
14								44							
15		1.69(-[illegible]						45							
16								46							
17		1.37(-[illegible]						47							
18								48							
19								49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE E-2 (Cont'd)

I^{131} ELEVATED GUMMED-PAPER CONTAMINATION: RELEASE 3

(curies/meter^2)

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		2.57(-8					
2							
3		6.48(-8					
4							
5		3.7·(-8					
6							
7		1.0·(-7					
8							
9		1.40(-7					
10							
11		1.36(-7					
12							
13		1.29(-7					
14							
15		1.21(-7					
16							
17		2.7:(-8					
18							
19							
20							
21		1.27(-7					
22							
23							
24							
25		2.73(-8					
26							
27							
28							
29		7.41(-3					
30							

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
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58							
59							
60							
61							

TABLE E-2 (Cont'd)

I^{131} ELEVATED GUMMED-PAPER CONTAMINATION: RELEASE 4

(curies/meter^2)

	A			B		C			A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5								35							
6								36							
7								37							
8								38							
9								39							
10								40							
11								41							
12								42							
13								43							
14								44							
15								45							
16								46							
17								47							
18								48							
19		1.5?(-8						49							
20								50							
21		1.01(-[illegible]						51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE E-2 (Cont'd)

I^{131} ELEVATED GUMMED-PAPER CONTAMINATION: RELEASE 5

(curies/meter^2)

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15		1.34(-					
16							
17		2.00(-6					
18							
19		1.01(-6					
20							
21		1.0(-7					
22							
23							
24							
25		2.0 (-7					
26							
27							
28							
29		3.00(-7					
30							

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31		2.14(-7					
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							
61							

TABLE E-2 (Cont'd)

I^{131} ELEVATED GUMMED-PAPER CONTAMINATION- RELEASE 10

(curies/meter^2)

	A			B		C			A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		2.58(-8						31							
2								32							
3		1.70(-8						33							
4								34							
5		6.82(-8						35							
6								36							
7		9.79(-8						37							
8								38							
9		1.07(-7						39							
10								40							
11		1.08(-7						41							
12								42							
13		6.70(-8						43							
14								44							
15		2.07(-7						45							
16								46							
17		1.50(-7						47							
18								48							
19		2.79(-7						49							
20								50							
21		3.49(-7						51							
22								52							
23		4.42(-7						53							
24								54							
25		4.32(-7						55							
26								56							
27		3.07(-7						57							
28								58							
29		1.89(-7						59							
30								60							
								61							

TABLE E-2 (Cont'd)

I^{131} ELEVATED GUMMED-PAPER CONTAMINATION: RELEASE 11

(curies/meter^2)

	A R C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13		8.55(-9					
14							
15		9.80(-7					
16							
17		1.02(-6					
18							
19		1.38(-7					
20							
21		1.07(-8					
22							
23		9.15(-9					
24							
25		9.58(-9					
26							
27							
28							
29							
30							

	A R C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							
51							
52							
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55							
56							
57							
58							
59							
60							
61							

TABLE E-3

I^{131} GRASS CONTAMINATION: RELEASE 1

(curies/meter^2)

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12			3.15(-5				
13		2.46(-5	9.80(-6				
14			1.45(-5				
15		1.03(-4	2.84(-5				
16							
17		7.35(-5					
18							
19		1.81(-5					
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
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54							
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58							
59							
60							
61							

TABLE E-3 (Cont'd)

I^{131} GRASS CONTAMINATION: RELEASE 10

(curies/meter^2)

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		1.46(-7					
2							
3		1.34(-7					
4							
5		3.52(-7					
6							
7		3.78(-7					
8							
9		6.17(-7					
10							
11		6.20(-7					
12							
13		7.04(-7					
14							
15		9.39(-7					
16							
17		7.85(-7					
18							
19		1.74(-6					
20							
21		3.75(-6					
22							
23		1.75(-6					
24							
25		2.35(-6					
26							
27		1.38(-6					
28							
29							
30							

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31		2.69(-7					
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
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61							

TABLE E-4

I^{131} AIR CONCENTRATION: RELEASE 1

(curie-sec/meter^3)

	A R C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1							
2							
3							
4							
5							
6							
7					3.90(-6		
8					1.39(-5	2.83(-5	
9				7.83(-6		1.84(-4	
10					2.18(-5	1.85(-4	
11			7.22(-5	3.04(-5	3.08(-5	1.08(-4	
12			2.34(-4		8.99(-5		1.90(-6
13			6.11(-4		2.66(-4	1.05(-5	1.14(-5
14			5.82(-4		1.45(-4	2.08(-5	1.07(-5
15		4.03(-3	7.89(-4		5.20(-5	1.59(-5	1.39(-5
16			1.61(-3		2.08(-5	9.14(-6	8.08(-6
17		4.57(-3	1.78(-3		1.60(-5	5.05(-6	6.07(-6
18			5.85(-4			1.88(-5	4.47(-6
19		1.39(-3	3.10(-4			2.92(-6	
20			1.02(-4				4.50(-6
21		1.03(-6				1.63(-5	3.63(-6
22						1.91(-6	3.00(-6
23						2.33(-6	
24						2.16(-6	3.17(-6
25						2.12(-6	3.76(-6
26						2.26(-6	3.42(-6
27							3.25(-6
28						2.08(-6	2.35(-6
29						2.25(-6	8.04(-7
30						2.33(-6	

	A R C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31						1.35(-6	
32						7.79(-7	
33						4.45(-7	
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							
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52							
53							
54							
55							
56							
57							
58							
59							
60							
61							

TABLE E-4 (Cont'd)

I^{131} AIR CONCENTRATION: RELEASE 2

(curie-sec/meter^3)

	A R C								A R C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31					[illegible]	[illegible]	[illegible]
2								32					1.07(-5	5.13(-7	[illegible]
3								33					1.95(-5		[illegible]
4								34					2.39(-5	[illegible]	[illegible]
5								35					1.54(-5	5.57(-7	[illegible]
6								36					1.42(-5	4.27(-7	[illegible]
7								37					[illegible]	3.35(-7	[illegible]
8								38					1.37(-5	[illegible]	[illegible]
9								39					1.25(-5	2.45(-7	[illegible]
10								40					7.07(-6	1.96(-7	[illegible]
11								41				3.94(-4		[illegible]	[illegible]
12								42					2.10(-6		[illegible]
13								43				2.45(-4	1.50(-6		[illegible]
14								44						5.25(-7	[illegible]
15								45		4.99(-6		[illegible]		[illegible]	[illegible]
16								46				1.50(-4		3.21(-6	
17								47		1.39(-5		1.45(-4			
18								48				1.13(-4		8.01(-7	
19								49		1.00(-5		6.69(-5		[illegible]	
20								50				6.34(-5		3.70(-7	
21							2.91(-7	51		1.54(-5		5.03(-5		2.77(-7	
22								52				5.59(-5			
23							4.59(-7	53		7.50(-5	6.24(-5	7.74(-5			
24							5.98(-7	54			[illegible]	7.06(-5			
25							6.96(-7	55		1.44(-3	[illegible]	[illegible]			
26							[illegible]	56			1.21(-3	7.29(-5			
27							[illegible]	57		3.00(-3	[illegible]	[illegible]			
28							[illegible]	58			1.34(-3				
29							2.40(-6	59		3.25(-3					
30					5.04(-7	3.50(-8	2.33(-8	60			1.07(-3				
								61							

TABLE E-4 (Cont'd)

^{131}I AIR CONCENTRATION: RELEASE 3

(curie-sec/meter^3)

	A R C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		2.37(-5					
2							
3		3.40(-5					
4							
5		5.36(-5					
6							
7		6.74(-5					
8							
9		7.[illegible]0(-5					
10							
11		7.15(-5					
12							
13		7.[illegible]2(-5					
14							
15		[illegible].81(-5					
16							
17		[illegible].90(-5					
18							
19							
20							
21		[illegible].0[illegible](-5					
22							
23							
24							
25							
26							
27							
28							
29		4.61(-5					
30							

	A R C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31		3.17(-5					
32							
33		2.75(-5					
34							
35		2.[illegible]4(-5					
36							
37		3.50(-5					
38							
39		2.48(-5					
40							
41		3.2[illegible](-5					
42							
43		3.21(-5					
44							
45		2.27(-5					
46							
47		1.91(-5					
48							
49		1.42(-5					
50							
51							
52							
53							
54							
55							
56							
57		6.17(-6					
58							
59							
60							
61							

	A B C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		3.37(-6					
2							
3		7.68(-6					
4							
5		6.77(-6					
6							
7		4.87(-6					
8							
9		5.51(-6					
10							
11		2.70(-6					
12							
13		2.70(-6					
14							
15		3.02(-6					
16							
17		7.80(-6					
18							
19		2.22(-5					
20							
21		1.49(-5					
22							
23							
24							
25							
26							
27		5.87(-6					
28							
29		9.51(-6					
30							

	A B C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31		7.20(-6					
32							
33		7.00(-6					
34							
35		6.67(-6					
36							
37		4.48(-6					
38							
39		3.26(-6					
40							
41							
42							
43		2.07(-6					
44							
45							
46							
47							
48							
49							
50							
51							
52							
53		1.61(-6					
54							
55							
56							
57		2.52(-6					
58							
59							
60							
61							

TABLE E-4 (Cont'd)

I^{131} AIR CONCENTRATION: RELEASE 5

(curie-sec/meter^3)

	A		B		C		
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13		2.10(-5					
14							
15		5.81(-4	2.91(-5				2.69(-7
16			6.99(-5				
17		7.44(-4	5.26(-4				1.79(-7
18							4.36(-7
19		4.29(-4	1.05(-4	1.21(-5			
20			1.03(-4	1.20(-4		1.16(-6	
21			7.31(-5	1.55(-4		1.32(-6	5.54(-7
22			7.03(-5	8.15(-5		1.75(-6	9.20(-7
23			6.71(-5			1.63(-6	
24			2.75(-5				1.11(-6
25			2.67(-5	2.30(-5		1.63(-6	1.34(-6
26			2.57(-5	1.50(-5		1.69(-6	9.35(-7
27		6.82(-5	1.79(-5	1.33(-5			8.37(-7
28			1.43(-5	1.55(-5			6.74(-7
29		8.86(-5	1.02(-5	1.53(-5		1.40(-6	5.76(-7
30				1.49(-5	1.42(-6	1.65(-6	5.56(-7

	A		B		C		
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31		7.36(-5	1.36(-5	1.07(-5	3.59(-6	1.74(-6	5.77(-7
32			1.93(-5		4.44(-6	1.28(-6	2.06(-7
33		1.01(-4	1.68(-5	7.92(-6	5.47(-6		
34			2.00(-5	7.14(-6	4.56(-6	3.98(-7	9.41(-8
35		5.79(-5	1.25(-5	7.41(-6	3.62(-6	1.95(-8	
36			1.98(-5	1.05(-5	3.29(-6		
37		2.62(-5	1.00(-6		1.24(-6	5.00(-8	
38			2.40(-5		2.84(-6		
39		2.42(-5			9.70(-7		
40			2.16(-5				
41		2.55(-5	2.42(-5				
42			1.36(-5				
43		3.84(-5					
44			1.58(-5				
45		7.06(-5					
46			1.74(-5				
47		4.63(-5	7.10(-6				
48							
49		2.24(-6					
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							
61							

TABLE E-4 (Cont'd)

^{131}I AIR CONCENTRATION RELEASE 8

(curie-sec/meter^3)

	A		B		C		
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		2.47(-5					5.53(-6
2			6.84(-5		4.32(-5		5.65(-6
3		6.67(-4	1.45(-4	4.44(-4	3.39(-5	1.91(-5	5.01(-6
4			2.37(-4	1.10(-3	1.30(-5	2.19(-5	
5		1.05(-2	1.31(-3	1.75(-3		1.79(-5	2.40(-7
6			5.15(-3	1.27(-3		2.03(-5	
7		7.73(-3	7.58(-3	3.49(-4	[illegible]	2.02(-5	
8			1.85(-3	7.17(-5		1.14(-5	
9		1.94(-3	2.37(-4	6.26(-6		1.20(-5	
10			2.06(-5	3.40(-7		1.14(-5	
11			3.89(-6			9.70(-6	
12			4.74(-7				
13						1.21(-5	
14							
15						1.00(-5	
16						2.28(-6	
17						3.69(-6	
18						1.25(-6	
19							
20						2.07(-7	
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							

	A		B		C		
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							
61							

TABLE E-4 (Cont'd)

^{131}I AIR CONCENTRATION: RELEASE 10

(curie-sec/meter^3)

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1	3.50(-5						3.48(-7
2							
3		2.30(-5					2.58(-7
4			1.70(-5				
5	1.05(-4	2.13(-5	3.97(-5				1.85(-7
6			5.29(-5	5.48(-6			1.41(-7
7		4.0[illegible](-5	5.4[illegible](-5				7.72(-8
8			6.60(-5	3.7[illegible](-5			
9	6.70(-5	4.73(-5	6.24(-5	2.97(-5			
10			7.23(-5	3.84(-5			
11			5.83(-5				5.21(-8
12				2.24(-5			
13	3.20(-4	4.08(-5	6.86(-5	1.70(-5	4.29(-6		
14			6.38(-5	1.01(-5			
15		7.23(-5	7.08(-5	1.07(-5	7.45(-6	1.05(-6	
16			5.99(-5	8.73(-6			
17	3.60(-4	3.30(-5	6.43(-5	7.90(-6		3.39(-6	
18				9.61(-6			
19		1.54(-4	3.77(-5	7.56(-6	4.50(-6	2.08(-6	
20			3.24(-5	6.44(-6			
21	1.40(-3	2.02(-4	2.38(-5	4.43(-6	4.02(-6	2.05(-6	
22			5.41(-6	4.25(-6			
23			3.76(-6		4.93(-6	2.16(-6	
24			7.61(-7				
25	2.00(-3				3.54(-6	1.45(-6	
26			2.71(-6				
27		1.37(-4			1.36(-6	1.14(-6	
28							
29	3.70(-3	6.61(-5			5.78(-7	5.13(-7	
30							

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31		2.07(-5				5.80(-7	
32							
33		5.25(-7				5.33(-7	
34							
35						1.[illegible](-7	
36							
37		2.23(-7					
38							
39		3.34(-7					
40							
41							
42							
43							
44							
45							
46							
47							
48							
49		4.44(-7					
50							
51		5.72(-7					
52							
53							
54							
55							
56							
57		5.28(-7					
58							
59							
60							
61							

TABLE E-4 (Cont'd)

^{131}I AIR CONCENTRATION RELEASE 11

(curie-sec/meter^3)

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1	3.50(-7						
2							
3							
4							
5		8.32(-7					
6							
7		6.53(-7				5.03(-7	
8							
9	4.20(-5					9.00(-7	
10							
11						1.38(-6	
12							
13	1.15(-4	1.44(-5		2.90(-7		1.81(-6	
14							
15		2.98(-5	1.26(-6	2.18(-7		1.79(-6	
16			7.61(-6	2.25(-7			
17	.65(-4	4.45(-4	2.70(-4	3.64(-7		1.81(-6	
18				1.25(-6			
19		5.15(-5	1.58(-4	1.03(-6			
20			4.69(-5				
21	4.60(-7	2.02(-6				1.01(-7	
22				1.41(-4			
23							
24				7.54(-9			
25	1.55(-7						
26							
27							
28				7.54(-9			
29							
30							

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							
61							

TABLE E-5

Cs^{137} GROUND-LEVEL GUMMED-PAPER CONTAMINATION: RELEASE 1

(curies/meter^2)

	A			B		C	
	15 FEET	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1							
2	4.01(-7						
3							
4	9.95(-7						
5							
6							
7				1.19(-11			
8	1.12(-6						
9				1.74(-11			
10							
11				7.63(-11			
12	1.08(-6						
13		2.58(-8					2.38(-11
14							1.08(-11
15		7.11(-8		4.80(-9			
16	9.50(-7					1.16(-11	1.18(-11
17		3.93(-8					
18							
19		3.99(-9		1.19(-11		1.98(-7	
20							2.07(-11
21							
22							
23							
24	1.38(-7						
25							
26							
27							
28	1.74(-8						
29							
30							

	A			B		C	
	150 FEET	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31							
32	2.15(-8						
33							
34							
35							
36	2.00(-8						
37							
38							
39							
40	9.17(-9						
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							
61							

TABLE E-5 (Cont'd)

Cs^{137} GROUND-LEVEL GUMMED-PAPER CONTAMINATION: RELEASE 2

(curies/meter^2)

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							
51							
52							
53							
54							
55		2.13(-8					
56							
57		3.53(-8					
58							
59		2.63(-8					
60							
61							

TABLE E-5 (Cont'd)

Cs^{137} GROUND-LEVEL GUMMED-PAPER CONTAMINATION: RELEASE 3

(curies/meter^2)

	A			B		C			A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5								35							
6								36							
7		2.31(-9						37							
8								38							
9								39							
10								40							
11								41							
12								42							
13								43							
14								44							
15								45							
16								46							
17								47							
18								48							
19								49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE E-5 (Cont'd)

Cs^{137} GROUND-LEVEL GUMMED-PAPER CONTAMINATION: RELEASE 5

(curies/meter^2)

	A				B		C
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17		1.72(-8					
18							
19							
20							
21		6.86(-10					
22							
23							
24							
25		2.08(-9					
26							
27							
28							
29		4.74(-9					
30							

	A				B		C
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31							
32							
33		6.45(-9					
34							
35							
36							
37		2.30(-9					
38							
39							
40							
41		2.82(-9					
42							
43		6.90(-9					
44							
45		1.70(-8					
46							
47		6.85(-9					
48							
49		1.19(-9					
50							
51		1.10(-9					
52							
53							
54							
55							
56							
57							
58							
59							
60							
61							

TABLE E-5 (Cont'd)

Cs^{137} GROUND-LEVEL GUMMED-PAPER CONTAMINATION: RELEASE B

(curies/meter^2)

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		1.23(-9					
2							
3		2.0-(-9					
4							
5		4.98(-8					
6							
7		1.50(-7					
8							
9		1.58(-7					
10							
11		1.04(-9					
12							
13		3.51(-10					
14							
15		3.10(-10					
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							
61							

TABLE E-5 (Cont'd)

Cs^{137} GROUND-LEVEL GUMMED-PAPER CONTAMINATION: RELEASE 10

(curies/meter^2)

	A R C								A R C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		4.72(-9						31							
2								32							
3		3.09(-8						33							
4								34							
5		2.15(-8						35							
6				3.01(-9				36							
7		3.53(-8						37							
8				5.73(-9				38							
9		1.95(-8		6.82(-9				39							
10				6.24(-9		2.56(-9		40							
11		1.52(-8		1.15(-9				41							
12				2.31(-9				42							
13		1.79(-8		7.97(-9				43							
14				1.11(-9				44							
15		1.17(-8						45							
16				1.03(-9		1.64(-9		46							
17		7.13(-9						47							
18								48							
19		2.53(-8						49							
20						1.01(-9		50							
21		1.42(-8						51							
22								52							
23		1.21(-8						53							
24								54							
25		1.28(-8						55							
26								56							
27		9.52(-9						57							
28								58							
29								59							
30								60							
								61							

TABLE E-5 (Cont'd)
Cs^{137} GROUND-LEVEL GUMMED-PAPER CONTAMINATION: RELEASE 11
(curies/meter^2)

	A R C								A R C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5								35							
6								36							
7								37							
8								38							
9						1.62(-9		39							
10						2.92(-9		40							
11								41							
12								42							
13		8.79(-9						43							
14								44							
15		1.57(-7						45							
16								46							
17		2.24(-7						47							
18								48							
19		1.56(-8		4.09(-9				49							
20				5.28(-9				50							
21				3.63(-9				51							
22				2.17(-8				52							
23		1.52(-9		7.78(-9				53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE E-6

Cs^{137} ELEVATED GUMMED-PAPER CONTAMINATION: RELEASE 2

(curies/meter^2)

	A B C								A B C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5								35							
6								36							
7								37							
8								38							
9								39							
10								40							
11								41							
12								42							
13								43							
14								44							
15								45							
16								46							
17								47							
18								48							
19								49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55		2.25(-8					
26								56							
27								57		3.12(-8					
28								58							
29								59		2.30(-8					
30								60							
								61		2.42(-9					

TABLE E-6 (Cont'd)
Cs^{137} ELEVATED GUMMED-PAPER CONTAMINATION: RELEASE 3
(curies/meter^2)

	A			B			C		A			B			C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5		4.06(-10						35							
6								36							
7		9.3·(-10						37							
8								38							
9								39							
10								40							
11								41							
12								42							
13		1.02(-9						43							
14								44							
15								45							
16								46							
17								47							
18								48							
19								49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE E-6 (Cont'd)

Cs^{137} ELEVATED GUMMED-PAPER CONTAMINATION: RELEASE 5

(curies/meter^2)

	A			B		C			A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5								35							
6								36							
7								37							
8								38							
9								39							
10								40							
11								41							
12								42							
13								43							
14								44							
15								45							
16								46							
17								47							
18								48							
19								49							
20								50							
21		1.08(-9						51							
22								52							
23								53							
24								54							
25		3.36(-9						55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE E-6 (Cont'd)

Cs^{137} ELEVATED GUMMED-PAPER CONTAMINATION: RELEASE B

(curies/meter^2)

	A			B			C			A			B			C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		9.35(-10						31							
2								32							
3		1.53(-9						33							
4								34							
5		4.90(-8						35							
6								36							
7		1.76(-7						37							
8								38							
9		2.42(-7						39							
10								40							
11		1.26(-8						41							
12								42							
13		4.05(-10						43							
14								44							
15		2.92(-10						45							
16								46							
17								47							
18								48							
19								49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE E-6 (Cont'd)

Cs^{137} ELEVATED GUMMED-PAPER CONTAMINATION: RELEASE 10

(curies/meter^2)

	A B C								A B C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		1.25(-8						31							
2								32							
3		4.39(-8						33							
4								34							
5		3.41(-8						35							
6								36							
7		1.46(-8						37							
8								38							
9		2.64(-8						39							
10								40							
11		3.20(-8						41							
12								42							
13		1.28(-8						43							
14								44							
15								45							
16								46							
17		2.37(-8						47							
18								48							
19		1.32(-8						49							
20								50							
21		1.90(-8						51							
22								52							
23		2.63(-8						53							
24								54							
25		1.18(-8						55							
26								56							
27		1.66(-8						57							
28								58							
29		4.67(-9						59							
30								60							
								61							

TABLE E-6 (Cont'd)

Cs^{137} ELEVATED GUMMED-PAPER CONTAMINATION: RELEASE 11

(curies/meter^2)

	A			B		C			A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5								35							
6								36							
7								37							
8								38							
9								39							
10								40							
11								41							
12								42							
13		1.46(-8						43							
14								44							
15		2.01(-7						45							
16								46							
17		2.02(-7						47							
18								48							
19		2.80(-8						49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE E-7
Cs^{137} GRASS CONTAMINATION: RELEASE 1
(curies/meter^2)

	A B C								A B C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5								35							
6								36							
7								37							
8								38							
9								39							
10								40							
11								41							
12			4.63(-9					42							
13		3.05(-8	1.72(-8					43							
14			1.33(-8					44							
15		7.53(-8	1.51(-8					45							
16								46							
17		5.18(-8						47							
18								48							
19		5.30(-10						49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE E-7 (Cont'd)
Cs^{137} GRASS CONTAMINATION: RELEASE 10
(curies/meter^2)

	A B C								A B C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		1.24(-8						31		1.86(-9					
2								32							
3		1.27(-8						33							
4								34							
5		1.33(-8						35							
6								36							
7		1.85(-8						37							
8								38							
9		2.54(-8						39							
10								40							
11		5.78(-8						41							
12								42							
13		4.42(-8						43							
14								44							
15		1.02(-8						45							
16								46							
17		1.01(-8						47							
18								48							
19		1.92(-8						49							
20								50							
21		3.68(-8						51							
22								52							
23		9.91(-9						53							
24								54							
25		2.61(-9						55							
26								56							
27		6.38(-9						57							
28								58							
29								59							
30								60							
								61							

TABLE E-8
Cs^{137} SOIL CONTAMINATION: RELEASE 1
(curies/meter^2)

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12			1.11(-9				
13		1.71(-9	1.17(-9				
14			7.4(-10				
15		2.03(-9	5.5(-10				
16			6.5(-10				
17			7.4(-10				
18			8.5(-10				
19		1.35(-9					
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							
61							

TABLE E-9
Cs^{137} AIR CONCENTRATION; RELEASE 1
(curie-sec/meter^3)

	A			B		C			A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5								35							
6								36							
7					4.70(-9			37							
8						2.03(-7		38							
9						1.02(-6		39							
10					2.08(-7	7.60(-7		40							
11				2.34(-7	2.39(-7	3.05(-7		41							
12			2.37(-6		5.91(-7			42							
13		8.26(-6	6.01(-6		7.76(-7		2.51(-8	43							
14			4.65(-6		7.50(-8	9.68(-8	3.50(-8	44							
15		1.81(-5	3.21(-6		1.14(-7	9.67(-8		45							
16			4.83(-6			4.38(-8	3.00(-8	46							
17		1.33(-5	3.00(-6			2.40(-8		47							
18			4.86(-7			2.50(-8	2.30(-8	48							
19		1.37(-6		2.90(-8				49							
20						3.00(-8	2.35(-8	50							
21		1.62(-7						51							
22								52							
23								53							
24								54							
25							2.50(-8	55							
26								56							
27							2.50(-8	57							
28							1.80(-8	58							
29							1.02(-8	59							
30								60							
								61							

TABLE E-9 (Cont'd)

Cs^{137} AIR CONCENTRATION, RELEASE 2

(curie-sec/meter^3)

	A			B			C			A			B			C		
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							4.80(-8
2								32					1.04(-7		5.90(-8
3								33					1.70(-7		9.30(-8
4								34					1.81(-7	4.77(-8	1.20(-7
5								35					1.68(-7	4.29(-8	1.22(-7
6								36					1.24(-7	3.86(-8	9.00(-8
7								37					6.40(-8		4.25(-8
8								38					1.35(-7	1.80(-8	3.42(-8
9								39					9.52(-8		3.42(-8
10								40						1.12(-8	5.42(-8
11								41				4.90(-9			2.70(-8
12								42					3.10(-8		
13								43				2.37(-8	1.45(-8		
14								44				4.36(-6		2.80(-8	9.20(-9
15								45				2.61(-6			
16								46				1.63(-6		2.80(-8	
17								47				1.15(-6			
18								48				5.99(-7		6.40(-9	
19								49				3.61(-7			
20								50				2.56(-7			
21							3.40(-9	51							
22								52							
23							1.03(-8	53		4.92(-7	6.01(-7				
24								54			6.37(-6				
25							1.13(-8	55		1.02(-5	9.35(-6				
26								56			5.84(-6				
27							1.90(-8	57		2.08(-5	5.77(-6				
28								58			4.90(-6				
29							3.60(-8	59		1.28(-5					
30								60							
								61							

TABLE E-9 (Cont'd)
Cs^{137} AIR CONCENTRATION, RELEASE 4
(curie-sec/meter^3)

	A			B		C			A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		1.18(-7						31							
2								32							
3								33							
4								34							
5								35							
6								36							
7								37							
8								38							
9								39							
10								40							
11								41							
12								42							
13								43							
14								44							
15								45							
16								46							
17								47							
18								48							
19								49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE E-9 (Cont'd)
Cs^{137} AIR CONCENTRATION; RELEASE 5
(curie-sec/meter^3)

	A R C								A R C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31		2.50(-6	2.56(-7	3.40(-7			4.88(-8
2								32					4.58(-8		
3								33		3.54(-6	4.22(-7	2.18(-7	7.15(-8		
4								34							
5								35		3.19(-6	2.64(-7	2.69(-7			
6								36					7.59(-8		
7								37		9.62(-7	2.82(-7				
8								38					2.83(-8		
9								39		7.11(-7					
10								40					2.33(-8		
11								41		9.68(-7	5.25(-7				
12								42							
13		4.46(-7						43		2.08(-6	6.12(-7				
14								44							
15		1.37(-5						45		5.03(-6	6.66(-7				
16			9.35(-7					46							
17		1.48(-5	7.37(-6					47		2.55(-6	2.72(-7				
18								48							
19		3.38(-6	2.57(-6					49		4.49(-7					
20			1.59(-6	7.79(-7		2.10(-8		50							
21		5.27(-7	1.41(-6	1.34(-6		1.21(-8		51							
22			1.50(-6	1.41(-6		1.90(-8	1.36(-8	52							
23			1.61(-6			2.01(-8		53							
24			6.44(-7				1.82(-8	54							
25			3.27(-7	4.43(-7		2.08(-8		55							
26			4.08(07			2.62(-8	2.26(-8	56							
27		1.89(-6	2.08(-7	2.85(-7			1.05(-8	57							
28							8.97(-9	58							
29		3.09(-6	1.23(-7	4.35(-7		3.38(-8	5.95(-9	59							
30						2.05(-8	1.61(-8	60							
								61							

TABLE E-9 (Cont'd)
Cs^{137} AIR CONCENTRATION; RELEASE 8
(curie-sec/meter^3)

	A R C								A R C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		5.20(-8					2.18(-8	31							
2				7.11(-6	2.10(-7		2.52(-8	32							
3		8.42(-7	4.90(-8	1.71(-5	1.12(-6	3.40(-7	3.00(-8	33							
4			1.28(-5	2.12(-5	1.94(-8	3.86(-7	2.11(-8	34							
5		3.78(-5	5.82(-5	1.46(-5		3.36(-7		35							
6			6.63(-5	1.26(-5		1.47(-7		36							
7		1.06(-4	7.17(-5	3.82(-6		2.61(-7		37							
8			2.42(-5	1.00(-6		1.17(-7		38							
9				6.80(-8		1.66(-7		39							
10			4.90(-7					40							
11		2.80(-8				1.39(-7		41							
12								42							
13						1.10(-7		43							
14								44							
15						1.06(-7		45							
16								46							
17						4.35(-8		47							
18						2.47(-8		48							
19								49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE E-9 (Cont'd)

Cs^{137} AIR CONCENTRATION, RELEASE 10

(curie-sec/meter^3)

	A			B		C			A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1	1.2(-4	9.81(-6					7.99(-8	31		1.00(-6				2.74(-8	
2								32							
3		3.10(-5	8.20(-6				5.75(-8	33						4.52(-8	
4			1.13(-5					34							
5	1.5(-4	2.03(-5	1.80(-5				1.37(-8	35						4.94(-9	
6			2.15(-5	2.27(-6			2.08(-8	36							
7		1.85(-5	2.16(-5					37							
8			1.97(-5	8.99(-6			1.28(-8	38							
9	1.05(-4	1.83(-5	1.73(-5	8.74(-6				39							
10			1.50(-5	9.40(-6				40							
11		2.06(-5	1.04(-5					41							
12				4.36(-6				42							
13	1.35(-4	1.20(-5	4.56(-6	3.06(-6	8.67(-7			43							
14			4.88(-6	1.89(-6				44							
15		1.06(-5	5.82(-6	1.86(-6	1.28(-6	3.94(-7		45							
16			4.40(-6	8.62(-7				46							
17	1.95(-4	1.09(-5	3.00(-6	7.40(-7		8.50(-7		47							
18				8.23(-7				48							
19		1.67(-5	1.65(-6	6.33(-7	1.35(-7	4.19(-7		49							
20			1.68(-6	5.08(-7				50							
21	2.25(-4	1.85(-5	6.34(-7	5.43(-7	4.16(-7	3.74(-7		51							
22			1.01(-7	3.74(-7				52							
23			8.28(-8		4.59(-7	3.58(-7		53							
24								54							
25	2.45(-4				2.15(-7	1.82(-7		55							
26								56							
27		7.38(-6			5.50(-8	1.48(-7		57							
28								58							
29	3.50(-4	4.19(-6				2.83(-8		59							
30								60							
								61							

TABLE E-9 (Cont'd)

Cs^{137} AIR CONCENTRATION; RELEASE 11

(curie-sec/meter^3)

	A	B	C				
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1							
2							
3							
4							
5	3.65(-5						
6							
7						1.39(-7	
8							
9	1.33(-4					2.90(-7	
10							
11						3.72(-7	
12							
13	3.10(-4	7.05(-7		1.67(-7		3.45(-7	
14							
15		5.40(-5				3.27(-7	
16			9.34(-6				
17	2.90(-4	6.03(-5	3.38(-5	2.32(-7		4.16(-7	
18				2.59(-6			
19		9.38(-6	2.72(-5	1.69(-6			
20			1.83(-5				
21		1.36(-6		4.49(-6			
22				1.78(-5			
23							
24							
25	2.00(-7						
26							
27			4.17(-8				
28							
29							
30							

	A	B	C				
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							
61							

TABLE E-10

Ru^{103} GROUND-LEVEL GUMMED-PAPER CONTAMINATION: RELEASE 1

(curies/meter^2)

	A			B		C			A			B		C	
	15 FEET	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		15 FEET	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2	1.33(-6							32	7.28(-8						
3								33							
4	5.16(-6							34							
5								35							
6								36	4.57(-8						
7						3.35(-11		37							
8	7.35(-6							38							
9				3.77(-10				39							
10								40	2.46(-8						
11				3.42(-10				41							
12	4.63(-6							42							
13		5.67(-8						43							
14							1.14(-11	44							
15		1.24(-7						45							
16	2.57(-6					4.48(-11	6.40(-11	46							
17		4.20(-8						47							
18								48							
19		4.46(-9				4.64(-8		49							
20								50							
21								51							
22								52							
23								53							
24	1.03(-6							54							
25								55							
26								56							
27							1.04(-10	57							
28	1.50(-7							58							
29								59							
30								60							
								61							

TABLE E-10 (Cont'd)

Ru^{103} GROUND-LEVEL GUMMED-PAPER CONTAMINATION: RELEASE 2

(curies/meter^2)

	A	B	C						A	B	C				
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5								35							
6								36							
7								37							
8								38							
9								39							
10								40							
11								41							
12								42							
13								43							
14								44							
15								45							
16								46							
17								47							
18								48							
19								49							
20								50							
21								51							
22								52							
23								53		1.08(-8					
24								54							
25								55		3.77(-8					
26								56							
27								57		5.26(-8					
28								58							
29								59		4.13(-8					
30								60							
								61							

TABLE E-10 (Cont'd)
Ru^{103} GROUND-LEVEL GUMMED-PAPER CONTAMINATION: RELEASE 3
(curies/meter^2)

	A			B			C		A			B			C
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5								35							
6								36							
7		3.87(-9						37							
8								38							
9		2.01(-9						39							
10								40							
11								41							
12								42							
13								43							
14								44							
15								45							
16								46							
17								47							
18								48							
19								49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE E-10 (Cont'd)

Ru^{103} GROUND-LEVEL GUMMED-PAPER CONTAMINATION: RELEASE 5

(curies/meter^2)

	A			B		C			A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33		8.23(-9					
4								34							
5								35							
6								36							
7								37		8.98(-9					
8								38							
9								39							
10								40							
11								41		9.90(-9					
12								42							
13								43		2.29(-8					
14								44							
15								45		5.20(-8					
16								46							
17		1.44(-8						47		7.60(-8					
18								48							
19								49		1.05(-8					
20								50							
21		7.19(-10						51		2.98(-9					
22								52							
23								53							
24								54							
25		2.27(-9						55							
26								56							
27								57							
28								58							
29		3.24(-9						59							
30								60							
								61							

TABLE E-10 (Cont'd)
Ru^{103} GROUND-LEVEL GUMMED-PAPER CONTAMINATION: RELEASE B
(curies/meter^2)

	A B C								A B C						
	700 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		1.37(-9						31							
2								32							
3		3.16(-9						33							
4								34							
5		1.59(-7						35							
6								36							
7		1.20(-6						37							
8								38							
9		1.57(-6						39							
10								40							
11		5.15(-8						41							
12								42							
13		2.56(-9						43							
14								44							
15		2.60(-9						45							
16								46							
17		5.42(-10						47							
18								48							
19								49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE E-10 (Cont'd)
Ru^{103} GROUND-LEVEL GUMMED-PAPER CONTAMINATION: RELEASE 10
(curies/meter^2)

	A			B		C			A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		4.47(-8						31							
2								32							
3		1.67(-7						33							
4								34							
5		1.07(-7						35							
6				5.09(-9				36							
7		1.18(-7						37							
8				2.26(-8				38							
9		1.04(-7		2.93(-8				39							
10				2.33(-8		9.25(-9		40							
11		1.40(-7		1.26(-8				41							
12				9.34(-9				42							
13		1.32(-7		1.97(-8				43							
14				3.98(-9				44							
15		7.07(-8						45							
16				1.72(-9		2.15(-9		46							
17		1.75(-8						47							
18						1.64(-9		48							
19		3.43(-8						49							
20						1.92(-9		50							
21		1.70(-8						51							
22						1.65(-9		52							
23		1.20(-8						53							
24						1.10(-9		54							
25		1.36(-8						55							
26						6.51(-10		56							
27		7.01(-9						57							
28								58							
29								59							
30								60							
								61							

TABLE E-10 (Cont'd)

Ru^{103} GROUND-LEVEL GUMMED-PAPER CONTAMINATION: RELEASE 11

(curies/meter^2)

	A			B		C			A			B		C	
	116 METERS	1850 METERS	2320 METERS	4000 METERS	8250 METERS	16250 METERS	32300 METERS		100 METERS	1000 METERS	2900 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5								35							
6						1.50(-9		36							
7						5.60(-10		37							
8						7.34(-10		38							
9						3.24(-9		39							
10						2.91(-9		40							
11								41							
12						1.13(-9		42							
13		2.40(-8						43							
14						1.46(-9		44							
15		3.76(-7						45							
16						1.88(-9		46							
17		4.44(-7		1.40(-8				47							
18				2.28(-9		2.26(-9		48							
19		5.20(-8		1.58(-8		7.51(-10		49							
20				2.36(-8		1.22(-9		50							
21		1.74(-8		1.29(-8				51							
22				2.65(-8		2.26(-9		52							
23		6.38(-9		6.95(-9				53							
24				2.25(-9				54							
25		1.88(-9						55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE E-11

Ru^{103} ELEVATED GUMMED-PAPER CONTAMINATION: RELEASE 2

(curies/meter^2)

	A			B		C			A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5								35							
6								36							
7								37							
8								38							
9								39							
10								40							
11								41							
12								42							
13								43							
14								44							
15								45							
16								46							
17								47							
18								48							
19								49		9.74(-9					
20								50							
21								51		2.70(-8					
22								52							
23								53		4.33(-9					
24								54							
25								55		4.62(-8					
26								56							
27								57		6.16(-8					
28								58							
29								59		4.69(-8					
30								60							
								61		4.07(-9					

TABLE E-11 (cont'd)

Ru^{103} ELEVATED GUMMED-PAPER CONTAMINATION: RELEASE 3

(curies/meter^2)

	A			B		C			A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5		3.98(-9						35							
6								36							
7		3.24(-9						37							
8								38							
9								39							
10								40							
11								41							
12								42							
13		1.92(-9						43							
14								44							
15								45							
16								46							
17								47							
18								48							
19								49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE E-11 (cont'd)

Ru^{103} ELEVATED GUMMED-PAPER CONTAMINATION: RELEASE 5

(curies/meter^2)

	A B C								A B C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5								35							
6								36							
7								37							
8								38							
9								39							
10								40							
11								41							
12								42							
13								43							
14								44							
15								45							
16								46							
17								47							
18								48							
19								49							
20								50							
21		4.87(-10						51							
22								52							
23								53							
24								54							
25		1.49(-9						55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE E-11 (cont'd)

Ru^{103} ELEVATED GUMMED-PAPER CONTAMINATION: RELEASE 8

(curies/meter^2)

	A				B		C		A				B		C
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		1.09(-9						31							
2								32							
3		5.00(-8						33							
4								34							
5		3.62(-7						35							
6								36							
7		1.54(-6						37							
8								38							
9		2.43(-6						39							
10								40							
11		1.05(-7						41							
12								42							
13		3.21(-10						43							
14								44							
15		2.91(-9						45							
16								46							
17								47							
18								48							
19								49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE E-11 (cont'd)
Ru^{103} ELEVATED GUMMED-PAPER CONTAMINATION: RELEASE 10
(curies/meter^2)

	A R C								A R C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		2.09(-8						31							
2								32							
3		2.74(-7						33							
4								34							
5		1.80(-7						35							
6								36							
7		1.23(-7						37							
8								38							
9		1.96(-7						39							
10								40							
11		2.92(-7						41							
12								42							
13		1.97(-7						43							
14								44							
15		8.32(-8						45							
16								46							
17		3.41(-8						47							
18								48							
19		3.08(-8						49							
20								50							
21		2.62(-8						51							
22								52							
23		2.77(-8						53							
24								54							
25		1.54(-8						55							
26								56							
27		1.17(-8						57							
28								58							
29		7.60(-9						59							
30								60							
								61							

TABLE E-11 (cont'd)

Ru^{103} ELEVATED GUMMED-PAPER CONTAMINATION: RELEASE 11

(curies/meter^2)

	A R C								A R C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5								35							
6								36							
7								37							
8								38							
9								39							
10								40							
11								41							
12								42							
13		3.63(-8						43							
14								44							
15		6.00(-7						45							
16								46							
17		4.61(-7						47							
18								48							
19		7.61(-8						49							
20								50							
21		2.35(-8						51							
22								52							
23		9.16(-9						53							
24								54							
25		5.28(-9						55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE E-12
Ru^{103} GRASS CONTAMINATION: RELEASE 1
(curies/meter^2)

	A R C								A R C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5								35							
6								36							
7								37							
8								38							
9								39							
10								40							
11								41							
12			5.99(-8					42							
13		2.03(-7	1.11(-7					43							
14			4.68(-8					44							
15		1.99(-7	2.46(-8					45							
16								46							
17		3.05(-8						47							
18								48							
19		2.02(-9						49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE E-12 (Cont'd)
Ru^{103} GRASS CONTAMINATION: RELEASE 10
(curies/meter^2)

	A			B		C			A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		1.35(-7						31		4.46(-10					
2								32							
3		1.29(-7						33							
4								34							
5		2.06(-7						35							
6								36							
7		2.56(-7						37							
8								38							
9		5.10(-7						39							
10								40							
11		6.52(-7						41							
12								42							
13		6.75(-7						43							
14								44							
15		1.10(-7						45							
16								46							
17		2.01(-8						47							
18								48							
19		2.38(-8						49							
20								50							
21		2.04(-7						51							
22								52							
23		1.05(08						53							
24								54							
25		2.82(-9						55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE C-13

Ru^{103} SOIL CONTAMINATION- RELEASE 1

(curies/meter^2)

	A		B		C				A		B		C		
	700 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		700 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5								35							
6								36							
7								37							
8								38							
9								39							
10								40							
11								41							
12			8.4(-9					42							
13		2.19(-9	3.23(-8					43							
14			8.9(-9					44							
15		1.3(-9	4.55(-9					45							
16								46							
17								47							
18								48							
19		3.9(-9						49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE E-14

Ru^{103} AIR CONCENTRATION: RELEASE 1

(curie-sec/meter^3)

	A R C								A R C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5								35							
6						4.30(-9		36							
7					1.20(-7	8.00(-9		37							
8						3.30(-7		38							
9				1.60(-7		1.17(-6		39							
10					3.69(-7	7.78(-7		40							
11				1.11(-6	3.84(-7	3.64(-7		41							
12			4.83(-6		5.56(-7			42							
13		1.57(-5	1.12(-5		8.42(-7	2.00(-8	5.60(-8	43							
14			8.17(-6		1.80(-7	1.23(-7	6.49(-8	44							
15		2.67(-5	3.65(-6	4.59(-9	1.08(-7	1.42(-7		45							
16			3.42(-6			8.00(-8	5.50(-8	46							
17		1.21(-5	2.19(-6			3.10(-8		47							
18			2.99(-7			4.50(-8	5.50(-8	48							
19		1.05(-6		1.80(-7				49							
20						4.20(-8	2.00(-8	50							
21		4.41(-7						51							
22								52							
23								53							
24								54							
25							2.30(-8	55							
26								56							
27							1.40(-8	57							
28							2.70(-8	58							
29							8.83(-9	59							
30								60							
								61							

TABLE E-14 (Cont'd)

Ru^{103} AIR CONCENTRATION: RELEASE 2

(curie-sec/meter^3)

	A			B		C			A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							6.70(-8
2								32					1.02(-7		1.20(-7
3								33					2.57(-7		1.60(-7
4								34					3.19(-7	8.03(-8	1.64(-7
5								35					2.65(-7	7.28(-8	1.06(-7
6								36					1.06(-7	9.37(-8	1.45(-7
7								37					9.10(-8		1.07(-7
8								38					2.00(-7	2.40(-8	9.26(-8
9								39					2.36(-7		9.26(-8
10								40						2.50(-8	1.16(-7
11								41				3.16(-7			1.36(-7
12								42				3.60(-7	9.72(-8		
13								43				2.82(-7	6.00(-8		
14								44				1.54(-6		3.90(-8	2.50(-8
15								45				3.00(-6			
16								46				1.50(-6		2.60(-8	
17								47		7.52(-7		9.66(-7			
18								48				7.37(-7			
19								49		9.34(-7		7.02(-7			
20								50			4.67(-7	5.81(-7			
21								51		3.63(-6	9.59(-7				
22								52							
23								53		4.06(-6	2.83(-6				
24								54			1.19(-5				
25								55		1.27(-5	8.54(-6				
26								56			8.04(-6				
27							3.30(-8	57		2.02(-5	6.30(-6				
28								58			6.99(-6				
29							4.60(-8	59		1.65(-5					
30								60							
								61							

TABLE E-14 (Cont'd)

Ru^{103} AIR CONCENTRATION: RELEASE 3

(curie-sec/meter^3)

	A			B			C
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	15000 METERS	32000 METERS
1		1.09(-6					
2							
3		1.36(-6					
4							
5		1.43(-6					
6							
7		1.14(-6					
8							
9		1.15(-6					
10							
11		1.48(-6					
12							
13		1.64(-6					
14							
15		1.05(-6					
16							
17		1.14(-6					
18							
19		6.53(-7					
20							
21		1.04(-6					
22							
23							
24							
25							
26							
27							
28							
29		5.05(-7					
30							

	A			B			C
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	15000 METERS	32000 METERS
31							
32							
33		8.12(-7					
34							
35							
36							
37		4.36(-7					
38							
39							
40							
41		3.69(-7					
42							
43							
44							
45							
46							
47							
48							
49							
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							
61							

TABLE E-14 (Cont'd)
Ru^{103} AIR CONCENTRATION: RELEASE 4
(curie-sec/meter^3)

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		8.84(-8					
2							
3							
4							
5							
6							
7		1.49(-7					
8							
9							
10							
11							
12							
13							
14							
15							
16							
17		9.50(-8					
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							
61							

TABLE E-14 (Cont'd)

Ru^{103} AIR CONCENTRATION: RELEASE 5

(curie-sec/meter^3)

	A				B		C
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13		3.02(-7					
14							
15		4.88(-6					
16			6.50(-7				
17		9.67(-6	4.77(-6				
18							
19		2.63(-6	1.31(-6				
20			5.06(-7	8.55(-7		2.25(-8	
21			6.29(-7	1.46(-6		4.47(-8	
22			4.71(-7	7.38(-7		3.64(-8	1.06(-8
23			4.10(-7			3.86(-8	
24			2.61(-7				1.07(-8
25			2.19(-7	1.58(-7		2.94(-8	
26			3.12(-7			3.53(-8	1.58(-8
27		6.64(-7	1.91(-7	1.32(-7			9.78(-9
28							1.49(-8
29		1.02(-6	1.87(-7			3.56(-8	1.77(-8
30						2.24(-8	2.95(-8

	A				B		C
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31		8.15(-7	1.45(-7		4.98(-8	2.37(-8	1.00(-8
32					4.86(-8	1.77(-8	
33		1.86(-6	2.52(-7		6.15(-8		
34							
35		1.66(-6	2.06(-7				
36							
37		1.21(-6	5.65(-7				
38					2.01(-8		
39		1.29(-6					
40							
41		9.09(-7	1.36(-6				
42							
43		2.71(-6	9.71(-7				
44							
45		5.42(-6	6.16(-7				
46							
47		4.50(-6	3.30(-7				
48							
49		7.97(-7					
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							
61							

TABLE E-14 (Cont'd)
Ru^{103} AIR CONCENTRATION: RELEASE 8
(curie-sec/meter^3)

	A			B		C			A			B		C		
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		1.40(-7					5.72(-8	31							
2			3.79(-8	6.49(-5	2.57(-6		5.33(-8	32							
3		2.10(-5	4.95(-7	1.11(-4	2.12(-6	1.80(-6	5.98(-8	33							
4			1.00(-4	8.58(-5	8.14(-8	1.84(-6	5.41(-8	34							
5		1.05(-4	6.06(-4	4.68(-5		1.75(-6		35							
6			4.90(-4	2.11(-5		9.15(-7		36							
7		6.62(-4	1.15(-4	5.00(-6		1.41(-6		37							
8			3.28(-5	1.53(-6		6.29(-7		38							
9				2.91(-7		5.92(-7		39							
10			2.90(-6					40							
11		6.60(-8	7.88(-7			4.75(-7		41							
12								42							
13						4.43(-7		43							
14								44							
15						3.13(-7		45							
16								46							
17						1.00(-7		47							
18						3.39(-8		48							
19								49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE E-14 (Cont'd)

Ru^{103} AIR CONCENTRATION: RELEASE 10

(curie-sec/meter^3)

	A			B		C			A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1	7.60(-4	3.99(-5					1.93(-7	31		1.04(-6				5.73(-8	
2								32							
3		1.33(-4	3.36(-5				1.83(-7	33						4.93(-8	
4			5.48(-5					34							
5	9.00(-4	7.50(-5	6.72(-5	6.51(-7			1.25(-7	35						1.30(-8	
6			8.13(-5	8.37(-6			1.00(-7	36							
7		7.09(-5	7.80(-5				6.62(-8	37							
8			7.11(-5	3.48(-5			5.17(-8	38							
9	5.50(-4	7.04(-5	6.02(-5	2.92(-5			2.69(-8	39							
10			5.10(-5	3.14(-5				40							
11		1.13(-4	3.18(-5				2.14(-8	41							
12				1.31(-5				42							
13	8.5(-4	5.87(-5	1.39(-5	9.45(-6	2.62(-6			43							
14			1.12(-5	6.00(-6				44							
15		3.09(-5	8.40(-6	5.04(-6	4.61(-6	1.30(-6		45							
16			6.95(-6	2.02(-6				46							
17	1.05(-3	2.13(-5	5.35(-6	3.42(-6		2.82(-6		47							
18				1.18(-6				48							
19		3.11(-5	2.19(-6	1.01(-6	4.35(-7	1.44(-6		49							
20			2.48(-6	9.77(-7				50							
21	6.30(-4	3.32(-5	9.77(-7	5.59(-7	6.14(-7	1.15(-6		51							
22			1.32(-7	6.79(-9				52							
23			1.46(-7		7.59(-7	9.28(-7		53							
24								54							
25	3.05(-4				3.01(-7	3.42(-7		55							
26								56							
27		9.85(-6			6.75(-8	1.78(-7		57							
28								58							
29	6.50(-4	4.27(-6			2.09(-8	6.25(-8		59							
30								60							
								61							

TABLE E-14 (Cont'd)

Ru^{103} AIR CONCENTRATION: RELEASE 11

(curie-sec/meter^3)

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1	2.00(-7						
2							
3							
4							
5	2.20(-4	7.97(-8					
6							
7		1.08(-7				5.13(-7	
8							
9	7.40(-4					1.22(-6	
10							
11						1.38(-6	
12				4.22(-7			
13	1.30(-3	2.23(-6		7.82(-7		1.08(-6	
14				8.55(-7			
15		2.33(-4	3.76(-8		9.43(-8	9.30(-7	
16			1.41(-5				
17	6.60(-4	1.98(-4	5.79(-5	1.49(-6		1.19(-6	
18				1.50(-5			
19		3.33(-5	1.06(-4	1.40(-5			
20			1.00(-4				
21	2.20(-7	1.45(-5		1.35(-5		6.12(-8	
22				2.72(-5			
23							
24							
25	3.40(-6						
26							
27		3.85(-7	1.54(-8				
28							
29							
30							

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							
61							

TABLE E-15

Zr^{95}-Nb^{95} GROUND-LEVEL GUMMED-PAPER CONTAMINATION: RELEASE 1

(curies/meter^2)

	A			B		C			A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5								35							
6								36							
7								37							
8						2.4(-11		38							
9								39							
10								40							
11				5.51(-11				41							
12								42							
13								43							
14							7.98(-11	44							
15								45							
16								46							
17								47							
18								48							
19								49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27							3.44(-14	57							
28	1.09(-7							58							
29								59							
30								60							
								61							

TABLE E-15 (Cont'd)

Zr^{95}-Nb^{95} GROUND-LEVEL GUMMED-PAPER CONTAMINATION: RELEASE 5

(curies/meter^2)

	A		B		C				A		B		C		
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33		6.74(-10					
4								34							
5								35							
6								36							
7								37		1.29(-9					
8								38							
9								39							
10								40							
11								41		7.10(-10					
12								42							
13								43		1.21(-9					
14								44							
15								45							
16								46							
17								47							
18								48							
19								49		1.33(-9					
20								50							
21								51							
22								52							
23								53							
24							3.24(-9	54							
25		7.32(-10						55							
26								56							
27				2.14(-7			1.54(-8	57							
28								58							
29							1.16(-8	59							
30								60							
								61							

TABLE E-15 (Cont'd)

Zr^{95}-Nb^{95} GROUND-LEVEL GUMMED-PAPER CONTAMINATION: RELEASE B

(curies/meter^2)

	A B C								A B C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		3.62(-9						31							
2								32							
3		8.79(-9						33							
4								34							
5		1.00(-7						35							
6								36							
7		1.80(-7						37							
8								38							
9		3.69(-7						39							
10								40							
11		9.14(-9						41							
12								42							
13		2.99(-9						43							
14								44							
15		2.76(-9						45							
16								46							
17		9.25(-10						47							
18								48							
19								49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE E-16
Zr^{95}-Nb^{95} ELEVATED GUMMED-PAPER CONTAMINATION: RELEASE 8
(curies/meter^2)

	A B C								A B C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		1.38(-8						31							
2								32							
3		6.40(-9						33							
4								34							
5								35							
6								36							
7		2.55(-7						37							
8								38							
9		6.55(-7						39							
10								40							
11		1.01(-8						41							
12								42							
13		4.54(-10						43							
14								44							
15		2.05(-10						45							
16								46							
17								47							
18								48							
19								49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE E-17
Zr^{95}-Nb^{95} GRASS CONTAMINATION: RELEASE 10
(curies/meter^2)

	A B C								A B C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		1.80(-8						31		9.30(-10					
2								32							
3		1.62(-9						33							
4								34							
5		1.76(-8						35							
6								36							
7		2.67(-8						37							
8								38							
9		5.39(-8						39							
10								40							
11		7.65(-8						41							
12								42							
13		1.55(-7						43							
14								44							
15		7.10(-9						45							
16								46							
17								47							
18								48							
19								49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE E-18
Zr^{95}-Nb^{95} SOIL CONTAMINATION: RELEASE 1
(curies/meter^2)

	A B C								A B C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5								35							
6								36							
7								37							
8								38							
9								39							
10								40							
11								41							
12			4.65(-9					42							
13		4.05(-9	6.0(-9					43							
14			1.63(-9					44							
15		4.9(-9	1.08(-9					45							
16								46							
17								47							
18			9.0(-9					48							
19		3.9(-9						49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE E-19
Zr^{95}-Nb^{95} AIR CONCENTRATION: RELEASE 1
(curie-sec/meter^{-3})

	A			B		C			A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5								35							
6						5.19(-9		36							
7					3.80(-8	8.80(-4		37							
8								38							
9				5.30(-11				39							
10								40							
11								41							
12								42							
13							6.90(-9	43							
14								44							
15								45							
16								46							
17								47							
18							5.50(-9	48							
19								49							
20							3.30(-9	50							
21								51							
22								52							
23								53							
24								54							
25							8.10(-9	55							
26								56							
27								57							
28							6.50(-9	58							
29							1.15(-8	59							
30								60							
								61							

TABLE E-19 (Cont'd)
Zr^{95}-Nb^{95} AIR CONCENTRATION: RELEASE 2
(curie-sec/meter^3)

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							1.10(-8
22							
23							1.40(-8
24							
25							1.50(-8
26							
27							
28							
29							1.60(-8
30							

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31							8.40(-9
32					4.80(-8		
33							1.10(-8
34							
35							
36							
37					3.89(-8		
38					3.90(-8	1.30(-8	
39							
40						1.32(-8	
41				5.68(-8	8.48(-8		
42				1.35(-10	2.05(-8	1.20(-8	
43					4.16(-8		
44						2.30(-8	
45							
46						2.60(-8	
47							
48						2.00(-8	
49							
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							
61							

TABLE E-19 (Cont'd)
Zr^{95}-Nb^{95} AIR CONCENTRATION: RELEASE 5
(curie-sec/meter^3)

	A			B			C
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16			1.73(-7				
17			7.62(-7				
18							
19			4.18(-7				
20							
21			4.03(-7				
22			1.89(-7				
23			2.63(-7				
24			1.53(-7				3.24(-9
25			1.27(-7				
26			1.81(-7				
27			9.25(-8	2.14(-7			1.54(-8
28							
29			1.71(-7				1.16(-8
30							

	A			B			C
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31			8.49(-8				
32							
33							
34							
35			1.68(-7				
36							
37			1.80(-7				
38							
39							
40							
41			3.37(-7				
42							
43			1.83(-7				
44							
45							
46							
47			1.41(-7				
48							
49							
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							
61							

TABLE E-19 (Cont'd)
Zr^{95}-Nb^{95} AIR CONCENTRATION: RELEASE 8
(curie-sec/meter^3)

	A R C								A R C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1							7.89(-9	31							
2				4.93(-6	2.50(-8		2.38(-9	32							
3				1.18(-5		7.50(-8		33							
4			1.65(-5	5.09(-6		1.07(-7		34							
5			5.52(-5	1.02(-6		1.02(-7		35							
6			2.66(-5	1.92(-6		4.74(-8		36							
7		4.26(-5	5.20(-6	4.61(-8		7.92(-8		37							
8			9.89(-7	4.97(-9		1.88(-8		38							
9				5.29(-8		3.59(-8		39							
10								40							
11						2.18(-8		41							
12								42							
13								43							
14								44							
15						1.68(-8		45							
16								46							
17						4.98(-9		47							
18						2.38(-8		48							
19								49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE E-19 (Cont'd)
Zr^{95}-Nb^{95} AIR CONCENTRATION; RELEASE 11
(curie-sec/meter^3)

	A	B	C				
	190 METERS	1250 METERS	2250 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1							
2							
3							
4							
5	5.00(-6						
6							
7						5.29(-8	
8							
9	3.35(-5					4.14(-8	
10							
11							
12							
13	1.05(-4						
14							
15							
16							
17	1.40(-4					2.94(-8	
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							

	A	B	C				
	190 METERS	1000 METERS	2500 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							
61							

TABLE E-20

Ce^{141} GROUND-LEVEL GUMMED-PAPER CONTAMINATION: RELEASE 1

(curies/meter^2)

	A			B			C
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11				2.88(-11			
12							
13							
14							
15							
16							
17							
18							1.97(-10
19				6.66(-11		2.98(-8	
20							
21							
22							
23							
24							
25							
26							
27							5.30(-11
28							6.70(-11
29							
30							

	A			B			C
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							
61							

TABLE E-21
Ce^{141} AIR CONCENTRATION; RELEASE 1
(curie-sec/meter^3)

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1							
2							
3							
4							
5							
6							
7				2.40(-7			
8							
9							
10							
11							
12							
13							
14							
15							
16							7.60(-9
17							
18						8.70(-9	
19							
20						6.00(-8	6.90(-9
21							
22							
23							
24							
25							1.80(-8
26							
27							1.10(-9
28							5.50(-8
29							
30							

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							
61							

Ce^{141} AIR CONCENTRATION: RELEASE 2
(curie-sec/meter^3)

	A B C								A B C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							8.80(-9
3								33							7.00(-9
4								34							
5								35							
6								36							
7								37							
8								38					2.50(-8	5.85(-9	
9								39					4.66(-8		
10								40						2.80(-8	
11								41							
12								42						2.90(-8	
13								43							
14								44						2.50(-8	
15								45							
16								46						2.60(-9	
17								47							
18								48						2.20(-9	
19								49							
20								50							
21							2.30(-8	51							
22								52							
23								53							
24								54							
25							8.20(-9	55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE E-21 (Cont'd)

Ce^{141} AIR CONCENTRATION: RELEASE 8

(curie-sec/meter^3)

	A R C								A R C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2				[illegible](-7				32							
3				[illegible](-[illegible]	7.34(-8			33							
4				7.14(-7	[illegible](-8			34							
5								35							
6								36							
7								37							
8								38							
9								39							
10								40							
11								41							
12								42							
13								43							
14								44							
15								45							
16								46							
17								47							
18								48							
19								49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

APPENDIX F

DEPOSITION VELOCITIES

The ratio between ground and integral-air radioactivity levels is called the deposition velocity ($V_g = \frac{\text{ground contamination}}{\text{integral-air concentration}}$). Having determined its value and established its range of values, one is able to predict the expected ground-contamination levels for a given air concentration.

During FRT II, values of V_g on gummed paper, grass, and soil were determined for I^{131}, Cs^{137}, Ru^{103}, and $Te^{127m - 129m}$. Arc averages of the deposition velocities are shown in Table F-1. The data do not indicate a significant dependence of V_g on distance downwind.

Table F-2 presents the over-all average deposition velocities which were obtained from the data in Tables F-3 through F-15.

TABLE F-1

ARC AVERAGES OF DEPOSITION VELOCITIES
(cm/sec)

Measurement	Rel.	1000-Meter Arc	2000-Meter Arc	4000-Meter Arc	1600-Meter Arc	3200-Meter Arc
I^{131} Gummed Paper (ground level)	1	0.41±0.06 [4]		0.17±0.17 [2]	0.26±0.19 [8]	0.20±0.06 [6]
	2	0.337±0.209 [8]				
	3	0.118±0.039 [11]				
	4	0.180±0.066 [9]				
	5	0.216±0.092 [9]		0.216±0.091 [9]		
	8	0.28±0.25 [5]				
	10	0.156±0.042 [11]		0.176±0.036 [8]		
	11	0.63±0.67 [5]		0.11 [1]	1.23±1.23 [2]	
I^{131} Gummed Paper (1.2 meters above ground)	3	0.187±0.033 [11]				
	4	0.068±0.001 [2]				
	5	0.292±0.052 [3]				
	8	0.30±0.22 [5]				
	10	0.233±0.062 [12]				
	11	1.06±1.33 [5]				
I^{131} Rye Grass	1	1.82±0.66 [3]	2.26±1.005 [4]			
	10	1.21±0.40 [12]				
Cs^{137} Soil	1	0.044±0.048 [3]	0.045±0.059 [7]			

[ ] Number of determinations

TABLE F-1 (Cont'd)

ARC AVERAGES OF DEPOSITION VELOCITIES
(cm/sec)

Measurement	Rel.	1000-Meter Arc	2000-Meter Arc	4000-Meter Arc	1600-Meter Arc	3200-Meter Arc
Ru^{103} Gummed Paper (ground level)	1	0.399±0.057 [4]		0.133±0.145 [2]	0.056 [1]	0.067±0.07 [2]
	2	0.477±0.336 [6]				
	3	0.257±0.116 [2]				
	5	0.739±0.65 [19]				
	8	0.36±0.41 [4]				
	10	0.133±0.053 [12]		0.091±0.050 [8]		
	11	0.346±0.410 [12]		0.110±0.024 [5]	0.188±0.110 [2]	
Ru^{103} Gummed Paper (1.2 meters above ground)	3	0.22±0.106 [3]				
	8	0.40±0.26 [4]				
	10	0.201±0.080 [13]				
	11	0.502±0.632 [5]				
Ru^{103} Rye Grass	1	0.605±0.49 [4]	0.848±0.33 [4]			
	10	0.468±0.406 [12]				
Ru^{103} Soil	1	0.14±0.20 [3]				
Te^{127m} Gummed Paper (ground level)	1 & 5	1.07±1.8 [4]				
Te^{129m} Gummed Paper (ground level)	1 & 5	0.342±0.49 [4]				

TABLE F-2

OVER-ALL AVERAGE ISOTOPIC DEPOSITION VELOCITIES
(cm/sec)

Collection Media	I^{131}	Cs^{137}	Ru^{103}	$Te^{127m - 129m}$
Gummed Paper	0.28 ± 0.39 [136]	0.21 ± 0.27 [79]	0.34 ± 0.31 [97]	0.71 ± 1.3 [8]
Grass	1.53 ± 0.59 [19]	0.19 ± 0.17 [21]	0.57 ± 0.42 [20]	--
Soil	--	0.045 ± 0.053 [10]	0.113 ± 0.178 [7]	--

[ ] Number of determinations

TABLE F-3
^{131}I ON GROUND-LEVEL GUMMED PAPER: RELEASE 1
(Vg in cm/sec)

	A			B		C			A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5								35							
6								36							
7								37							
8								38							
9				0.055?		0.016		39							
10						0.085		40							
11				0.293		0.232		41							
12								42							
13						(6.65)	0.179	43							
14						0.368	0.191	44							
15		0.348				0.170	0.159	45							
16						0.181	0.189	46							
17		0.462					0.191	47							
18							0.315	48							
19		0.360						49							
20								50							
21		0.467						51							
22								52							
23						0.559		53							
24								54							
25								55							
26						0.474		56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE F-3 (Cont'd)
I^{131} ON GROUND-LEVEL GUMMED PAPER: RELEASE 2
(Vg in cm/sec)

	A		B		C				A		B		C		
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5								35							
6								36							
7								37							
8								38							
9								39							
10								40							
11								41							
12								42							
13								43							
14								44							
15								45		0.422					
16								46							
17								47		0.217					
18								48							
19								49		0.306					
20								50							
21								51		0.324					
22								52							
23								53		0.220					
24								54							
25								55		0.227					
26								56							
27								57		0.209					
28								58							
29								59		0.269					
30								60							
								61							

TABLE F-3 (Cont'd)

^{131}I ON GROUND-LEVEL GUMMED PAPER: RELEASE 3

(V_g in cm/sec)

	A			B		C			A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		0.106						31							
2								32							
3		0.165						33							
4								34							
5		0.135						35		0.138					
6								36							
7		0.157						37							
8								38							
9		0.095						39							
10								40							
11		0.141						41							
12								42							
13		0.107						43		0.026					
14								44							
15		0.135						45							
16								46							
17		0.102						47							
18								48							
19								49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE F-3 (Cont'd)
I^{131} ON GROUND-LEVEL GUMMED PAPER: RELEASE 4
(Vg in cm/sec)

	A	B	C						A	B	C				
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		0.30						31							
2								32							
3								33		0.103					
4								34							
5		0.207						35							
6								36							
7								37		0.117					
8								38							
9		0.183						39							
10								40							
11								41							
12								42							
13								43							
14								44							
15								45							
16								46							
17		0.247						47							
18								48							
19		0.165						49							
20								50							
21		0.189						51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29		0.111						59							
30								60							
								61							

TABLE F-3 (Cont'd)

^{131}I ON GROUND-LEVEL GUMMED PAPER: RELEASE 5

(Vg in cm/sec)

	A			B		C			A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	6000 METERS	10000 METERS	22000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	6000 METERS	10000 METERS	22000 METERS
1								31		0.245		0.207			
2								32							
3								33							
4								34							
5								35		0.359		0.[illegible]40			
6								36							
7								37		0.303					
8								38							
9								39		0.364					
10								40							
11								41		0.321					
12								42							
13		0.327						43		0.385					
14								44							
15								45		0.424					
16								46							
17								47		0.389					
18								48							
19		0.[illegible]18		0.417				49		0.497					
20				0.128				50							
21				0.110				51							
22								52							
23								53							
24								54							
25				0.169				55							
26								56							
27				0.177				57							
28								58							
29		0.246		0.254				59							
30								60							

TABLE F-3 (Cont'd)

I^{131} ON GROUND-LEVEL GUMMED PAPER: RELEASE 8

(V_g in cm/sec)

	A			B			C		A			B			C
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		0.725						31							
2								32							
3		0.190						33							
4								34							
5		0.196						35							
6								36							
7		0.138						37							
8								38							
9		0.143						39							
10								40							
11								41							
12								42							
13								43							
14								44							
15								45							
16								46							
17								47							
18								48							
19								49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE F-3 (Cont'd)

I^{131} ON GROUND-LEVEL GUMMED PAPER: RELEASE 10

(Vg in cm/sec)

	A R C								A R C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3		0.164						33							
4								34							
5		0.195						35							
6				0.121				36							
7		0.158						37							
8				0.151				38							
9		0.156		0.197				39							
10				0.199				40							
11		0.075						41							
12				0.180				42							
13		0.195		0.224				43							
14				0.148				44							
15		0.173						45							
16				0.201				46							
17		0.144						47							
18								48							
19		0.145						49							
20								50							
21		0.214						51							
22								52							
23								53							
24								54							
25								55							
26								56							
27		0.102						57							
28								58							
29								59							
30								60							
								61							

TABLE F-3 (Cont'd)
^{131}I ON GROUND-LEVEL GUMMED PAPER: RELEASE 11
(Vg in cm/sec)

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1							
2							
3							
4							
5							
6							
7						0.355	
8							
9						2.10	
10							
11							
12							
13		0.327					
14							
15		1.81					
16							
17		0.312					
18							
19		0.163					
20							
21		0.560					
22				0.111			
23							
24							
25							
26							
27							
28							
29							
30							

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							
61							

TABLE F-4

I^{131} ON ELEVATED GUMMED PAPER: RELEASE 3

(Vg in cm/sec)

	A R C								A R C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		0.269						31							
2								32							
3		0.194						33							
4								34							
5		0.182						35							
6								36							
7		0.154						37							
8								38							
9		0.189						39							
10								40							
11		0.193						41							
12								42							
13		0.183						43							
14								44							
15		0.178						45							
16								46							
17		0.141						47							
18								48							
19								49							
20								50							
21		0.209						51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29		0.164						59							
30								60							
								61							

TABLE F-4 (Cont'd)
I^{131} ON ELEVATED GUMMED PAPER: RELEASE 4
(Vg in cm/sec)

	A R C								A R C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5								35							
6								36							
7								37							
8								38							
9								39							
10								40							
11								41							
12								42							
13								43							
14								44							
15								45							
16								46							
17								47							
18								48							
19		0.0699						49							
20								50							
21		0.0678						51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE F-4 (Cont'd)
I^{131} ON ELEVATED GUMMED PAPER: RELEASE 5
(Vg in cm/sec)

	A		B		C				A		B		C		
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5								35							
6								36							
7								37							
8								38							
9								39							
10								40							
11								41							
12								42							
13								43							
14								44							
15								45							
16								46							
17								47							
18								48							
19		0.237						49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29		0.341						59							
30		0.298						60							
								61							

TABLE F-4 (Cont'd)
I^{131} ON ELEVATED GUMMED PAPER: RELEASE 8
(V_g in cm/sec)

	A B C								A B C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		0.676						31							
2								32							
3		0.230						33							
4								34							
5		0.230						35							
6								36							
7		0.122						37							
8								38							
9		0.264						39							
10								40							
11								41							
12								42							
13								43							
14								44							
15								45							
16								46							
17								47							
18								48							
19								49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE F-4 (Cont'd)
I^{131} ON ELEVATED GUMMED PAPER: RELEASE 10
(V_g in cm/sec)

	A B C								A B C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3		0.335						33							
4								34							
5		0.320						35							
6								36							
7		0.239						37							
8								38							
9		0.227						39							
10								40							
11		0.148						41							
12								42							
13		0.213						43							
14								44							
15		0.287						45							
16								46							
17		0.162						47							
18								48							
19		0.181						49							
20								50							
21		0.173						51							
22								52							
23								53							
24								54							
25								55							
26								56							
27		0.224						57							
28								58							
29		0.286						59							
30								60							
								61							

TABLE F-4 (Cont'd)

I^{131} ON ELEVATED GUMMED PAPER: RELEASE 11

(Vg in cm/sec)

	A			B		C			A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5								35							
6								36							
7								37							
8								38							
9								39							
10								40							
11								41							
12								42							
13		0.593						43							
14								44							
15		3.40						45							
16								46							
17		0.232						47							
18								48							
19		0.268						49							
20								50							
21		0.928						51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE F-5
I^{131} ON RYE GRASS: RELEASE 1
(Vg in cm/sec)

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12			1.35				
13			1.60				
14			2.49				
15		2.55	3.59				
16							
17		1.62					
18							
19		1.30					
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							
61							

TABLE F-5 (Cont'd)
I^{131} ON RYE GRASS: RELEASE 10
(Vg in cm/sec)

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1							
2							
3		0.567					
4							
5		1.65					
6							
7		0.931					
8							
9		1.30					
10							
11		0.855					
12							
13		1.73					
14							
15		1.30					
16							
17		0.844					
18							
19		1.13					
20							
21		1.86					
22							
23							
24							
25							
26							
27		1.01					
28							
29							
30							

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31		1.30					
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							
61							

TABLE F-6

Cs^{137} ON GROUND-LEVEL GUMMED PAPER: RELEASE 1

(Vg in cm/sec)

	A			B		C			A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5								35							
6								36							
7								37							
8								38							
9								39							
10								40							
11				0.0326				41							
12								42							
13		0.312					0.0948	43							
14							0.0308	44							
15		0.393						45							
16						0.0379	0.0393	46							
17		0.295						47							
18								48							
19		0.291		0.0410				49							
20							0.0891	50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE F-6 (Cont'd)
Cs^{137} ON GROUND-LEVEL GUMMED PAPER: RELEASE 2
(V_g in cm/sec)

	A			B		C			A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5								35							
6								36							
7								37							
8								38							
9								39							
10								40							
11								41							
12								42							
13								43							
14								44							
15								45							
16								46							
17								47							
18								48							
19								49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55		0.209					
26								56							
27								57		0.169					
28								58							
29								59		0.205					
30								60							
								61							

TABLE F-6 (Cont'd)

Cs^{137} ON GROUND-LEVEL GUMMED PAPER: RELEASE 3

(Vg in cm/sec)

	A		B		C		
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1							
2							
3							
4							
5							
6							
7		0.283					
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							

	A		B		C		
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							
61							

TABLE F-6 (Cont'd)
Cs^{137} ON GROUND-LEVEL GUMMED PAPER: RELEASE 5
(V_g in cm/sec)

	A			B			C
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17		0.116					
18							
19							
20							
21		0.130					
22							
23							
24							
25							
26							
27							
28							
29		0.153					
30							

	A			B			C
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31							
32							
33		0.192					
34							
35							
36							
37		0.239					
38							
39							
40							
41		0.291					
42							
43		0.331					
44							
45		0.338					
46							
47		0.269					
48							
49		0.265					
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							
61							

TABLE F-6 (Cont'd)

Cs^{137} ON GROUND-LEVEL GUMMED PAPER: RELEASE 8

(V_g in cm/sec)

	A			B		C			A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3		0.245						33							
4								34							
5		0.132						35							
6								36							
7		0.150						37							
8								38							
9								39							
10								40							
11								41							
12								42							
13								43							
14								44							
15								45							
16								46							
17								47							
18								48							
19								49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE F-6 (Cont'd)
Cs^{137} ON GROUND-LEVEL GUMMED PAPER: RELEASE 10
(V_g in cm/sec)

	A			B			C
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		0.044					
2							
3		0.100					
4							
5		0.106					
6				0.133			
7		0.191					
8				0.064			
9		0.106		0.079			
10				0.066			
11		0.074					
12				0.053			
13		0.142		0.250			
14				0.059			
15		0.110					
16				0.120			
17		0.065					
18							
19		0.151					
20							
21		0.077					
22							
23							
24							
25							
26							
27		0.129					
28							
29							
30							

	A			B			C
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
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57							
58							
59							
60							
61							

TABLE F-6 (Cont'd)
Cs^{137} ON GROUND-LEVEL GUMMED PAPER: RELEASE 11
(Vg in cm/sec)

	A			B			C		A			B			C
	183 METERS	1524 METERS	2224 METERS	4024 METERS	8022 METERS	16220 METERS	32003 METERS		100 METERS	1200 METERS	2800 METERS	4500 METERS	8220 METERS	16420 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5								35							
6								36							
7								37							
8								38							
9						0.559		39							
10								40							
11								41							
12								42							
13		1.24						43							
14								44							
15		0.291						45							
16								46							
17		0.372						47							
18								48							
19		0.166		0.242				49							
20								50							
21				0.0809				51							
22				0.122				52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE F-7
Cs^{137} ON ELEVATED GUMMED PAPER: RELEASE 3
(Vg in cm/sec)

	A		B		C		
	125 METERS	1220 METERS	2[illegible] METERS	4[illegible] METERS	[illegible] METERS	15[illegible] METERS	32200 METERS
1							
2							
3							
4							
5		0.0654					
6							
7		0.116					
8							
9							
10							
11							
12							
13		0.149					
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							

	A		B		C		
	100 METERS	1000 METERS	2000 METERS	4000 METERS	[illegible] METERS	15[illegible] METERS	32[illegible] METERS
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							
61							

TABLE F-7 (Cont'd)
Cs^{137} ON ELEVATED GUMMED PAPER: RELEASE 5
(V_g in cm/sec)

	A	B	C						A	B	C				
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5								35							
6								36							
7								37							
8								38							
9								39							
10								40							
11								41							
12								42							
13								43							
14								44							
15								45							
16								46							
17								47							
18								48							
19								49							
20								50							
21		0.204						51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE F-7 (Cont'd)
Cs^{137} ON ELEVATED GUMMED PAPER: RELEASE 8
(Vg in cm/sec)

	A				B		C		A				B		C
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3		0.192						33							
4								34							
5		0.130						35							
6								36							
7		0.166						37							
8								38							
9								39							
10								40							
11								41							
12								42							
13								43							
14								44							
15								45							
16								46							
17								47							
18								48							
19								49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE F-7 (Cont'd)
Cs^{137} ON ELEVATED GUMMED PAPER: RELEASE 10
(Vg in cm/sec)

	A	B	C						A	B	C				
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		0.127						31							
2								32							
3		0.141						33							
4								34							
5		0.165						35							
6								36							
7		0.079						37							
8								38							
9		0.144						39							
10								40							
11		0.155						41							
12								42							
13		0.101						43							
14								44							
15								45							
16								46							
17		0.217						47							
18								48							
19		0.083						49							
20								50							
21		0.103						51							
22								52							
23								53							
24								54							
25								55							
26								56							
27		0.225						57							
28								58							
29		0.113						59							
30								60							
								61							

TABLE F-7 (Cont'd)
Cs^{137} ON ELEVATED GUMMED PAPER: RELEASE 11
(Vg in cm/sec)

	A			B		C	
	100 METERS	1000 METERS	2250 METERS	4500 METERS	8250 METERS	16250 METERS	32250 METERS
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13		2.07					
14							
15		0.372					
16							
17		0.335					
18							
19		0.299					
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							

	A			B		C	
	100 METERS	1000 METERS	2250 METERS	4500 METERS	8250 METERS	16250 METERS	32250 METERS
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							
61							

TABLE F-8
Cs^{137} ON RYE GRASS: RELEASE 1
(Vg in cm/sec)

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12			0.195				
13		0.368	0.236				
14			0.286				
15		0.419	0.470				
16							
17		0.389					
18							
19		0.0398					
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							
61							

TABLE F-8 (Cont'd)
Cs^{137} ON RYE GRASS: RELEASE 10
(V_g in cm/sec)

	A	B	C						A	B	C				
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		0.126						31		0.186					
2								32							
3		0.0377						33							
4								34							
5		0.0655						35							
6								36							
7		0.100						37							
8								38							
9		0.139						39							
10								40							
11		0.-81						41							
12								42							
13		0.351						43							
14								44							
15		0.0962						45							
16								46							
17		0.0926						47							
18								48							
19		0.115						49							
20								50							
21		0.199						51							
22								52							
23								53							
24								54							
25								55							
26								56							
27		0.0962						57							
28								58							
29								59							
30								60							
								61							

TABLE F-9
Cs^{137} ON SOIL: RELEASE 1
(Vg in cm/sec)

	A B C								A B C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5								35							
6								36							
7								37							
8								38							
9								39							
10								40							
11								41							
12			0.0463					42							
13		0.0207	0.0194					43							
14			0.0159					44							
15		0.0112	0.0171					45							
16			0.0136					46							
17			0.0247					47							
18			0.177					48							
19		0.0335						49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE F-10
Ru^{103} ON GROUND-LEVEL GUMMED PAPER: RELEASE 1
(Vg in cm/sec)

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1							
2							
3							
4							
5							
6							
7							
8							
9				0.236			
10							
11				0.0308			
12							
13		0.361					
14							0.0176
15		0.469					
16						0.056	0.116
17		0.347					
18							
19		0.425					
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							
61							

TABLE F-10 (Cont'd)
Ru^{103} ON GROUND-LEVEL GUMMED PAPER: RELEASE 2
(Vg in cm/sec)

	A		B		C		
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							

	A		B		C		
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49		1.043					
50							
51		0.745					
52							
53		0.266					
54							
55		0.297					
56							
57		0.261					
58							
59		0.250					
60							
61							

TABLE F-10 (Cont'd)
Ru^{103} ON GROUND-LEVEL GUMMED PAPER: RELEASE 3
(Vg in cm/sec)

	A			B		C			A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33		0.442					
4								34							
5								35							
6								36							
7		0.339						37		0.742					
8								38							
9		0.175						39							
10								40							
11								41		1.09					
12								42							
13								43		0.945					
14								44							
15								45		0.959					
16								46							
17		0.149						47		1.69					
18								48							
19								49		1.32					
20								50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29		0.318						59							
30								60							
								61							

TABLE F-10 (Cont'd)
Ru^{103} ON GROUND-LEVEL GUMMED PAPER: RELEASE 8
(Vg in cm/sec)

	A			B		C			A			B		C		
	100 METERS	1020 METERS	2000 METERS	4000 METERS	8200 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8200 METERS	16000 METERS	32000 METERS
1		0.073						31							
2								32							
3		0.150						33							
4								34							
5		0.151						35							
6								36							
7		0.176						37							
8								38							
9								39							
10								40							
11								41							
12								42							
13								43							
14								44							
15								45							
16								46							
17								47							
18								48							
19								49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE F-10 (Cont'd)
Ru^{103} ON GROUND-LEVEL GUMMED PAPER: RELEASE 10
(Vg in cm/sec)

	A R C								A R C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		0.112						31							
2								32							
3		0.125						33							
4								34							
5		0.143						35							
6				0.051				36							
7		0.169						37							
8				0.065				38							
9		0.148		0.100				39							
10				0.074				40							
11		0.124						41							
12				0.071				42							
13		0.225		0.209				43							
14				0.066				44							
15		0.228						45							
16				0.085				46							
17		0.083						47							
18								48							
19		0.110						49							
20								50							
21		0.051						51							
22								52							
23								53							
24								54							
25								55							
26								56							
27		0.071						57							
28								58							
29								59							
30								60							
								61							

TABLE F-10 (Cont'd)
Ru^{103} ON GROUND-LEVEL GUMMED PAPER: RELEASE 11
(Vg in cm/sec)

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1							
2							
3							
4							
5							
6							
7						0.109	
8							
9						0.266	
10							
11							
12							
13		1.07					
14							
15		0.161					
16							
17		0.224		0.0939			
18				0.152			
19		0.155		0.113			
20							
21		0.120		0.0950			
22				0.0974			
23							
24							
25							
26							
27							
28							
29							
30							

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							
61							

TABLE F-11 (Cont'd)

Ru^{103} ON ELEVATED GUMMED PAPER: RELEASE 3

(Vg in cm/sec)

	A B C								A B C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5		0.278						35							
6								36							
7		0.294						37							
8								38							
9								39							
10								40							
11								41							
12								42							
13		0.099						43							
14								44							
15								45							
16								46							
17								47							
18								48							
19								49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE F-11 (Cont'd)

Ru^{103} ON ELEVATED GUMMED PAPER: RELEASE 8

(Vg in cm/sec)

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		0.771					
2							
3		0.242					
4							
5		0.345					
6							
7		0.226					
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							
61							

TABLE F-11 (Cont'd)

Ru^{103} ON ELEVATED GUMMED PAPER: RELEASE 10

(Vg in cm/sec)

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		0.228					
2							
3		0.198					
4							
5		0.240					
6							
7		0.174					
8							
9		0.279					
10							
11		0.259					
12							
13		0.336					
14							
15		0.269					
16							
17		0.160					
18							
19		0.099					
20							
21		0.079					
22							
23							
24							
25							
26							
27		0.119					
28							
29		0.178					
30							

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							
61							

TABLE F-11 (Cont'd)

Ru^{103} ON ELEVATED GUMMED PAPER: RELEASE 1

(Vg in cm/sec)

	A			B		C	
	100 METERS	1250 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13		1.63					
14							
15		0.259					
16							
17		0.233					
18							
19		0.229					
20							
21		0.162					
22							
23							
24							
25							
26							
27							
28							
29							
30							

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							
61							

TABLE F-12
Ru^{103} ON RYE GRASS: RELEASE 1
(Vg in cm/sec)

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12			1.23				
13		1.23	0.991				
14			0.409				
15		0.739	0.674				
16							
17		0.255					
18							
19		0.192					
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							

	A			B		C	
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							
61							

TABLE F-12 (Cont'd)
Ru^{103} ON RYE GRASS: RELEASE 10
(Vg in cm/sec)

	A R C								A R C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1		0.333						31		0.0429					
2								32							
3		0.0970						33							
4								34							
5		0.277						35							
6								36							
7		0.360						37							
8								38							
9		0.724						39							
10								40							
11		0.754						41							
12								42							
13		1.15						43							
14								44							
15		0.513						45							
16								46							
17		0.0944						47							
18								48							
19		0.0765						49							
20								50							
21		1.19						51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE F-13
Ru^{103} ON SOIL: RELEASE 1
(Vg in cm/sec)

	A			B			C
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12			0.174				
13		0.0139	0.285				
14			0.107				
15		0.0487	0.125				
16							
17							
18							
19		0.371					
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							

	A			B			C
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							
61							

TABLE F-14
Te^{127m} ON GROUND-LEVEL GUMMED PAPER; RELEASE 1
(V_g in cm/sec)

	A			B			C		A			B			C
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5								35							
6								36							
7								37							
8								38							
9								39							
10								40							
11								41							
12								42							
13		0.255						43							
14								44							
15		3.95						45							
16								46							
17		0.092						47							
18								48							
19								49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE F-14 (Cont'd)
Te^{127m} ON GROUND-LEVEL GUMMED PAPER: RELEASE 5
(Vg in cm/sec)

	A			B			C		A			B			C
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5								35							
6								36							
7								37							
8								38							
9								39							
10								40							
11								41							
12								42							
13								43							
14								44							
15								45							
16								46							
17		0.082						47							
18								48							
19								49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE F-15
Te^{129m} ON GROUND-LEVEL GUMMED PAPER: RELEASE 1
(Vg in cm/sec)

	A	B	C						A	B	C				
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5								35							
6								36							
7								37							
8								38							
9								39							
10								40							
11								41							
12								42							
13		0.267						43							
14								44							
15		0.037						45							
16								46							
17		1.06						47							
18								48							
19								49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

TABLE F-15 (Cont'd)
Te^{129m} ON GROUND-LEVEL GUMMED PAPER: RELEASE 5
(Vg in cm/sec)

	A R C								A R C						
	100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS		100 METERS	1000 METERS	2000 METERS	4000 METERS	8000 METERS	16000 METERS	32000 METERS
1								31							
2								32							
3								33							
4								34							
5								35							
6								36							
7								37							
8								38							
9								39							
10								40							
11								41							
12								42							
13								43							
14								44							
15								45							
16								46							
17		0.00347						47							
18								48							
19								49							
20								50							
21								51							
22								52							
23								53							
24								54							
25								55							
26								56							
27								57							
28								58							
29								59							
30								60							
								61							

APPENDIX G

DIFFUSION PARAMETERS

During the analysis of FRT-I diffusion data, a numerical method was developed to fit field-test data and obtain atmospheric diffusion parameters (Ref. 1). This method was programmed on the IBM-704 digital computer and used to obtain the diffusion-parameter values shown in Tables G-1 and G-2. These values are based on over 100 sets of field-test data obtained from four major field-release tests.

TABLE G-1

FRT-II EXPERIMENTAL DIFFUSION PARAMETERS
(to 3200 meters)

Rel.	Isotope	n	$\bar{u}$	m_y	m_z	C_y	Q/C_z	C_z
1	I^{131}	0.291	4.60	1.01	0.50	0.0356	47.8	0.070
1	Cs^{137}	0.291	4.60	1.13	0.42	0.0129	0.088	0.88
1	Ru^{103}	0.291	4.60	1.14	0.46	0.0114	0.152	0.43
2	I^{131}	0.393	3.25	1.13	0.79	0.0191	212	0.0045
2	Cs^{137}	0.393	3.25	1.26	0.58	0.0054	0.228	0.054
2	Ru^{103}	0.393	3.25	1.22	0.43	0.0092	0.0902	1.1
5	I^{131}	0.296	3.75	1.22	0.91	0.0089	165	0.0018
5	Cs^{137}	0.296	3.75	1.05	1.09	0.0407	10.6	0.0001
5	Ru^{103}	0.296	3.75	1.03	0.87	0.0429	1.43	0.0059
8	I^{131}	0.446	2.00	1.26	1.19	0.0419	6080	0.0004
8	Cs^{137}	0.446	2.00	1.07	1.37	0.0166	256	0.0006
8	Ru^{103}	0.446	2.00	1.29	1.50	0.0029	4090	0.000003
10	I^{131}	0.539	2.50	0.95	0.42	0.1580	1.39	0.55
10	Cs^{137}	0.539	2.50	0.79	0.42	0.4639	0.224	2.3
10	Ru^{103}	0.539	2.50	0.70	0.48	0.8137	1.16	0.0021
11	I^{131}	0.404	3.25	--	--	--	--	--
11	Cs^{137}	0.404	3.25	0.95	0.26	0.0717	0.0627	6.1
11	Ru^{103}	0.404	3.25	0.96	0.30	0.0692	0.404	2.2

TABLE G-2

EXPERIMENTAL DIFFUSION PARAMETERS: STANFORD, PRAIRIE GRASS, FRT I, AND FRT II

STANFORD (to 200 meters)

	C_y(avg)	C_y	m_y(avg)	m_y	C_z	m_z
Lapse	0.47 ± 0.28[19]	0.43 ± 0.17[14]	0.78 ± 0.15[20]	0.82 ± 0.11[15]	0.03 ± 0.03[14]	1.29 ± 0.33[14]
Inversion		0.57 ± 0.48[5]		0.66 ± 0.20[5]	0.15 ± 0.07[5]	0.73 ± 0.21[6]

PRAIRIE GRASS (to 800 meters)

	C_y(avg)	C_y	m_y(avg)	m_y	C_z	m_z
Lapse	0.43 ± 0.18[59]	0.46 ± 0.19[27]	0.76 ± 0.10[60]	0.83 ± 0.08[29]	0.03 ± 0.03[29]	1.27 ± 0.28[29]
Inversion		0.40 ± 0.13[32]		0.69 ± 0.09[31]	0.20 ± 0.13[31]	0.73 ± 0.18[31]

PRAIRIE GRASS AND STANFORD

	C_y(avg)	C_y	m_y(avg)	m_y	C_z	m_z
Lapse	0.44 ± 0.20[78]	0.45 ± 0.18[41]	0.76 ± 0.12[80]	0.83 ± 0.09[44]	0.03 ± 0.03[43]	1.27 ± 0.29[43]
Inversion		0.43 ± 0.21[37]		0.69 ± 0.10[36]	0.20 ± 0.12[36]	0.73 ± 0.18[37]

FRT I (to 3200 meters)

	C_y(avg)	C_y	m_y(avg)	m_y	C_z	m_z
Lapse	0.759±0.758[19]	1.298±0.877 8	0.729±0.134[19]	0.639±0.087[8]	0.090±0.059[7]	1.300±0.193[8]
Inversion		0.374±0.296[11]		0.795±0.126[11]	0.33 ±0.314[8]	0.819± 0.43[11]

FRT II (to 32000 meters)

	C_y(avg)	C_y	m_y(avg)	m_y	C_z	m_z
Inversion		0.107±0.212[17]		1.068±0.166[17]	0.d ± 1.5[17]	0.709±0.382[17]

[ ] Number of determinations

APPENDIX H

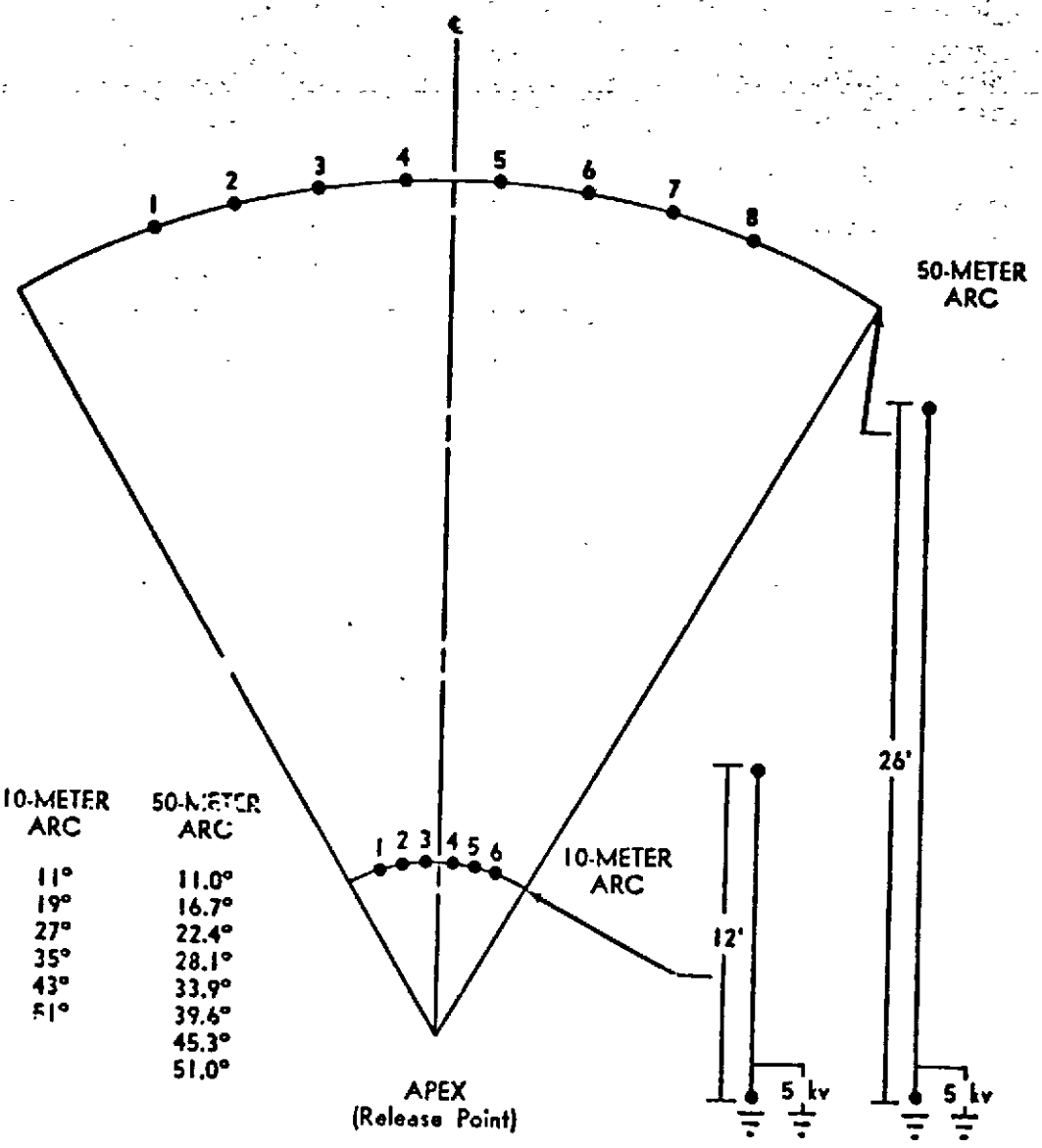
CHARGED-WIRE MEASUREMENTS

Charged-wire sampling has proved to be a simple, yet very valuable tool for sampling airborne fission products. It consists of a fine wire stretched between two points and charged to some potential with respect to the earth (Fig. H-1). Experience during FRT I has shown that wires immediately in front of the release point collect airborne fission products regardless of the charge on the wires. Positively and negatively charged wires collected gross activity with equal efficiency, while neutral wires were about a factor-of-2 less efficient.

The relative isotopic collection efficiencies of the wires were calibrated by low-volume samplers located at the charged-wire positions 1, 2, 3, and 4 on the 10-meter arc during the third release. Results indicate that the relative iosotopic collection efficiency is 1 for I^{131}, 2 for Ru^{103}, 3 for Cs^{137}, and 200 for Zr^{95}. Insufficient data are currently available to add a statistical significance to these efficiencies.

H-1 Charged-Wire Release Percents

The release percents in Table H-1 are normalized to a 24% release for I^{131} and the measured collection efficiencies. Values were obtained by numerically integrating the profiles across the 10- and 50-meter arcs and ratioing them with the isotopic inventories in the source.



WIRE	10-METER ARC	50-METER ARC
1	11°	11.0°
2	19°	16.7°
3	27°	22.4°
4	35°	28.1°
5	43°	33.9°
6	51°	39.6°
7		45.3°
8		51.0°

FIGURE H-1. CHARGED-WIRE NETWORK

TABLE H-1

ISOTOPIC RELEASE PERCENTS BASED ON CHARGED-WIRE PROFILES

Isotope	10-Meter Arc	50-Meter Arc
Zr^{95}-Nb^{95}	0.0009	0.0014
Cs^{137}	24	18
Ru^{103}	1.8	1.2
I^{131}	24	24

TABLE H-2

CHARGED-WIRE AND FRACTIONAL-SAMPLING RELEASE PERCENTS

Release Number	I^{131}			Cs^{137}			Ru^{103}			Zr^{95}-Nb^{95}		
	Frac. Samp.	10-m Arc	50-m Arc	Frac. Samp.	10-m Arc	50-m Arc	Frac. Samp.	10-m Arc	50-m Arc	Frac. Samp.	10-m Arc	50-m Arc
3	11	24	24	51	57	65	1	4	3	--	0.0022	0.0022
4	25	24	24	16	8	5	0.2	0.2	0.4	--	0.0003	0.00005
8	14	24	24	32	15	8	0.3	3	1	--	0.0001	0.002
10	33	24	24	100	16	2	0.08	0.4	0.3	--	--	--
11	10	24	24	67	--	7	3	--	1	--	--	--

The release percents from individual releases are given in Table H-2. They show some consistency within a given release; but from one release to another, they vary considerably.

Charged-wire isotopic collection efficiencies were based on data from Release 3; there is a possibility that the efficiencies were influenced by the heat (ionization) of the source.

H-2 Charged-Wire Release Heights

Vertical wires were chopped into 6-inch segments and analyzed by gamma spectral analysis to obtain vertical concentration profiles for I^{131}, Cs^{137}, Ru^{103}, and Zr^{95}-Nb^{95}. The data presented graphically in Figures H-2 through H-5 effectively locate the height of the maximum concentrations. These figures present arc profiles of isotopic activities and vertical profiles at selected charged-wire locations.

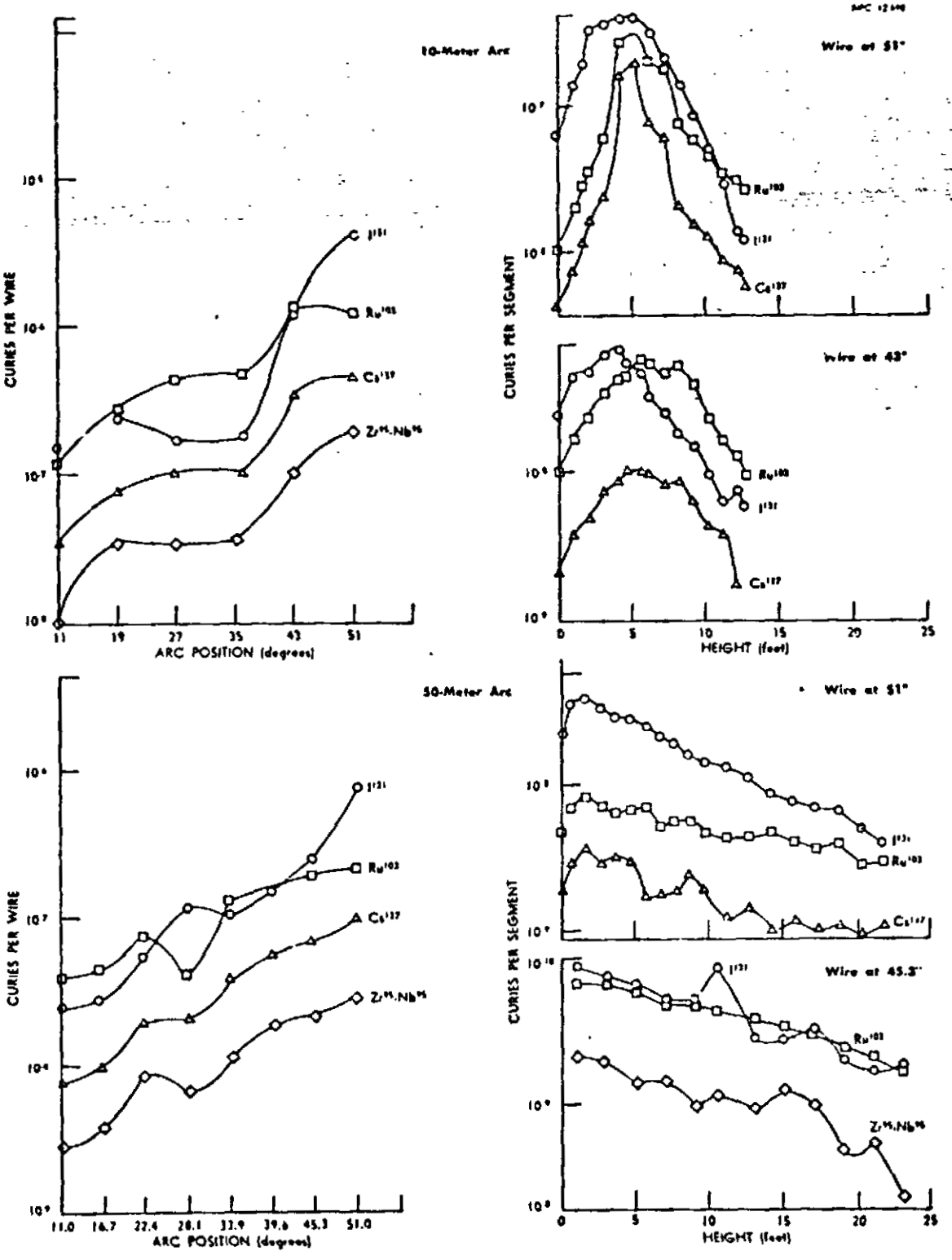


FIGURE H-2. CHARGED WIRE PROFILES FOR RELEASE 3

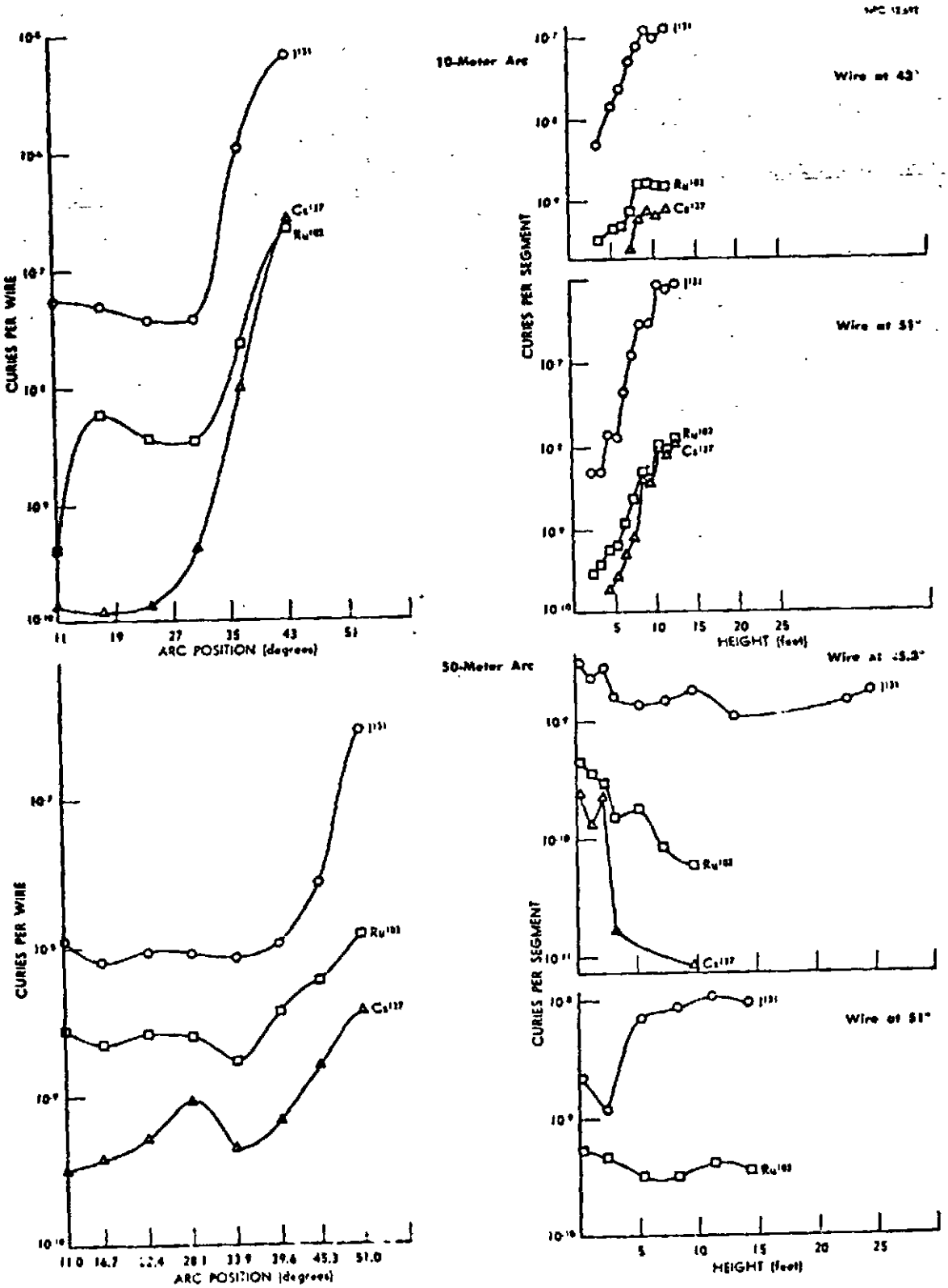


FIGURE H-3. CHARGED-WIRE PROFILES FOR RELEASE 4

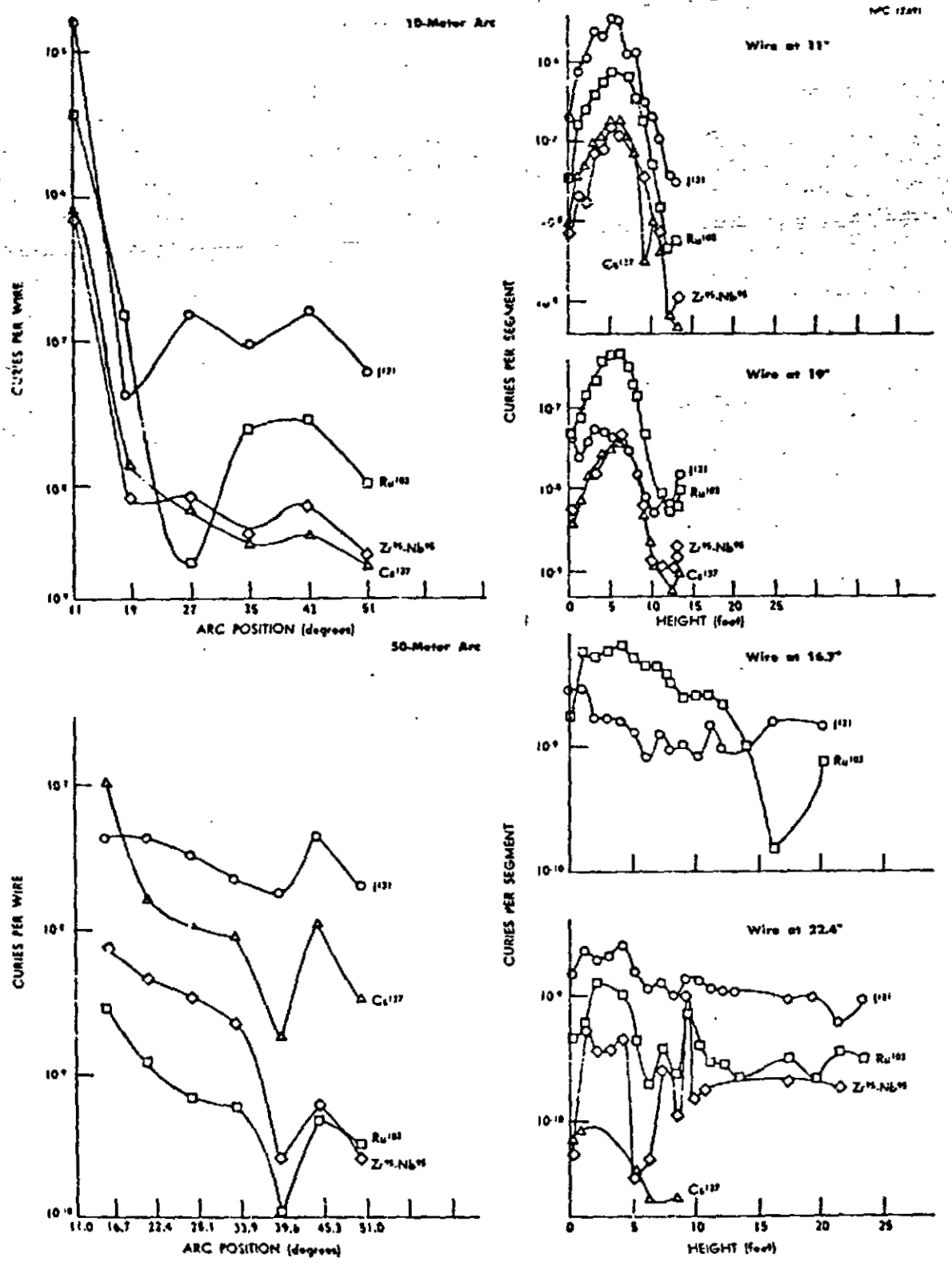


FIGURE H-4. CHARGED-WIRE PROFILES FOR RELEASE 8

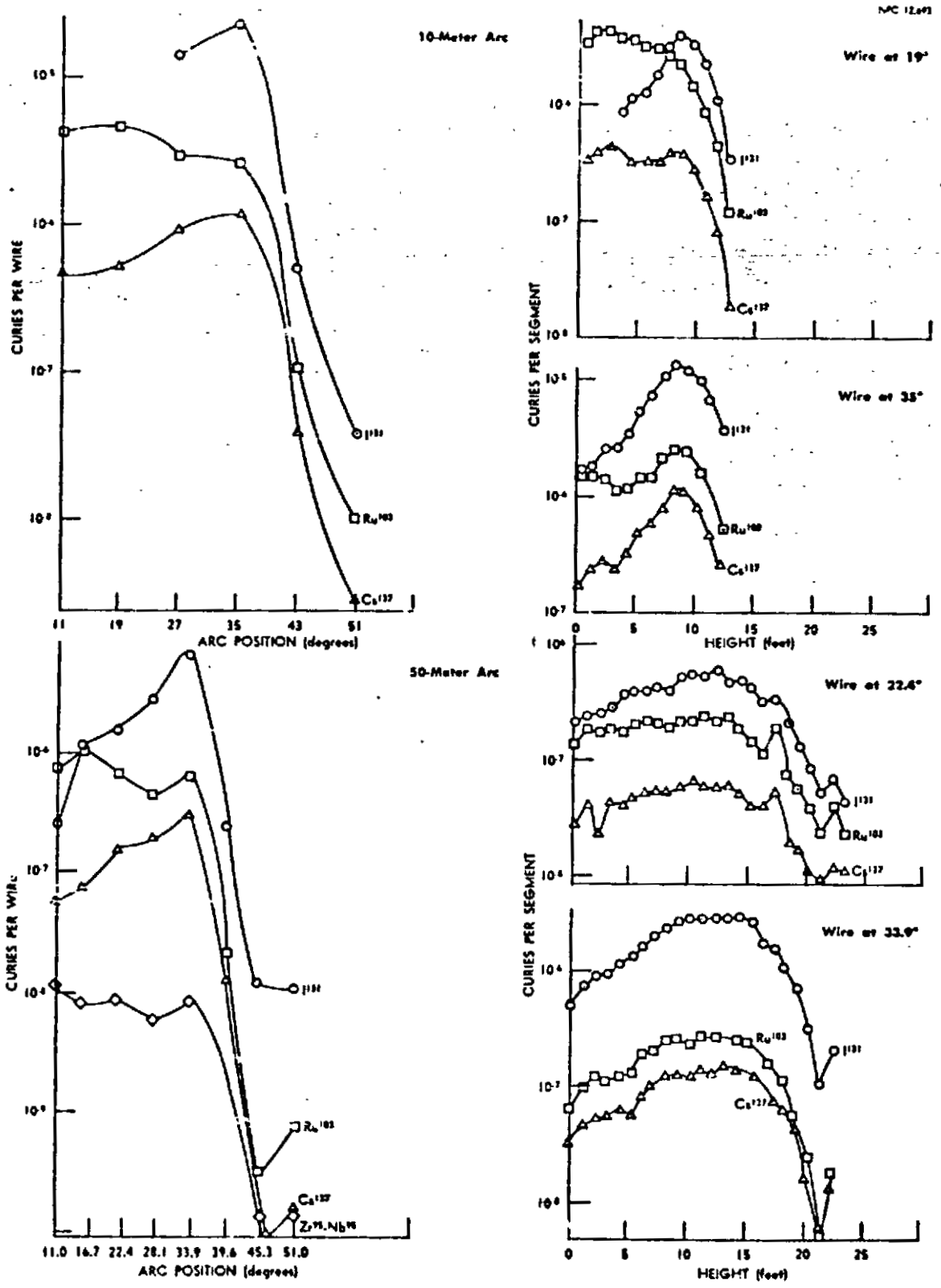


FIGURE H-5. CHARGED-WIRE PROFILES FOR RELEASE 10

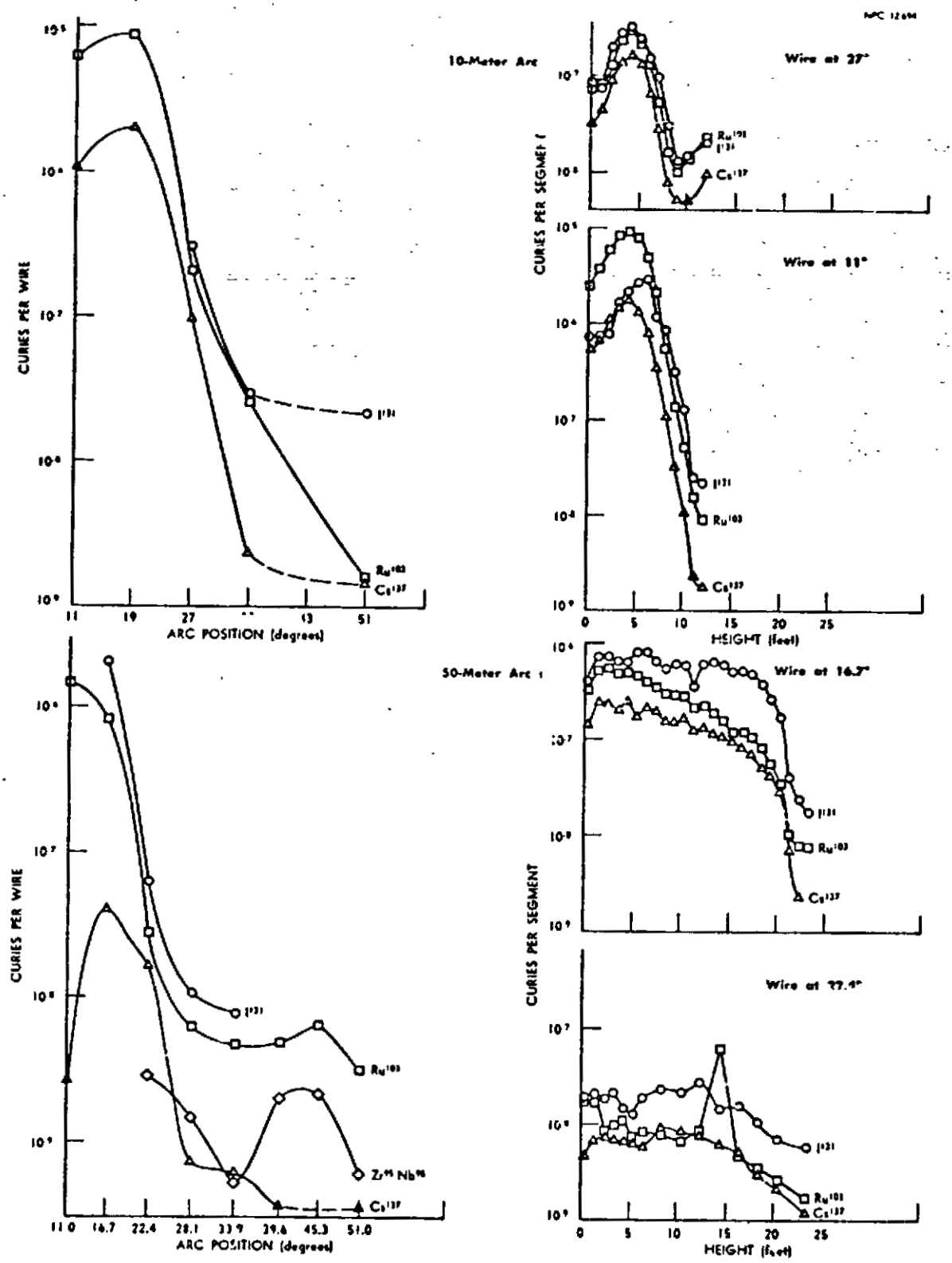


FIGURE H-6. CHARGED-WIRE PROFILES FOR RELEASE 11

APPENDIX I

ECOLOGICAL MEASUREMENTS

All eight fission-products releases were performed during a three-month period between August and October of 1959. On 1 February 1960, about 3 months following the last release of the FRT-II series, six-inch soil samples were taken. Results were intended to show the soil uptake, and thereby to provide information that would add statistically to data from other sources to be used for various plant-cycle studies.

I-1 Rainfall

Rainfall amounts for August, September, and October were about 1.5, 0.75, and 0.35 inches, respectively. No precipitation measurements were made during the period 1 November through 1 February. At the time the soil samples were taken, the ground was observed to be completely saturated with moisture, with approximately 50% of the surrounding areas being covered with snow and water.

I-2 Soil Composition

In 1953, the University of Utah Ecological Research team analyzed the soil in an area near the salt flats, with the results shown in Table I-1. On the test grid where the soil samples were taken, however, the water table was about 18 inches below the surface and the salt and moisture contents were higher than those shown in the table.

TABLE I-1

SOIL COMPOSITION

Chemical Analysis							
Depth (in.)	pH	% Moisture	Salts (% Dry Weight of Sample)				
			NaCl	Na_2SO_4	Na_2CO_3	$NaHCO_3$	Total
Surface	8.4	4.4	20.80	0.842	0	0.018	21.600
12	8.4	21.7	4.90	0.204	0.021	0.087	5.300
24	8.4	22.1	4.05	0.275	0.037	0.081	4.240
36	8.6	28.7	5.40	0.204	0.023	0.070	5.47

Mechanical Analysis						
Depth (in.)	Particle Size (% Dry Weight of Sample)					
	20 Mesh Screen	40 Mesh Screen	60 Mesh Screen	80 Mesh Screen	100 Mesh Screen	% particles too large to pass through 20-mesh screen
Surface	0.4	8.6	17.1	7.6	10.4	55.9
12	0.1	0.4	1.0	0.9	1.0	96.6
24	0.0	0.2	0.3	1.3	3.1	95.1
36	0.0	0.1	0.4	0.8	1.8	96.9

I-3 Sampling Technique

By use of a metal tube, a 6-inch plug about 1-1/2 inches in diameter was removed from seven positions along the 10-meter arcs. The cores were cut into 1-inch sections, weighed, and analyzed for relative abundances of Zr^{95}-Nb^{95}, Cs^{137}, and Ru^{103} by pulse-height techniques.

I-4 Results

The percents of total activity on each sample are given in Table I-2 and plotted in Figure I-1. Beyond the second plug, the activity shows considerable spread. This may be due to contamination caused by pushing the tube into the ground and carrying part of the surface contamination with it. Generally, however, over 90% of the activity remained in the top two inches of the soil. The averages from the first two plugs were fitted and are shown in Figure I-1 (lower right-hand corner).

TABLE I-2

PERCENT OF TOTAL ACTIVITY IN EACH SAMPLE

	Depth (in.)	Samples 1	2	3	4	5	6	7	Average
Zr^{95}-Nb^{95}	1	90.4	91.2	97	100	89	50	33	78.8 ±26.14
	2	1.9	8.39	--	--	11	25	17	12.66± 8.77
	3	0.48	0.18	--	--	--	25	16	10.4 ±12.2
	4	0.24	0.28	--	--	--	--	33	11.17±18.9
	5	0.72	0	--	--	--	--	--	.72
	6	6.3	0.24	3	--	--	--	--	3.18± 3.03
Cs^{137}	1	76.3	90	98	100	64	92	33	74.38±37.5
	2	5.7	--	0.3	--	36	3	6.6	10.32±16.3
	3	--	3	--	--	--	6	13.2	7.4 ± 5.24
	4	--	3	--	--	--	--	6.6	4.8 ± 2.55
	5	3.7	--	--	--	--	--	6.6	5.15± 2.05
	6	14	4	2	--	--	--	33	13.25±14.18
Ru^{103}	1	72	92.2	97	83	82	90.5	35	78.81±21.00
	2	5.8	7.0	0.05	14	12	3.5	9.5	7.41± 4.84
	3	1.5	0.2	0.03	0.9	1.0	2.5	15	3.02± 5.35
	4	1.2	0.15	--	0.9	1.3	--	15	3.71± 6.33
	5	1.5	--	--	0.7	1.0	--	4	1.8 ± 1.5
	6	18	0.32	3	1.1	1.5	3.5	21	6.92± 8.7

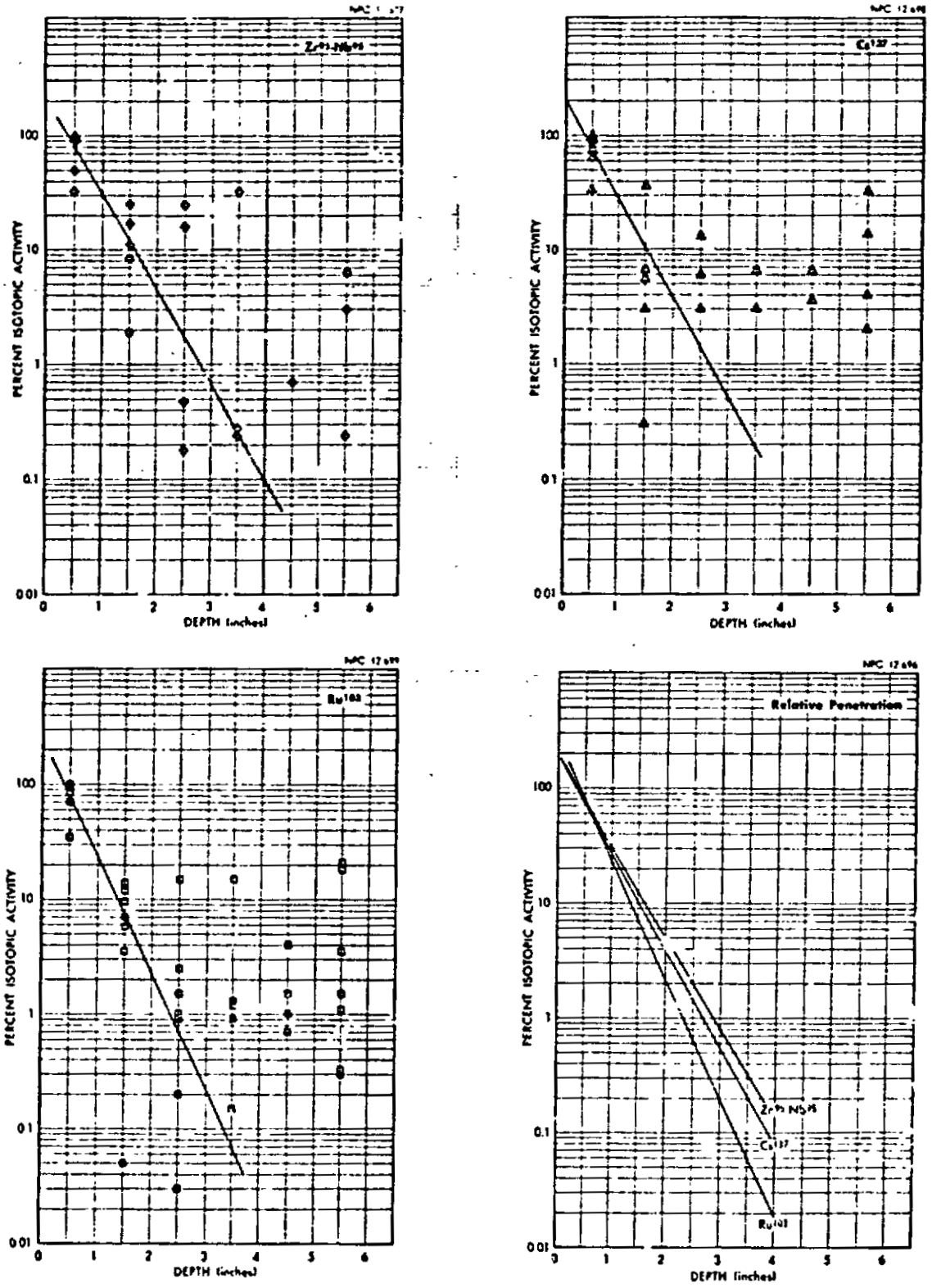


FIGURE I-1. RELATIVE ISOTOPIC PENETRATION IN SOIL

The difference is small - within the margin of experimental error - consequently, inconclusive. On the other hand, the low salt penetration is natural and can be explained.

Solubles, such as the salts of cesium, ruthenium, zirconium, and niobium, dissolve in, and are carried upward by, soil moisture. This moisture moves by capillary action in the direction of a gradient that lies between the water table and the dry surface. As moisture leaves the soil (effected by sun and wind), salts remain and concentrate at the surface.

REFERENCES

1. Fission Products Field Release Test I. Convair-Fort Worth Report FZK-9-140 (NARF-59-32T, September 1959). U

2. Safety Analysis Program Review for Nuclear-Powered Vehicles. Convair-Fort Worth Report FZK-9-148 (NARF-60-13T, 15 April 1960).

3. Theoretical Possibilities and Consequences of Major Accidents in Large Nuclear Power Plants. U.S.A.E.C. Report WASH-740 (March 1957). U

4. Rosinski, Jan, "Source Studies on the Evaluation of Gummed-Paper Collectors Used in Determining Radioactive Fallout," Transactions, American Geophysical Union, Vol. 38, No. 6 (December 1957)

5. Crochman, J. C., Predicting the Atmospheric Diffusion of Fission Products, Convair-Fort Worth Report FZM-1968 (Paper Presented at the Summer Meeting of the American Nuclear Society, Chicago, Illinois, 12-15 June 1960). U

6. Private Communication between Mr. R. C. Shank of Phillips Petroleum Company, Atomic Energy Division, Idaho Falls, and Mr. J. E. Werler, Convair-Fort Worth (Phillips Petroleum File: Sh-179-59A, 21 December 1959).

7. Johnson, J. C., Physical Meteorology, John Wiley and Sons, New York (1954), pp. 147-175.

8. Halstead, M. H., Forecasting Micrometeorlogical Variables, Final Report, Air Force Cambridge Research Center Report TR-57-275 (1957).

9. Taylor, R. J., "Similarity Theory in the Relation Between Fluxes and Gradients in the Lower Atmosphere," Quarterly Journal, Royal Meteorological Society, 86 (1960).

10. Deacon, E. L. "Vertical Diffusion in the Lowest Layers of the Atmosphere," Quarterly Journal, Royal Meteorological Society, 75 (1949).

11. Letau, H., "Note on the Structure of the Atmospheric Surface Layer," Journal of Meteorology, 13 (1956), pp. 507-508.

Aug. 24, 1994

Lee Davidson
Deseret News Washington Bureau Chief
13222 Trimfield Lane
Germantown, MD 20874-1148

Commander
Dugway Proving Ground
Dugway, Utah 84022

Dear sir,

Pursuant to the Freedom of Information Act, 5 U.S.C. 552, I request access to and a copy of the following document (listed exactly as it appears in an Energy Department bibliography), which deals with some testing that occurred at Dugway:

Aircraft Nuclear Propulsion, 1960. "Fission products field release test II.'' Nuclear Aircraft Research Facility. Convair-Forth Worth. ANP document No. NARF-59-32T F2K-9-140, Report AFSWC TR-60-26. Albuquerque, N.M.: Air Force Special Weapons Center.

That volume deals with 11 experiments at Dugway that simulated a nuclear reactor meltdown by melting nuclear fuel rods in a furnace. The tests were part of efforts to help design nuclear-powered aircraft. I am also seeking it through the Air Force and DOE, but figured your large technical library may have a copy.

I agree to pay reasonable duplication fees, but please notify me prior to incurring any expenses. As a news media reporter, I am required under the FOIA only to pay for the direct cost of duplication after the first 100 pages.

Also please waive any applicable fees because release of this information is in the public interest, and is being gathered for public dissemination by the Deseret News of Salt Lake City.

If my request is denied in whole or part, I ask you to justify all deletions by reference to specific exemptions of the act. I will also expect you to release all segregable portions of otherwise exempt material. I reserve the right to appeal your decision to withhold any information or to deny a fee waiver.

If questions arise, my phone numbers are: work, 202-737-5311; home, 301-540-8720; and fax, 202-737-5312. I look forward to your reply within 10 business days, as the law requires.

Sincerely,

Lee Davidson

Lee Davidson
Desert News Washington Bureau chief

August 30, 1994

Office of the Command Judge Advocate

Lee Davidson
Deseret News Washington Bureau Chief
13222 Trimfield Land
Germantown, MD 20874-1148

Dear Mr. Davidson:

This is to confirm the telephone conversation between you and Elaine Stangler, this date, regards your Freedom of Information Act request dated August 24, 1994 wherein you asked for a copy of: Aircraft Nuclear Propulsion, 1960. "Fission products field release test II." Nuclear Aircraft Research Facility. Conviar-Fort Worth. ANP document No. NARF-59-32T F2K-9-140, Report AFSWC TR-69-26. Albuquerque, N.M.: Air Force Special Weapons Center.

You were told that we have found a document responsive to your request. However, it is an Air Force document and we do not have authority to release it. The document and your request is being forwarded to 11 MSS/MSIS (FOIA), 1000 Air Force Pentagon, Washington DC 20330-1000. They will respond directly to you.

The document is unclassified and contains 387 pages. You agreed to pay reproduction charges, minus the first 100 pages or $43.00. Please make your check payable to the Treasurer of the United States and submit it to our office.

Respectfully,

Bruce C. Evans
Major, U.S. Army Judge
Advocate General's Corps
Command Judge Advocate

STEDP-JA 30 August 1994

MEMORANDUM FOR 11MSS/MSIS, (FOIA), 1000 Air Force Pentagon, Washington, D.C. 30330-1000

SUBJECT: FOIA Request, Lee Davidson, Deseret News, 24 Aug 94

1. The enclosed document, Fission Products Field Release Test II, by HQ Air Force Special Weapons Center, Sep 60, is a document we found responsive to subject FOIA request.

2. Pursuant to the telephone conversation this date, between Carolyn Price, your office and Elaine Stangler, DPG the document and request are being forward for your action.

3. A copy of our reply to the requester is also enclosed. You will note that he has agreed to pay reproduction charges in the category of news media. He was asked to make check payable to Treasurer of the United States and submit it to our office.

Encl
as

BRUCE C. EVANS
MAJ, JA
Command Judge Advocate

STEDP-JA 31 August 1994

MEMORANDUM FOR DOL-T

SUBJECT: Federal Express Document

1. Request the enclosed documents be Federal Expressed to the following address:

11MSS/MSIS
(FOIA)
1000 AIR FORCE PENTAGON
WASHINGTON DC 20330-1000

2. Our cost center and XO are:

Elaine Stangler
Paralegal

October 13, 1994

Office of the Commander

Honorable Orrin Hatch
United States Senator
8402 Federal Building
Salt Lake City, Utah 84138

Dear Senator Hatch:

Please find enclosed documents concerning radiation testing performed by the U.S. Air Force and the Atomic Energy Commission at Dugway during the 1950s. These documents were referred to in several articles recently published by Mr. Lee Davidson, a writer for the ***Deseret News***, and obtained by Mr. Davidson under the Freedom of Information Act (FOIA).

We located these documents in a response to a FOIA request. Since these were Air Force documents, we initiated a request to them for release authority. We were also preparing a request for release authority from the Radiation Emergency Communication Center (RECC) when we learned that Mr. Davidson had published his articles. The authorization to release this kind of information takes a considerable amount of time. It is unclear who gave Mr. Davidson the documents and granted authorization for their release.

My staff and I continue our willingness to provide any information available to us that may be of benefit to the public. I regret that I did not have the authority to release this information sooner. Please distribute to any agency you feel has a need to see this testing documentation.

If you have any questions about this information, please feel free to contact my Public Affairs Officer, Mrs. Melynda Petrie at 831-2116 or the Command Judge Advocate, Major Bruce Evans at 831-3333.

Sincerely,

Eugene A. Fuzy
Colonel, U.S. Army
Commanding

Enclosures

October 13, 1994

Office of the Commander

Dr. Suzanne Winters
State Science Advisor
Office of Planning and Budget
1116 State Capitol Building
Salt Lake City, Utah 84114

Dear Dr. Winters:

Please find enclosed documents concerning radiation testing performed by the U.S. Air Force and the Atomic Energy Commission at Dugway during the 1950s. These documents were referred to in several articles recently published by Mr. Lee Davidson, a writer for the ***Deseret News***, and obtained by Mr. Davidson under the Freedom of Information Act (FOIA).

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Because of your interest in radiation testing at Dugway, my staff and I continue our willingness to provide you with any information available to us that may be of benefit to the public. I regret that I did not have the authority to release this information sooner. Please distribute to any agency you feel has a need to see this testing documentation.

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Sincerely,

Eugene A. Fuzy
Colonel, U.S. Army
Commanding

Enclosures

October 13, 1994

Office of the Commander

Honorable Karen Shepherd
House of Representatives
414 Cannon House Office Building
Washington, D. C. 20515-4401

Dear Representative Shepherd:

Please find enclosed documents concerning radiation testing performed by the U.S. Air Force and the Atomic Energy Commission at Dugway during the 1950s. These documents were referred to in several articles recently published by Mr. Lee Davidson, a writer for the ***Deseret News***, and obtained by Mr. Davidson under the Freedom of Information Act (FOIA).

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Sincerely,

Eugene A. Fuzy
Colonel, U.S. Army
Commanding

Enclosures

October 13, 1994

Office of the Commander

Honorable Robert Bennett
United States Senator
4225 Federal Building
Salt Lake City, Utah 84138

Dear Senator Bennett:

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Sincerely,

Eugene A. Fuzy
Colonel, U.S. Army
Commanding

Enclosures

October 13, 1994

Office of the Commander

Honorable Michael O. Leavitt
Governor of Utah
210 State Capitol Building
Salt Lake City, Utah 84114

Dear Governor Leavitt:

Please find enclosed documents concerning radiation testing performed by the U.S. Air Force and the Atomic Energy Commission at Dugway during the 1950s. These documents were referred to in several articles recently published by Mr. Lee Davidson, a writer for the ***Deseret News***, and obtained by Mr. Davidson under the Freedom of Information Act (FOIA).

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Commanding

Enclosures