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OPERATION RANGER

Nevada Test Site, Jan. - Feb. 1951

Volume 5

PROGRAM REPORTS—OPERATIONAL

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Wright Air Development Center, Wright-Patterson Air Force Base, Dayton, Ohio	135 – 138
Commanding General, Air Force Cambridge Research Center, 230 Albany St., Cambridge 39, Mass.	139 – 140
Commanding General, Armed Forces Special Weapons Project, PO Box 2610 Washington 25, D. C.	141 – 149
Asst. for Development Planning, Headquarters USAF, Washington 25, D. C.	150
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Commanding Officer, Test Command, Armed Forces Special Weapons Project, PO Box 5600, Albuquerque, N. Mex.	154 – 156
Weapon Test Reports Group, TIS	157
Surplus in TISOR for DMA	158 – 200

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1. Ranger Air Observations
   By Gaelen Felt
2. Weather Support for Operation Ranger
   By Demetrius H. Russell
3. Effects of Atomic Blasts on Wildlife at the Nevada Test Site
   By O. V. Deming and Louis D. Hatch
4. Report of Rad-Safe Group
   By T. L. Shipman

Volume 6
ADMINISTRATIVE SUMMARY REPORT
By Carroll L. Tyler

Volume 7
INDEX

* * * * *

SUPPLEMENTARY LIST OF RANGER REPORTS

The following reports pertain to long-range blast effects resulting from Operation Ranger tests. Since these reports are not included in the Ranger

[redacted]

volumes, they are cited here for general information and interest.

"Continuous Radioactivity Monitoring of the Atmosphere at the Atomic Energy Project, University of California at Los Angeles; Part I: The Period after the Nevada Tests." L. Baurmash, W. R. Kennedy, G. Streit. UCLA-145. July 20, 1951. (Official Use Only)

"Fall-out in Southeastern United States during January and February 1951 from the Nevada Atomic Tests." F. J. Davis. ORNL-1081. Nov. 27, 1951. (Official Use Only)

"Survey of Fall-out of Radioactive Material following the Las Vegas, Nevada, Test Explosions." NYO-LA-1. Feb. 27, 1951. (Official Use Only)

"Evaluation of the Effects of Atomic Bomb Detonations in the State of Nevada on Air-borne Contamination at Knolls Atomic Power Laboratory, Knolls Site and Environs." L. J. Cherubin. KAPL-559. May 7, 1951. (Secret)

"Observations on Fall-out from the Nevada Tests; January 27 to February 6, 1951." M. M. Weiss and J. B. H. Kuper. Brookhaven National Laboratory. TID-5027. (Official Use Only)

[redacted]

CONTENTS

Page

Report 1
RANGER AIR OBSERVATIONS 11
By Gaelen Felt

Report 2
WEATHER SUPPORT FOR OPERATION RANGER 15
By Demetrius H. Russell

Report 3
EFFECTS OF ATOMIC BLASTS ON WILDLIFE AT NEVADA TEST SITE 50
By Oscar V. Deming and Louis D. Hatch

Report 4
REPORT OF RAD-SAFE GROUP. 54
By Thomas L. Shipman, M. D.

[redacted]

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REPORT 1*

RANGER AIR OBSERVATIONS

Gaelen Felt
Los Alamos Scientific Laboratory, Los Alamos, N. Mex.

1.1 INTRODUCTION

This report deals with qualitative physiological observations and a few crude quantitative measurements made from two B-50D's, Bullpup and Reindeer. The true quantitative measurements made from Bullpup are the subiect of a separate report ("Summary of Test Results," by Frederick Reines, this volume, Part II).

Prior to the beginning of Operation Ranger, the flight crews of both Special Weapons Command (SWC) and Strategic Air Command (SAC) airplanes were informed of the general characteristics of atomic weapons, particularly those features which distinguished the weapons either in character or degree from the more common explosives with which the crews were familiar. The crews were asked to look for such things as the purple ion glow, the separation of fusion of shock waves, and the negative phase and to estimate the circular error, the time required for the cloud to reach bombing altitude, and the maximum height attained by the cloud. In addition, before each mission a few members of each crew were given stop watches and were asked to measure time of fall, shock arrival time, and the interval separating the shocks.

On all shots the track was between 270 and 283°. Bombing altitude on all shots except shot F was 19,700 ft above the target (radar altimeter determination); on shot F the altitude was 29,500 ft.

1.2 GENERAL CHARACTERISTICS

All five live drops resulted in explosions which were very obviously nuclear, although the characteristic features were more pronounced for the explosions with high yields than for those with low yields.

Members of the crew who looked directly at the bomb through dark goggles agreed that all flashes from the bombs were more luminous than the sun as seen from the earth. The flashes from shots A and E, viewed without goggles, looked very much like the flash from the HE drop. Flashes from shots B_1 and B_2 were much brighter, and from shot F the flash was of such high luminosity that when observed through goggles the entire Nevada Test Site appeared a bright orange.

The men in the planes who did not look directly at the bomb did not wear goggles. To them the inside of the airplane at the time of the first flash appeared almost as light as in the daytime. No optical difficulty was encountered in reading instruments by any of the men who did not look directly at the bomb. One man aboard the SAC airplane looked directly at the flash from shot F with one eye covered. He suffered no loss of vision in the covered eye but was completely blinded in the other for about 15 sec. After ½ min he had regained sufficient vision in the exposed eye to read flight instruments.

*Dated Feb. 24, 1951.

Thermal radiation from shots B_1, B_2, and F was pronounced. The heat from shot B_1 was unexpectedly strong, and many of the observers instinctively ducked away from the scanners' windows, but the heat from shots A and E was so slight at bombing altitude that it was observed on shot A only and by just one man.

Early fireball characteristics could not, of course, be observed, but after about 2 sec the shock wave was clearly visible. The shock wave could be seen until it reached a radius of approximately 10,000 ft. At that time the fireball had faded to a reddish orange hue, and the violet glow had begun to appear. Also, the rising ball of fire had begun to look more like a doughnut. The center regions appeared to rise faster and to spill out over the sides.

Except in the case of shot F, the orange glow had changed to violet by the time the shock wave reached bombing altitude. The persistence of the violet glow seemed qualitatively related to the yield, although atmospheric conditions prevented any measurable correlation. The cloud from shot F retained a distinctly violet tinge until it reached bombing altitude.

The clouds from shots B_1 and F had a more familiar appearance than the clouds from the other three bombs. The cloud from shot B_2 was apparently fairly well sheared by the time it reached 20,000 ft, and the clouds from shots A and E could not be followed visually to bombing altitude. The cloud from shot B_1 was the most impressive since this cloud rose well above the ground haze. The mushroom top and a good portion of the stem were visible. The cloud from shot F, although it appeared to go higher, was obscured except for the very top by thin cirrus clouds. The top of this cloud was still discernible from a position south of Flagstaff, Ariz.

1.3 ROUGH MEASUREMENTS

Measurements were made of the time of fall, shock arrival time, shock separation time, and the time required for the cloud to reach bombing altitude. These measurements were made with stop watches and, for cloud rise, with wrist watches. Better measurements were obtained from the photographs of ground zero taken with standard K-24 aerial cameras and the photographs of the radar panorama (B-scope) taken from the bombing position.

The stop-watch measurements of time of fall agree within 0.2 sec with the more accurate measurements made on the ground. These measurements are listed in Table 1.1 for comparison. Clearly, any pronounced deviation from the ballistic table predictions can be detected by a stop watch even though the watch is started from an indefinite signal such as the lurch of the airplane produced by the bomb leaving the bay.

The measurements of shock arrival time and of shock separation are much less informative. Differences in time of arrival of the first shock from all nuclear shots except shot F are of no significance for three reasons:

1. Shock arrival time at large distances is not a very sensitive function of yield.
2. The geometrical range to the point of burst was not constant or accurately known.
3. The shock or acoustic path was affected by uncertain wind conditions and unknown temperature distributions.

The mean arrival time of the first shock at the SWC airplane for all shots except shot F was 18.1 sec from detonation, with a measured range from 17.6 to 18.8 sec. It is likely that these times would have been more reliable if each of the four measurements had been made by the same person, but it is still doubtful, for the reasons given above, whether any significance could be assigned to the differences.

The significance of the interval between first and second shocks is also uncertain. In most cases the separate arrival times of the shocks were measured rather than the interval itself, and then not accurately. Furthermore, the SAC crew felt three shocks on shot B_1, as did the SWC crew on shot F. The third shock was weak in both cases, but it was nonetheless definite. One would expect two shocks of roughly equal strength, separated roughly by the interval observed (approximately 1.5 sec) if the incident and reflected shocks from a 1000-ft burst were not fused, but one cannot easily explain three shocks. On the other hand, the occurrence of closely spaced multiple shocks at the control point is equally puzzling.

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For completeness, the time of arrival of the first shock from shot F was 27.5 sec, and the separation time of the first and second shocks was 3.0 sec. The great difference between these values and for the other four shots is explained, of course, by the 30,000-ft release altitude and the greater height of burst.

The shock strength in every case was regarded by the air crews as mild. They were somewhat more concerned about the interval between shocks than about the strength of the shocks. Their feeling was that a pair of moderate shocks properly spaced might correspond to a natural resonant frequency of the aircraft structure and would therefore be more damaging than a fused shock of double strength.

A definite negative phase was not identified. Any negative phase would be difficult to detect without instruments since the normal settling of the airplane after the positive shock obscures such an effect.

The time required for the cloud to reach bombing altitude was measured successfully on shot B_1 alone. It required 3¼ min for this cloud to reach the altitude of the SAC airplane, 27,600 ft above sea level and 23,400 ft above the burst. The clouds from shots A and E were not observed at altitude. Cloud-rise measurements on shots B_2 and F were poor.

Aerial photographs and radarscope photographs were taken to determine whether radar alone would be sufficient to locate the position of a tactical burst. The Ranger results indicate that the method is not promising. The radar "looked" at a rather large area, several hundred square miles, whereas the area of interest was quite small. No indication of the presence of the bomb was found on any of the scope photographs. The K-camera photographs were, on the other hand, excellent. These photographs showed features of the nuclear explosions that were not observable from the ground and also showed enough terrain features to have made possible a location of actual ground zero should the ground cameras have failed.

1.4 ROUGH ESTIMATES

It proved possible to make rough estimates from the airplanes of the location of the burst and of the yield. Properly speaking, the relative yield, rather than the yield itself, was estimated. Actual values were based on the measured yields of shots A and B_1.

The technique of estimating yields is based on a consideration of the phenomena discussed in Secs. 1.1 and 1.3. Almost all these characteristics are yield-dependent in some way. In particular, the initial brightness, the lapse of time before fading of the fireball, the size and early rate of rise of the cloud, the persistence of the ion glow, and the shock strength are good yield-determination factors. Admittedly, a good estimate depends on frequent observations and on a knowledge of how the external characteristics of nuclear explosions vary with distance.

The physiological Bhangmeter readings on shots E, B_2, and F are given in Table 1.2 with the measured relative-yield values. Members of both crews agreed that the yield from shot B_2 was slightly smaller than the yield from shot B_1. The estimate for shot F was complicated by the fact that the release altitude was different. This change necessitated a major adjustment in calibration of the thermal-radiation and shock-strength detectors. The other indications of yield were less strongly affected.

Estimates of ground zero consisted of two parts: estimates of the circular error and estimates of the bearing from the aiming point. In regard to circular error, it can only be said that in every case the crews correctly estimated the error to be less than 500 ft.

Since, even in those cases in which the target array was not turned off a few seconds after release, it was impossible to see the lights through the dark goggles, the estimate of ground zero could not be accurate. Nevertheless, by carefully watching the target on the dummy runs and by noting its position with respect to Frenchman Lake and the roads running toward the blockhouse, one could retain a fairly accurate impression of its position. In the first flash, one could generally see well enough to estimate the error and the bearing. About 2 min later it was possible to make a second and rougher estimate from the position of the stem of the cloud.

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Three of the five drops were so close to the aiming point that no agreement could be reached in regard to the bearing. On shots B_2 and F the bursts were correctly estimated to be in the southwest quadrant.

Table 1.1—Time-of-fall Measurements

Shot	Stop-watch measurement, sec	Ground measurement, sec
HE	35.3	35.25
A	35.3	35.36
B_1	35.4	35.35
E	35.4	35.27
B_2	35.4	35.40
F	45.0	44.86

Table 1.2—Relative Yields on Shots E, B_2, and F

Shot	Estimated relative yield	Measured relative yield
E	1	1.0
B_2	7	6.5
F	25	22

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REPORT 2*

WEATHER SUPPORT FOR OPERATION RANGER

Maj. Demetrius H. Russell, USAF

Headquarters, 2059th Air Weather Wing,
Tinker Air Force Base, Okla.

ABSTRACT

This report describes the operation of the USAF Air Weather Service unit which supported Operation Ranger of the Atomic Energy Commission in the vicinity of Las Vegas, Nev., during the period Jan. 22 to Feb. 6, 1951. Records of weather forecasts, both verbal and coded, appear as appendixes to this report.

2.1 ORGANIZATION AND PERSONNEL

The organization for weather support is indicated in Fig. 2.1. The Beatty, Nev., rawinsonde section and the observing section at the target command post were in place three weeks prior to the establishment of the analysis section at Nellis AFB, Nev., on January 22. The pilot-balloon sections at Tonopah and Indian Springs and the rawinsonde section at Nellis AFB were brought into the project as rapidly as possible after their requirements were determined. Similarly, the personnel of the weather analysis section at Nellis was more than doubled (from its initial state determined in preliminary planning) as the operational requirements became fully known or were expanded.

The channel for weather information indicating the particular agency using the data disseminated from the analysis section is shown in Fig. 2.2.

The two roving pibal teams located at Caliente, Nev., and Cedar City, Utah, were placed under the operational control of the Rad-Safe group of the Los Alamos Scientific Laboratory. Rad-Safe personnel controlled these teams, determining the number of runs each should make.

2.2 OPERATIONS

2.2.1 Weather-analysis Section.

Prior to the establishment of the weather-support operating procedure, it was necessary to confer with J. C. Clark (in charge of operations at the test range) to explain the time schedule for weather reports and the earliest times at which a complete daily forecast could be made. It was then decided to prepare at 2000P daily a comprehensive briefing of the forecast for each morning at 0600P. Based on the time of the observations, these were essentially 24- and 48-hr forecasts issued approximately 12 and 36 hr prior to shot time. Data based on the 1500Z (0700P) upper-air soundings would begin to arrive at the analysis section via teletype

*Dated Mar. 1, 1951.

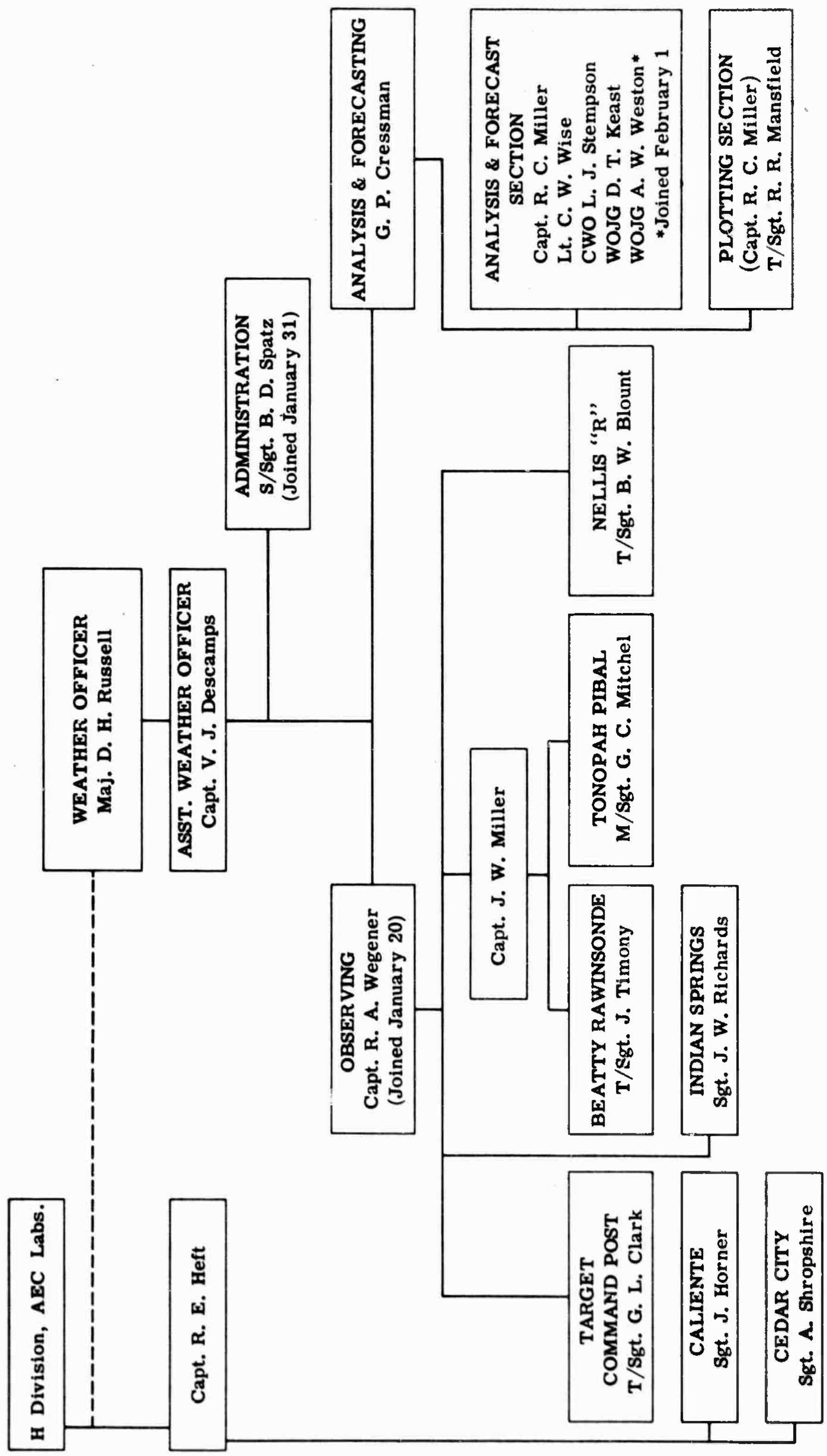

Fig. 2.1—Organization for weather support in Operation Ranger.

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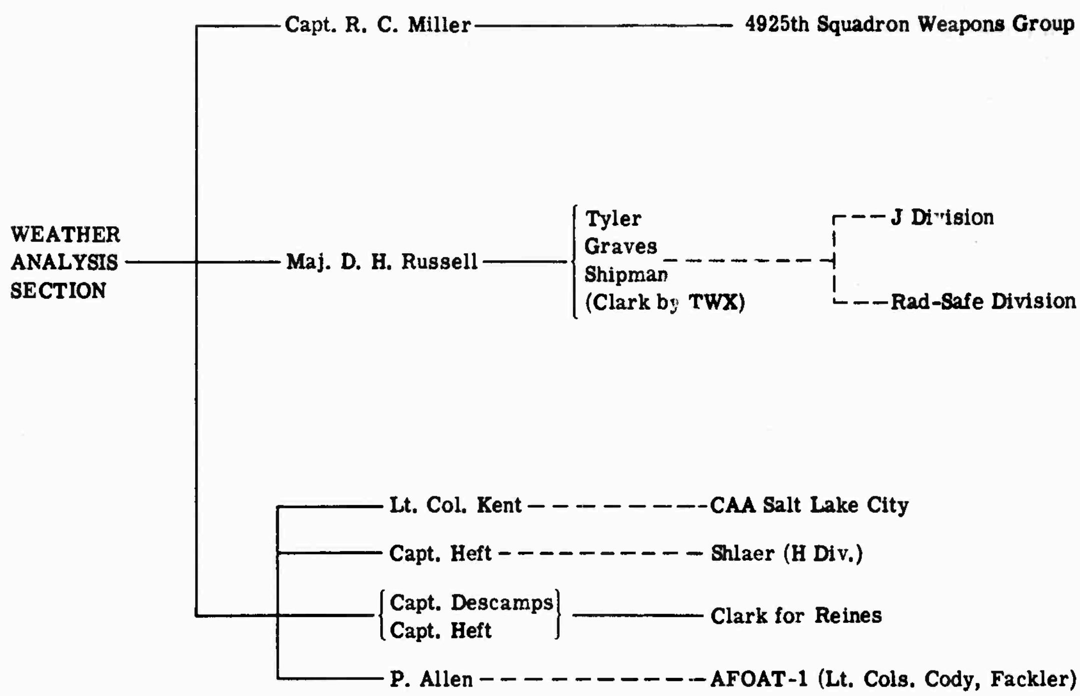

Fig. 2.2—Channel for weather information. Dotted lines indicate that the pure meteorological data have been developed to fit the needs of personnel using the data.

at 0915P, and the final, second transmission would begin at 1315P. The 1030P surface map was drawn for use with the 1500Z upper-air maps, resulting in a daily maximum analysis and forecasting effort beginning at approximately 1100P and continuing until the forecast was completed at 1930 to 2000P. This forecast was used for the 2000P general briefing. To maintain a check on the forecast briefing at 2000P, sectional surface maps were analyzed every 3 hr, or more often as the situation warranted. Cloud-cover maps were used during critical periods immediately prior to shot time. The charts analyzed are as follows:

1. Schedule of required analyses:

1500Z	700-, 500-, and 300-mb charts; isotachs for 700, 500, and 300 mb; thickness charts for surface (1000) to 700, 700 to 500, and 500 to 300.
1830Z	Complete surface synoptic chart for ZI and all Pacific and Alaskan data available.
2130Z	Surface sectional chart, Pacific Coast to 95°W.
0030Z	Surface sectional chart, Pacific Coast to 95°W.
0300Z	700- and 500-mb charts.
0330Z	700- and 500-mb charts, Pacific Coast to 95°W.
0630Z	Complete surface synoptic chart for ZI and all Pacific and Alaskan data available.
0930Z	Surface sectional chart, Pacific Coast to 95°W.
1230Z	Surface sectional chart, Pacific Coast to 95°W.
1530Z	Surface sectional chart, Pacific Coast to 95°W.

2. Prognostic charts prepared once daily, based on the 1500Z upper-air data and the 1830Z surface data, were for 24 and 48 hr (from time of data) for surface (1000 mb) and 700, 500, and 300 mb.

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3. The following auxiliary charts were prepared on a regular basis: (1) adiabatic charts for Beatty, Las Vegas, and Ely; (2) hodographs for ships Nan and Uncle and for Beatty, Nellis, Tonopah, Indian Springs, target command post, and Las Vegas; (3) surface temperature and pressure graphs for target command post, Nellis, and Las Vegas; and (4) chart of forecast lapse rate for target area. (Streamlines were drawn upon the facsimile winds-aloft charts.)

4. Snow-cover charts and local cloud-cover charts were drawn as necessary.

In addition to the general weather and winds over the target area at shot time (used as 0600P for meteorological purposes) forecasts of winds, pressures, temperatures, and clouds were prepared for the Special Weapons Group. The schedule of operations of the weather-analysis section is given in Table 2.1, which lists the times the forecasts were to be ready, a summary of the data to be contained in each forecast, and the agency requiring the forecast. A record of all forecasts issued, including the names of the individuals preparing the forecasts, is presented in Appendix A.

Table 2.1—Schedule of Weather Operations

Time of forecast	Forecast data	Purpose
1945P	For shot time. Clouds below bombing altitude; winds, each 2000 ft; precipitation downwind or in general area for H + 6; trajectories forecast, H + 24, 700, 500, and 300 mb	Used by Russell in general briefing at 2000P [one copy of forecast passed to Clark at target control point; Allen used trajectories for AFOAT-1 (Cody, Fackler, etc.)]
1945P	(Capt. Heft prepared fall-out pattern for use by Shlaer, H Division)	
2300P	For shot time. Altimeter setting, surface temp., general weather, strike airplane route weather at operational levels	Phoned by Capt. R. C. Miller to Capt. E. Miller, 4925th at target control point
0230P	For shot time. Surface temp.; altimeter setting; surface wind and relative humidity; 10,000-ft wind; bombing altitude wind, temp., and relative humidity	Phoned by Capt. R. C. Miller to Capt. E. Miller, 4925th at target control point
0245P	(Same as 1945P requirement. Target weather was checked, and 0100 winds from periphery stations were used to check forecast)	Used by Russell in 0300 check briefing for Tyler and Graves
0400P	(Forecast trajectories corrected by 0100 winds)	(Allen delivered to AFOAT-1. See 1945P)
0500P	[Phoned latest (0400P) winds to Russell at AEC command post]	For continuing briefing of Tyler and Graves as necessary
1245P	General outlook (as determined by incoming data after spot analysis)	Used by Russell at 1300 briefing for general planning of operations for next morning
	Computations	
H + 7 hr	Temperature, pressure, density, and humidity at target surface and burst altitude	

[redacted]

2.2.2 Briefing

The first briefing occurred at 2000P, January 24. At this general briefing, attended by the heads of all the staffs of the laboratories and the supporting agencies, it was agreed that additional briefings for C. L. Tyler, Test Director, and A. Graves, head of J Division (Operations), would be held at 1300P daily and also at 0300P on shot days. The 1300P briefing would be for the purpose of planning the over-all operation for a shot the following morning. The 0300P briefing would be a final check briefing before shot time. Neither of these two briefings would minimize the importance of the daily general briefing at 2000P which would continue to be the maximum forecast effort in accordance with our established policy.

The first part of each briefing was conducted by the weather officer. (This procedure was not followed on two post-shot occasions when T. L. Shipman, in charge of Rad-Safe, preceded the weather briefing.) The weather-briefing procedure was kept flexible throughout the operation. As a rule, the forecast itself was presented first. Then certain aids were employed to illustrate better the anticipated results of the weather on the shot. (The briefings were conducted in the AEC command post at Nellis, approximately 3/8 mile from the weather-analysis section.) The illustrations ending the weather portion of the briefing blended with the advisory board's discussion which followed the weather briefing.

The minimum number of briefing aids used was a single wind profile of upper winds from five stations plus the forecast wind. This was used during one 0300P check briefing, which confirmed the weather given at the previous 2000P briefing. The maximum number of aids used included the most recent surface and 700- (or 500-) mb charts; 24- and 48-hr prognostic charts for the surface, 700, 500, and 300 mb; a wind profile including the forecast winds; a proposed trajectory for 10,000, 20,000, and 30,000 ft msl, including 12-, 24-, 36-, and 48-hr positions; and a simplified adiabatic diagram indicating forecast lapse rate and cloud levels.

Time consumed during weather briefings ranged from as little as 2 min (at "no-change" check briefings) to as much as 15 to 20 min during a 2000P general briefing.

2.2.3 Periphery Observing Stations

The 2060th Mobile Weather Squadron furnished stations at Beatty, Tonopah, and Indian Springs; the rawinsonde section at Nellis; and the station at the target command post. The U. S. Weather Bureau stations at Ely and Las Vegas increased the number of raobs and pibals from two to four per day.

The schedule of operation of these rawinsonde, radiosonde, and pilot-balloon reporting stations is given in Table 2.2. During periods between shots, the required number of observations from these stations was reduced in order that personnel and equipment might better withstand the periods of maximum effort.

(a) Beatty. The Beatty rawinsonde section was the largest of the outlying observing stations. It departed from Tinker Air Force Base, Okla., Dec. 26, 1950, one officer and 13 airmen traveling in a convoy composed of one K-6 van, two 6X6 cargo carriers, and three pickup trucks. The convoy arrived at Beatty the afternoon of December 30, arranged for temporary quarters over the New Year's week end, and secured regular housing on January 2.

A survey revealed the Beatty airstrip to be unsuitable for rawinsonde section operation because of excessive angles to the horizon. After surveying sites in the Amargosa Desert and Sarcobatus Flat, a site was chosen 4½ miles northeast of Beatty on the east side of highway 95. The SCR-658 was placed on a knoll approximately 15 ft above the surrounding terrain. The K-6 van and associated equipment were placed on the lee (south) side of the knoll. The installation was accomplished during a sandstorm with wind speed reaching 40 knots. With the exception of final calibration, installation was completed by nightfall on December 31.

On January 1, final adjustments were made, and the receptor AN/FMQ-1 was calibrated. A successful initial rawinsonde observation was made without difficulty; the SCR-658 was functioning properly as indicated by comparison of rawin and rabal data. Initial orientation was made by solar observation; later checks were made with reference to Polaris and to a bench mark established by the Geodetic Survey. The initial elevation established by reference to a contour map was later verified by a Geodetic Survey team flown up from Nellis Air Force Base by the station weather officer at Nellis.

[redacted]

Table 2.2 — Time Schedule for Telephoned Weather Reports

Reporting station	Type of report	Daily report scheduled (PST)	Additional D day reports scheduled (PST)	Reports due at weather station (PST)	Distribution	Copies
Indian Springs	Pibal	0100, 0700, 1300, 1800	0400, shot time, 1000	As soon as possible or 1 hr after observation	Proj. analyst (AFOAT received 0700–1900 pibals)	2
Tonopah	Pibal	0100, 0700, 1300, 1800	0400, 1000	2 hr after observation	Proj. analyst (AFOAT received 0700–1900 pibals)	2
Beatty	Rawinsonde	0000, 0700, 1300, 1800	Winds at 0400, 1000	3 hr after observation	Proj. analyst, teletype operator	2
Target command post	Pibal	0100	0400, 0800	1 hr after observation	Proj. analyst	1
Target command post	Surface observation	1900–0700	1900–1000		Proj. analyst	1
Caliente	Pibal	None	0800, 1000	As soon as possible	Capt. Heft	1
Cedar City	Pibal	None	1100	As soon as possible	Capt. Heft	1
Nellis AFB	Rabal or rawin	0700, 1300, 1630, 2330	1000, 0400	2½ hr after observation	Proj. analyst, teletype operator	2
McCarran	Rawinsonde	0100, 1300 (0700 and 1900 on teletype)	None	0400, 1600	Proj. analyst	1
Ely	Rawinsonde, pibal	0100, 1900 (0700 and 1900 on teletype)	1000 (pibal only)	0400, 1600	Proj. analyst	1
Muroc	Rawin	2300	None	0100	Proj. analyst	1

A schedule of four observations per day was established at 0330Z, January 2. Two scheduled observations were missed (January 4 and 12) because of signal failure either during the base line check or immediately after release. The difficulty was due to an improper battery-charging procedure. An SOP for battery charging was prepared and rigidly enforced. No other runs were missed during the project.

Since commercial hydrogen was not initially available, ML-185B generators were used until 30 tanks of hydrogen were received from the AEC on January 8; 250 additional tanks were received on January 12. (Some of these additional tanks were supplied to the Tonopah and Indian Springs pibal sections which were established later.) Numerous supply items were provided by the 2060th Mobile Weather Squadron or Nellis Air Force Base with a minimum of delay.

On January 25, the first of a series of maximum efforts was made without difficulty. All subsequent maximum efforts were met satisfactorily. In order to meet time deadlines, ML-391A balloons were used for daylight and nighttime observations, with total inflation weights in excess of 4000 g. Ascension rates of 450 to 490 m per minute were attained. Even with this excessive amount of hydrogen, most balloon bursts occurred above the 100-mb level (53,000 ft). Comparable results could not be obtained with ML-131 balloons during periods between maximum efforts.

The only major breakdown of equipment occurred on February 5. The PE-95 generator did not maintain a steady flow of current. A PE-75W was used to supplement the PE-95 for one observation. At 0001P, February 6, the PE-95 was completely inoperative; a questionable observation was made using the two reserve PE-75W's available. The power from these two units was not steady enough to obtain reliable data. A "pickled" PE-95 was obtained through the base weather station at Nellis at 2200P, February 5, and was in operation at Beatty by 0400P, February 6.

At 1600P, February 6, preliminary steps were taken for packing equipment. Orders for roll-up were received at 2000P, and by 2330P all packing was completed. Final loading and policing were completed by 0900P, February 7.

(b) Indian Springs. The Indian Springs pibal unit was established January 25 in order to provide an additional source of wind data and to reduce the work load of the two airmen at the target-command-post weather station. The command-post requirements of surface observations, pibals, and additional classified duties coupled with the handicap of dining and sleeping some 30 miles from the operating location were more than two observers could meet properly. Since no other Q-cleared personnel were available, establishment of the Indian Springs pibal unit permitted a reduction of the number of pibals to be taken at the command post.

(c) Tonopah. The Tonopah pibal section, which began operation on January 25, appeared to be the least representative meteorologically of the observing stations. The 0400P pibal message on February 6 is at such great variance with other reports that it appears likely to be in error. Copies of the coded upper winds and radiosonde messages received from the periphery stations plus the extra messages filed by the U. S. Weather Bureau stations at Las Vegas (LAS) and Ely, Nev., are contained in Appendix B.

Surface observations taken at the target command post and at other periphery stations were filed at the weather detachment at Los Alamos (see Sec. 2.5).

2.2.4 Short-range Weather Reconnaissance

The possibilities of having a weather-reconnaissance aircraft whose prime mission would be to support the weather-analysis section were first mentioned at Andrews AFB on January 15. The suggestion to coordinate this requirement with the reconnaissance unit supporting another phase of the project did not bear fruit. Consequently, arrangements were made through the Nellis AFB weather officer to obtain special reconnaissance of weather (clouds in particular) over the target area during the hours immediately preceding shot time.

The first such "pay-off" mission was flown in a C-47; later it became necessary to employ a T-33 because of the altitudes involved. Attempts were made to obtain a regular pilot report on clouds in the target area daily at 0330, 1230, and 1530P when the situation warranted.

[redacted]

This arrangement was fairly satisfactory, but it required much time and effort. This could have been avoided if such procedure had been authorized and coordinated previously.

2.3 WEATHER COMMUNICATIONS

Facilities of the Nellis AFB weather station used were teletype circuits AF 9894 and CAA A-8009 and facsimile circuit 10201. In addition, a leased teletype circuit, Western Union C-35, was installed for the project. Emergency action was taken to connect this circuit through the K-6 push-key cabinet of the base weather station in order to effect a stand-by teletype machine.

The need for Pacific reports available on Western Union teletype circuit 0-8274 was partially filled through daily telephone calls to the base weather station at March AFB, Riverside, Calif. This telephone relay was a satisfactory stop-gap method of obtaining Pacific island and ship reports necessary in view of the extended forecasts desired by AEC officials. (Although the 48-hr forecasts were the most extended record forecasts, the requirement for three-day-plus outlooks was answered verbally at general briefings.)

Relay of special reconnaissance and pilot reports was accomplished via radio contact to the Nellis control tower and thence by interphone "squawk-box" to the base weather station for relay to the weather-analysis unit. On shot days the weather officer remained at the AEC command post at Nellis from the 0300P briefing through shot time. From 0330P through shot time, the AFOAT-1 radio station provided periodic pireps, on request, through project aircraft circling over the target area.

There were three telephones in the weather-analysis section connected through the AEC switchboard at Nellis. During periods of maximum effort by the periphery observing stations, these three lines were busy simultaneously. A fourth line into the base weather station through the Nellis base exchange was also used. All reports from Beatty and Tonopah and two daily reports from the U. S. Weather Bureau at Ely were telephoned collect. These reports were telephoned on a pseudo schedule, i.e., as soon as possible after scheduled release time. The communications to these three locations were not completely satisfactory since difficulty was often experienced in contacting them at other than "scheduled" times. For example, reticence existed in contacting Beatty at, for instance, 0300P on shot day to ask for a special observation. Beatty was on a party-line connection, and security considerations perhaps outweighed the operational weather requirement.

The stations at Indian Springs and the target command post used AEC lines through an AEC switchboard at Indian Springs and an AEC trunk line to Nellis.

Plans to operate the periphery observing stations on full schedule through 0700P, February 7 (final H plus 24 hr), were discarded when the AEC telephones became inoperative at approximately 2100P, February 6. Assuming that the telephones had been disconnected, orders were issued via the Nellis AFB telephone exchange for the observing stations to begin the roll-up. It was learned on the morning of February 7 that the telephones were again operative.

A request for special bulletins ($UANH_x$ and $ZWNH_x$) to be prepared by the USAF Weather Central, Washington, D. C., and transmitted to the project weather-analysis unit was placed on January 23. The difficulties involved in finally securing nearly 100 per cent receipt of the bulletins at Nellis are explained as follows:

Originally ZWNH and UANH bulletins were transmitted from Andrews (KADW) to Nellis (LSV) as addressed messages. Routing was KADW via AF 9891 to Sherman (FLV), FLV to Lowry (LRY) via 9890, and LRY to LSV via 9894. Since this routing required a double relay and was on the crowded USAF weather teletype net, AACS was requested to establish the following routing for these messages: KADW via 9877 to SUU (Fairfield, Calif.) and SUU via 9894 to LSV.

On January 25, in MANAM HKGS, AACS/12, Headquarters AACS scheduled transmission of ZWNH and UANH on circuits 9877 and 9894. In several instances schedules for these transmissions conflicted with the circuit schedule then effective on 9894. This fact was reported to Headquarters, 1800th AACS, who advised Headquarters AACS and requested rescheduling

[redacted]

of those bulletins whose transmission times coincided with transmission times of other data on 9894. In MANAM HKGS, AACS/15, January 26, Headquarters AACS rescheduled transmission times of certain ZWNH bulletins on 9894 but did not eliminate the previously reported conflicts in transmission times. Again the matter was reported to Headquarters, 1800th AACS, and action was being taken to amend the schedule of circuit 9894 when the project was completed.

During the first few days after the transmissions began, approximately 30 per cent were received at Nellis. Within one week 70 per cent were received. As the project concluded, nearly 100 per cent were received.

2.4 SUPPLY

The bulk of equipment and supplies for the periphery stations was provided by the 2060th Mobile Weather Squadron at Tinker AFB, Okla., and the 9th Weather Squadron at March AFB, Calif. Other expendable items were flown from the 10th Weather Squadron at Sacramento and the 19th at Denver. The Commanding Officer of the 9th Weather Squadron and the Matériel Officers of both the 9th and 19th Weather Squadrons were at Nellis during the operation in order that the supply problems might be solved more expeditiously.

The Nellis AFB Weather Officer and the 9th's Matériel Officer completely equipped the weather-analysis section except for one light table and some expendable charts which had been air-lifted from the USAF Weather Central at Washington. Local purchase using AEC funds was utilized for a few items, i.e., Celotex board (for display), pens, and cleaning fluid.

2.5 DISPOSITION OF DATA

The completed maps and charts used in the weather-analysis section were placed in the custody of the weather officer at the Los Alamos Scientific Laboratory for ready reference by laboratory personnel.

Rawinsonde records, after being sent to parent headquarters for checking, were forwarded to the Chief, Data Control Unit, 4th Floor, Unit 3, New Orleans Port of Embarkation, New Orleans 12, La., for microfilming and permanent filing.

Records of the upper-air messages telephoned to the weather-analysis section have been made a part of this report, Appendix B.

2.6 SECURITY

All Air Weather Service personnel participating in the operation were advised regarding security in accordance with instructions from the Director of Security, SFO, Atomic Energy Commission, Los Alamos.

2.7 COMMENTS AND RECOMMENDATIONS

The following comments and recommendations are based on the assumption that, in a future test operation of the AEC in the same general area, similar weather support will be required of the Air Weather Service.

2.7.1 Analysis and Forecasting

The requirement for weather forecasts for AEC test operations is unique in regard to the specific accuracies at the target and the precise meteorological conditions which must exist at the immediate target area and within the continental limits of the United States to permit safety of operations. In view of this, the most capable forecasters using the most advanced analysis and forecasting techniques should be made available by the Chief, Air Weather Service, during the period of test operations. (For Operation Ranger, the experienced personnel

[redacted]

assigned to the weather-analysis section and their modified "differential" or "thickness" methods are believed to have met this requirement.)

2.7.2 Initial Operating Date

The complete weather supporting unit, including all its periphery stations, should be in full operation no less than 10 days prior to the earliest possible test date indicated by the J Division of the Los Alamos Scientific Laboratory.

2.7.3 Short-range Weather Reconnaissance

On occasion a requirement exists for air weather reconnaissance within the area of 200 miles of the target to altitudes of 40,000 ft msl. These observations should be made by personnel experienced in both weather observations and aircraft operations. In the absence of knowledge concerning a more suitable solution, the use of a T-33 manned by two weather-forecaster pilots is recommended. Whatever the final solution, the aircraft(s) and crew(s), when needed, should be placed under the operational control of the project weather officer with support of the weather-analysis section as its (their) prime mission.

2.7.4 Communications

(These remarks are based on the assumption that the weather-analysis section may not be at Nellis AFB.) Weather communications should include no less than that required to deliver data scheduled on facsimile circuit 10201 and on teletype circuits AF 9894, C-35, A-8009, and 0-8274. The weather teletypes should be immediately adjacent to the central weather unit.

No less than four telephones should be located within the weather section; provision should be made so that contact with the periphery stations can be made from the central station with a relatively adequate amount of security.

Provision should be made so that reconnaissance and pilot weather reports relayed to a ground control (or other) radio station can be delivered to the weather unit with a minimum of delay.

2.7.5 Security

Operation of weather support was handicapped by the fact that only four individuals possessed Q clearances. It is recommended that all personnel within the centrally located weather unit and no less than one individual at each of the outlying stations be cleared in accordance with the regulations governing the Atomic Energy Commission. In addition, the squadron commanders supporting the operation and the base weather officer nearest the test range should possess the same clearances.

[redacted]

Appendix A

RECORD OF VERBAL FORECASTS

1

Forecaster: Cressman
To: Representative of Deputy Test Director
Date of forecast: 2100L, January 23
Verifying time: 1500Z (0700L), January 25
Conditions at target area: No clouds below 23,000 ft. No precipitation in southeast Nevada. Winds, NW between ground and 10,000 ft, backing to WNW at 23,000 ft. 23,000-ft wind, 40 knots. 10,000-ft wind, 20 knots.
Comments: The officer who called said he would check again the morning of the 24th. That will still be an outlook. We should remind him that the final forecast for the 25th will be ready at about 1900 local time on the 24th.

2

Forecaster: Cressman
To: Capt. R. E. Smith at 1200C for Clark
Date of forecast: 1157L, January 24
Verifying time: 0700L, January 24
Conditions at target area: No clouds below 23,000 ft. No precipitation in southern Nevada. Winds from north at all levels. 23,000-ft wind, 25 knots. 10,000-ft wind, 12 knots.

3

Forecasters: Cressman and Stempson
To: Maj. Russell for general briefing
Date of forecast: 1900L, January 24
1. Time valid: 0600L (1400Z), January 25
Conditions at target area: Scattered cirrus clouds at 30,000 ft msl; no clouds below this level. Deck of overcast altostratus will lie with west edge along Nevada TMM Utah border with bases at 20,000 ft msl. Intermittent rain will fall north of 38°N and east of 114°W. Winds over target (direction in degrees from true north and speed in knots):

Surface	060-05	14,000 ft	350-12	24,000 ft	300-22
6,000 ft	040-06	16,000 ft	340-14	26,000 ft	300-25
8,000 ft	030-07	18,000 ft	330-16	28,000 ft	290-27
10,000 ft	020-08	20,000 ft	310-18	30,000 ft	290-28
12,000 ft	360-10	22,000 ft	310-20		

2. Time valid: 0600L (1400Z), January 26
Conditions at target area: Scattered cirrus clouds at 30,000 ft msl; no clouds below this level. No cloudiness except scattered cirrus within 200 miles of target. No precipitation within 350 miles of target. Winds over target (direction in degrees from true north and speed in knots):

Surface	050-03	14,000 ft	350-14	24,000 ft	320-24
6,000 ft	020-05	16,000 ft	340-16	28,000 ft	310-28
8,000 ft	010-08	18,000 ft	340-18	28,000 ft	300-33
10,000 ft	360-10	20,000 ft	330-18	30,000 ft	290-38
12,000 ft	350-12	22,000 ft	330-20		

4

Forecaster: Cressman
To: Capt. E. Miller at Mophead, read by Maj. Kent
Date of forecast: 2300L, January 24
Verifying time: 0600L (1400Z), January 25
Conditions at target area: Scattered cirrus at 30,000 ft msl. Surface temp., 38°F. Altimeter setting, 30.31. Weather last half of trip from Winslow: broken cirrus at 30,000 ft msl.

5

Forecaster: R. C. Miller
To: Capt. E. Miller at Mophead
Date of forecast: 0250L, January 25
Verifying time: 0600L (1400Z), January 25
Conditions at target area: Scattered cirrus at 30,000 ft msl. Surface temp., 38°F. Altimeter setting, 30.31; surface wind, 060 at 5 knots; 10,000-ft wind, 040 at 6 knots; 22,000-ft wind, 300 at 15 knots; 22,000-ft temp., −24°C; 22,000-ft RH, 15 per cent.

6

Planning forecast
Verifying time: 0550P, January 28
Conditions at target area: Clear. Altimeter setting, 30.30 in.

Wind altitude, ft	Direction and speed	Temp.	Humidity, %
Surface	Calm	42°F	
10,000	290-10		
22,000	290-10	−22°C	30
23,000	280-12	−24°C	30

Comment: This forecast was requested by Mophead weather observer and was read to him at 0520P, January 25, by Lt. Wise.

7

Planning forecast
Forecaster: Cressman
To: Maj. Russell for briefing Tyler and Graves
Date of forecast: 1300L, January 25
Time valid: 0600L (1400Z), January 28
Conditions at target area: Clear. No precipitation within 350 miles of target. Winds over target, light and variable. High at 700 mb, centered approximately on target. Trajectories from target starting at 0600L, January 28, will remain within 200 miles of target for first 24 hr at all levels below 20,000 ft.

8

Forecasters: Cressman and Stempson
For: General briefing
Date of forecast: 2000P, January 25
1. Time valid: 0600P (1400Z), January 26
Conditions at target area: Clear. No precipitation within

350 miles of target. Winds high at 10,000 ft, centered near target area. Winds light and variable below 20,000 ft. Trajectories from target starting at 0800P, January 28, will remain within 200 miles of target for first 24 hr at all levels below 20,000 ft.

2. Time valid: 0600P (1400Z), January 27

Conditions at target area: Scattered cirrus at 30,000 ft msl; no other clouds. Light intermittent rain will be falling approximately 350 miles northeast of target. Winds over target (direction in degrees from true north and speed in knots):

Surface	150-05	14,000 ft	290-14	24,000 ft	290-23
8,000 ft	180-08	16,000 ft	300-18	28,000 ft	270-25
8,000 ft	240-08	18,000 ft	300-18	28,000 ft	280-28
10,000 ft	290-10	20,000 ft	300-20	30,000 ft	250-30
12,000 ft	290-12	22,000 ft	300-22		

Trajectories from target starting at 0600P, January 27, should turn toward east-northeast after a few hours travel.

9

Forecaster: R. C. Miller

To: Not disseminated

Date of forecast: 2000 CST, January 25

Verifying time: 0600L, January 28

Conditions at target area: Clear. Surface temp., 36°F. Altimeter setting: based on LSV alt., 29.98; based on INS alt., 29.90. Surface wind, light and variable. 10,000-ft wind, 230 at 8 knots. 22,000-ft wind, 230 at 5 knots. 22,000-ft temp., −25.5°C. 22,000-ft RH, 25 per cent.

10

Forecaster: Cressman

To: Maj. Russell for noon general briefing

Date of forecast: 1245P, January 26

Time valid: 0600P, January 27

Conditions at target area: Scattered cirrus at 30,000 ft msl; no other clouds. Scattered light precipitation will be falling approximately 350 miles northeast of target. Winds over target (direction in degrees from true north and speed in knots):

Surface	150-05	14,000 ft	300-16
6,000 ft	180-06	16,000 ft	300-18
8,000 ft	290-10	18,000 ft	300-20
10,000 ft	300-15	20,000 ft	300-23
12,000 ft	300-15	22,000 ft	300-25

No significant change from winds in forecast 8 above 22,000 ft.

11

Forecasters: Cressman and Stempson

To: Maj. Russell for general briefing

Date of forecast: 1930P, January 26

1. Time valid: 0600P, January 27

Conditions at target area: Scattered cirrus at 25,000 ft msl; no other clouds. Scattered light precipitation will be falling approximately 350 miles northeast of target. Winds over target (direction in degrees from true north and speed in knots):

Surface	150-02	14,000 ft	280-18	24,000 ft	280-33
6,000 ft	210-05	16,000 ft	290-23	26,000 ft	280-36
8,000 ft	240-08	18,000 ft	290-25	28,000 ft	270-38
10,000 ft	280-12	20,000 ft	290-28	30,000 ft	260-40
12,000 ft	280-15	22,000 ft	290-30		

2. Time valid: 0800P, January 28

Conditions at target area: Scattered cirrus at 25,000 ft msl; no other clouds. Light snow will be falling approximately 450 miles northeast of target. Winds over target (direction in degrees from true north and speed in knots):

Surface	050-05	14,000 ft	300-22	24,000 ft	310-40
6,000 ft	380-08	16,000 ft	300-25	26,000 ft	310-48
8,000 ft	320-12	18,000 ft	300-28	28,000 ft	320-53
10,000 ft	290-18	20,000 ft	310-30	30,000 ft	320-80
12,000 ft	290-20	22,000 ft	310-33		

12

Forecaster: R. C. Miller

To: Mophead control, Capt. E. Miller

Date of forecast: 2245L, January 26

Verifying time: 0800L, January 27

Conditions at target area: Scattered cirrus above 23,000 ft msl. Visibility, 20 miles. Surface temp., 35°F. Altimeter setting, 29.83 in. Surface wind, 150 at 5 knots. 10,000-ft wind, 280 at 12 knots. 22,000-ft wind, 290 at 30 knots. 22,000-ft temp., −24.5°C. 22,000-ft RH, 30 per cent.

Route forecast: Winslow to target area, 0400L to 0600L, January 27. Sky $^{6}/_{10}$ cirrus at 25,000 ft msl decreasing to $^{3}/_{10}$ cirrus over Nevada. Visibilities over 15 miles. 10,000-ft (msl) wind, 280 at 10 knots. 14,000-ft (msl) wind, 280 at 15 knots. 12,000-ft (msl) wind, 270 at 10 knots. 18,000-ft (msl) wind, 300 at 15 knots. Verification of this forecast was telephoned to Capt. E. Miller at 0430P.

13

Forecasters: Cressman and Stempson

To: Maj. Russell for noon briefing

Date of forecast: 1230P, January 27

Conditions at target area: Scattered cirrus at 23,000 ft msl. Scattered altocumulus at 17,000 ft msl. Light snow will be falling approximately 450 miles northeast of target. Winds over target (direction in degrees from true north and speed in knots):

Surface	050-05	14,000 ft	260-25	24,000 ft	260-42
6,000 ft	360-08	16,000 ft	260-29	26,000 ft	260-50
8,000 ft	300-12	18,000 ft	260-31	28,000 ft	260-55
10,000 ft	270-18	20,000 ft	250-33	30,000 ft	260-63
12,000 ft	260-22	22,000 ft	250-35		

14

Forecasters: Cressman and Stempson

To: Maj. Russell for general briefing

Date of forecast: 1930P, January 27

Time valid: 0600P, January 28

Conditions at target area: Sky $^{3}/_{8}$ cirrus at 23,000 ft msl; $^{4}/_{8}$ altocumulus at 18,000 ft msl. Light precipitation will be falling approximately 350 miles northeast of target. Winds over target: (direction in degrees from true north and speed in knots):

Surface	220-05	14,000 ft	250-32	24,000 ft	240-47
6,000 ft	230-09	16,000 ft	240-38	26,000 ft	240-48
8,000 ft	240-16	18,000 ft	240-42	28,000 ft	240-49
10,000 ft	250-22	20,000 ft	240-45	30,000 ft	240-50
12,000 ft	250-28	22,000 ft	240-46		

Time valid: 0600P, January 29

Conditions at target area: Sky $^{4}/_{8}$ stratocumulus at 12,000 ft msl. Light precipitation over major mountain ranges in Nevada at forecast time, spreading into mountainous areas in Utah and northern Arizona by 1300P. Winds over target (direction in degrees from true north and speed in knots):

Surface	290-08	14,000 ft	280-40	24,000 ft	300-68
6,000 ft	310-16	16,000 ft	290-46	26,000 ft	300-72
8,000 ft	300-23	16,000 ft	290-53	28,000 ft	310-76
10,000 ft	280-26	20,000 ft	290-60	30,000 ft	310-80
12,000 ft	280-34	22,000 ft	290-64		

15

Forecaster: R. C. Miller
To: Mophead control, Capt. E. Miller
Date of forecast: 2245L, January 27
Verifying time: 0600L, January 28
Conditions at target area: Sky 3/8 cirrus at 23,000 ft msl; 4/8 altocumulus at 16,000 ft msl. Visibility, 6 miles. Surface temp., 40°F. Altimeter setting, 29.67 in. Surface wind, 220 at 5 knots. 10,000-ft wind, 250 at 22 knots. 22,000-ft wind, 270 at 15 knots [check this closely (250-30)]. 22,000-ft temp., −26.5°C. 22,000-ft RH, 62 per cent.
Route forecast: Winslow to target area, 0400L to 0600L, January 28. Sky 2/8 cirrus at 23,000 ft msl over Arizona, increasing to 5/8 cirrus at 23,000 ft msl over Nevada. 4/8 altocumulus-altostratus over entire route. Visibility, 6 miles. 14,000-ft wind, 260 at 30 knots; shifting to 250 at 30 knots, LSV to target area. This forecast was telephoned to Mophead at 2300C and 0230C.

16

Forecaster: Cressman
Date of forecast: 0300 check forecast, January 26
Time valid: 0600P, January 28
Conditions at target area. Winds (direction in degrees from true north and speed in knots):

Surface	270-05	14,000 ft	260-21	24,000 ft	260-32
6,000 ft	260-07	16,000 ft	270-24	26,000 ft	260-34
6,000 ft	290-12	16,000 ft	270-26	26,000 ft	260-36
10,000 ft	260-15	20,000 ft	270-26	30,000 ft	260-36
12,000 ft	280-16	22,000 ft	260-30		

Change in 20,000- to 22,000-ft winds was telephoned to Capt. E. Miller at 0400P. Verified at 0433P.

17

Forecasters: Cressman and Stempson
To: Maj. Russell for noon briefing
Date of forecast: 1145P, January 28
Time valid: 0600P, January 30
Conditions at target area: Clear. No precipitation within 300 miles. Winds over target: Light and variable under 6,000 ft; WNW at about 12 knots at 10,000 ft, increasing without much change in direction to WNW at about 30 knots at 30,000 ft.

18

Forecaster: Keast
To: Mophead control, Capt. E. Miller
Date of forecast: 2245L, January 28
Verifying time: 0600L, January 29
Conditions at target area: Sky 1/8 cirrus at 20,000 ft msl; 1/8 altostratus at 14,000 ft msl. Visibility, 7 miles. Surface temp., 43°F. Altimeter setting, 29.77 in. Surface wind, 210 at 8 knots. 10,000-ft wind, 250 at 18 knots. 22,000-ft wind, 270 at 40 knots. 22,000-ft temp., −29.5°C. 22,000-ft RH, 75 per cent.
Route forecast: Winslow to target area. Sky 3/8 cirrus at 25,000 ft, lowering to 20,000 ft and increasing to 5/8 over target area. 6/8 stratus, bases at 10,000 ft msl, Winslow to Grand Canyon, rising to 5/8 at 14,000 ft over target area. Visibility, 8 miles. 14,000-ft wind, 250 at 35 knots.

19

Forecaster: Cressman
Note: This is a record of a verbal forecast delivered at 1330P by Maj. Russell to Tyler and Macy as requested at 1315P, January 29. The 1030P facsimile map (surface) was discussed. Mention was made of the high aloft in the Pacific and of the manner in which it handicapped our analysis technique.
Date of forecast: 1315P, January 29
General weather Tuesday: Broken stratocumulus over Nevada. Snow on mountains in area. Snow over Utah and Colorado. (Snow at Los Alamos today and tomorrow.)
General weather Wednesday: Scattered stratocumulus over target at 0600, increasing to broken during the day. Snow on mountains in Utah and Colorado. Winds at surface at target, light, east, backing through NE and N to NW aloft.

20

Forecasters: Cressman and Stempson
Forecast for 0600L, January 30, target area
Date of forecast: 1930P, January 29
1. Time valid: 0600P, January 30
Conditions at target area: Overcast stratocumulus, bases at 5000 ft msl. Snow will be falling along mountain ridges over Nevada, Utah, and northern Arizona. Winds, blank.
2. Time valid: 0600P, January 31
Conditions at target area: Scattered stratocumulus over target at 0600, increasing to broken during day. Snow will be falling along mountain ridges over southern half of Utah and northern half of Arizona (within 150 miles of target). Winds (direction in degrees from true north and speed in knots):

Surface	060-06	14,000 ft	320-33	26,000 ft	320-62
4,000 ft	050-08	16,000 ft	310-39	28,000 ft	320-66
6,000 ft	540-15	16,000 ft	310-43	30,000 ft	330-70
8,000 ft	520-16	20,000 ft	310-53		
10,000 ft	520-25	24,000 ft	310-53		

21

Forecaster: R. C. Miller
To: Not disseminated, for record only
Date of forecast: 2200P, January 29
Verifying time: 0600L, January 30
Conditions at target area: Overcast stratocumulus, bases at 5000 ft msl. Occasional snow flurries. Snow along mountain ridges over Nevada. Visibility, 7 miles. Surface temp., 22°F. Altimeter setting, 29.96 in. Surface wind, 040 at 15 knots. 10,000-ft wind, 250 at 25 knots. 22,000-ft wind, 240 at 45 knots. 22,000-ft temp., −31.5°C. 22,000-ft RH, 87 per cent.

22

Forecaster: Cressman
To: Maj. Russell for noon briefing
Date of forecast: 1215P, January 30
1. Time valid: 0600P, January 31
Conditions at target area: A few thin stratocumulus clouds along mountains at 0600P, increasing to scattered during day. Snow will be falling along mountain ridges over southern half of Utah and northern Arizona (within 150

miles of target). Snow will be falling from clouds having tops at approximately 14,000 ft msl west of longitude 107°W. Winds (direction in degrees from true north and speed in knots):

Surface	080-05	14,000 ft	330-33	26,000 ft	320-62
4,000 ft		16,000 ft	320-39	28,000 ft	320-66
6,000 ft	030-08	18,000 ft	320-43	30,000 ft	320-70
8,000 ft	340-13	20,000 ft	320-48	35,000 ft	
10,000 ft	330-18	22,000 ft	320-53	40,000 ft	
12,000 ft	330-25	24,000 ft	320-58	45,000 ft	

2. Time valid: 0600P, February 1

Conditions at target area: Clear over target. No precipitation within approximately 250 miles of target. Winds, little change from January 31.

23

Forecasters: Cressman and Stempson
To: Maj. Russell for 2000P briefing
Date of forecast: 1900P, January 30
1. Time valid: 0600P, January 31

Conditions at target area: A few thin stratocumulus clouds along mountains. Light snow will be falling along mountain ridges over northeastern Arizona (approximately 220 miles from target). Snow will be falling from clouds having tops at approximately 13,000 ft msl. Winds (direction in degrees from true north and speed in knots):

Surface	080-03	14,000 ft	350-28	26,000 ft	340-60
4,000 ft		16,000 ft	350-30	28,000 ft	330-75
6,000 ft	030-08	18,000 ft	340-32	30,000 ft	330-90
8,000 ft	330-16	20,000 ft	340-34	35,000 ft	
10,000 ft	360-22	22,000 ft	340-40	40,000 ft	
12,000 ft	360-26	24,000 ft	340-50	45,000 ft	

2. Time valid: 0600P, February 1

Conditions at target area: Scattered altocumulus, bases at 14,000 ft msl, mostly along mountains. No precipitation within 500 miles downwind of target. Winds (direction in degrees from true north and speed in knots):

Surface	Calm	14,000 ft	340-20	26,000 ft	320-55
4,000 ft		16,000 ft	330-24	28,000 ft	310-63
6,000 ft	310-04	18,000 ft	320-27	30,000 ft	310-70
8,000 ft	320-08	20,000 ft	320-30	35,000 ft	
10,000 ft	340-13	22,000 ft	320-36	40,000 ft	
12,000 ft	340-18	24,000 ft	320-45	45,000 ft	

24

Forecaster: R. C. Miller
To: Not disseminated, for record only.
Date of forecast: 2200P, January 30
Verifying time: 0600L, January 31

Conditions at target area: A few thin stratocumulus clouds along mountains. Light snow in mountain ridges of northeastern Arizona. Visibility, 20 miles. Surface temp., 17°F. Altimeter setting: 29.99 in. Surface winds, 080 at 3 knots. 10,000-ft wind, 360 at 22 knots. 22,000-ft wind, 340 at 40 knots. 22,000-ft temp., −36.5°C. 22,000-ft RH, 85 per cent.

25

Forecaster: Keast
To: Maj. Russell for 1300P briefing
Date of forecast: 1230P, January 31
Time valid: 0800P, February 1

Conditions at target area: Scattered altocumulus, bases at 14,000 ft msl. No precipitation within 500 miles downwind of target. Winds (direction in degrees from true north and speed in knots):

Surface	Calm	14,000 ft	340-24	26,000 ft	310-68
4,000 ft		16,000 ft	330-28	28,000 ft	310-66
6,000 ft	310-04	18,000 ft	320-31	30,000 ft	310-74
8,000 ft	320-08	20,000 ft	310-34	35,000 ft	
10,000 ft	340-13	22,000 ft	310-40	40,000 ft	
12,000 ft	340-20	24,000 ft	310-49	45,000 ft	

26

Forecasters: Cressman, Stempson, and Wise
To: Maj. Russell for general briefing (2000)
Date of forecast: 1930P, January 31
1. Time valid: 0600P, February 1

Conditions at target area: Sky 2/8 altocumulus, bases at 14,000 ft msl and tops at 15,000 ft msl. No precipitation within 650 miles of target (downwind).

Route forecast: Kirtland to Las Vegas, clear, except for scattered altocumulus the last 150 miles, with bases at 14,000 ft msl and tops at 15,000 ft msl. Average wind, Kirtland to Las Vegas, 330 at 60 knots (14,000 ft). Winds (direction in degrees from true north and speed in knots):

Surface	Calm	14,000 ft	330-30	26,000 ft	330-68
4,000 ft		16,000 ft	330-39	28,000 ft	330-70
6,000 ft	060-03	18,000 ft	330-48	30,000 ft	330-72
8,000 ft	010-08	20,000 ft	330-58	35,000 ft	
10,000 ft	330-20	22,000 ft	330-62	40,000 ft	
12,000 ft	330-24	24,000 ft	330-65	45,000 ft	

2. Time valid: 0600P, February 2

Conditions at target area: Scattered altocumulus at 14,000 ft msl. Light precipitation will be falling 350 miles northeast of target. Winds (direction in degrees from true north and speed in knots):

Surface	200-04	14,000 ft		26,000 ft	310-58
6,000 ft	220-08	16,000 ft	310-34	28,000 ft	310-61
8,000 ft	290-10	18,000 ft	310-39	30,000 ft	300-65
10,000 ft	310-22	20,000 ft	310-44	35,000 ft	
12,000 ft	310-26	22,000 ft	310-48	40,000 ft	
14,000 ft	310-30	24,000 ft	310-53	45,000 ft	

27

Forecaster: R. C. Miller
To: Mophead control, Capt. E. Miller
Date of forecast: 2200P, January 31
Verifying time: 0600L, February 1

Conditions at target area: Sky 5/8 altocumulus, with bases at 12,000 ft msl and tops at 14,000 ft msl. Visibility 10 miles. Surface temp., 22°. Surface RH, 80 per cent. Altimeter setting, 036 in. Surface wind, calm. 10,000-ft wind, 330 at 24 knots (changed to 300 at 24 knots and 320 at 30 knots at 0230C). 22,000-ft wind, 330 at 62 knots (changed to 320 at 90 knots and 320 at 80 knots at 0230C). 22,000-ft temp., −31.5°C. 22,000-ft RH, 60 per cent.

28

Forecaster: Cressman
To: Maj. Russell for check briefing
Date of forecast: 0230P, February 1
Time valid: 0600P, February 1

Conditions at target area: Sky 5/8 altocumulus, with bases at 12,000 ft msl and tops at 14,000 ft msl. No precipitation within 650 miles downwind from target. Winds (direction in degrees from true north and speed in knots):

Surface	Calm	14,000 ft	320-50	24,000 ft	320-85
6,000 ft	360-05	16,000 ft	320-60	26,000 ft	320-88
8,000 ft	340-10	18,000 ft	320-65	28,000 ft	320-90
10,000 ft	300-24	20,000 ft	320-70	30,000 ft	320-90
12,000 ft	310-34	22,000 ft	320-80		

29

Forecasters: Stempson and Keast
To: Maj. Russell for 1300P briefing
Date of forecast: 1220P, February 1
Time valid: 0600P, February 2
Conditions at target area: Scattered cirrus, bases at 25,000 ft; few altocumulus, bases at 12,000 ft. No precipitation within 600 miles downwind of target. Winds (direction in degrees from true north and speed in knots):

Surface	Calm	14,000 ft	310-28	24,000 ft	310-50
6,000 ft	220-08	16,000 ft	310-32	26,000 ft	310-55
8,000 ft	280-10	18,000 ft	310-36	28,000 ft	300-58
10,000 ft	300-18	20,000 ft	310-42	30,000 ft	300-60
12,000 ft	300-22	22,000 ft	310-46		

30

Forecasters: Cressman, Wise, and Stempson
To: Maj. Russell for general briefing (2000P)
Date of forecast: 1945P, February 1
1. Time valid: 0600P, February 2
Conditions at target area: Sky 3/8 cirrus, with bases at 25,000 ft msl; 2/8 altocumulus, with bases at 12,000 ft msl and tops at 13,000 ft msl. No precipitation within 600 miles downwind of target. Winds (direction in degrees from true north and speed in knots):

Surface	Calm	14,000 ft	320-32	26,000 ft	310-50
4,000 ft		16,000 ft	310-34	28,000 ft	310-60
6,000 ft	060-07	18,000 ft	310-36	30,000 ft	310-70
8,000 ft	010-12	20,000 ft	310-38	35,000 ft	
10,000 ft	340-27	22,000 ft	310-40	40,000 ft	
12,000 ft	330-30	24,000 ft	310-42	45,000 ft	

2. Time valid: 0600P, February 3
Conditions at target area: Sky 4/8 cirrus, bases at 25,000 ft msl; 4/8 altocumulus, bases at 12,000 ft msl and tops at 14,000 ft msl. No precipitation within 600 miles downwind of target.

31

Forecaster: R. C. Miller
To: Mophead control, Capt. E. Miller (preliminary target forecast)
Date of forecast: 2000P, February 1
Time valid: 0600L, February 2
Conditions at target area: Sky 2/8 cirrus at 25,000 ft msl and 2/8 altocumulus at 12,000 ft msl. Visibility, 10 miles. Surface temp., 19°F. Surface RH, 80 per cent. Surface altimeter setting, 046 in. Surface wind, calm. 10,000-ft wind, 340 at 26 knots. 22,000-ft wind, 300 at 40 knots. 22,000-ft temp., −28°C. 22,000-ft RH, 60 per cent. (This forecast was telephoned to Mophead at 2000C.)

32

Forecaster: R. C. Miller
To: Mophead control, Capt. E. Miller
Date of forecast: 2200P, February 1
Time valid: 0600L, February 2
Conditions at target area: Sky 2/8 cirrus at 25,000 ft msl and 2/8 altocumulus at 12,000 ft msl. Visibility, 10 miles. Surface temp., 19°F. Surface RH, 80 per cent. Surface altimeter setting, 046 in. Surface wind, calm. 10,000-ft wind, 340 at 26 knots. 22,000-ft wind, 300 at 40 knots. 22,000-ft temp., −28°C. 22,000-ft RH, 60 per cent.
Route forecast: INW to target. Clear, becoming scattered at 25,000 ft msl and 12,000 ft msl over target area. 14,000-ft wind, 340 at 45 knots. (This forecast was telephoned to Mophead at 2300C.)

33

Forecaster: R. C. Miller
To: Capt. E. Miller
Date of forecast: 0130P, February 2
Time valid: 0600L, February 2
Conditions at target area: Sky 3/8 cirrus at 25,000 ft msl and 2/8 altocumulus at 12,000 ft msl. Visibility, 10 miles. Surface temp., 21°F. Surface RH, 73 per cent. Surface altimeter setting, 046 in. Surface wind, calm. 10,000-ft wind, 230 at 25 knots. 22,000-ft wind, 300 at 45 knots. 22,000-ft temp., −22.3°C. 22,000-ft RH, 19 per cent. (This forecast was telephoned to Capt. E. Miller at 0230P.)

34

Forecasters: Cressman, Wise, Stempson, and Miller
To: Maj. Russell for general briefing (0300L)
Date of forecast: 0240P, February 2
Time valid: 0600P, February 2
Conditions at target area: Sky 3/8 cirrus, with bases at 25,000 ft msl, and 3/8 altocumulus, with bases at 12,000 ft msl and tops at 13,000 ft msl. No precipitation within 600 miles downwind of target. Winds (direction in degrees from true north and speed in knots):

Surface	Calm	14,000 ft	310-35	26,000 ft	300-50
4,000 ft		16,000 ft	300-35	28,000 ft	300-60
6,000 ft	180-04	18,000 ft	310-36	30,000 ft	300-60
8,000 ft	240-08	20,000 ft	310-45	35,000 ft	
10,000 ft	280-25	22,000 ft	300-45	40,000 ft	
12,000 ft	290-32	24,000 ft	300-45	45,000 ft	

35

Forecasters: Cressman and Stempson
To: Maj. Russell for general briefing
Date of forecast: 1930P, February 3
Time valid: 0600P, February 5
Conditions at target area: Scattered cirrus, with bases at 25,000 ft msl, and scattered altocumulus, with bases at 14,000 ft msl. No precipitation within 1000 miles downwind of target. Winds (direction in degrees from true north and speed in knots):

Surface	200-03	14,000 ft	270-28	26,000 ft	270-39
4,000 ft		16,000 ft	270-30	28,000 ft	270-45
6,000 ft	240-08	18,000 ft	270-31	30,000 ft	270-50
8,000 ft	260-15	20,000 ft	270-32	35,000 ft	270-55
10,000 ft	270-25	22,000 ft	270-33	40,000 ft	270-60
12,000 ft	270-26	24,000 ft	270-35	45,000 ft	

36

Forecaster: Cressman
To: Maj. Russell for noon briefing
Date of forecast: 1215P, February 4
Time valid: 0600P, February 5
Conditions at target area: Scattered cirrus, with bases at 25,000 ft msl, and scattered altocumulus, with bases at 16,000 ft msl. No precipitation within 1000 miles downwind of target. Winds (direction in degrees from true north and speed in knots):

[redacted]

Surface	200-03	14,000 ft	270-28	26,000 ft	270-39
4,000 ft		16,000 ft	270-30	28,000 ft	270-45
6,000 ft	240-08	18,000 ft	270-31	30,000 ft	270-50
8,000 ft	260-15	20,000 ft	270-32	35,000 ft	270-55
10,000 ft	270-25	22,000 ft	270-33	40,000 ft	270-60
12,000 ft	270-26	24,000 ft	270-35	45,000 ft	

This is a check forecast on forecast 35.

37

Forecasters: Cressman and Stempson
For: General briefing (2000P, February 4)
Date of forecast: 1930P, February 4
1. Time valid: 0600P, February 5
Conditions at target area: Sky 4/8 thin cirrostratus, with bases at 24,000 ft msl and tops at 25,000 ft msl; 4/8 altocumulus, with bases at 16,000 ft msl and tops at 18,000 ft msl. Precipitation will be falling over NE Utah and SW Wyoming north of latitude 40°N. No precipitation downwind of target at elevations above 8000 ft msl. Winds (direction in degrees from true north and speed in knots):

4,000 ft	120-05	16,000 ft	250-33	28,000 ft	270-65
6,000 ft		18,000 ft	250-40	30,000 ft	280-72
8,000 ft	160-08	20,000 ft	260-45	35,000 ft	280-80
10,000 ft	210-15	22,000 ft	260-50	40,000 ft	280-95
12,000 ft	240-22	24,000 ft	260-55	45,000 ft	270-105
14,000 ft	240-28	26,000 ft	270-60		

2. Time valid: 0600P, February 6
Conditions at target area: Scattered cirrostratus at 24,000 ft msl. Scattered altocumulus at 14,000 ft msl. Precipitation will be falling in south central Colorado and north central New Mexico. Winds (direction in degrees from true north and speed in knots):

4,000 ft	Calm	16,000 ft	290-33	28,000 ft	280-55
6,000 ft		18,000 ft	290-35	30,000 ft	280-62
8,000 ft	050-06	20,000 ft	290-39	35,000 ft	280-68
10,000 ft	340-12	22,000 ft	280-42	40,000 ft	280-74
12,000 ft	300-28	24,000 ft	280-45	45,000 ft	280-80
14,000 ft	300-30	26,000 ft	280-50		

38

Forecaster: R. C. Miller
To: Mophead control, Capt. E. Miller
Time valid: 0600P, February 5
Date of forecast: 2000P and 2230P, February 4
Conditions at target area: Sky, at 2000P, 4/8 cirrostratus at 24,000 ft msl and 4/8 altocumulus at 16,000 ft msl. Sky, at 2230P, 2/8 cirrostratus at 24,000 ft msl and 2/8 altocumulus at 16,000 ft msl. The following data were obtained for both the 2000P and 2230P forecasts: Surface temp., 37°F. Surface RH, 75 per cent. Surface wind, 120 at 5 knots. Altimeter setting, 992 in. 10,000-ft wind, 240 at 22 knots. 20,000-ft wind, 260 at 50 knots. 25,000-ft wind, 270 at 60 knots. 32,000-ft wind, 280 at 85 knots. 32,000-ft RH, 15 per cent. 32,000-ft temp., −42°C.
Route forecast: INW-CP. Scattered clouds at 25,000 ft msl and 16,000 ft msl. 14,000-ft wind, 270 at 25 knots.

39

Forecasters: Cressman and Stempson
To: Maj. Russell for 1300P briefing, February 5
Date of forecast: 1200P, February 5
Time valid: 0600P, February 6
Conditions at target area: Few cirrostratus at 24,000 ft msl and few altocumulus at 14,000 ft msl. Precipitation will be falling in north central Colorado. Winds (direction in degrees from true north and speed in knots):

Surface	Calm	14,000 ft	320-30	26,000 ft	290-66
4,000 ft		16,000 ft	310-40	28,000 ft	290-69
6,000 ft	050-06	18,000 ft	310-48	30,000 ft	290-72
8,000 ft	010-12	20,000 ft	300-54	35,000-ft	290-80
10,000 ft	330-18	22,000 ft	300-58	40,000 ft	290-86
12,000 ft	320-24	24,000 ft	290-62	45,000 ft	

Briefing discussion included: Light precipitation from Mississippi Valley eastward, including Appalachian—precipitation at 15,000 ft and below. Approx. trajectories, center line emphasized:

	24	48
10,000	West Texas	NW Gulf of Mexico
20,000	South of New Orleans	North Carolina
30,000	12 hr, West Central Texas	24 hr, South Carolina

40

Forecasters: Cressman, Stempson, and Wise
To: Maj. Russell for 2000P briefing
Date of forecast: 1945P, February 5
1. Time valid: 0600P, February 6
Conditions at target area: Sky 4/8 thin cirrostratus at 27,000 ft msl; no other clouds. See prognostic charts for location of precipitation areas. Winds (direction in degrees from true north and speed in knots):

Surface	Calm	14,000 ft	330-38	26,000 ft	320-68
4,000 ft		16,000 ft	320-44	28,000 ft	310-70
6,000 ft	050-06	18,000 ft	320-50	30,000 ft	310-72
8,000 ft	360-15	20,000 ft	320-58	35,000 ft	310-85
10,000 ft	320-28	22,000 ft	320-62	40,000 ft	310-100
12,000 ft	330-32	24,000 ft	320-65	45,000 ft	

2. Time valid: 0600P, February 7
Conditions at target area: Sky 4/8 altocumulus, with bases at 14,000 ft msl, and 5/8 cirrostratus, with bases at 26,000 ft msl. No precipitation within 1000 miles downwind of target. Winds (direction in degrees from true north and speed in knots):

Surface	120-05	14,000 ft	280-48	26,000 ft	280-75
4,000 ft		16,000 ft	280-55	28,000 ft	280-78
6,000 ft	180-08	18,000 ft	280-58	30,000 ft	280-80
8,000 ft	240-20	20,000 ft	280-62	35,000 ft	280-90
10,000 ft	280-30	22,000 ft	280-66	40,000 ft	290-105
12,000 ft	280-38	24,000 ft	280-70	45,000 ft	

41

Forecaster: R. C. Miller
To: Mophead control, Capt. E. Miller
Time valid: 0600P, February 6
Date of forecast: 2000P, 2230P, and 0230P, February 5
Conditions at target area: (The following data apply to all three forecast times unless otherwise noted.) Sky 4/8 cirrostratus at 27,000 ft. Surface temp., 40°F. Surface RH, 72 per cent. Surface wind, calm. Altimeter setting, 30.04 (2000P and 2230P); 30.06 (0230P). 10,000-ft wind, 320 at 28 knots (2000P and 2230P); 320 at 24 knots (0230P). 20,000-ft wind, 320 at 58 knots (2000P and 2230P); 320 at 50 knots (0230P). 25,000-ft wind, 320 at 65 knots (2000P and 2230P); 320 at 54 knots (0230P). 32,000-ft wind, 310 at 79 knots (2000P and 2230P); 310 at 65 knots (0230P). 32,000-ft RH, 15 per cent. 32,000-ft temp., −42.5°C (2000P and 2230P); −45°C (0230P).

[redacted]

Route forecast: INW-CP. Scattered cirrus at 27,000 ft msl. 14,000-ft wind, 310 at 35 knots.

42

Forecasters: Cressman, Stempson, and Wise
To: Maj. Russell for 0300P briefing, February 6
Date of forecast: 0230P, February 6
Time valid: 0600P, February 6
Conditions at target area: Sky $^4/_8$ thin cirrostratus at 27,000 ft msl; no other clouds. See prognostic charts for location of precipitation areas. Winds (direction in degrees from true north and speed in knots):

Surface	Calm	14,000 ft	330-38	26,000 ft	310-56
4,000 ft		16,000 ft	320-42	28,000 ft	310-58
6,000 ft	050-06	18,000 ft	320-46	30,000 ft	310-60
8,000 ft	360-15	20,000 ft	320-50	35,000 ft	310-70
10,000 ft	320-24	22,000 ft	320-52	40,000 ft	310-80
12,000 ft	330-30	24,000 ft	320-54	45,000 ft	

Appendix B

RECORD OF CODED MESSAGES

BEATTY RAOB, 0100P, JANUARY 23

BTY09	90306	02811	00209	00072	85511	09023	03526
70033	00552	03336	50890	63741	03335	40432	77990
03332	30107	90999	03334	55555	11886	11051	22743
02534	33724	02564	44603	57622	55430	71825	66310
90990	77213	11990	10190	20968	10159		

BEATTY RAWIN, 0100P, JANUARY 23

BTY09	00208	43608	3625	63425	3526	83330	3333
03336	23237	43342	63338	03353	53333	03428	53131

BEATTY RAOB, 0700P, JANUARY 24

BTY15	90402	00511	00000	00079	85575	07006	00419
70037	02587	00221	50906	64992	64992	03527	40448
25999	03423	30111	90997	03321	20971	12998	03327
55555	11888	08042	22843	07501	33816	08000	44775
07592	55718	03559	66643	77578	55991	88426	72997
99304	90990	00190	15993	10158			

BEATTY RAWIN, 0700P, JANUARY 24

BTY15	00000	40000	0115	60116	0216	80418	03116
00219	20222	43626	63527	83530	03427	33522	53424
03321	53334	03325					

BEATTY RAOB, 1300P, JANUARY 24

BTY21	90317	02711	03209	85516	12519	03608	70044
06616	03609	50919	63998	03417	40464	76990	03131
30125	92993	03224	20977	14996	03419	15543	15996
03239	10351	14997	03329	55555	11807	13004	22863
03645	10993	44548	59990	55313	90990	66168	21994
77137	14990	88113	15997	99095	13993	10158	

BEATTY RAWIN, 1300P, JANUARY 24

BTY21	03209	43409	3609	60102	3605	83506	3605
00108	20116	40122	63621	83519	03418	53130	03122
53308	03419	53236	03349	53330			

BEATTY RAOB, 1900P, JANUARY 24

BTY03	90607	99913	00000	00077	85524	11997	00107
70048	04993	00508	50918	65999	03416	40452	77999
03017	30109	91999	02716	20966	14999	02407	55555
11875	13990	22778	08990	33757	08991	44356	85994
55344	84994	66317	88998	77195	16992	10166	09119

BEATTY RABAL, 1900P, JANUARY 24

BTY03	00000	40108	0107	60106	0209	80209	0208
00408	20310	40116	60220	83618	03315	33313	53018
02718	52708	02407					

ELY RAOB, 0100P, January 24

48609	81753	55214	01804	00086	05521	70036	51553
03319	50895	63755	40438	75675	55555	11810	03008
22797	04017	33737	00533	44600	57613	48659	30097
32996	20948	16993	15513	16992	10328	13990	55555
55358	82946	66318	89992	77173	21955	88160	17992
99077	16994	10165	01608				

ELY RAOB, 1300P, JANUARY 24

48621	81711	50511	03304	00074	85518	70040	02571
03320	50909	64999	03355	40451	76994	03140	55555
11729	02571	22695	02687	33630	00995		

LAS VEGAS RAOB, 0100P, JANUARY 24

38609	94605	51410	02405	00067	85512	10509	00208
70036	03675	03118	50905	63763	03332	40450	75881
55555	11938	14020	22924	15021	33834	09518	44808
10531	55630	52703	66606	54633	77540	58724	

Second Transmission

38659	30112	92991	20969	14995	15536	15990	10344
18996	55555	88312	90990	99166	23990	00164	18992
11146	14993	22050	10995	33044	12995		

LAS VEGAS RABAL, 0100P, JANUARY 24

38609	02405	304	40407	0309	63612	3513	83515
3417	03217	23124	43233	63230	83431	03331	

LAS VEGAS RAOB, 1300P, JANUARY 24

38621	94618	59811	00803	00063	85514	12541	03514
70039	05665	00313	50914	62996	03525	40459	25990
03127	55555	11901	14509	22732	06622	33665	03694

Second Transmission, 1300P

38871 30123 91990 03115 20981 14990 03827 15548
17995 03030 10352 19998 03139 55555 44313 88998
55170 22994 86138 14990 77113 15993 88094 21997
99082 17993 00052 13998 11048 15993 22025 07998
33023 09994 44017 06993

LAS VEGAS RABAL, 1300P, JANUARY 24

99994 03828 53028 03349 53038 03315 53812 00815
50310 01010 51406

LAS VEGAS RAOB, 1900P, JANUARY 24

38803 94811 50414 02709 00061 85516 14528 00315
70048 07998 00419 50921 62996 03512 40465 75992
03418 55555 11936 19007 22818 12533 33744 08845

Second Transmission

38853 30129 90997 20990 12999 15582 13999 10387
20994 55555 44314 88990 55173 19990 86135 13994
77073 18994 88052 11992 99044 12990

LAS VEGAS RABAL, 1900P, JANUARY 24

38803 02709 3308 40112 0214 80418 0418 80318
0318 00417 20420 40323 80217 83512 03513 53315

CALIENTE (CORNELIUS HOTEL) PIBAL, 0800P, JANUARY 25

1600Z 00000 3214 83210 0304 80803 1203 01503
21801 40311 60610 83603 02812 52528

CEDAR CITY PIBAL, 0900P, JANUARY 25

CDC17 02002 81905 1903 81809 3808 03608 3511
21014 2012 43813 3413 83409 31112 83112 2914
02917 52719 02509

COMMAND POST PIBAL, 0100P, JANUARY 25

00000 40000 0210 60712 0109 80612 0712 00305
0507 20508

INDIAN SPRINGS PIBAL, 0145P, JANUARY 25

INS09 00000 40000 0312 60514 0911 80913 0507
00903 0807 00710 0510 40511 50511 60511

INDIAN SPRINGS PIBAL, 0438P, JANUARY 25

01002 41002 0310 60811 0814 80707 1202 01505
1406 21108 0913 40910

ELY RAOB, 0100P, JANUARY 25

48609 81854 56614 01814 00096 85525 70044 05990
03225 50912 64996 03326 40455 76997 55555 11800
05014 22757 06864 33731 07993
48659 30117 90993 20980 13993 15546 17992 10350
18992 55555 44306 89995 55172 21992 66133 15991
77090 17996

ELY RAOB, 1300P, JANUARY 25

48621 81318 63611 02207 00051 85505 70036 07991
02415 50909 64994 02619 40449 77997 02730 55555
11800 15596 22811 50998
48671 70108 92990 02641 20966 13998 02439 15545
10998 03040 10350 19995 02736 55555 33314 90990
44185 16998 55099 19996 86058 14992 77047 09999
88027 08996

TONOPAH PIBAL, 0100P, JANUARY 25

TPH09 00000 63020 4020 80520 5018 02019 27015
47017 57017 7017

TONOPAH PIBAL, 0700P, JANUARY 25

TPH15 00000 80000 0000 81608 1710 02013 22109
41908 82105 81904 03004 32510 52719 02631 52427
02463 52398

TONOPAH PIBAL, 1300P, JANUARY 25

TPH21 0000 63603 0912 81915 1912 02213 22019
4218 62015 82218 02217 32526 52528 02433 52342

TONOPAH PIBAL, JANUARY 25

TPH03 03505 80605 1408 81815 2020 02120 22221
42319 82214 82411 02812 32620 52833 02930 53153

NELLIS RABAL, 0100P, JANUARY 25

LSV09 00000 44444 34569 0610 80609 0607 00608
20315 40414 60217 80109 02806

NELLIS PIBAL, 0700P, JANUARY 25

LSV15 00000 0705 40409 0510 80609 0708 80710
0609 00905 20905 40710 60818 80910 00505 33307
53008 02810 52621 01914 52020

NELLIS RAWIN, JANUARY 25

LSV21 00000 3601 40101 0302 62401 3101 80902
0102 01702 21802 41502 61802 82802 02402 52504
02205 52505 02907 53206 03106 53011 03115

NELLIS RABAL, 1900P, JANUARY 25

LSV03 00000 3503 43504 1204 61205 1807 82808
1907 01709 21716 41812 62010 82108 02408 32610
52613 02228 52136 02030

LAS VEGAS RAOB, 0100P, JANUARY 25

38609 94606 50214 02404 00065 85514 13502 00415
70046 07995 00510 50919 63993 40462 77990 55555
11943 15044 22924 17022 33823 11515 44796 11624
55775 12996 66750 11999

Second Transmission

38659 30123 91993 20983 13995 15558 11999 10361
20990 55555 77308 90990 88175 18999 99079 17990

LAS VEGAS PIBAL, JANUARY 25

38609 02404 3504 40209 0413 60412 0509 80708
0710 00510 26512 40413 60306 80107

LAS VEGAS RAOB, 1300P, JANUARY 25

38621 94318 00811 00607 00053 85505 13577 00304
70039 70039 07997 01308 50914 61997 02605 40459
76990 02510 55555 11897 15513 22815 12616 33802
14990 44760 12999 55574 55990

Second Transmission

38671 30118 92998 02321 20975 12998 02417 15559
11994 02829 10363 1991 03227 55555 66328 88990
77185 14992 88172 09999 99089 20994 00078 17994
11065 18997 22060 14998 33016 06991 44014 03991

LAS VEGAS RABAL, 1300P, JANUARY 25

99993	52127	02417	52823	03033	53227	03218	50109
00418	50810	000912	50613	00914			

TONOPAH PIBAL, 1900P, JANUARY 25

TPH03	03505	60605	1408	81815	2020	02120	22221
42319	62214	82411	02812	32620	52833	02930	53153

LAS VEGAS RAWIN, 1900P, JANUARY 25

LAS03	02509	0102	40504	0503	61302	1605	81607
1508	01709	21811	41818	61813	82007	02208	52510
02324							

LAS VEGAS RAOB, JANUARY 25

LAS03	38603	94111	51114	02509	00046	85499	13647
00403	70033	06999	01710	50905	63991	02207	40449
76997	02410	55555	11928	18506	22896	18511	33848
13657	44827	15993	14997	66577	56992	77541	58992
38653	30106	93996	02226	20961	11990	15551	10994
10364	18992	55555	88322	90990	99204	11992	00188
08999	11076	20994	22061	15995	33035	11996	44033
08995							

BEATTY RAWIN, 0001P, JANUARY 25

BTY08	00000	40108	0107	60105	0305	80503	0604
00705	20107	40311	60218	83308	03017	32911	52918
02617	52414	02117	53231	03228	52941		

BEATTY RAOB, 0001P, JANUARY 25

BTY08	90604	00112	00000	00080	85222	11501	00107
70052	07990	00405	50922	63997	03007	40462	78992
02916	55555	11873	11024	22798	10571	33762	11995
44548	59995						

Second Transmission

BTY58	30120	91992	02618	20981	13990	03117	15553
13995	03233	10366	18993	03005	55555	55166	18992
66142	12997	77092	10158				

BEATTY RAOB, 0400P, JANUARY 25

BTY12	90502	51512	03203	00075	85512	09998	00107
70043	07990	01709	50913	64992	03508	40453	78998
02814	30107	92995	02506	20323	12993	02024	15538
12998	03126	10352	17993	55555	11875	08004	22857
08004	33847	10507	44813	11628	55744	11990	66544
60990	77527	60997	88177	17996	99082	20990	00069
16990	10159						

BEATTY RAWIN, JANUARY 25

BTY12	03203	43303	0107	60207	0306	80506	0706
01608	21108	41008	60710	80208	03108	32912	52815
02525	52316	02018	53127				

22,000 ft, 228-10

BEATTY RAOB, 0700P, JANUARY 25

BTY15	90200	53811	03404	00075	05508	08531	00606
70036	06993	01910	50908	63992	07403	40451	77993
02816	30107	92997	02322	20968	12990	02124	55555
11880	04526	22864	03519	33826	10572	44814	10622
55794	11992	55763	11992	77542	57998	88485	64995
99318	90990	00188	14998	10167	13998	10158	10190
15546							

BEATTY RAWIN, 0700P, JANUARY 25

BTY15	03404	43606	0507	61105	1208	81004	2107
02010	21509	41210	61107	80905	02505	32711	52818
02419	52123	02124					

BEATTY RAOB, 1300P, JANUARY 25

BTY2	90015	08311	00000	00058	85506	10992	00000
70033	04998	01713	50897	65996	02115	40435	79997
02425	30088	94991	02337	20944	12999	02327	15528
11991	02527	10337	18998	03221	55555	11869	11991
22824	08992	33798	10996	44756	09991	55553	80997
66452	71994	77327	90990	88193	14999	99160	11990
00092	20090	11068	17998	22039	09998	33033	10997
44018	08992	10168	59001	10158			

BEATTY RAWIN, 1300P, JANUARY 25

BTY21	00000	40000	0000	61709	1710	81308	1905
01810	21415	42310	61607	81920	00812	52423	02324
52232	02324	52527	02825	53018	03607	50616	70710

BEATTY RAOB, 2000P, JANUARY 25

BTY04	89806	51213	03604	00119	85487	11529	03602
70015	04999	02014	50880	65990	02318	40421	78872
02323	30078	93991	02327	55555	11866	12511	22815
10565	33780	11571	44545	60991	55428	73847	66372
82908	77322	90982	88246	03992	10158		

BEATTY RAWIN, 2000P, JANUARY 25

BTY04	03604	43604	3602	62305	1911	81913	2012
02014	21917	42014	62112	82218	02317	32322	52323
02328	52319						

MUROC RAOB, 2200P, JANUARY 26

93210	00214	02006	00031	85477	10831	02517	70997
00682	02513	50857	66993	01908	40398	78917	02218
55555	11908	12021	22875	12812	33836	09831	44810
09831	55660	52705	66844	52736	77512	65990	88441
77916							

MUF56	30052	93993	02211	20921	02998	55555	99370
83912	00323	90011	11273	00992	22257	00992	33223
04999	04208	01997	55153	09992	10190	15520	10158

MUROC RAWIN, 2200P, JANUARY 26

MUF06	02006	12417	42517	2716	82812	2812	72812
2714	92712	02512	22611	42603	62306	82106	01808
52316	02217	52712					

BEATTY RAOB, 0100P, JANUARY 26

BTY09	89601	53913	03604	00055	85490	08619	03605
70013	03999	02021	50881	64992	02324	40421	77999
02228	30075	94992	02736	20927	10998	02929	55555
11802	08536	22771	08996	33335	88992	44250	04994
66193	12992	77152	08999	10190	15658	10158	

BEATTY RAWIN, 0100P, JANUARY 26

BTY09	03604	43605	3605	62008	1813	81920	2023
02021	22220	42320	62323	82323	02324	52439	02731
52631	02928	52936					

BEATTY RAOB, 0800P, JANUARY 26

BTY15	89502	55211	00905	00053	85489	10536	03506

[redacted]

55555 11865 10526 22795 08573 33783 09621 44708
06990 10190 70008 02220 10158

BEATTY RAWIN, 0800P, JANUARY 26

BTY15 00905 40108 3505 82604 2208 82413 2311
02220

BEATTY RAOB, 1900P, JANUARY 28

89107 53611 00000 00062 85478 11998 01802 70000
02993 03409 50883 85993 02824 40404 78990 02823
55555 11887 12990

BEATTY RAWIN, 1900P, JANUARY 28

41802 82804 0105 80209 0109 03409 23009 42814
82816 82922 02824 32824

BEATTY RAOB, 1900P, JANUARY 26

30082 91995 02826 20931 08990 02734 15530 07997
02940 55555 11867 12990 22208 07996 33192 04992
44137 09990 10168 58914 10158

BEATTY RAWIN, 1900P, JANUARY 28

52824 02725 52835 02738 52840

BEATTY RAWIN, 2359P, JANUARY 28

BTY08 03603 40504 0803 62709 1812 82509 2708
02717 22814 42516 62624 82830 02841 32627 52630
02829 52624 02628 52952 03048 52847 02942
22,000 ft, 200-33

ELY RAWIN, 0100P, JANUARY 26

48609 80952 60714 01708 00076 85496 70016 06990
02427 50886 64997 02529 40426 78994 55555 11782
09621 22766 08638 33727 08992 44430 73877 10168
04340 48659 30082 92999 20940 12990 15531 08992
10348 16991 55555 55330 88991 68188 12999 77177
07999 88083 17997 99041 10998 10168 04033

ELY RAOB, 1300P, JANUARY 26

48621 80613 07114 03209 00034 85481 70005 00644
03012 50862 66992 40400 79861 55555 11800 11613
22674 51707 33662 52605 44627 54639 55574 60634
86556 61667 77538 62781 88423 76906 48671 30055
93995 20912 09999 15503 07993 10331 17994 55555
99334 87929 00210 10990 11126 09998 22094 19997
33075 13995 44070 16991 55026 08995

TONOPAH PIBAL, 0900Z(0100P), JANUARY 26

TPH09 03403 63403 0702 82510 3129 02036 22226
42120 62124 82326 02434 32429 52340

TONOPAH PIBAL, 0700P, JANUARY 26

TPH15 03304 63405 3609 83418 3319 03215 23017
42615 62721 82622 02328 32433 52440 02724 52830
02943 52980

TONOPAH PIBAL, 1300P, JANUARY 26

TPH21 01302 61802 2805 83217 3216 03113 22815
42822 62721 82731 02732 32728 52729 02735

TONOPAH PIBAL, 1800P, JANUARY 26

TPH02 03403 83406 3310 83510 3610 03217 22922
42718 82919 02723 32537 52449

INDIAN SPRINGS PIBAL, 2056P, JANUARY 26

INS04 00000 42705 2806 62904 2902 82603 2403
02405 22104 42305 82810 82615 02921

COMMAND POST PIBAL (INS), 1000Z(0600P), JANUARY 26

00000 40000 2205 62114 2124 81924 2031 02030
2030 22127

COMMAND POST PIBAL, 0600P, JANUARY 26

01102 41002 1304 62209 2223 82021 2125 02028
2031 22129 2127

NELLIS RAWIN, 0100P, JANUARY 26

LSV09 00000 20000 0000 41707 1910 61912 1913
81914 2013 02113 22312 42317 62218 82119 02121
52327 02630 52639

NELLIS RAWIN, 1630P, JANUARY 26

LSV01 00000 20000 0000 40000 2309 62309 2410
82510 2510 02506 22705 43109 62912 82918 02922
52733 02533 52918

NELLIS RABAL, 2330P, JANUARY 26

LSV08 00000 20000 0000 40000 0000 62210 2212
82412 2511 02510 22510 42509 62618 82618 02716
52633 02636 52621 02729

LAS VEGAS RAOB, 0100P, JANUARY 26

38609 93805 51414 01602 00044 85490 14564 01502
70020 06991 01812 50892 63994 02120 40434 76996
55555 11928 14032 22900 16012 33835 14582 44765
11994
38659 30094 92999 20955 09990 15547 10994 10360
18990 55555 55316 90990 66248 04994 77166 08995
88088 20997 99033 11990

LAS VEGAS RABAL, 0100P, JANUARY 26

LAS09 01602 1103 40802 1501 62008 2016 81915
1815 01812 22108 42212 62312 82313

LAS VEGAS RAOB, 1300P, JANUARY 26

38621 93617 52211 01002 00033 85483 12584 03007
70011 03687 02617 50881 63997 02815 40424 76997
02725 55555 11899 13549 22739 08671 33674 03713
44568 56763

Second Transmission

38671 30080 93998 02639 20940 08990 02828 15534
10990 02947 10349 17996 02924 55555 55371 81954
66323 89976 77241 04998 88185 06998 99078 19993
00057 15995 11029 06999 22022 07997 33017 04993

LAS VEGAS RABAL, 1300P, JANUARY 26

99994 02828 52843 03040 52825 03116 50605 00707
50614 00910 51106

LAS VEGAS RAOB, 1900P, JANUARY 26

38603 93409 54114 02005 00029 85477 13555 02211
70002 03694 02508 50868 64999 02912 40408 77992
02830 55555 11912 15547 22623 53734 33587 55751
38653 30065 92994 20926 05993 15522 09993 10340
18996 55555 44396 77919 55364 83903 66318 89006
77217 07998 88196 04998 99093 20994 00035 09996

LAS VEGAS RABAL, 1900P, JANUARY 26

LAS03 02005 1902 42205 2210 62210 2211 82313
2412 02508 22806 42809 63011 83112 02817 52728
02636

MUROC RAOB, 2300P, JANUARY 27

MUF07 93110 01310 00030 85473 99999 70987 52581
50837 70732 40369 79888 55555 11908 07524 44444
22778 02538 33606 58642 44472 73764 55456 72809
MUF57 30018 95999 20894 99995 55555 66339 89994
77278 00990 88268 97992 99235 99996 00216 99910
11189 99999 22164 04993 10190 15499 10158

No MUROC RAWIN because of high winds.

CEDAR CITY PIBAL, 1500P, JANUARY 27

CDU23 2018 61923 1809 82417 2321 02417 12620
22621

CEDAR CITY PIBAL, 1900P, JANUARY 27

CDU02 01921 62024 1935 82150 2137 02619 2326
22715 2119

BEATTY RAOB, 0001P, JANUARY 27

BTY08 89102 53111 03604 00038 85476 08519 00703
70998 01641 02813 50857 66992 02629 40395 79995
02629 30053 91998 02626 20913 04998 02745 15510
09991 02952 10323 16993 02836 55555 11853 08519
22808 07541 33781 07581 44696 01643 55593 58998
66564 59999 77309 90990 88217 10993 99205 04991
00112 17990 11097 16992 22091 20994 33086 17998
44079 17998 55077 15998 66067 17992 10158

BEATTY RAOB, 0400P, JANUARY 27

BTY12 89000 54111 00104 00040 85472 07007 00903
70995 01584 02714 50854 66996 02630 40390 79992
02732 30043 93997 02726 20906 04999 02732 15506
08991 02630 55555 11867 06004 22837 08513 33763
05559 44767 06589 55579 59725 66258 63993 77327
90990 88218 07995 99207 04993 00193 05595 11172
04997 22138 10995 10158

BEATTY RAWIN, 0400P, JANUARY 27

BTY12 00104 40303 1304 62007 2209 82614 2716
02714 22817 42920 62725 82629 02540 52733 02527
52728 02648 52831 02730

BEATTY RAOB, 0700P, JANUARY 27

BTY15 89101 56611 03603 00042 85475 08555 00000
70030 01634 03027 50854 66991 02635 40490 78993
02727 30044 93996 02720 20911 03991 02918 15514
07990 02825 10468
16996 02914 55555 11765 06617 22589 59671 33559
61708 44535 61809 55487 67099 66345 87997 77225
05995 88208 029995 99185 04997 00167 049990 11083
18995 22070 15990 33063 16994 44040 09993 10158

BEATTY RAWIN, 0700P, JANUARY 27

BTY15 03603 40000 00000 60000 0000 80000 2818
03022 22523 43024 62725 82630 02730 32730 52826
02720 52823 02823 52856 02916 52917 02921

BEATTY RAOB, 1000P, JANUARY 27

BTY18 88909 52611 00000 00036 35470 05549 00000
70984 52514 02718 50830 69993 02724 40359 82992
02629 30004 96998 02527 55555 11810 02565 22762
02586 33588 62676 44538 67726 55525 66802 66345
40990 77260 03994 88210 04996 10190 20882 10158

BEATTY RAWIN, 1000P, JANUARY 27

BTY18 00000 40000 0000 62006 2208 82507 2713
02718 22818 42818 62817 82722 02726 52625 02529
52632

BEATTY RAOB, 2100Z, JANUARY 27

BTY21 88914 52511 00000 00023 05453 09549 02804
70971 50614 02713 50824 68791 02723 55555 11854
10543 22776 02575 33760 03611 44533 64679 55518
67727 66494 68822 77446 74995 10158

BEATTY RAWIN, 1300P, JANUARY 27

BTY21 00000 40000 2704 62205 2210 82510 2612
02713 22715 42923 62925 82826 02617

BEATTY RAWIN, 1900P, JANUARY 27

BTY03 00000 40000 1707 61810 1913 82215 2414
02714 22819 43018 63216 83017 02919 32826 52823

BEATTY RAOB, 1900P, JANUARY 27

BTY03 88708 08551 00000 00018 85465 09562 01707
70986 02590 02714 50844 69824 03017 40397 79995
02823 55555 11864 09556 22712 03583 33628 56632
44601 59774 55550 62997 66507 68835 77469 73795
88463 73786 99420 77902 00371 83993 11341 89994
10158

CALIENTE PIBAL, 1000P, JANUARY 27

00903 51517 61815 72313 82411 92720 02822 22829

CALIENTE PIBAL, 1200P, JANUARY 27

01803 51811 61814 71813 82422 92622 02624 22628

TONOPAH PIBAL, 0100P, JANUARY 27

TPH09 00000 60000 0000 82405 2208 02212 22314
42309 62309 82515 02413 32619 52524

TONOPAH PIBAL, 0400P, JANUARY 27

TPH 00000 60000 0000 82210 2611 02509 22911
42913 63114 83116 02620 32520 52420

TONOPAH PIBAL, 0700P, JANUARY 27

TPH15 00207 60106 3306 82912 2817 02834 22729
42844 62946 82935 02732 32837 52733 02635

TONOPAH PIBAL, 1000P, JANUARY 27

TPH18 02402 62402 2704 83307 3314 03119 22728
22730

Balloon entered cloud $^{5}/_{10}$ altocumulus and $^{8}/_{10}$ cirrostratus.

[redacted]

TONOPAH PIBAL, 1300P, JANUARY 27

TPH21 01802 61902 2104 83008 3113 02820 22829
42834 82932 82932 02834 32727 52734 02840

TONOPAH PIBAL, 1800P, JANUARY 27

TPH02 C3203 83105 2908 82818 2711 02714 22815
42813 82725 82825 02532

INDIAN SPRINGS PIBAL, 0100P, JANUARY 27

INS09 40000 3504 83308 2709 82810 2810 02709
22808 42813 62517 82708 02707

INDIAN SPRINGS PIBAL, 0400P, JANUARY 27

00000 40000 2817 81918 1922 82307 2514 02713
22114 42214

INDIAN SPRINGS PIBAL, JANUARY 27

INS15 00000 40000 0000 81005 71805 81907 92410
02814 22913 42916 82619 82819 82628 02833 52834
02835 52841 02831 52639 02835

INDIAN SPRINGS PIBAL, 1000P, JANUARY 27

00000 40000 1104 61504 1803 82603 3005 03009
23015 42816 62619 82728 22722 52828 02832 52629

INDIAN SPRINGS PIBAL, 1300P, JANUARY 27

00000 40000 3204 63208 2907 82508 2315 02519
22812 42512 62714 82722 02827 52627

INDIAN SPRINGS PIBAL, 1800P, JANUARY 27

00000 40000 0505 60304 3602 82205 2107 02409
22713 43207

COMMAND POST PIBAL, 0100P, JANUARY 27

01503 41603 2309 62216 2216 82511 2809 02709
2713 22714 2714

COMMAND POST PIBAL, 0400P, JANUARY 27

01303 41403 2306 62118 2118 82412 2615 02617
2616 22617 2617 42617 52617

COMMAND POST PIBAL, 0700P, JANUARY 27

00000 40000 2304 61808 2212 82911 3015 03018
23024 42718 62530 82730 02730

NELLIS RAWIN, 0400P, JANUARY 27

LSV12 12345 00000 62413 2416 82515 2614 02518
22619 42621 62523 82525 02526 52632 02732 52630
02743 52659

NELLIS RAWIN, 0700P, JANUARY 27

LSV15 00000 1706 41913 2019 82215 2313 82214
2314 02512 22614 42522 62627 82532 02532 32632
52630 02533 52526 02627

NELLIS RAWIN, 1000P, JANUARY 27

LSV18 00000 44444 34587 89024 63112 83112 02916
52629 02635 53636

NELLIS RAWIN, 1300P, JANUARY 27

LSV21 00000 1204 41910 2015 62212 2415 82509
2809 03107 22810 42612 62927 82523 02526 52528
02542

NELLIS RAWIN, 1830P, JANUARY 27

LSV02 00000 1805 41810 1915 62016 2113 82111
2110 02008 21909 42509 62617 82623 02624 52529
02533 52525 02642 52650

NELLIS RAWIN, 2359P, JANUARY 27

LSV08 00707 20709 1916 41922 1927 62018 2015
82113 2215 02410 22805 42810 82713 82410 03017
52818 02826 52844 02645

ELY RAOB, 0200P, JANUARY 27

48610 80351 55814 01813 00045 85478 70990 50641
02515 50846 68886 40384 78832 55555 11782 05601
22766 05601 33630 55589 44565 61622 48660 55555
55340 86926

ELY RAOB, 1300P, JANUARY 27

48621 80109 53714 02509 00014 85463 70985 51589
02720 50835 66998 40371 80996 55555 11794 08543
22681 58637 33566 61781 48671 30022 95990 20884
00994 15487 08996 10312 13991 55555 44362 86976
55336 89979 66231 07992 77225 03992 88085 16998
99063 11990 00030 10991

LAS VEGAS RAOB, 0100P, JANUARY 27

38609 93304 52414 02302 00030 85473 11537 02207
70998 03682 02613 50863 65992 02516 40403 77905
55555 11925 13013 22916 14000 33600 55741 44412
75899 38659 30062 93992 20929 03997 15528 08998
10349 17999 55555 55354 84965 66319 89995
05995 88222 05996 99213 02999 00086 19995 11035
08994

LAS VEGAS RABAL, JANUARY 27

LAS09 02302 1802 42005 2307 62613 2717 82620
2619 0251 22413 42416 62519 82516 02515

LAS VEGAS RAWIN, JANUARY 27

LAS 36521 93215 51711 01302 00021 85471 12531
02114 70994 02611 03005 50855 66990 02622 40393
78885 02723 55555 11896 12537 22872 14525 23799
08561 44730 05637 55636 53637 66570 58777 77463
70852
LAS 38871 30047 95991 02333 20913 01998 02638
15518 07996 02837 10337 16991 02620 55555 88333
89941 99245 03990 00228 03992 11220 98999 22081
18994 33067 16994 44057 10998 55027 07998 66012
98999
40000 02843 52837 02644 52624

BEATTY RAOB, 0001P, JANUARY 28

BTY08 88804 52014 03607 00028 85467 08006 00000
70985 50621 02814 50837 63792 03017 40371 80858
03216 30021 95997 02535 20889 01993 02848 15496
06993 02866 10320 16995 55555 11870 07005 22846
08009 33750 01545 44625 56704 55550 64990 66460
73783 77337 90971 88274 00993 99008 17995 00054
11997 10147

BEATTY RAWIN, 0001P, JANUARY 28

BTY08 03607 40000 0000 80000 2404 83004 3009
02814 22718 52914 82918 83017 03015 33218 53018
02533 52735 02840 02840 52872

BEATTY RAOB, 0500P, JANUARY 28

BTY13 88802 51511 03604 00032 85465 99999 01203
70981 50672 02820 50835 68997 02923 40367 82993
02928 30010 97994 03132 55555 11888 02515 44444
22815 04522 33773 02551 44762 02556 55735 01582
66723 01637 77607 58732 88475 71993 99469 71991
00352 90990 11263 03997 10158

BEATTY RAWIN, 0500P, JANUARY 28

BTY13 03604 42203 1003 63508 000C 80000 0000
02818 23017 43120 63225 82922 03024 33030 53227
03132

BEATTY RAOB, 0700P, JANUARY 28

BTY15 89050 52513 00000 00038 85480 04011 00000
70994 50997 02817 50845 89776 03030 40375 83998
03032 30012 98993 02843 20871 04994 02755 15470
06993 02742 55555 11853 04012 22793 01528 33716
00658 44568 62787 55441 77873 66237 04998 77141
06998 88113 14998 99105 14996 10190 10296 10158

BEATTY RAWIN, 0700P, JANUARY 28

BTY15 00000 4000 0000 60000 0000 80000 3017
02818 23016 43120 63025 83030 03029 32731 52831
02934 52934 02962 52742 02795
22,000 ft, 300-30

BEATTY RAOB, JANUARY 28

BTY22 88913 00213 01408 00029 85472 09503 02107
70022 02870 02617 50845 68758 02837 40379 80886
02848 30030 95993 02845 20888 01999 02862 15496
06997 02677 55555 11796 03531 22768 01554 33727
03602 44556 62685 55227 08996 66220 05991 77167
02993 88107 11999 10190 10327 10158

BEATTY RAWIN, JANUARY 28

BTY22 01408 41907 2107 61908 1911 82014 2316
02617 22613 42817 62927 82934 02744 22843 52842
02856 52849 02872 52877 02770

BEATTY WINDS ALOFT OBS., 2000P, JANUARY 28

BTY04 07706 42108 1810 61911 1913 82212 2512
02615 22517 42524 62532 82638 02743 32754 52752
02730 52778

BEATTY R/S OBS., 0400Z, JANUARY 28

BTY04 88911 50114 02706 00022 85471 08506 01810
70985 50658 02615 50832 70749 02639 40360 82846
02759 30003 98997 02750 20845 04992 55555 11756
22736 00607 33670 52674 44580 62714 55348 90923
66246 09994 77215 10991 88204 04999 99188 03991
10158

MUROC WINDS ALOFT OBS., 2300P, JANUARY 28

MUF07 02315 2318 42426 2527 62628 2621 82622
2630 02530 22531 42534 62635 82437 02641 52648
02666

MUROC R/S OBS., 2200P, JANUARY 28

MUF06 93308 06714 02315 00039 85478 03521 02528
70992 50998 02519 50854 71741 02434 40383 82883
02543 55555 11915 05033 22892 05023 33816 01574
44768 04634 55723 01991 66675 52684 77470 74768
MUF56 30028 97997 55555 88349 89915 99243 09993
00216 08991 10190 20872 10158

LAS VEGAS RAOB, 0200P, JANUARY 28

LAS 38610 93107 00714 02906 00019 85466 09503
02310 70987 01581 02409 50844 69821 02711 40378
80935 03014 55555 11913 12004 22753 05542 33669
51634 44582 60686 55570 60701 66557 61797 77510
67784 88474 71797 38660 30025 96992 20895 00990
15504 05997 10333 14996 55555 99347 88991 00274
01996 11268 98997 22086 17999 33073 15998 44064
18991 55061 14995 66041 09997 77035 11997 88028
06996

LAS VEGAS RAWIN, 0200P, JANUARY 28

LAS10 02906 2306 42209 2309 62607 2710 62713
2512 02409 22410 42515 62715 82813 03014 53013

LAS VEGAS RAOB, JANUARY 28

38621 93218 00111 01808 00021 85471 10001 01913
70990 00617 02517 55555 11798 05521 22751 04532
33738 03586 44708 01581 55683 00710 66848 51999
77598 57751 88533 63747

CALIENTE PIBAL, 1800Z, JANUARY 28

01812 51811 61812 72417 82529 92626 02725 22735
42735 62732 82739 02735 52635

INDIAN SPRINGS PIBAL, 0119P, JANUARY 28

00000 40000 2202 62402 2704 82408 2511 02713
22814 42613 62508

INDIAN SPRINGS PIBAL, 0405P, JANUARY 28

INS04P 00000 40000 3305 63404 3203 82704 2709
03010 23022 43025 63222

INDIAN SPRINGS PIBAL, 0700P, JANUARY 28

INS15 02703 42705 3005 63104 3004 82807 2910
02914 22915 43115 63220 83120 03025 52929

INDIAN SPRINGS PIBAL, 1000P, JANUARY 28

INS18 03002 43004 2404 62403 2406 82409 2513
02715 22820 43019 63025 83029 02928 53033

INDIAN SPRINGS PIBAL, JANUARY 28

INS21 01803 41805 2004 62304 2405 82308 0315
02519 22818 40917 62922 82825 02928 52934 02939
57947

INDIAN SPRINGS PIBAL, 1800P, JANUARY 28

INS02 02303 42304 1505 61106 1005 81003 2107
00210
Form due to clouds

ELY RAOB, 0100P, JANUARY 28

48609 80054 57114 02804 00037 85468 70976 53996

02621 50823 68994 40356 80991 55555 11793 04990
22614 61991 33576 61994 44445 74873 10168 08045
48659 30008 95997 20865 02995 15473 06997 10302
13993 55555 55343 88995 66240 07999 77235 05997
88185 01990 99120 12991 00112 09994 11089 17992
22083 16996 33075 09991 44065 12994 55035 08993

ELY R/S OBS., 2100Z, JANUARY 28

48621 80008 57314 01907 00022 85465 70978 54661
02310 50819 69747 02864 40351 80927 55555 11790
04647 22620 62697 33594 62679 44567 64675 48671
30995 98998 20846 01998 15452 09990 10279 13995
55555 55348 89002 66258 08990 77181 00996 88092
14991 99030 08992

NELLIS RABAL, JANUARY 28

LSV18 00000 1904 42006 2107 62110 2210 8208
2811 02713 23115 43217 62919 83125 03026 52722
02726 52642 02630

This transmission is in error because of computation on the basis of 1019 mb (sea level) instead of surface P (943 mb). Note: Above this has the effect of making the speed of the 18,000-ft wind approximately 19 knots and of reducing others as well.

NELLIS RABAL, JANUARY 28

LSV21 00000 0906 41709 2012 62013 2109 82217
2317 02516 22611 42817 62824 82925 02927 52931
03139 52743 02660

NELLIS RAWIN, 1630P, JANUARY 28

LSV00 01613 1817 42022 2017 62117 2217 82315
2513 02713 22709 42720 62827 82731 02730 32740
52841 02955 52758 02761

TONOPAH PIBAL, 0900Z, JANUARY 28

TPH 0900Z 03312 03215 3219 83223 2727 02928
22830 42923 63035 83137 03150 33254

TONOPAH PIBAL, JANUARY 28

TPH12 03208 63111 3015 83019 2920 02817 22616
42521 62524 82622 02829 32936

TONOPAH PIBAL, JANUARY 28

TPH15 03602 63307 3112 83115 2820 02828 22933
43039 63043 82946 02942 32936 52930 03138 52853

TONOPAH PIBAL, 1000P, JANUARY 28

TPH18 00000 60000 2805 82313 2821 02830 22936
43044 62946 82945 02846 32948 52948 02945 52743
02783

TONOPAH PIBAL, 1300P, JANUARY 28

TPH21 01806 61806 1906 82410 2716 02526 22938
42940 62842 82845 02746 32850 55654 02761 52956
02768

TONOPAH PIBAL, 1800P, JANUARY 28

0912 61914 2013 32109 2511 02615 22622 42828
62940 83080

COMMAND POST PIBAL, 0100P, JANUARY 28

01806 41806 2219 62216 2215 82217 2323 02619
2917 22717 32622

COMMAND POST PIBAL, 0400P, JANUARY 28

122 02003 42004 2411 62316 2413 82610 2810
02611 2512 22513

COMMAND POST PIBAL, 0700P, JANUARY 28

01808 41908 2410 62412 2506 82707 3013 03026
22918 43119 63121 83127 03023 22929 52936 02933

BEATTY RAOB, 0700P, JANUARY 29

BTY15 88950 54612 00000 00035 85467 02531 01507
70973 54617 02606 50813 73759 02525 40334 86886
02560 30961 03997 02578 20849 02997 02641 15458
03999 02756 10295 11995 55555 11792 52511 22612
61664 33533 70713 44380 90931 55177 01997 66076
09994 77070 13991 88034 07996

BEATTY RAWIN, 0700P, JANUARY 29

BTY15 00000 41507 1507 62007 2207 82406 2505
02606 22519 42622 62570 82523 02531 22660 52656
02578 52550 02639 52752

BEATTY RAOB, 1900P, JANUARY 29

BTY03 88900 54511 00304 00035 85467 52793 03610
70966 57993 03010 50792 77992 02621 40306 88998
02647 30934 02992 02542 20797 00999 02627 15409
02994 02639 55555 11820 55996 22141 00996 33124
06990 10168 08940 10190 10260 10158

BEATTY RAWIN, 1900P, JANUARY 29

BTY03 00303 43609 3611 63508 3308 83308 3308
02711 22514 42618 62622 82621 02627 32642 52551
02547 52636 02652 52643

TONOPAH PIBAL, 0100P, JANUARY 29

TPH09 03107 63110 3212 83012 2613 02712 22523
43023 62925 82921 02924

TONOPAH PIBAL, 0700P, JANUARY 29

TPH15 03216 63215 3211 83007 2908 02611 22508

LAS VEGAS RAOB, 0100P, JANUARY 29

LAS09 38609 93211 52214 02115 00020 85468 08604
02210 70984 51652 02611 50834 69731 40366 81851
55555 11924 12541 22623 56734 33535 67732 44515
67719 55462 73771 38659 30014 96992 20865 06994
15470 03995 10306 12990 55555 66346 89935 77221
11991 88158 02997 99072 14998 00062 12994

LAS VEGAS PIBAL, 0100P, JANUARY 29

LAS09 02115 2111 42211 2211 62211 2113 82214
2313 02612 22612 42612 62512

LAS VEGAS RAOB, 1300P, JANUARY 29

LAS21 38621 93111 05214 02509 00021 85464 04017
02120 70975 54563 02439 50820 71751 40347 83884
55555 11922 11042 22676 55575 33589 61639 44525
68738 38671 30986 00999 55555 55360 90952 66282
04997 77068 08999 88058 12995 99C46 08990 00020
02999 11018 04999 22014 01995

[redacted]

ELY RAOB, 0100P, JANUARY 29

ELY09	48609	80257	62714	03630	00046	85475	70975
55575	03612	50814	73752	40339	84876	55555	11795
57642	22780	58654	33758	55606	44745	56818	55732
54591	66675	56576	48659	30981	98999	20830	02992
15442	03994	10283	10990	55555	77360	88929	88240
08998	99182	00999	00122	09990	11110	07994	22097
10997	33094	07993	44079	10994			

ELY RAOB, 1300P, JANUARY 29

ELY21	48621	80360	63610	00063	85481	70969	61635
50798	74179	40316	87902	55555	11730	65872	22709
64677	33688	60624	44588	86897	48671	30948	04990
20797	02992	15409	01991	10257	07996	55555	55269
08994	66093	06991	77075	11990	88045	06997	99035
09992	00030	05999					

INDIAN SPRINGS PIBAL, 0100P, JANUARY 29

INS09	02504	42506	2504	62705	2709	82415	2317

INDIAN SPRINGS PIBAL, 0400P, JANUARY 29

INS12	02904	42904	3204	63006	2613	82318

INDIAN SPRINGS PIBAL, 0700P, JANUARY 29

INS15	00000	40000	0000	63302	2707	82315	2317
02416	22712	42813	62617	82633	02838	52549	

COMMAND POST PIBAL, 0800P, JANUARY 29

CP18	00000	40000	2306	62212	2118	82014	2306
02512	22613	42721	62527	82629	02545		

NELLIS RAWIN, 0100P, JANUARY 29

LSV09	01511	1927	41929	2028	62124	2127	82217
2320	02624	22632	42635	62544	82547	02549	52648
02561	52666	02645	52578	02251			

NELLIS RAWIN, 0400P, JANUARY 29

LSV12	01819	2015	42014	2013	62013	2213	82418
2527	02533	22639	42639	62546	82548	02451	52556
02468	52564	02572					

NELLIS RAWIN, 1300P, JANUARY 29

LSV21	00000	0203	43407	2011	62011	2217	82218
2323	02334	22447	42547	62440	82446	02344	52347
02354	52458	02458					

NELLIS RAWIN, 1600P, JANUARY 29

LSV00	00226	10523	40720	2811	62114	2216	82520
2522	02524	22426	42426	62433	82549	02257	32259
52262	02557	52448	02447	52544			

NELLIS RAWIN, 0700P, JANUARY 30

LSV15	00327	30411	43507	3106	63207	3407	83109
3109	03009	22414	42411	62409	82516	02417	32321
52230	02625	52630	02737				

NELLIS RAOB, 1300P, JANUARY 30

LSV21	38621	93504	58411	03421	00038	85468	52632
03428	70996	59636	03316	50794	76996	03014	40309
89995	03113	55555	11772	58667	22746	55616	33690
60642	44666	60667	55602	66817	66589	66836	38671
30943	97969	03522	20817	50990	03127	15433	01993
03132	10287	07999	02728	55555	77376	93995	88294
98998	99132	01998	00104	08993	11090	06996	22085
96995							

NELLIS RAWIN, 1300P, JANUARY 30

LSV21	03610	0429	40308	3508	63409	3407	83508
3510	03511	23413	43012	62909	82909	00311	53416
03422	53325	03135	52929	02939	52922	03021	

NELLIS RAWIN, 1700P, JANUARY 30

LSV01	00315	0207	40108	3608	83508	3508	83816
0128	03625	23525	43417	83417	83417	03522	33839
53670	00280	53548	03441	53025	03229		

NELLIS PIBAL, 1900P, JANUARY 30

LSV03	00226	0523	40720	2811	62114	2216	82520
2522	02524	22426	42426	62433	82549	02257	32259
52262	02557	52448	02447	52544			

NELLIS RAWIN, 2359P, JANUARY 30

LSV08	00315	3041[illegible]	40610	0902	60114	3610	83612
3412	03327	23335	43442	63450	83575	08517	53581*
08409	58512						

*25,000-ft data missing, obtained by rabal.

INDIAN SPRINGS PIBAL, 0700P, JANUARY 30

INS15	00000	40000	0109	63810	3609

INDIAN SPRINGS PIBAL, 1900P, JANUARY 30

INS03	00209	40111	0205	63602	0105	80110	0125
00135	20136	43630	63640	83643	03640		

MUROC RAOB, 2200P, JANUARY 30

MUF06	93601	52310	00051	85482	00526	70986	55992
50837	64995	40377	78990	55555	11885	03580	02787
53684	33742	53715	44673	56992	55645	58991	66590
59991	77463	68998					
MUF06	30028	95999	20878	12993	55555	99330	90990
00162	05998	10190	15471	10156			

TONOPAH PIBAL, 1900P, JANUARY 30

TPH03	03318	63318	3318	83418	3522	03[illegible]26	23624
43635	63644	83444	03361	33290	58360		

BEATTY RAWIN, 0900P, JANUARY 30

BTY17	00313	43620	3525	63626	3626	83621	0218
03616	23413	40108	63511	83312	03213	33612	53621
03612	53216	03113					

BEATTY RAOB, 0900P, JANUARY 30

BTY17	09355	60111	00313	00070	85476	58622	03525
70964	61645	00117	50783	77875	03311	40295	90990
03611	30923	00990	03614	20794	98992	03215	55555
11794	63691	22756	62658	33741	60635	44714	60635
55552	74764	66526	74825	77325	98996	88320	98993
99188	00990	00164	96999	10155	10190	15415	

BEATTY RAWIN, 1900P, JANUARY 30

BTY03	03613	43524	3432	63632	0132	80131	0130
00128	23631	43635	63540	83657	08674	23684	33695
58624							

BEATTY RAOB, 1900P, JANUARY 30

BTY03 89554 64214 03613 00060 85482 57694 03532
70972 61993 00129 50806 68999 03658 40338 82996
03699 30903 96999 55555 11783 60707 22728 62761
33686 61990 44654 64990 55231 94998 10158

ELY RAOB, 0100P, JANUARY 30

ELY09 48609 80370 74914 00123 00080 85486 70965
61644 03105 50786 77801 40301 39001 55555 11276
65717 22717 66707 33704 61633 44456 82855
ELY09 48659 30930 01990 20793 00990 15407 01990
10263 05990 55555 55283 03994 66224 02999 77207
98999 88081 08992 99075 06998

ELY RABAL, 0700P, JANUARY 30

ELY15 (Levels below 35,000 ft missing) 53119 03025
52834

ELY RAOB, 0700P, JANUARY 30

ELY15 48615 80465 70714 00317 00082 85488 70968
62677 00110 50783 78991 02716 40298 90990 03014
55555 11763 68741 22743 67737 33693 62660 44655
15722 55591 71749 66568 72756 77526 77815 88502
77908
ELY15 48665 30923 02996 03012 20782 01995 03020
15392 02999 02933 10244 07990 55555 99315 02994
00125 02997 11077 09998 22057 07994

ELY RAOB, 1300P, JANUARY 30

ELY21 48621 80459 67211 00120 00065 85484 70972
66793 00117 50791 76996 03629 40388 88996 03525
55555 11795 60678 22685 67833 33865 65996
ELY21 48671 30941 48999 00280 20797 04990 03437
15404 01999 03245 10256 06990 03123 55555 44261
04993 55063 10997 66055 06990 77040 06997

BEATTY RAOB, 0700P, JANUARY 31

BTY15 89858 67514 00000 00079 85489 58701 03612
70981 59999 03443 50326 67998 08309 40362 79999
30011 96992 20855 13994 15449 07997 55555 11858
58695 22814 60713 33772 58721 44758 58990 55677
59727 66655 60731 77644 59665 88617 62673 99604
61686 00557 62756 11533 64993 22337 90990 33204
14992 44170 16992 55117 10992 10155 10190 10079

BEATTY RAWIN, 0700P, JANUARY 31

BTY15 00000 40000 3612 63519 3533 83540 3438
03443 23357 43373 63388 88309 08246

BEATTY RAWIN, 1300P, JANUARY 31

BTY21 03409 43510 3615 63621 3628 83632 3533
03442 23250

BEATTY RAOB, 1300P, JANUARY 31

BTY21 89902 66414 03409 00068 85497 51637 03615
70993 59744 03442 50840 69777 40372 79885 30024
94998 55555 11805 55717 22797 55719 33715 59754
44678 60721 55653 58676 66626 59707 77595 58704
88574 59739 99488 71787 00330 90073 11260 01996
10155

BEATTY RAWIN, 1800P, JANUARY 31

BTY02 03604 43606 0109 60114 3615 83514 3417
03322 23132 43044 63154 83158 03162 23171 53197
03098 53081

BEATTY RAOB, 1800P, JANUARY 31

BTY02 89951 60113 03604 00069 85495 52992 03609
70992 59692 03322 50840 69702 03159 40372 81842
03180 30022 94995 08002 20878 06993 55555 11879
50994 22732 59739 33682 55634 44624 60633 55593
60616 66553 63644 77338 90941 88212 11992 99177
03995 10168 09073 10518

BEATTY RAWIN, 2300P, JANUARY 31

BTY07 00403 40406 0307 63507 3408 83211 2922
02931 23147 43257 63258 83277 03287 33196* 53185
03076

*Data above 20,000 ft obtained with elevation angle of SCR658 less than 15°.

BEATTY RAOB, 2300P, JANUARY 31

BTY07 90250 58614 00403 00078 85504 54601 00307
70997 60659 02930 50827 74996 03277 40350 84995
03191 30988 96991 03026 20868 00990 55555 11768
59629 22725 44614 63649 55554 69713 66523 71838
77458 79997 88438 80994 99355 92998 00258 02990
11238 02090 22163 06999 10190 15461 10158

INDIAN SPRINGS PIBAL, 0700P, JANUARY 31

INS15 03203 43404 3604 63604 3614 83521 3623
03424 23344 43669 63369 83380

INDIAN SPRINGS PIBAL, 1300P, JANUARY 31

INS21 00000 40403 0604 60604 0409 83514 3418
03324 23350 43366 63375 83379 03379

INDIAN SPRINGS PIBAL, 1800P, JANUARY 31

INS02 00905 40809 0910 61010 0909 80406 0110
03519 23241

ELY RAOB, 0100P, JANUARY 31

ELY09 48609 80674 79410 00097 85498 70974 66819
50790 72803 40317 83914 55555 11788 64237 22770
64736 33732 67773 44682 66817 55623 20845 66603
70992 77514 72868 88[illegible]7 72792 99470 74804
ELY09 48659 30962 98997 20812 06994 15413 05993
10253 06997 55555 00357 87977 11214 08999 22120
08999 33065 10991 44060 07997

ELY RAOB, 1300P, JANUARY 31

ELY21 48621 80857 69814 00216 00085 85499 70984
68795 03417 50802 69997 03284 40336 79998 03297
55555 11646 72876 22614 72998 33574 66999 44525
70993
ELY21 48671 30987 94999 08210 20840 13993 08222
15441 06997 08113 10247 13993 55555 55334 89994
66178 0199[illegible] 77128 07995 88071 12990 99064 08997
00049 1299[illegible] 11032 08993

NELLIS RAWIN, 0700P, JANUARY 31

LSV15 00[illegible]3 0413 40311 3207 63212 3318 83424
3429 03337 23347 43378 63364 83391 03395 38[illegible]10
53385 08405 53388

NELLIS RAWIN, 1300P, JANUARY 31

LSV21 00407 0410 40408 0407 60115 3817 83320
3324 03431 23351 43373 83378 63362 03487 53382
03365 53380 03391

NELLIS RAWIN, 1700P, JANUARY 31

LSV01 00313 0519 40516 0315 80109 0203 63416
3225 03234 23344 43357 63261 63365 03374 33371
53274 03264 53189 03264

LAS VEGAS RAOB, 0100P, JANUARY 31

[illegible]AS09 38809 94151 65714 00410 00055 65480 55996
[illegible]530 70973 60990 03431 50609 66993 40362 61991
55555 11764 59998 22726 58996 33630 64996 44562
64992 10166 09440 30008 97995 20654 11996 15449
07996 10264 09994 55555 55348 69997 66212 12990
77075 15990 86060 11991 10168 04035

LAS VEGAS RABAL, JANUARY 31

LAS21 53189 06308 53299 06261

LAS VEGAS RAOB, 1300P, JANUARY 31

LAS21 38621 94603 66111 00710 00069 65496 55731
00109 70990 61991 03430 50839 65798 03379 40377
78917 03360 55555 11775 58771 22695 61791 33647
59721 44625 60747 55609 56767 86583 59994 77552
62804

LAS VEGAS RAOB, 1300P, JANUARY 31

LAS21 38671 30031 94993 03190 20882 06997 03295
15480 08993 03299 10303 14999 03278 55555 88335
88001 99215 12993 00174 03997 11102 15993 22093
12998 33065 14997

TONOPAH PIBAL, 0700P, JANUARY 31

TPH15 03405 63308 3214 83419 3430 03343 23355
43368 63382 83389 03397 38300 58307 08313

TONOPAH PIBAL, 1300P, JANUARY 31

TPH21 02502 62604 2706 82611 3218 03327 23350
43260 63264 83373 08203 33275

TONOPAH PIBAL, 1900P, JANUARY 31

TPH03 01405 61306 1405 81904 3210 03419 23315
43217 63219

BEATTY RAWIN, 0400P, FEBRUARY 1

BTY12 03603 43605 3608 63611 3515 83323 3330
03437 23453 43456 63470 63376 03350 23368 33069
53358

BEATTY RAOB, 0400P, FEBRUARY 1

BTY12 90452 591[illegible]4 03603 00084 85509 55611 03608
70002 60648 03437 50842 71613 03375 40367 64903
03365 30010 97997 20656 03996 55555 11794 57643
22725 62643 33670 58648 44634 59734 55600 62993
66530 66600 77363 87984 88226 09996 99213 06994
00170 06993 10190 15459 10158

BEATTY RAWIN, 0700P, FEBRUARY 1

BTY15 00000 43407 3507 63210 3318 63528 3432
03443 23851 43353 63359 63384 03396 33390 53366
03291

BEATTY RAOB, 0700P, FEBRUARY 1

BTY15 90457 61514 00000 00092 65508 57637 03008
70031 59871 03440 50636 71802 03367 40363 63922
06303 30006 97997 03391 20652 12992 15438 08999
55555 11890 55814 22615 60850 33606 59643 44735
60667 55710 56655 68678 59754 77613 61788 66551
67788 99370 [illegible]6 00193 13996 11168 11993 22134
07996 1015[illegible]

BEA[illegible] [illegible]AWIN, 1000P, FEBRUARY 1

BT[illegible]6 [illegible]402 40204 0206 60107 0419 83329 3436
03539 23455 43446 63452 63473 03384 33274 53283
03295 53266 02961 58005 03150 53152 03020 52919
03117

BEATTY RAOB, 1000P, FEBRUARY 1

BTY16 90701 58211 01403 00090 65518 54614 00306
70018 54621 03540 50864 87799 03463 40396 60913
03263 30048 95990 03489 20893 14991 02960 15475
10993 08002 10304 12998 03065 55555 11666 53602
22824 56824 33775 56623 54758 53591 55703 53706
66850 57722 77562 61721 68545 65744 99488 66820
66603 00326 90990 11166 16998 22172 08990 33157
15995 10995 44143 10995 55128 07998 66061 14996
77050 11993 88025 01901 99019 03996 00017 96998
11015 00990 10158

BEATTY RAWIN, 1300P, FEBRUARY 1

BTY21 00603 40202 3606 63612 3615 63522 3527
03532 23344 43438 63249 83145 03270 33255 53360
03399 53287 02742

BEATTY RAOB, 1300P, FEBRUARY 1

BTY21 90505 56611 00603 00083 85515 52607 03607
70017 55653 03537 50661 70771 03143 40393 60990
03235 30036 00992 03399 20868 16993 02938 11875
00552 22802 56612 33773 53635 44756 54642 55720
54703 66625 59757 77550 84687 88456 75863 [illegible]325
09990 00166 18994 10158

BEATTY RAWIN, 1600P, FEBRUARY 1

BTY02 3604 43606 0109 60114 3615 83514 3417
03322 23132 43044 63154 83158 03162 33171 53197
03098 53081

BEATTY RAOB, 1800P, FEBRUARY 1

BTY02 89951 60113 03604 00069 85495 52992 03609
70992 59692 03322 50640 69702 03159 40372 81642
03180 30022 94995 08002 20878 06993 55555 11679
50994 22732 59739 33682 55634 44624 60633 55593
60616 66553 63644 77338 90941 88214 11992 99177
03995 10168 09073 10158

BEATTY RAWIN, 2359P, FEBRUARY 1

BTY08 00000 40000 0000 61904 4444 84444 4444
04444 24444 44441 64444 83054 03046 22847 52936
02945 53152 03093

BEATTY RAOB, 2359P, FEBRUARY 1

BTY08 90454 58014 00000 00085 85510 52604 70016
52993 50867 70760 03054 40405 78996 02844 30056
96992 02946 20899 17993 03095 55555 11892 51575
22820 53592 33743 50645 44722 50654 55702 52683
66665 55703 77612 57704 88474 72794 99460 70826
00444 71993 11337 90990 22181 16991 33174 15998
10158 10190 15468

INDIAN SPRINGS PIBAL, 0100P, FEBRUARY 1

INS09 02504 40606 0707 60806 0203 83006 3117
03226 23135 43143

INDIAN SPRINGS PIBAL, 0400P, FEBRUARY 1

INS12 01108 40907 0906 60806 0305 83312 3321
03330 23333 43462 63469 83473 03484

INDIAN SPRINGS PIBAL, 0700P, FEBRUARY 1

INS15 02709 40407 1104 60802 3507 83415 3321
03320 23438 43450 63466 83469 03484

INDIAN SPRINGS PIBAL, 1000P, FEBRUARY 1

INS18 00105 40503 0702 60303 3306 83312 3323
03430 23548 43450 63463 83476 03479

INDIAN SPRINGS PIBAL, 1300P, FEBRUARY 1

INS21 00000 40502 0401 60103 3411 83420 3428
03431 23442 43450 63456 83456 03457

INDIAN SPRINGS PIBAL, 1900P, FEBRUARY 1

INS03 00405 41006 1004 60604 3607 83414 3420
03426 23441 43358 63331 83350 03251 53257

TONOPAH PIBAL, 0100P, FEBRUARY 1

TPH09 01803 62008 2714 83221 2228 03327 23327
43432 63235 83231 03835 33139

TONOPAH PIBAL, 0400P, FEBRUARY 1

TPH12 03309 63410 3215 83121 3226 03329 23452
43461 63569 83569

TONOPAH PIBAL, 0700P, FEBRUARY 1

TPH15 03409 63510 3316 83123 3226 03235 23450
43358 63563 83386 03287 33287 53395 08320

TONOPAH PIBAL, 1000P, FEBRUARY 1

TPH15 00000 60000 0000 83124 3129 03235 23349
43462 63370 83365 03265 33269 53178 03392 53389
08000 53296

TONOPAH PIBAL, 1300P, FEBRUARY 1

TPH21 01405 62108 3113 83220 3229 03334 23248
43260 63357 83349 03250 33159 53166 03293

INDIAN SPRINGS PIBAL, 1800P, FEBRUARY 1

INS02 1203 81813 3222 03326 23228 43131 63033
87835 02954 32862

COMMAND POST PIBAL, 0100P, FEBRUARY 1

CP09 03506 43606 0608 60610 0807 83514 3321
03431 23240

COMMAND POST PIBAL, 0400P, FEBRUARY 1

CP12 00203 40204 0215 [illegible] [illegible] 83620 3427
03423 3323

COMMAND POST PIBAL, 0700P, FEBRUARY 1

CP15 00000 40000 0405 60109 3418 83328 3421
03428 13549 23454

NELLIS RAWIN, 0500P, FEBRUARY 1

LSV13 00308 0309 40210 0109 60107 3609 83317
3426 03332 23332 43352 63363 83370 03383 53494
08311 53280

NELLIS RAWIN, 0700P, FEBRUARY 1

LSV15 00000 0306 40310 0211 63610 3610 83409
3420 03423 23440 43460 63463 83467 03382 38403
53482 08425 58435 03280

NELLIS RAWIN, 1000P, FEBRUARY 1

LSV18 00413 0411 40410 0209 60105 3603 83603
3604 03514 23544 43356 63486 83486 03366 53487
03386 53385 03261 53263

NELLIS RAWIN, 1300P, FEBRUARY 1

LSV21 00000 3003 43405 3505 63306 3409 83412
3520 03525 23434 43450 63363 83365 03358 53367
03388 53365 03386

NELLIS RAWIN, 1700P, FEBRUARY 1

LSV01 00000 0402 40303 3603 63305 3307 83510
3418 03431 23555 43451 63345 83342 03152 23163
53260 03262 53366 03366

NELLIS RAWIN, 2359P, FEBRUARY 1

LSV08 00313 0314 40314 0209 63507 3309 83312
3317 03129 23136 43154 63160 83164 03166 53084
02990 51989 02984

LAS VEGAS RAOB, 0100P, FEBRUARY 1

LAS09 38609 95150 63810 00085 85508 56631 70000
61611 50828 74781 40349 85944 55555 11914 51690
22775 60653 33723 59647 44677 62686 55628 65686
66620 64677 77604 66685 88591 65673
LAS09 38659 30994 93992 20872 00990 15478 06995
10305 15992 55555 99353 89017 00229 01995 11212
98991 22076 17993 33049 13990 44080 08992

LAS VEGAS RAOB, 1300P, FEBRUARY 1

LAS21 38621 95204 60411 01104 00087 85514 54641
03206 70014 54734 03544 50867 65808 03368 40405
78912 03276 55555 11929 01667 22800 57644 33740
54644 44712 54731 55596 58724 66532 62711 38671
30059 94993 03383 20910 15992 03065 15489 09994
03080 10312 15996 02959 55555 77384 81932 88333
88996 99184 19996 00175 10993 11139 09990 22095
16995 33552 14997 44047 10994 55030 06996 66022
00991 77016 04994 88010 01998

LAS VEGAS RABAL, 1300P, FEBRUARY 1

99993 53379 03059 53080 03056 52949 02938 52925

ELY RAOB, 0100P, FEBRUARY 1

ELY09 48609 81265 69114 03602 00101 85513 70993
66826 03317 50815 73778 40340 83898 55555 11720
66233 22746 64762 33656 66996 44650 65993 55590
67834 66540 23812 77532 71771

ELY RAOB, 0100P, FEBRUARY 1

ELY09 48659 30929 00911 20834 01996 15446 04995
10281 11996 55555 88365 89991 99247 07995 00241
04990 11164 00997 22265 14993 33035 10990

ELY RAOB, 1300P, FEBRUARY 1

ELY21 48621 81451 65914 00304 00095 85515 70011
63673 03119 50848 68774 03370 40384 78907 03290
55555 11744 58698 22691 62679 33670 61646 44633
61749 55590 64692 66522 67771
ELY21 48671 30038 94993 03297 20886 13997 15486
10991 10297 10998 55555 88330 89983 99184 16990
00178 12995 11055 12993 22045 08990 33024 04998

MUROC RAOB, 2200P, FEBRUARY 1

MUF06 94902 54310 00088 85520 02601 70036 99999
50892 67793 40430 79990 55555 11906 05565 22882
02590 33856 01603 44794 05612 55760 02632 66740
03632 77706 00999 44444 88618 56995 99564 60698
00530 65743 11426 75990 30080 96990 55555 22334
90890 33226 11994 10158

INDIAN SPRINGS PIBAL, 0100P, FEBRUARY 2

INS09 00000 0000 40000 0000 60000 80000 0000
00000 22932 43131 63336 83340 03353 53046 03038
53044

INDIAN SPRINGS PIBAL, 0400P, FEBRUARY 2

INS12 02402 40403 1304 61307 0709 82312 2518
02720 23029 43130 83031 83032

INDIAN SPRINGS PIBAL, 0700P, FEBRUARY 2

INS15 00103 42203 1410 81311 1608 82413 2620
02722 22827 42930 62932 82935 03033 53035

INDIAN SPRINGS PIBAL, 1000P, FEBRUARY 2

INS18 00000 41203 1206 81207 1207 81807 2828
02836 22621 42826 62837 82840 03030 52943 02940

INDIAN SPRINGS PIBAL, 1315P, FEBRUARY 2

INS21 00906 41008 1010 61107 1209 82211 2319
02523 22726 42726 62834 82938 02845 52833

INDIAN SPRINGS PIBAL, 1800P, FEBRUARY 2

INS02 00705 40907 0904 60804 1704 82507 2515
02719 22832 42838 62946 82959 02952 52958 02956

NELLIS RAWIN, 0000P, FEBRUARY 2

LSV08 00000 0603 40606 0608 60415 0114 83511
3316 03322 23322 43339 63341 83343 03149 53157
03252 53149 03152 53044

NELLIS RAWIN, 0400P, FEBRUARY 2

LSV12 00000 0304 40305 0708 61508 2008 82209
2715 03135 23137 43128 63232 83238 02940 52942
03045 53050 02951 52868

NELLIS RAWIN, 0700P, FEBRUARY 2

LSV15 00000 1803 42105 1603 81713 1917 82219
2521 02621 22928 43027 63030 83034 03141 33145
53134 03047 53148 02959 53068 02850

NELLIS RAWIN, 1000P, FEBRUARY 2

LSV18 00000 44444 34599 61408 2019 82828 2730
02832 22625 42726 62931 83033 03039 52941 02942
53268

NELLIS RABAL, 1000P, FEBRUARY 2

03268 52962 00270

NELLIS RAWIN, 1300P, FEBRUARY 2

LSV21 00000 44444 34599 62010 2110 82515 2720
02814 22823 42733 62937 82843 02837 52944 02953
53152 02942 52963 02868 52860

NELLIS RAWIN, 1700P, FEBRUARY 2

LSV01 00409 0409 40610 0509 83202 2517 82518
2518 02615 22820 42823 62935 82944 02944 22947
52757 02962 53060 03057

BEATTY RAWIN, 0400P, FEBRUARY 2

BTY12 00000 40000 2505 62010 2115 82317 2419
02619 22821 42935 63036 82846 02939 23033 52939

BEATTY RAOB, 0400P, FEBRUARY 2

BTY12 90858 61014 00000 00100 85520 53602 02505
70028 00662 02618 50880 68781 02845 40402 77997
03041 30074 94996 55555 11882 52576 22858 53608
33842 52599 44809 54603 55788 50631 66752 50634
77730 02682 88520 67727 99512 67733 00458 72859
11443 72851 22418 75881 33322 90990 44238 07993
10155

BEATTY RAWIN, 0700P, FEBRUARY 2

BTY15 00000 40000 1808 81812 21115 82317 2817
02716 02721 42735 62838 82939 02938 33037 52938
02848

BEATTY RAOB, 0700P, FEBRUARY 2

BTY15 90958 60111 00000 00329 85522 52597 01807
70031 01682 02716 50885 87767 02938 40421 77847
03037 30075 94990 02845 55555 11879 52589 22835
52608 33808 54619 44796 52655 55728 02887 86550
63705 77441 71805 88322 90003 99285 96997 10158

BEATTY RAWIN, 1000P, FEBRUARY 2

BTY18 00000 40000 0000 62411 2118 82214 2617
02720 22618 42623 62830 82948 02945 32835 52926
02830 52932

BEATTY RAOB, 1000P, FEBRUARY 2

BTY18 91003 56514 00000 00002 85528 51578 00000
70105 01634 02620 50897 66751 02948 40437 77851
02927 30059 94992 02931 20903 15998 15470 10993
10287 16990 55555 11888 00582 22680 51563 33830

[redacted]

52608 44817 51627 55792 00594 77762 50674 77747
03644 88578 60684 99543 65774 00484 67734 11325
90922 22178 21945 33165 20990 44145 08993 55116
15995 66093 12996 10158

BEATTY RAWIN, 1900P, FEBRUARY 2

BTY03 0000 40000 1704 61906 2210 82514 2718
02924 22934 42949 63059 82969 03047 32963

BEATTY RAOB, 1900P, FEBRUARY 2

BTY03 90601 59214 00000 00085 85519 02602 01704
70034 00678 02924 50893 64716 02969 40438 75848
02963 30100 91995 20958 13997 55555 11896 04584
22825 00617 33798 01641 44794 00644 55770 06603
66623 56676 77533 62671 88468 66773 99350 81939
00310 90990 11197 14998 10158

COMMAND POST PIBAL, 0100P, FEBRUARY 2

CP09 00000 40000 0702 61804 2401 82505 2717
02716 12915 23035 3136 43137 53133

COMMAND POST PIBAL, 0300P, FEBRUARY 2

CP11 00000 40000 1802 62401 1909 81919 2423
02621 12725 22825 32919

COMMAND POST PIBAL, 0700P, FEBRUARY 2

CP15 00000 40000 1902 62206 2215 82226 2623
02724 22931 42937 62941 82837 02944

LAS VEGAS RAOB, 0100P, FEBRUARY 2

LAS09 38609 95553 57314 03003 00095 85523 51671
00606 70033 50702 03329 50892 66793 40434 76992
55555 11945 01564 22936 02596 33900 00677 44802
51639 55768 01628 66607 55712 77541 63735 88477
68842 99461 67997 38659 30091 93994 29042 13998
15521 10992 10338 18992 55555 00322 89992 11170
16997 22167 13992 33136 08992 44090 19997 55045
15994 66040 11995

LAS VEGAS PIBAL, 1300P, FEBRUARY 2

LAS21 38621 01203 0703 40903 2204 62314 2522
82628 2736 02737 22737 42739 62942 82843 02837
52844

LAS VEGAS RAOB, 1300P, FEBRUARY 2

LAS21 38621 95207 67414 01203 00086 85517 50661
00205 70035 03679 02836 50901 65783 02840 40443
75857 02845 55555 11835 04618 22772 03676 33746
05663 44598 55686 55478 66763

LAS VEGAS RAOB, 1300P, FEBRUARY 2

LAS21 38671 30103 92998 20959 14997 15528 10990
10346 17996 55555 66378 78868 77321 89981 88177
22991 99092 19997 00050 16996 11031 10998 22026
05994 33012 01999

ELY RAOB, 0100P, FEBRUARY 2

ELY09 48609 81662 66414 01811 00109 85523 70021
54681 02818 50874 66749 40410 78822 55555 11800
56626 22756 55633 33750 53623 44685 54672 55630
57733 66605 58643 77420 77802 48659 30067 94990
20916 14999 15491 12998 55555 88324 89936 99172
17994 00168 13998 11136 [illegible] 22120 14994 10190
10310

ELY RAOB, 1300P, FEBRUARY 2

ELY21 48264 81500 60714 [illegible] 00083 85515 70024
54651 02725 50868 69722 40405 78823 55555 11782
52622 22740 50591 33657 57668 44622 60769 55558
63719 66485 70726
ELY21 48671 30059 94994 20901 18997 15464 18997
10272 17996 55555 77330 89941 88178 12997 99165
16994 00138 12990 11055 16998 22042 12994

TONOPAH PIBAL, 0400P, FEBRUARY 2

TPH12 00304 60605 1310 82013 2313 02118 22632
42633 62643 82737 02869 37923 52896

TONOPAH PIBAL, 0700P, FEBRUARY 2

TPH15 03604 60505 1207 81708 2311 02717 22724
42742 62855 82860 02972 32873

TONOPAH PIBAL, 1000P, FEBRUARY 2

TPH18 00000 60000 1309 81811 2617 02619 22527
42745 62770 82850 02876 32961 52961 02768

TONOPAH PIBAL, 1300P, FEBRUARY 2

TPH21 02306 61608 1411 81610 2009 02716 22726
46639 62761 82778 02875 52897

TONOPAH PIBAL, 1800P, FEBRUARY 2

TPH02 03306 60706 1205 81804 2405 01911 22431
42464 62563 82570 07723

MUROC RAOB, 2200P, FEBRUARY 2

MUF06 94503 51410 00076 85517 12551 70041 04561
50911 62766 40460 72995 55555 11906 12554 22875
10596 33857 12575 44835 10544 55820 10554 66678
62658 77489 63776
MUF06(56) 30125 91997 55555 88310 30990 99220
10990 10190 20081 10158

ST. GEORGE, UTAH, PIBAL, 1100P, FEBRUARY 2

SGU19 00000 1004 40808 1110 61111 1805 82214
2320 02426 22627 42827

ST. GEORGE, UTAH, PIBAL, 1400P, FEBRUARY 2

SGU22 01803 2005 41406 1312 61309 2108 82420
2615 02821 22732 42736 62928 82719

ST. GEORGE, UTAH, PIBAL, 1700P, FEBRUARY 2

SGU01 02702 2704 41905 2909 63409 0209 80614
0815 00819 20920 41030 61145

MOAPA, NEV., PIBAL, 1230P, FEBRUARY 2

MOAPA20 00000 20000 41502 2109 62217 2305

MOAPA, NEV., PIBAL, 1500P, FEBRUARY 2

MOAPA23 00000 20000 0000 40505 1309 62011
2307 82611 2615 02625 22623 42823 62744 82741

MOAPA, NEV., PIBAL, 1800P, FEBRUARY 2

MOAPA02 00000 0000 40000

BEATTY RAWIN, 0700P, FEBRUARY 3

BTY15	03803	43608	3610	83809	2806	82514	2618
02918	23028	43034	63049	83050	03052	32853	52850

BEATTY RAOB, 0700P, FEBRUARY 3

BTY15	90653	59411	03603	00091	85516	00592	03610
70031	50562	02919	50892	65707	03056	40432	78999
02850	30089	94991	20903	16996	15464	18990	10296
:9990	55555	11880	00594	22820	00602	33780	06553
44617	57595	55445	72802	66438	71753	77422	72836
77168	22996	88142	16990	99089	20991	10158	

BEATTY RAWIN, 0700P, FEBRUARY 3

BTY15	03603	43608	3810	83309	2806	82514	2618
02918	23028	43034	83049	83050	03052	32853	52850

−21.3°C, 47%, wind 22,970

BEATTY RAOB, 0700P, FEBRUARY 3

BTY15	90853	59411	03803	00091	85518	00592	03810
70031	50582	02919	50892	85707	03056	40432	78997
02850	30089	94991	20903	18998	15484	18990	10298
19990	55555	11880	00594	22820	00802	33780	08553
44817	57595	55445	72802	68438	71753	77422	72838
77168	22996	88142	18990	99089	20991	10158	

BEATTY RAWIN, 1900P, FEBRUARY 3

BTY03	00000	40000	0000	61709	1810	82213	2517
02620	22922	42929	63042	83043	02948	32949	52847
02853	52861	07810					

BEATTY RAOB, 1900P, FEBRUARY 3

BTY03	90207	62214	00000	00065	85510	06627	00000
70032	03561	02720	50894	64778	02944	40436	75992
02847	30103	87993	02854	20989	02990	07807	55555
11886	10579	22772	09547	33608	55603	44472	67826
55178	16990	10158					

ELY RAOB, 0100P, FEBRUARY 3

48609	81352	59314	00505	00078	85511	70016	54631
02731	50864	67707	40404	76826	55555	11793	52613
22779	51621	33725	51637	44644	59636	55628	59616
66577	61632	77494	67701				
48659	30064	92997	20920	14998	15479	20999	10287
14997	55555	88322	88967	99154	25991	00145	16994
11072	16997						

ELY RAOB, 1300P, FEBRUARY 3

48621	81405	53814	02708	00073	85511	70023	54589
02715	50876	64699	40421	74899	55555	11802	04566
22567	59627	33437	70841	48671	30083	91999	20939
14992	15512	12994	10327	15993	55555	44323	87007
55180	18995	66138	10995	77115	15995	88072	20993
99036	12991	00030	06996	11022	11997	22015	09997

INDIAN SPRINGS PIBAL, 0100P, FEBRUARY 3

INS09	00000	42801	2803	62903	2903	82612	2719
02823	23089	42838	63038	83045	03058	52972	

INDIAN SPRINGS PIBAL, 0400P, FEBRUARY 3

INS12	00000	42901	3503	60203	3306	82912	2919
02922	22922	43224	63037	83035	02948		

INDIAN SPRINGS PIBAL, 0700P, FEBRUARY 3

00000	40000	1804	61806	2104	82707	2616	02620
22725	43026	83250	83039	02841	52851		

INDIAN SPRINGS PIBAL, 1800Z (1000P), FEBRUARY 3

01103	40805	0906	60104	2804	82712	2717	02818
22802	43232	63036	82945	02945	52958		

INDIAN SPRINGS PIBAL, FEBRUARY 3

INS02	1800P	00000	41004	1405	61808	1807	82205
2807	02805						

LAS VEGAS RAOB, 0200P, FEBRUARY 3

83610	95151	58414	00603	00083	85515	01647	03408
70035	04625	02919	50901	83724	40443	78893	55555
11937	05591	22925	05611	33836	01843	44823	02838
55805	02641	68792	07613	77782	09632	88617	54831
99456	89757						

LAS VEGAS RAOB, 0200P, FEBRUARY 3

38880	30101	20957	14992	15517	22996	10325	17992
55555	00340	86922	11318	90982	22160	24996	33147
16999	44141	12998	55080	20995	66059	18994	77055
15990	88045	15997					

LAS VEGAS RAOB, 1300P, FEBRUARY 3

LAS21	38621	94810	61611	01102	00072	85511	04636
03604	70036	04576	03019	50903	62735	03040	40448
75885	02943	55555	11930	09641	22842	04632	33797
11593	44595	56625					
38671	30108	92991	02950	20966	12997	03055	15542
12995	08001	10356	18993	03076	55555	44320	88007
55170	17992	66163	13998	77806	23992	88080	20999
99067	23993	00042	12991				

LAS VEGAS RABAL, 1300P, FEBRUARY 3

LAS21	01202	1102	41002	3604	63404	2807	82611
2916	02918	23014	43025	63034	83037	02942	52944
02953	52950	02954	53096	03076	52958	03045	52930
02931	52928						

MUROC RAOB, 2200P, FEBRUARY 3

MUF06	93505	50710	00061	85495	12044	70019	03601
50885	82995	40481	55555	11910	13041	22864	13052
33790	08002	44746	05016	55653	52592	66638	52631
77582	56696	88546	58999	99480	64766	00430	71766
MUF06	30090	93891	20940	12997	15527	11992	55555
11381	78062	22318	90990	33194	13999	44180	09994
55149	11994	66130	18993	10158			

NELLIS RAWIN, 0040P, FEBRUARY 3

LSV07	00000	0000	41104	1704	62108	1903	82413
02411	22513	42623	62730	82730	02841	52949	02855
52865	02872						

NELLIS RAWIN, 0000P, FEBRUARY 3

LSV08	00000	20000	0000	40000	3303	62810	0615
82617	2717	02817	22922	43028	63136	83043	02838
52947	02867	52865	02863				

[redacted]

NELLIS RAWIN, 0700P, FEBRUARY 3

LSV15	00000	0507	40510	0307	63504	3005	82810
2713	02713	22924	43137	63037	82928	03044	32954
52956	02855	52962	02967	52988			

NELLIS RAWIN, 1600P, FEBRUARY 3

LSV00	00000	0403	40304	0904	61104	1103	80702
3008	02913	22717	42825	63035	82936	22939	32838
52840	32952	52958	02953	52987	53074		

NELLIS RAWIN, 2100Z (1300P), FEBRUARY 3

LSV21	00000	44444	34567	89099	22913	43119	63129
8[illegible]007	02944	52850	02853	52857	02853	52969	

TONOPAH PIBAL, 1900P, FEBRUARY 3

TPH03	00402	60909	1411	81810	2312	02416	23129
42726	62730	82834	02740	32754	52774		

TONOPAH PIBAL, 0700P, FEBRUARY 3

TPH15 Hydrogen-generator regulator froze up.

BEATTY RAWIN, 0700P, FEBRUARY 4

BTY15	00000	40000	3104	62506	2513	82714	2914
029[illegible]6	22917	43024	63138	82941	02843	32857	52853
[illegible]61	52750						

BEATTY RAOB, 0700P, FEBRUARY 4

BTY15	89851	56613	00000	00066	85494	02583	03104
70007	50596	02916	50863	65735	02942	40401	78905
02850	30055	93999	02850	20908	14991	15484	12998
10291	18992	55555	11862	52581	22816	00607	33758
04581	44588	60642	55565	58667	66727	74799	77420
74832	88332	88994	99174	16991	00088	19996	11061
19995	22057	15992	33042	15992	10158		

BEATTY RAWIN, 1300P, FEBRUARY 4

BTY21	00000	41801	1802	62901	0204	83609	3016
02719	22819	42931	62848	82849	02849	33040	52946
02998	52854	02868					

BEATTY RAOB, 1300P, FEBRUARY 4

BTY21	89614	54413	00000	00047	85482	07572	01802
70002	02573	02718	50858	66713	02946	40399	77992
02943	30055	74990	02995	20908	15991	02968	15484
12999	10298	16990	55555	11847	06575	22760	05576
33725	02589	44550	62655	55487	68731	66434	71859
77157	14995	88084	17996	99068	17990	00066	14990
10158							

BEATTY RAWIN, 1800P, FEBRUARY 4

BTY02	00000	40000	1807	61811	1814	81915	2017
02117	22720	43030	62953	82947	02933	32854	52861
02864	53191						

BEATTY RAOB, 1800P, FEBRUARY 4

BTY02	89509	53711	00000	00070	85489	07547	01905
70995	03574	02117	50862	62711	02944	40407	75822
02858	30066	92990	02966	55555	11825	07533	22785
08535	33618	54622	44555	58631	55310	90962	66224
08997	10190	20948	10158				

NELLIS RAWIN, 0700P, FEBRUARY 4

LSV15	00000	0604	40809	150[illegible]	63215	2630	82634
2634	02626	22925	42925	629[illegible]	[illegible]50	02854	22862
52868	02770	52877	02890	52791			

NELLIS RAWIN, 1300P, FEBRUARY 4

LSV21	00000	0503	43603	2905	62708	3009	83111
3220	03309	22712	42507	62616	82835	02952	52964
02801	52778	02788					

NELLIS RAWIN, 1700P, FEBRUARY 4

LSV01	00410	0506	40803	1806	62509	2207	82004
2104	02406	22815	42820	62824	82942	02844	32749
52752	02975	52961	02972				

LAS VEGAS RABAL, 0100P, FEBRUARY 4

LAS09	38609	02702	0000	42503	2512	62518	2521
82524	2527	02529	22528	42724	62733	82637	02731

LAS VEGAS RAOB, 0100P, FEBRUARY 4

LAS09	38609	94400	56714	02702	00063	85499	07579
02512	70023	04611	02530	50891	64814	02635	40434
76817	02865	55555	11934	08573	22908	07637	33862
07603	44795	09545	55748	05564	06718	05607	77635
50665	38659	30092	92997	20947	10996	15538	11995
10339	21996	55555	88315	90941	99208	72995	00168
07995	11078	24990	22057	10998			

LAS VEGAS RAOB, 1300P, FEBRUARY 4

LAS21	38621	94113	60114	00703	00050	85493	08586
02505	70016	02627	03207	50882	63764	02944	40426
75907	02956	55555	11896	02629	22810	07565	33796
08578	44544	59676	55464	67787	38671	30086	93990
20941	14990	15517	13998	10328	17998	55555	66325
88997	77177	15996	88132	12996	99080	20990	00074
17994	11065	19995					

INDIAN SPRINGS PIBAL, 0800P, FEBRUARY 4

INS16	00000	40503	0805	60509	3214	82521	2723
02822	23021	42917					

INDIAN SPRINGS PIBAL, 1800P, FEBRUARY 4

INS02	01106	41106	1404	61703	1804	82009	2212
02315	22515	43021	62831	82938	02847	52860	

TONOPAH PIBAL, 0700P, FEBRUARY 4

TPH15	00000	60000	3610	83420	3031	02934	22839
42937	62924	82741	02738	32853	52869	02865	52768

TONOPAH PIBAL, 1300P, FEBRUARY 4

TPH21	01305	61305	1607	82415	3122	02921	22626
42832	62844	82840	02845	32846	52852	02879	52996
02776	52655						

TONOPAH PIBAL, 1900P, FEBRUARY 4

TPH03	01806	61809	1814	81917	2016	02516	22617
42622	62724	82725	02628				

ELY RAOB, 0100P, FEBRUARY 4

ELY09	48609	81001	53114	02403	00060	85499	70012
51553	02625						

[redacted]

ELY RAOB, 0100P, FEBRUARY 4

ELY09 50868 67692 40404 78803 55555 11798 03531
22772 03522 33821 56589 48659 30059 93998 20910
13997 15494 11990 10310 18999 55555 44326 88928
55214 12997 66092 19991 77090 17990 88080 18998
99062 15999

ELY RAOB, 0300P, FEBRUARY 4

ELY21 48621 80811 50611 02807 00041 85488 70010
51586 02920 50826 67728 02946 40403 77994 02864
55555 11771 05551 22670 56622 33541 65717 44485
67743 55438 71868 48671 30055 96294 02855 20897
14996 02778 15469 15999 02794 10279 14998 02772
55555 66332 89999 77260 06991 88221 12991 99067
13992 00057 16990 11054 14990 10158

EDWARDS WINDS, 2200P, FEBRUARY 4

MUF06 02602 42619 2724 62729 2733 82838 2943
02843 22849 42847 62850 82892 02854

EDWARDS RAOB, 2200P, FEBRUARY 4

MUF06 93611 53714 00000 00044 85492 08578 02724
70013 02545 02842 50882 63693 02889 40427 74845
55555 11925 12521 22905 11530 33895 11533 44795
07513 55758 06550 66745 06543 77666 50546 88645
52625 99610 55636 00594 55622 11544 58651 22468
67714 33432 71771 44415 77816
MUF56 30092 91999 20940 15990 55555 55310 90990
66253 02990 77180 19999 10158

COMMAND POST PIBAL, 0100P, FEBRUARY 5

01203 41203 2604 62311 2217 82817 3017 03215
23020 43039

BEATTY PIBAL, 0000P, FEBRUARY 5

BTY08 00000 40000 0506 61805 2607 83013 3213
03114 22928 42943 62849 82870 02866 32974 52982
07912
Sfc 0130P; 3/10 AS; 10-13,000, 20+, −0.5, −4.7; Calm
893.3; 73%.

BEATTY RAOB, 0000P, FEBRUARY 5

BTY08 89400 54114 00000 00048 85484 04535 00406
70000 50562 03114 50861 61561 02870 40406 77830
02982 30061 93996 07954 55555 11881 04524 22863
05525 33836 05535 44811 04543 55769 05550 66612
57595 77558 60641 88443 70731 99320 90952 00205
13993 10190 20588 10158

BEATTY RAWIN, 0700P, FEBRUARY 5

BTY15 03204 43505 0306 60407 0407 80306 3107
02916 23034 43155 63163 83162 03167 33178 53172
03255

BEATTY RAOB, 0700P, FEBRUARY 5

BTY15 89301 53411 03203 00050 85481 04596 00306
70996 52561 02915 50850 65724 03163 40426 70992
03177 30050 93999 03250 55555 11875 05523 22823
14606 33795 04600 44592 60626 55558 61131 66528
64668 77520 63694 88450 70816 99323 90990 0293
95992 10158

BEATTY RAWIN, 1300P, FEBRUARY 5

BTY21 01603 41903 2803 83403 3508 83411 3410
03115 23231 43242 63147 83263

BEATTY RAOB, 1300P, FEBRUARY 5

BTY 89316 50611 01603 00037 85486 12007 02803
70007 00572 03115 50871 62994 03273 55555 11722
00560 22710 00565 33617 55712 44596 55682 55556
57747 66468 65993 10150 10144

BEATTY RAWIN, 1800P, FEBRUARY 5

BTY02 2703 42304 2304 62804 3404 80108 3610
03316 23231 43537 63250 83260 03163 33270 53359
03184 58106

BEATTY RAOB, 1800P, FEBRUARY 5

BTY02 89409 53513 02703 00039 85487 09532 02205
70005 51568 03304 50864 64731 03254 40409 75994
03265 30070 92996 03185 20918 14995 15483 99999
55555 11883 11532 22696 52563 33629 54724 44557
58747 55527 82704 66431 69847 77163 23993 44444
88125 17998 99110 18997 10190 15278 10158

INDIAN SPRINGS PIBAL, 0100P, FEBRUARY 5

INS 02302 42103 1004 61304 2707 82813 2919
02919 22922 43030 62943 82966 02974 52968
$^{3}/_{10}$ AS, est. 10,000, horizon to north

INDIAN SPRINGS PIBAL, 0400P, FEBRUARY 5

INS05 1200 00903 40503 0102 63503 3403 80108
0112 03613 23412 42729 62849

INDIAN SPRINGS PIBAL, 0700P, FEBRUARY 5

INS15 02402 42303 2805 63208 3205 83204 3409
03616 23310 42824 63030

INDIAN SPRINGS PIBAL, 1300P, FEBRUARY 5

INS21 00Z 02703 42207 2909 63013 3117 83119
3120 03020 23227 42225 63250 83259 03266 53176

INDIAN SPRINGS PIBAL, 1800P, FEBRUARY 5

INS02 02408 42516 2612 62609 2610 82711 3009
03010 23218 43232 63340 83351 03259 53265
Sky $^{1}/_{10}$ altocumulus; thin at 8,000 ft

TONOPAH PIBAL, 0100P, FEBRUARY 5

TPH09 00000 60000 1105 82113 3025 02933 22937

TONOPAH PIBAL, 0400P, FEBRUARY 5

TPH12 00000 60000 2912 83019 3035 03055 23042
42936

TONOPAH PIBAL, 0700P, FEBRUARY 5

TPH15 03503 63508 3416 83223 3033 02942 22943
43049 63142 83137 03062 33078
Sky $^{1}/_{10}$ cumulus at horizon; $^{5}/_{10}$ altocumulus from 3000 ft,
$^{10}/_{10}$ thin cumulostratus

TONOPAH PIBAL, 1300P, FEBRUARY 5

TPH21 02817 62918 3018 83015 3214 03317 23135
43145 63146 83066 03161 23168 53043
4 cu from 320

[redacted]

TONOPAH PIBAL, 1900P, FEBRUARY 5

TPH03Z 02704 62907 3213 83219 23327 433446
63349 83354 03351 33351
Clear

ELY RAOB, 0900Z (0100P), FEBRUARY 5

48609 80402 53714 02104 00036 85478 70994 51562
02732 50846 68718 40380 78827 55555 11792 06523
22574 61635 48659 30040 91998 20903 11999 55555
33315 88929 44163 20995 10190 15472

ELY RAOB, 1300P, FEBRUARY 5

48621 80508 50314 03417 00037 85481 70996 52584
03019 50844 67995 03262 40384 76997 03186 55555
11789 05534 22621 60631 33529 65822 44481 69992
55460 68992 48671 30041 93996 03298 20895 12999
08320 15461 18998 10263 16990 55555 66323 89997
77156 72992 88146 16996 99043 15996 00036 07999
11030 13991

LAS VEGAS RABAL, 0100P, FEBRUARY 5

LAS05 LAS09 03502 3501 42804 2510 62615 2818
83119 3115 03115 22814 42923 62938 82954

LAS VEGAS RAOB, 0100P, FEBRUARY 5

LAS05 38609 93702 55614 03502 00041 85401 07574
02400 70005 04599 03115 50874 62704 03058 40420
74822 11930 07576 22913 09574 33735 07587 44598
59634 55477 64717 38659 30086 90001 20950 12997
15520 20997 10325 16990 66110 13995 77076 18995
88055 14995 99050 16994 00039 09994

LAS VEGAS RAOB, 1300P, FEBRUARY 5

38621 93717 06314 02202 00035 85486 11571 02308
70007 00595 03218 50875 60994 03164 40424 74990
03064 55555 11676 52593 22624 54638 33578 54752
44538 57999 55526 57995

Second Transmission

38665 30087 91993 20948 13990 10314 17990 55555
66160 23997 77147 16991 88110 19995 99074 19997
00069 17998 11058 18995 22043 10998 33032 13996
44030 09994 55029 11999 66016 98999

MUROC RAOB, 0700Z, FEBRUARY 5

93711 04310 00048 85496 11024 70022 04565 50897
61521 40446 74990 55555 11917 13057 22869 11026
33840 11025 44808 08009 55792 09008 66750 09593
77673 06535 88650 04562 99637 02634 00547 57683
11446 67831
MUF 57 30111 90999 20972 12994 15547 13995
55555 22305 90990 33231 07995 44176 06995 55145
12999 66113 18996 10190 10350 10158

NELLIS RAWIN, 0000P, FEBRUARY 5

00000 44444 34599 61704 2204 82709 2819 02822
22721 42823 62936 82938 02850 22 52968 02973
53081 03087 52980

NELLIS RAWIN, 0700P, FEBRUARY 5

LSV15 00000 0000 43501 3502 60105 0311 80215
0115 03415 23115 42835 62945 83162 03068 33074
53077 03078 53077 02983 53089

NELLIS RAWIN, 0700P, FEBRUARY 5

LSV15 00000 0000 43501 3[illegible]2 60105 0311 80215
0115 03415 23115 42835 6[illegible]45 8[illegible]162 03068 33074
53077 03078 53077 02983 530[illegible]

NELLIS RAWIN, 1700P, FEBRUARY 5

LSV01 00000 2204 42608 2909 63110 3112 83116
3118 03222 23230 43242 63245 83255 03165 33165
53173 03268 53377 03165 53191

NELLIS RAWIN, 0000P, FEBRUARY 5

LSV08 00000 0000 42903 3010 63114 3118 83214
3316 03418 23324 43430 63432 83344 03344 53239
03048 53048 03156 53156

BEATTY RAWIN, 0100P, FEBRUARY 6

BTY08 00000 03327 23334 43340 63134 83134 03134
33040 52943 02938 53057 32,000 ft, 270 at 16 knots, −44.9°C

BEATTY RAOB, 0100P, FEBRUARY 6

BTY08 89800 55713 00000 00060 85497 63424 70012
51605 03327 50807 63724 03334 40418 77874 03041
92996 02833 55555 11861 09513 22718 51563 33676
52682 44643 53691 55583 58621 66212 13992 10190
20933 10158

BEATTY RAWIN, 0400P, FEBRUARY 6

BTY12 00000 43608 3508 63207 2912 83218 3327
03431 23435 43433 63235 83030 03029 32936 53043
02840 52940 03049 22842 32,000 ft, 280 at 42 knots, −55.8°C

BEATTY RAOB, 0400P, FEBRUARY 6

BTY12 89801 52712 00000 00062 85497 08503 03508
70008 01577 02431 50873 63714 02927 40415 75834
03040 30076 92994 02840 20930 13991 03047 55555
11874 08005 22734 03666 33697 01535 44564 58622
55462 68735 66313 90981 77188 15990 10158

BEATTY RAOB, 0700P, FEBRUARY 6

BTY15 89825 54711 00063 85497 06536 03410 70015
01561 03321 50881 64743 03133 40423 76991 03030
30081 93995 02837 20923 12997 03034 13995 03172
55335 11888 05555 22874 07530 33778 05553 44740
00547 55724 02543 66550 58689 77424 73844 88407
74863 99320 90990 00215 10990 11204 12995 22140
13995 33130 15998 10158

BEATTY RAWIN, 0700P, FEBRUARY 6

BTY15 00000 40000 3410 63314 3321 83523 3422
03321 23426 43530 63434 83133 03034 32926 52936
02837 22837 52841 03135 53174

BEATTY RAWIN, 1000P, FEBRUARY 6

BTY18 00204 40208 3615 63518 3322 82235 3426
03628 23627 43529 63327 83225 03028 32831 52835
03647 22544 52640 029[illegible] 58030 08057

BEATTY RAOB, 1000P, FEBRUARY 6

BTY18 90012 02611 00203 00064 85505 09994 00114
70026 02997 03628 50891 65991 03126 40431 78991

[redacted]

02833 30087 93994 02546 20948 09993 02943 15532
13990 08037 55555 11790 07995 22773 06994 33670
01990 44123 14992 10168 59012 10158 10190 10346

COMMAND POST PIBAL, 0100P, FEBRUARY 6

CP09 01204 41404 2804 83413 3520 83419 3112
02813 23235 43348 83353 83358 03340

COMMAND POST PIBAL, 0400P, FEBRUARY 6

CP12 01502 41402 0507 63509 3108 82710 2918
03127 23344 43443 63349 83340 03149 23142 53050
02945

COMMAND POST PIBAL, 0700P, FEBRUARY 6

CP15 02301 42002 0405 63109 3119 83230 3330
03323 23425 43429 63438 83342 02930 22933 53040

INDIAN SPRINGS PIBAL, 0100P, FEBRUARY 6

INS09 02704 42708 3114 63119 3117 83116 3120
03120 23337 43338 63338 83339 03244 53140

INDIAN SPRINGS PIBAL, 0400P, FEBRUARY 6

INS 02702 42902 3102 63004 3009 83015 3119
03320 23332 43333 63230

INDIAN SPRINGS PIBAL, 0800P, FEBRUARY 6

INS15 02702 42804 3005 62907 2910 83017 3221
03326 23422 43427 63431 83334 03336

INDIAN SPRINGS PIBAL, 1000P, FEBRUARY 6

INS18 02703 42904 2806 62807 3210 83318 3419
03522 23521 43532 63430 83328 03327

NELLIS RAWIN, 0400P, FEBRUARY 6

LSV12 00000 0000 40204 3307 63210 3214 83217
3220 03225 23326 43326 63332 83132 03035 53033
02840 52934 02933

NELLIS RAWIN, 0700P, FEBRUARY 6

LSV15 00000 0804 40807 0408 80105 3310 83219
3224 03326 23427 43332 63334 83128 03028 33032
53033 02937 52838 03130

NELLIS RAWIN, 1000P, FEBRUARY 6

LSV18 00000 1304 40704 3404 63310 3214 83214
3419 03523 23321 43425 83423 83224 03031 52827
02734 52735 02928 53067 03042 53050

LAS VEGAS RABAL, 0100P, FEBRUARY 6

LAS09 00603 0206 43510 3412 63414 3316 83416
3421 03323 23322 43325 63431 83335 03135

LAS VEGAS RAOB, 0100P, FEBRUARY 6

LAS 38609 94004 52514 00603 00051 85494 12516
03511 70018 02673 03323 50889 61743 03336 40441
73883 55555 11933 13001 22914 13527 33885 12522
44736 03541 55662 01725 66545 58687

LAS VEGAS RAOB, 0100P, FEBRUARY 6

LAS09 38659 30106 91996 20962 13997 15533 14996
10338 19994 55555 77356 80949 88309 90990 99165
20990 00155 14995 11085 23991 22045 12992 33036
15992 44033 11990

TONOPAH PIBAL, 0100P, FEBRUARY 6

TPH09 03204 63308 3111 82914 3016 02921 23028
43037 63049 83148 03143 33040
TPH Sfc 020; +1.8, −3.3; Calm 898.1; 69%

TONOPAH PIBAL, 0400P, FEBRUARY 6

TPH12 03207 63308 3310 82513 2617 02520 22629
42634 62634 82440 02537

TONOPAH PIBAL, 0700P, FEBRUARY 6

TPH15 02703 62909 3218 83125 3225 03326 23436
43344 63340 83130 03130

TONOPAH PIBAL, 1000P, FEBRUARY 6

TPH 3405 63308 3215 83224 3430 03437 23334
43137 63230 83125 03025 32830 52834 02646

TONOPAH PIBAL, 1300P, FEBRUARY 6

TPH21 02705 62805 3007 83412 3618 03525 23328
43126 63025 82925 02928 33029 53035 03043 52844
07912

NIPTON PIBAL, 0800P, FEBRUARY 6

Nipton 15 00000 3303 63209 3110 83016 3117
03311 23418 43222 63223 82922 02823 52826 02629

NIPTON PIBAL, 1200P, FEBRUARY 6

00000 40000 3205 63112 3412 83613 3202 03313
23521 43323 63224 83121 03128 52726 02438 52438

ELY RAOB, 0100P, FEBRUARY 6

48609 81054 85714 01809 00067 85500 70007 54603
03010 50865 62715 40411 75884 55535 11788 02523
22655 54723 33602 57768 44562 59857
48859 30074 91996 20932 13991 15503 16999 10305
16990 55555 55324 87982 66175 18996 77127 19996
88107 14999 99056 16996 00053 14991

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REPORT 3*

EFFECTS OF ATOMIC BLASTS ON WILDLIFE AT NEVADA TEST SITE

Oscar V. Deming and Louis D. Hatch

Office of the Refuge Manager, Desert Game Range, Las Vegas, Nev.

3.1 INTRODUCTION

The Office of the Refuge Manager was given the task of evaluating all material relative to the effects of the atomic blasts on wildlife and of making an over-all report of what happened to the wildlife at the time the explosions took place and in the days that followed. Material for this report was gathered through contacts with reliable people close to the blasts and from observation of much of the exposed area from an Air Force helicopter.

3.2 GENERAL EFFECTS OF THE ATOMIC BLASTS

Aerial observation of a large portion of the Sheep Range, Desert Range, Pinwater Range, Spotted Range, Belted Range, and Shoshone Mountains revealed no indications that the physical structure of the mountains in any of these areas had been disturbed by the blasts. There were no indications of rock slides or places where masses of rock had been shaken loose from cliffs or ledges. No surface disturbance was noted in the immediate vicinity of the blasts at the Nevada Test Site.

3.3 EFFECTS OF THE ATOMIC BLASTS ON WILDLIFE

3.3.1 General

The evaluation of the effects of the blasts on wildlife is somewhat speculative. Although it was possible to obtain information on the area to within 7 or 8 miles of the blasts, our knowledge of what took place near the center of the blast is based only on known material released to Civilian Defense officials (Fig. 3.1) and on our aerial observations. In general it is thought that the findings are close to actual conditions.

3.3.2 The Death Area

It is believed that all wildlife perished within a 2-mile radius of the atomic blasts. Since this radius is composed largely of bare ground, little, if any, wildlife was present. Within the

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*Digest of a report, dated Mar. 12, 1951, from the Refuge Manager, Desert Game Range, Las Vegas, Nev., to the Regional Director, Fish and Wildlife Service, Portland, Ore. This report was prepared and submitted by Oscar V. Deming, Wildlife Management Biologist; conclusion is by Louis D. Hatch, Refuge Manager.

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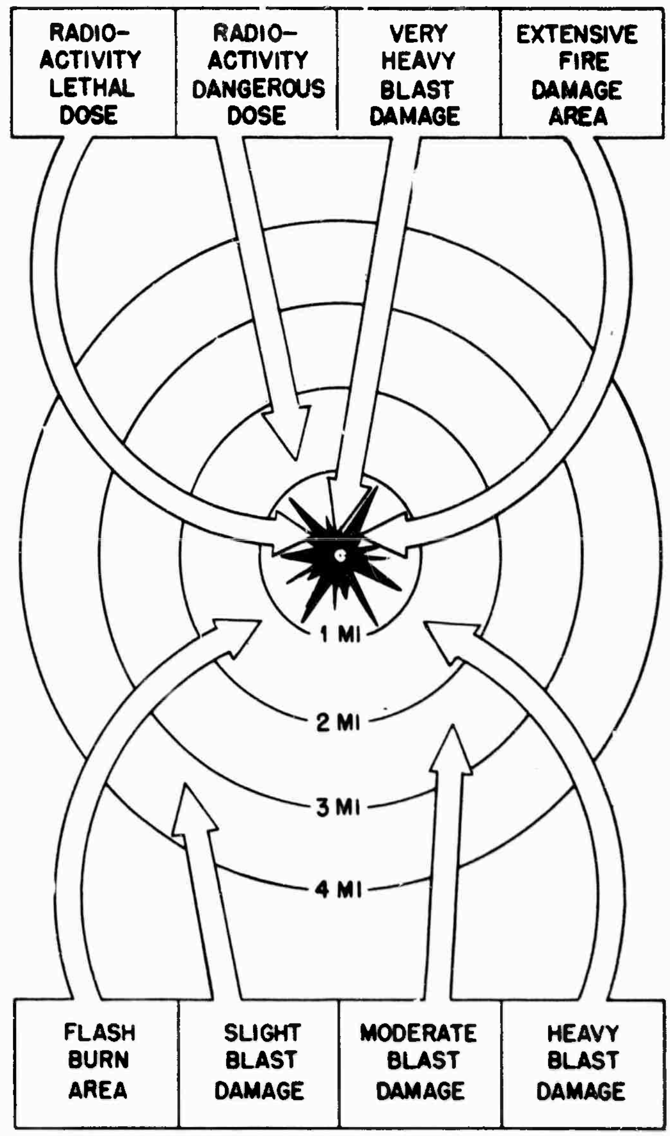

Fig. 3.1—Atomic damage in populated areas. Wildlife outside this zone would, in all probability, experience fright but not permanent injury. Chart drawn from the data of three speculative maps released to Civilian Defense officials by the U. S. Army.

next 2 miles, small ground mammals such as the antelope ground squirrel (Citellus Leucurus leucurus), pocket mouse (Perognathus spp.), kangaroo rat (Dipodomys spp.), and pocket gopher (Thomomys spp.) were present as in other similar valleys. Death or injury to these mammals would have been caused largely by secondary burns or light radioactivity. Severe concussion would be present, but this is not so pronounced near the ground level as it is a few feet above the surface.

3.3.3 The Critical Area

As shown in Fig. 3.2, the 4- to 8-mile radius is judged as a critical area. This area would be critical for large mammals, and injuries would be confined to those obtained when the animals were thrown to the ground by concussion. An employee of the AEC who was standing 8 miles from the fifth blast was knocked to the ground but did not experience any injury. Fellow workers, flat on the ground, had sand thrown in their faces.

Between the second and third blasts, several cattle (Calhoun Cattle Company) from the western extremity of the critical area were removed and tested and were found negative for radioactivity. They were later closely examined by the Wildlife Management Biologist of this office and were found to exhibit no evidence of bruises, cuts, or injured bones that might have occurred had they been thrown to the ground by the blasts. These cattle, corralled approximately 8 miles from the two blasts, experienced no apparent injury. It is largely on this evidence that it is assumed that there was no physical damage to the nearest deer at 10 miles, the nearest antelope at 29 miles, and the nearest bighorn at 22 miles.

3.3.4 Psychological Effects on Wildlife

It is believed that blasts left no permanent aftereffect on wildlife caused by fright or shock. Domestic animals at Las Vegas and Cold Creek in a line with the blasts showed fright and attempted to break out of enclosures. As the rumble of the blasts approached Indian Springs, the numerous dogs at the air base barked but did not run. Cats, which are assumed to be more highly strung animals, showed little concern. Most of the Calhoun Ranch cattle were bedded down when the blasts occurred, and their activity was confined to lowing or mooing. At Corn Creek, no pronounced evidence of more than momentary fright was noted in the mule, antelope, bighorn, and Canada goose.

An investigator made a trip into the restricted area between the second and third blasts and saw mule deer watering at Tippipah Spring, 16 miles from the blasts. Tracks indicated that deer had been watering there previous to his visit. He again entered the area three days after the last blast and saw jack rabbits within 5 miles of the center of the test site.

All evidence examined indicates that the blasts did not drive wildlife from their home range or cause more than momentary fright.

3.4 CONCLUSION

The wildlife which experienced harmful effects were limited to small rodents within 4 miles of the blasts. Big game were far enough away to experience little more than momentary fright. Unless future experiments are conducted under conditions different from those of the past experiments, there is little cause for alarm in regard to wildlife.

No major wildlife species were in the vicinity of the Nevada Test Site, and a stockproof and manproof fence is now being constructed around the perimeter of the area. Liaison is being carried on between this office and the AEC, as well as the Nellis Air Base, in order that we may keep abreast of further or any new developments.

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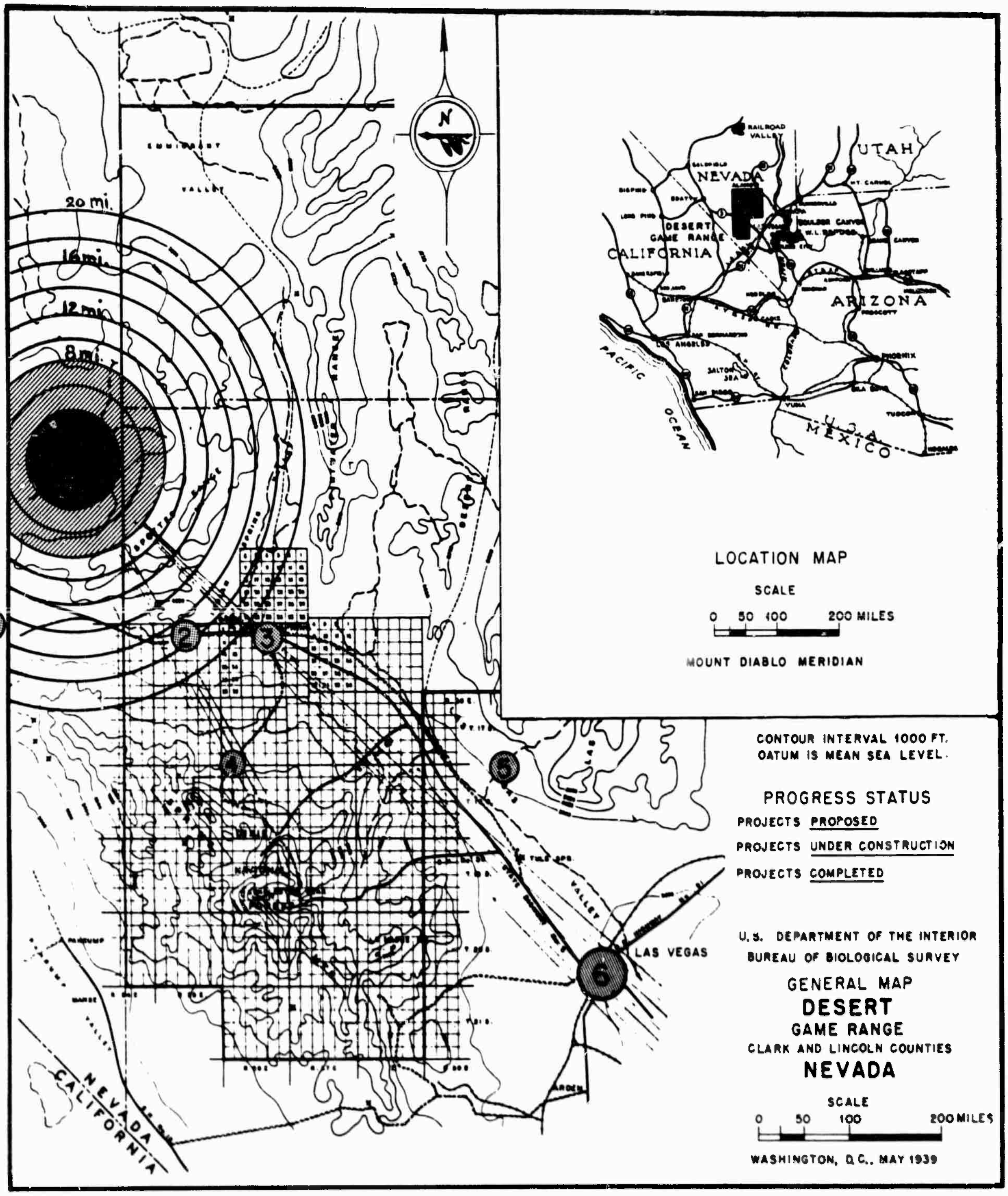

Fig. 3.2—Map of the desert game range of Clark and Lincoln counties, Nevada, showing degrees of atomic blast damage outward from the blast center. ●, death area. ◐, critical area. Lines running from center of death area indicate the direction of blasts that were damaging to buildings. Numbers in circles are information record stations: (1) Calhoun cattle, 15 miles; (2) Cactus Springs, 17 miles; (3) Indian Springs, 22 miles; (4) Cold Creek, 29 miles; (5) Corn Creek, 41 miles; (6) Las Vegas, 62 miles.

REPORT 4*

REPORT OF RAD-SAFE GROUP

Thomas L. Shipman, M. D.

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Following the completion of Operation Ranger a preliminary report of the activities of the Rad-Safe Group was prepared for the test director and other interested persons. This preliminary report contains much of descriptive interest, and, save for detailed data, it covers with broad brush strokes the most important aspects of the work. On rereading this report I am somewhat overcome with awe at our temerity in embarking on such an undertaking and filled with wonder that we fulfilled our stated objectives as well as we did. Great credit should go to those members of the Rad-Safe Group who through a combination of ability, common sense, and devotion to duty supported the group leader and surrounded him with a competence and loyalty which was truly inspiring.

For a proper understanding of the work of the Rad-Safe Group at Operation Ranger it is necessary to visualize the background. First notice of the operation came to us in the first week of December 1950. The first detonation took place on Jan. 27, 1951, and the last of the five shots was fired on Feb. 6, 1951. It can be seen that the time factor alone was one of tremendous importance. The tight schedule meant that extensive preparations had to be telescoped into a very few weeks. It should be added that everyone else connected with the operation was faced with the same problem. A second point of importance was the almost complete inexperience of the group. A couple of the members had been at Operation Sandstone, one had been present at Crossroads, and we even had one member who had witnessed the Trinity test! There were, however, no members of the group who had had real experience in the administrative side of test operations. The halt were cheerfully leading the blind! A final difficulty was the necessary utilization of makeshift—supplies, materials, facilities, and equipment of all sorts were in most cases inadequate or at least in part inappropriate for the jobs they were called upon to perform.

The delegation of authority under which the Rad-Safe Group operated is reproduced in Appendix A. Using slightly different words we established for ourselves three primary objectives: (1) the provision of all radiological-safety measures aimed at assuring the safety of all participating personnel; (2) making provision for radiological safety of the surrounding population, livestock, crops, and water supply; and (3) the acquisition of factual data which would be of scientific interest and which it was hoped would provide assurance to the Laboratory and to the AEC that similar test programs could be carried out at this same site on future occasions with safety for all concerned.

The first of these objectives was really the simplest, representing little more than an extension of the work routinely carried out by the monitoring section of Group H-1. The second of the objectives given above presented greater difficulties. It was obvious that many members

*Report dated Apr. 17, 1952.

of the group would be the first line of offense in educating the populace of the region and in providing necessary reassurance that people and property would not suffer damage. In this regard it must be admitted that our hopes were perhaps greater than our inner convictions. The importance of the third objective was not minimized, as it was perfectly obvious that the facts and figures produced would determine whether or not this particular continental site could be utilized as a permanent proving ground for operations of certain types, complementing but not necessarily replacing the existing proving ground at Eniwetok.

It was further realized that the extremely short time available made it necessary to accept certain arbitrary limitations as to what could and could not be done. It was stated, therefore, that we were limiting all ground survey to a radius of 200 miles from the site and that we could not see any necessity for concerning ourselves with aerial contamination beyond a radius of 500 to 600 miles. There simply was not time to train personnel and to procure instruments and transportation to cover a greater area. It was the firm conviction of the group, however, that these limits were perfectly reasonable ones and that, under the conditions of the tests as proposed, no significant health hazard could exist at greater distances. What might happen within these areas was a matter for considerable speculation.

It was apparent from the outset that there were three types of service which the Laboratory itself could not provide and which would have to be obtained elsewhere. The first and most important of these concerned meterology. Fortunately the Air Weather Service was ready and willing to undertake this responsibility; preliminary plans were discussed at a meeting held in Los Alamos on Dec. 18, 1950, with Col. Harold L. Smith, Maj. Gerard Leies, and Capt. Robert E. Heft, all of the AWS. At this meeting a tentative plan of operations was agreed upon, and it should be said at this point that in the end the AWS provided for us far more complete and more expert coverage than was at first thought possible.

Another service which could not be provided by the Laboratory was aerial survey work and cloud tracking. Here the responsibility was accepted by representatives of AFOAT-1, and a detailed plan of operations was presented by them at a meeting held on Dec. 21, 1950, with Col. J. J. Cody, Col. Reed, Capt. Harland, and Dr. Urrey representing AFOAT-1. The plan of operations which they presented at that time was the plan which was utilized essentially without change during the operation.

The very magnitude of the operation and the potential problems which might possibly result, problems on a scale far larger than any which could be handled by the Laboratory, called for the presence of a senior group of advisors. The Rad-Safe Group regarded itself as fortunate in having had available at all times for advice, moral support, and consolation Dr. Shields Warren and Dr. Walter Claus of the Division of Biology and Medicine, Dr. Howard Andrews of the U. S. Public Health Service, and Brig. Gen. James P. Cooney, Rad-Safe Officer for Operation Greenhouse. This group of men provided invaluable advice and support not only to the Rad-Safe Group but also to the directors of the operation itself.

The first organizational meeting of the staff of the Rad-Safe Group was held Dec. 8, 1950. From this derived the organization chart given in Appendix A. It is felt, in retrospect, that this organization was essentially sound and that it could be adapted to almost any test operation with only minor changes. It should be pointed out, however, that each member of the staff was chosen for a particular job because he had special knowledge, skills, or experience which fitted him for that type of work. These men were expected to use their knowledge and formulate their own decisions. They all proved worthy of the responsibility placed upon them. This fact is mentioned because a similar organization operating along military lines and staffed by military personnel must, of necessity, operate somewhat differently. Members of a military staff are sometimes chosen on the basis of rank rather than special skill or ability.

The personnel roster of the Rad-Safe Group is also given in Appendix A. It should be pointed out that the majority of the group, those from Los Alamos, had worked together previously and all knew each other. Great credit must be given to those who as comparative strangers joined us. At no time was there other than harmony and cooperation. Civilians and military men worked smoothly, arm in arm, and all vestige of rank was forgotten; petty jealousies were nonexistent, and what should have been a fertile breeding ground for short tempers failed to produce them.

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A description of the general working and living arrangements must be included. It was painfully obvious from the outset that the work of the Rad-Safe Group would have to be carried out with makeshift facilities at best. A limited amount of space was available at the control point for the site monitors, with living facilities provided at the Indian Springs Air Force Base. The group headquarters as well as the headquarters of the mobile monitoring teams was at Nellis Air Force Base outside of Las Vegas. Part of the personnel was housed at the base, and others at the El Cortez Hotel in Las Vegas. Members of the mobile teams and their section leaders were established in outlying communities. Communications were provided in which telephones, teletype, and radio were all used. Radio proved to be singularly unreliable owing to the distances to be covered and the irregularity of the terrain. The experience gained has been invaluable in planning for a communication network for a permanent site.

Transportation was provided by a strangely assorted fleet of carryalls, sedans, pickups, jeeps, and a weapons carrier. Very definite recommendations and specifications for vehicular transportation can now be made for any subsequent operation. In addition to the motor vehicles mentioned, of which there was a total of 18, a Carco Bonanza was at all times at our disposal, as were two helicopters. (It was not necessary at any time to make use of the helicopter at Nellis Base, although the availability of a helicopter should be regarded as essential.) The Carco Bonanza was used extensively, and a plane of this type or one slightly larger will also be necessary in future operations. At Nellis Base there was also available for our use a veritable fleet of jeeps, commanded by Capt. James R. Booth, Company C, 82nd Reconnaissance Battalion, Second Division. These jeeps and their drivers could have been used more extensively had the drivers been Q-cleared and thus able to enter the restricted areas. Jeeps would also be of more use in warm weather; they are not ideal for long trips on a cold winter night.

4.1 GENERAL PLAN OF OPERATIONS

The Rad-Safe Group had its headquarters in the building which had been assigned to our use at Nellis Air Force Base. In the south wing of this building were the communications headquarters, communications supply and repair room, and the office which served as headquarters for Dr. Graves and Capt. Tyler. The north wing contained adequate space for operations and supply room for AFOAT-1 as well as room for the storage and maintenance of monitoring instruments. The central portion of the building contained Rad-Safe headquarters, Rad-Safe communications, and the operations center for all regional monitoring. The AWS meterologists had their quarters in the base operations building.

Shortly after the first of January, crews of Air Weather Service personnel were making routine observations at the town of Beatty approximately 45 miles west of the firing site, at the control point itself, at Indian Springs, and at Nellis Base. This work included observations of the upper airs as well as those closer to the surface. These observations were carried out without interruption through the completion of the tests. During the week preceding the tests a group of expert analysts prepared the detailed charts similar to those used throughout the test period.

The majority of the monitoring personnel had assembled on Jan. 22, 1951, and they immediately started background and population surveys of the area. The members of the 10 mobile teams surveyed practically every passable road going north as far as Ely, Nev., east to Cedar Springs, Utah, south to Needles and Kingman, Ariz., southwest to Baker, Calif., and northwest to Tonopah, Nev. Groups of these teams had their local headquarters with installed radio and telephone communications at Caliente and Glendale, Nev., and Cedar City and St. George, Utah. On two occasions it proved perfectly simple to transfer a complete group of units from Glendale to Needles when such a shift became advisable. Water samples from Lake Mead were taken before, during, and after the test period.

The operations plan as developed in the weeks before the actual start of the test is given in Appendix B. Particular attention is called to Appendix B, Sec. 4B.4.1, on the permissible exposures for participating personnel. The imminence of Operation Greenhouse did not simplify the problem. It became established as a fact, however, that a permissible exposure of 3.0 r

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per test operation was a reasonable level. Practically all recovery operations could be accomplished without exceeding this limit, and at the same time the spirit if not the letter of the official AEC permissible level was not being violated.

The information given above has attempted to do little more than provide a general background to make a description of the actual operations more understandable. The sections which follow below are primarily descriptive, with most of the factual data being given in the various appendixes. It must not be forgotten that the entire operation was carried out on a "crash" basis and that reports were not infrequently sketchy and occasionally were nonexistent. This fact, sad but inescapable, resulted from the lack of time, lack of personnel, and lack of experience. No apology is made if data in certain fields seem inadequate.

4.2 SITE MONITORING

The bare recital of personnel exposures and ground levels as given in Appendix C fails to give any picture of the fears, the hopes, and the man-hours of work which were involved. One seemingly unrelated fact played a very important part in permitting a successful completion of the job in hand. The average trained monitor has been taught that he should shun exposure to radiation as the devil. He has had it impressed upon him that on encountering an area of contamination he is supposed to turn around and retreat to safety with all possible haste. In a weapons test a monitor is obliged to enter a contaminated area deliberately, sometimes receiving more exposure than he ever received before at any one time. This act violates all his dearly held precepts, and he must acquire something of a new outlook on life. Fortunately, operations in the Bayo Canyon Site at Los Alamos had provided a small nucleus of the necessary experience. The members of the little group who had participated in these activities were well prepared to enter contaminated areas calmly and with discretion, providing a careful and considered calculation of the risk involved. They also provided the necessary indoctrination of other monitors. At a weapons test the value of a monitor is questionable until he has undergone his first baptism of fire—or radiation. No test should be undertaken without at least a nucleus of test-experienced monitors since a green hand could easily and unnecessarily prevent a recovery party from completing its mission.

Initially, after each detonation in the operation, a preliminary survey of the target area was made by a monitor in a helicopter and by a team in a vehicle. In every case the monitors were able to penetrate to ground zero, providing information as to the highest levels which might be encountered subsequently. The initial survey, of course, was incomplete and was followed later by more careful and detailed surveys so that no recovery party entered the area without some information as to the levels to be expected.

All recovery parties were accompanied by monitors. The principal advantage of this is that the leader of the party and his group do not have to think about their exposures and thus divert their attention from the work in hand. The monitor takes care of following the exposures and advises the party leader when it becomes advisable to withdraw.

In so far as it was possible, all monitors were indoctrinated in the general experimental program, and an attempt was made to have each monitor familiarize himself with the details of the project with which he would be associated. This is felt to be of great importance as the monitor not only knows in advance what procedures are to be carried out but also appreciates the relative importance of the project and identifies himself with it.

A word of praise should be said for those monitors drawn from the Security Service and from other AEC installations. Working under new conditions and in strange surroundings they were highly cooperative and cheerful and became valued members of the team.

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4.3 OTHER ON-SITE ACTIVITIES

4.3.1 Photodosimetry

All persons entering the contaminated areas wore film badges which had to be returned to Los Alamos for processing. In spite of this cumbersome procedure there were no significant overexposures. We seriously underestimated the amount of manpower required to supervise the issue and return of film badges and pocket dosimeters and to maintain adequate records of exposures. The requirements for this work should be very carefully evaluated for any future test. Records of individual exposures are given in Appendix C. Behind this report lie long hours without sleep and an unselfish devotion to duty on the part of Arthur Murray, normally an organic chemist on the staff of Group H-4.

4.3.2 Supply

The short time available for the gathering of the necessary supplies, instruments, and materiel in general was only one of the problems facing Glenn Vogt, H Division supply officer. Makeshift transportation, inadequate storage space, and the not-infrequent indecision as to what was really needed all contributed to produce a glorious nightmare. After the dry run was over a species of order emerged from the chaos, and somehow the necessary equipment always seemed to appear when and where needed. Harry Allen and his coworkers literally accomplished miracles. A detailed listing of the major items of equipment utilized is given in Appendix D.

4.3.3 Decontamination

Personnel decontamination did not prove to be a problem; this was fortunate in that the facilities available for washing and showering were the most rudimentary. In practically no instance did the protective clothing which was issued—caps, coveralls, gloves, and booties—fail to give the necessary protection. This equipment was rendered more efficient by the copious use of masking tape to seal the openings at wrist and ankle.

Vehicle decontamination was a problem and might have been insoluble had it not been for the heroic efforts of Capt. William Kratz, USA, (C.E.). Captain Kratz was assigned to the group without restriction by the Corps of Engineers, and, since it turned out that vehicle contamination was his main interest, he was given the job. No one ever quite knew where he got the ramp, hose, steam generator, or any of the other supplies needed, but they were on hand when needed.

Confusion and serious inconvenience are bound to arise if it is necessary to use vehicles for both on-site and off-site work. Every effort should be made to have a motor pool of vehicles which are used exclusively for work in the target areas.

4.3.4 Construction Workers

The problem of construction personnel is easily forgotten, but it is of great importance. All construction workers and their supervisors who are to enter contaminated areas should have routine physical examinations, these to include chest X ray and complete blood counts. We were able to provide all but the chest X rays, which had to be disregarded. There are two points of importance, however: (1) construction workers and particularly their supervisors may receive exposures among the highest, and (2) the number of construction workers needed in the contaminated areas will invariably be underestimated until the last minute. It should also be kept in mind that medical supervision of this group is probably of greater importance than it is for the scientific personnel. This is the group from which spurious or fraudulent claims are most apt to arise.

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4.4 OFF-SITE MONITORING

The general plan for the mobile monitoring teams has been given in Sec. 4.1. The salient findings of this group will be found in Appendix G. All their findings are retained on file at Los Alamos and can be made available to those desiring them. These will not be given in this report, however, as they could easily produce serious misunderstandings if taken at their face value.

As for population in the surrounding area, the people living closest to the shot area were those at Indian Springs and Cactus Springs, approximately 25 miles away. (This means about four families in addition to the people based at Indian Springs Air Force Base itself.) To the southeast there was no one closer than the fringes of Las Vegas, approximately 65 miles away. To the east were scattered families along highway 93, none closer than 60 miles. To the north was a small community of 16 people at Groome Mine, 38 miles from the shot area. Thirty miles to the northwest were a few families at Lathrop Wells, with other people living at Beatty and in isolated houses generally to the west of the shot area, none closer than 50 miles.

The closest portion of Lake Mead to the shot area is approximately 80 miles. The town of Caliente (population approximately 1000) lies approximately 100 miles northeast of the site, with Pioche, slightly larger, about 25 miles farther north. The town of Goldfield is about 90 miles northwest of the site, with Tonopah some 25 miles beyond.

One unexpected group of residents turned out to be a herd of bighorn mountain sheep. These wards of the U. S. Fish and Wildlife Service are mostly in the sheep range 40 miles east-southeast of the site. One of our monitoring teams encountered a herd of about 50.

On the day preceding a shot, 10 vehicles with two-man crews were dispatched to the small communities in the region where weather forecasts indicated the cloud would pass. Roads and populated centers were monitored with survey instruments carried approximately 3 ft above the ground. As far as finding activity was concerned the work was disappointing to those craving excitement but reassuring to those wondering about the possibility of creating unsafe conditions. The members of the mobile teams had many memorable and amusing experiences: One group based at the town of Caliente even formed a basketball team and played, not too successfully, in a local tournament. One point of considerable technical interest did arise however. If a man happened to be actually in the path of the low-lying dust cloud he could measure significant amounts of activity while air-borne particles, very small in size, were actually around him. When this dust cloud had passed, there seemed to be little or nothing deposited on the ground and no residual activity of any significance. At the same time it was realized that the top of the cloud carried very considerable amounts of activity which could reach the ground at distances of hundreds or thousands of miles from the site of detonation. At none of the five shots, however, was there evidence of fall-out which might be dangerous to humans or animals within the radius covered by the mobile monitoring teams.

4.5 FALL-OUT STUDIES

The study of air-borne activities, with a consideration of individual particles, their sizes, and activities, obviously required equipment and an organization which could not be brought together in the time available. Studies on a very limited scale were carried out, however, and the results of these studies are given in Appendix E. It should be kept in mind that the levels found do not necessarily indicate the highest levels which might have been shown had the collecting station been placed in a more fortunate location. The successful collection of air-borne material depends to a large measure on luck and on saturating the area with collecting stations.

[redacted]

4.6 METEOROLOGY

It was realized that the personnel assigned to the operation by Air Weather Service would more than have their hands full with forecasting and could devote but little time to interpreting these forecasts for our own particular purposes. For this reason, Capt. Robert E. Heft, officer in charge of the AWS unit regularly assigned to H Division, was brought along rather as our private meteorologist. Capt. Heft performed a most valuable service in translating the meteorological forecasts into cloud and fall-out predictions. This enabled the mobile monitoring teams to place themselves in strategic locations in adequate time to detect the arrival of activity, if any. The experience gained also enabled Capt. Heft to devise a simplified method for predicting the location and time of fall-out, a method which he subsequently worked out in considerable detail with Lt. Col. Clifford A. Spohn, AWS. Capt. Heft's report is given in Appendix F.

4.7 NOTIFICATION TO CAA

One problem which was anticipated but quite unexplored concerned the provision of information to representatives of the CAA so that aircraft—commercial, private, and military—could be kept out of contaminated air. Discussion of the subject was not rendered any easier by the fact that there were no CAA representatives who had been cleared; in the end, expediency and common sense won out.

A procedure was worked out with Mr. De Arcy, Regional Director for CAA, in which the Salt Lake City office would be advised by code, at approximately 9 P.M. on the evening before a shot, that a specified area would be closed to air traffic the following morning for a specified period. It was understood that this information would be sent out over the CAA network at approximately 4 A.M. It was realized that the particular air lanes which would be closed and the duration of the closure would depend primarily on meteorological conditions. The procedure worked essentially as planned. It cannot truthfully be said that the arrangement was very satisfactory, but it is hard to see how a better arrangement can be made unless it can be agreed that a publicity release as to the date and approximate time of a proposed shot can be made. The CAA warning unquestionably constituted one of the most serious of the numerous ways in which absolute security in this regard could be violated.

4.8 CONTACTS WITH THE PUBLIC

Prior to the operation considerable apprehension had been expressed over the public reaction to having a series of atom bombs detonated in their vicinity. It was feared that disapproval might be vocal and loud, that there would result a series of complaints and a flood of claims for damage. It can be stated that these fears were groundless. The writer of this report was with the group which first advised the city and county officers of the proposed tests, and he and members of the group talked with various local citizens on numerous occasions. About the only reactions commonly encountered were interest and a desire to help. People almost never asked prying questions, and if they did so inadvertently they never pressed for an answer. Many people living in remote areas were of very great help to members of our group. Particular gratitude should be expressed to Dan Sheehan and his family at Groome Mine, just about the closest neighbors to the detonation.

There were many amusing incidents and many inquiries: A young chicken farmer wondered if the detonations had anything to do with an unexpectedly high incidence of infertility in his eggs, while the owner of the Blue Diamond Mine located to the north of Charleston Peak wanted to know if we had caused his Geiger-Mueller counter to hop around in an astonishing manner. There were numerous stories, some of them rather Balzacian, about the effect of the burst on people who witnessed it unexpectedly. On the whole people seemed rather proud to have the operation in their midst, and it was regarded generally as good for business.

[redacted]

4.9 OPERATIONS IN RETROSPECT

In Appendix G is given the summary description of each shot as it was written for the preliminary report. There is little that can be added. The group disbanded and returned to home stations, and there was not a man or woman who participated who did not share a glow of satisfaction in having been a part of a successful undertaking. We plunged immediately into plans and preparations for future test activities. All of us, I think, emerged considerably wiser.

4.10 CONCLUSIONS

Having read over the conclusions written for the preliminary report I find that the passage of several months has not altered my thinking in any respect, and for this reason the conclusions are repeated just as written at that time.

1. Operation Ranger was carried out without serious accident to personnel and without a significant overexposure. It had been previously agreed that exposures up to 3.0 r would be permitted for the operation (2.0 r for individuals planning to participate in Operation Greenhouse). The highest cumulative dosimeter recording was 3.1 r in the case of a McKee construction foreman. From this it would appear that the permissible level of 3.0 r for an operation of this sort is entirely reasonable.

2. No significant levels of contamination were found anywhere in the adjacent area. The fact that measurable activity was observed in the snow in New England bears out the contention that by far the greatest part of activity is in the upper part of the cloud, which in that particular case reached an altitude of approximately 35,000 ft. The blast damage seemed to be minimal, although the fact that any damage at all occurred as far away as Las Vegas was somewhat surprising, and it is obvious that the factors controlling this are poorly understood.

3. A very extensive amount of information to be added to the knowledge of weapon phenomenology was gathered. If this information proved nothing else, it certainly verified the belief that detonations of this type could be held at this site almost at will, with no resulting radiological hazards in the surrounding countryside, provided certain basic meteorological conditions are respected.

From the above conclusions I believe that it can be stated with a certain amount of pride that the Rad-Safe Group in Operation Ranger successfully carried out its assignment. It would be very nice at this point to extend a word of thanks to those who contributed so unselfishly to the success of the work. Such an attempt would simply produce a long list of names. The writer, however, has a very deep feeling of humility and gratitude to every member of the Rad-Safe Group, to the other individuals participating in the operation, and to the representatives of the outside agencies who found themselves drawn into this operation whether they wished to be or not. Particular thanks should be given to the inhabitants of Las Vegas and the surrounding country for the cheerful manner in which they put up with numerous inconveniences.

Out of Operation Ranger were drawn many valuable experiences, and it is deemed proper at this time to make a few recommendations:

1. The author of this report very strongly recommends that at no time in the future should test operations involve nuclear detonations on successive days.

2. It seems probable that proper instrumentation can be devised so that the majority of the regional monitoring can be done by airplane.

3. A larger pool of experienced monitors should be available at the site. It should be pointed out that familiarity with the various monitoring instruments does not constitute sufficient experience for men to go into areas where high and possibly dangerous levels of radiation exist. Practical experience under close supervision is required before the safety of scientific personnel can be placed in the hands of a monitor.

4. Operation Ranger required that many procedures be carried out with makeshift equipment. Specific recommendations on specific points, such as the type of vehicle to be used for site monitoring, the adequacy of protective clothing, and the operating procedure for regional monitoring, can now be made.

[redacted]

5. The participation of the Air Weather Service with an adequate number of Q-cleared personnel is essential.

6. Participation of AFOAT-1 with an adequate number of Q-cleared personnel is essential.

7. It is strongly recommended that Q clearance be obtained for one or more representatives of the CAA, who would then become participating members of any subsequent operation.

8. In any future operation it will be necessary to utilize a larger number of individuals who need not have technical training. These people are necessary to assist in more or less menial chores such as property clerking, chauffeuring, etc. It must be remembered, however, that in all probability no future operation will involve as many detonations in such a short time, and that the strain on personnel will consequently not be as great.

9. It is hoped that a limited number of civilian-defense personnel can be drawn into subsequent operations. The number of such people who can actually be incorporated into the monitoring group is, of course, limited, but it is hoped that a considerable number can be brought in at least as observers. The important thing for civilian-defense monitors to learn is how to approach an atom-bombed area and determine not only the margin of safety but also the amount of time which a person may safely spend in an area where residual contamination exists. Instruction along these lines should be given first of all to those who will subsequently have the responsibility of instructing other groups.

10. The members of the Rad-Safe Group appreciate the trust which was placed in them and at the same time feel with a certain amount of pride that they have earned the right to participate in the same capacity in future test operations.

Appendix A

ORGANIZATION

Reproduced in this appendix is the text of a letter delegating authority and responsibility to the chief of the Radiological-Safety Section, Operation Ranger. Also reproduced is the roster of personnel responsible for the success of the section, including the group proper, members of the AEC Protective Force, and additional personnel from AEC area offices and the U. S. Army Engineer Corps. Figure 4A.1 is the chart of the organization under which the Rad-Safe Group performed its duties and accomplished its objectives.

4A.1 DELEGATION OF AUTHORITIES AND RESPONSIBILITIES*

Pursuant to the Manager's directive of Jan. 17, 1951, you are hereby designated Chief, Radiological-Safety Section for Operation Ranger. In this position you are delegated the necessary authority to direct all radiological-safety operations incident to the successful test objective. The Radiological-Safety Section shall be staffed with such personnel as you require, drawn from the Los Alamos Scientific Laboratory and where necessary from other appropriate SFO units or units of the Department of Defense.

Your assignment of function as Chief, Radiological-Safety Section includes the following:

1. Coordination of activities designed to give adequate insurance of radiological safety.
2. Advice to this office on radiological-safety conditions as required.
3. Orientation of civilian personnel in the area as determined by you to be adequate.
4. Advice to this office of your operational plan for executing the radiological-safety program.

*Memorandum from Alvin C. Graves, Chief, Test Group, Operation Ranger, to Thomas L. Shipman, Chief, Radiological-Safety Section, Operation Ranger, Jan. 24, 1951.

[redacted]

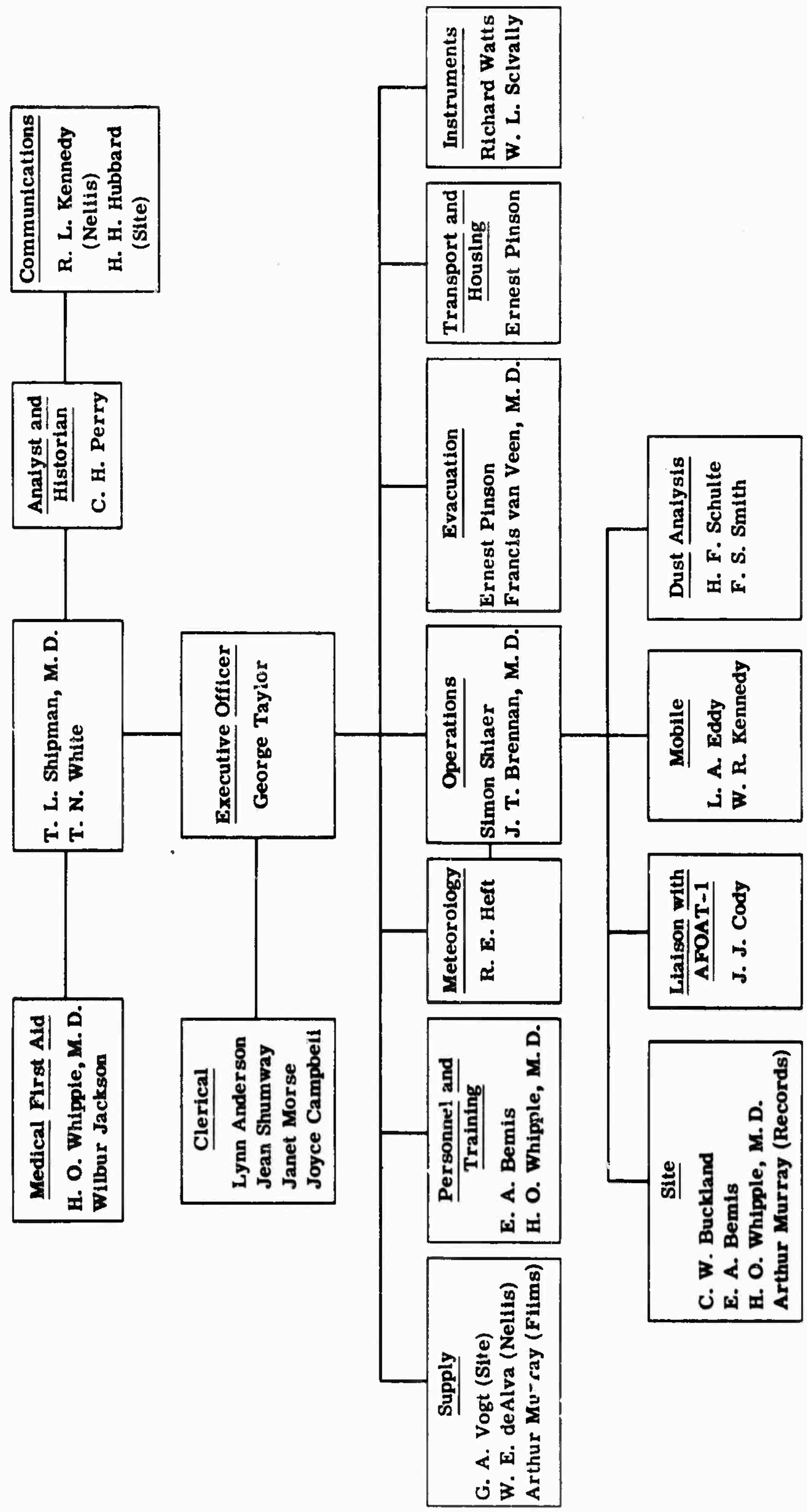

Fig. 4A.1— Rad-Safe Group organization chart.

[redacted]

5. Advice to this office of a complete listing of all personnel required to execute your operational plan for radiological safety, including name and organization affiliation.

6. Advice to this office of all administrative services required by the Radiological-Safety Section which the personnel of the section will not be able to execute themselves and will therefore have to call on others for accomplishment.

It is requested that this office be kept fully advised as to radiological-safety program and current problems. Upon completion of the operation it is directed that a complete report be submitted in collaboration with such supporting activities at the site as you have mentioned above in your operational plan, paragraph 4.

4A.2 RAD-SAFE GROUP: PERSONNEL ROSTER

Table 4A.1 is a list of personnel participating in the activities of the Rad-Safe Group. The uncertainties of the results of the operation made it apparent that personnel would be required

Table 4A.1—Rad-Safe Group Personnel

Los Alamos Scientific Laboratory	Division and group
Jack W. Aeby	H-1
William B. Allen	H-2
Lynn C. Anderson	HDO
George M. Angleton	H-1
Edwin A. Bemis	H-1
Wendell Biggers	J-3
Charles D. Blackwell	H-1
Lt. Col. James T. Brennan, M. D.	HDO
Carl W. Buckland	H-1
Joyce Campbell	J-6
Leo J. Carr	H-1
T/Sgt. George L. Clark	H-1
William E. de Alva	H-1
Maj. Leonard A. Eddy	H-1
Ralph E. Gosline	H-1
Capt. Robert E. Heft	H-1
Reynold L. Hoover	H-1
Edwin C. Hyatt	H-5
Ogden S. Johnson	H-4
William S. Johnson	H-5
William R. Kennedy	CMR-12
Johnnie L. Montoya	H-1
Michael Moore	J-3
Janet Morse	JDO
Arthur Murray	H-4
Charles H. Perry	H-1
Gordon Pettengill	H-1
Lt. Col. Ernest Pinson	H-4
Jose B. Romero	H-1
Anthony R. Ronzio	H-4

[redacted]

Table 4A.1 — (Continued)

Los Alamos Scientific Laboratory	Division and group
Harry F. Schulte	H-5
William L. Scivally	H-1
Thomas L. Shipman, M. D.	HDO
Simon Shlaer	H-1
Jean D. Shumway	H-1
Francis S. Smith	H-5
Chester Stanhope	CMR-12
Ellery Storm	H-1
Col. George W. Taylor	H-4
Maj. Francis van Veen, M. D.	H-4
Glenn A. Vogt	HDO
Richard Watts	P-1
Harry O. Whipple, M. D.	HDO
Thomas N. White	H-1

AEC Area Offices	Station	AEC Area Offices	Station
John E. Bradley	OROO	Frank G. Lowman	HOO
Stanley G. Fidler	COO	Jim Loy	NYOO
Edward D. Fleckenstein	COO	Dixon P. Schively	HOO
Lee Gemmell	NYOO	Frank E. Sentfle	NYOO
Robert E. Hayden	OROO	Milo Deane Voss	COO
Edward J. Kehoe	NYOO	Himan G. Yuster	NYOO
William Kingsley	Sandia	Fountain R. Zintz	COO

AEC Protective Force	U. S. Army Engineer Corps
Glenn W. Billups	Ernest H. Dhein
Morris S. Davis	Maj. James B. Hartgering
Joe A. Eckart	Capt. William Kratz
Wilbur Jackson	Capt. Kenneth Paate
James L. Jones	Capt. Lloyd H. Tipton
Lt. Mark J. Ludlow	Lt. Col. Richard D. Wolfe
William D. Madewell	
Earl P. Nordberg	
Gordon O. Spicer	

Carco Airlines
James S. Russell

[redacted]

in addition to that of the Los Alamos Scientific Laboratory. Members of the AEC Protective Force who had previously been trained as monitors were taken into the monitoring organization along with representatives of the emergency monitoring groups from most of the AEC area offices, whose services were procured by the Division of Biology and Medicine. The men comprising these particular groups are given, as are those of the U. S. Army Engineer Corps who took part in Rad-Safe operations. The Engineer Corps had urgently requested that it be permitted to participate in the Rad-Safe program, and somewhat reluctantly we agreed to accept six representatives. We were subsequently very glad that we did and feel that we were fortunate in having their assistance.

To complete the roster we must add the name of James S. Russell, Carco pilot, who was assigned with his Bonanza to the group and who, among other things, made it possible for us to complete the rotation of monitors so that every member of the organization had at least one opportunity to witness a shot from close up or to participate in site monitoring.

Appendix B

OPERATIONS PLAN

4B.1 GENERAL OBJECTIVES OF RAD-SAFE ACTIVITIES

1. Protection of personnel operating at the site.
2. Protection of general public residing in the area, including crops and animals.
3. Acquisition of information to be incorporated into the body of knowledge concerning the effects of atomic weapons.
4. Acquisition of knowledge to aid in determining the feasibility of future weapons test programs within the continental United States and acquisition of information to aid in determining the feasibility of detonating higher-yield weapons at the Nevada Test Site.
5. Public relations involving setting at rest the fears of the surrounding population both prior to and following detonations as well as establishing principles and procedures which will be of value in educating the public in matters connected with civil defense.
6. Training so that all members of the Rad-Safe organization will acquire experience and knowledge which will enable them to function more efficiently and more smoothly in any test operations which may be proposed for the future.

4B.2 PERSONNEL

It is anticipated that the entire personnel of the Rad-Safe Group will comprise the following groups:

H Division, CMR-12, and J-6	40
AEC Protective Service	6
AEC Emergency Monitors	17
U. S. Engineer Corps	6
Total	69

In addition, it is anticipated that the following representatives from Washington will be present: Dr. Shields Warren, Division of Biology and Medicine; Dr. Walter Claus, Division of Biology and Medicine; Dr. Joe Deal, Division of Biology and Medicine; Brig. Gen. James Cooney (MC), Division Military Application; Dr. Howard Andrews, U. S. Public Health Service; Dr. Charles Dunham, Division of Biology and Medicine; and Dr. Marvin Shoor, of Tracerlab, who has been assigned by J-6 to work with the monitoring section.

[redacted]

4B.3 OPERATIONS

4B.3.1 Site Monitoring

Test site monitoring is expected to be limited to within a few miles of ground zero. Test site monitoring will be based from Indian Springs, Nev., and the teams will operate out of the control point located approximately 8 miles south of ground zero. At this location all necessary Rad-Safe supplies and instrumentation will be provided.

Test site monitoring will utilize at least four teams of three men, each team provided with one radio-equipped vehicle which can communicate with the control point.

Soon after each shot one team will start toward ground zero, reporting its findings to the control point as it proceeds. The remaining teams accompanying the experimental personnel will start into the zero area at a time determined by the findings of the first team. These teams will monitor the recovery operations of all experimental groups until completed and will thereafter proceed with the collection and replacement of the planted Rad-Safe film badges required for the determination of gamma-ray dosage in the zero area.

Between shots it is planned to exchange personnel between test-site-monitoring and mobile-ground-monitoring operations in order to provide all Rad-Safe personnel with as broad experience as possible.

4B.3.2 Mobile Monitoring

Mobile-ground-monitoring teams will monitor for fall-out away from the test site and within a 200-mile radius of the firing point. It is expected that this activity will be conducted mainly in the Pahranagat and Meadow Valleys in Nevada and in the St. George and Cedar City areas in Utah, all lying generally to the east of the test site.

Mobile ground monitoring will be conducted by from five to ten teams, each in one vehicle, at least five of which will be radio-equipped. Each team will comprise three men. Contact with Rad-Safe headquarters at Las Vegas will be by telephone or by radio-relay through terrain-survey aircraft. Probable preshot location of teams will be two or more teams at Caliente, Nev., and three or more teams at Cedar City, Utah.

The primary areas in which the ground monitoring will be concentrated will be governed by the findings of a C-47 and a B-17 equipped for terrain-survey work.

As soon after the shot as a reliable indication of the direction of the cloud track is obtained from wind observations and cloud-tracking observations by other aircraft, the ground teams will be directed from Rad-Safe headquarters to start their survey in the areas indicated. The ground teams will report to Rad-Safe headquarters if any strong radiation is found in inhabited areas. Rad-Safe headquarters will send senior Rad-Safe personnel by airplane to confirm any such findings and to decide whether any action is necessary.

4B.3.3 Aerial Survey

Aerial survey work will be carried out in collaboration with AFOAT-1. According to present plans, two planes, a C-47 and a B-17, will be available for repeated survey activities within designated areas. It is felt that concern over ground contamination need not be shown for ground beyond a radius of 200 miles. Within this radius the results of the aerial survey, primarily those from the C-47, will be used to direct ground teams to areas of highest contamination. It is felt that monitoring for active material suspended in the air must be carried out over a radius of 500 to 600 miles for the protection of commercial, private, and military planes which may be flying through the area. A detailed operational plan has been submitted to representatives of AFOAT-1.

4B.3.4 Cloud Tracking

Tracking of the cloud and determining activities beyond the 500- to 600-mile radius are of primary interest to AFOAT-1, but the information derived will be of undoubted interest to the Laboratory. A detailed operation plan has been submitted by AFOAT-1, and it is anticipated

[redacted]

that the cloud will be followed at least to the east coast. An adequate number of properly equipped B-29's is available for this work.

4B.3.5 Fall-out Studies

Recording instruments will be placed at approximately 12 different locations throughout the country to determine, in so far as possible, the amount of active material falling to the ground. The exact sites for these instruments have not yet been chosen.

4B.3.6 Meteorology

In the over-all operation the importance of competent meteorological service and assistance cannot be overlooked. It is anticipated that no detonation will be made unless suitable synoptic conditions exist. For this reason the most expert forecasting service will be required. It is anticipated that Col. Holzman, Air Weather Service, will be the chief forecaster and will have available the following:

1. Existing meteorology services at Nellis Air Force Base, Las Vegas, will be augmented by additional AWS personnel, and high-altitude observations will be made.
2. AWS personnel will be based at Beatty for the purpose of making additional high-altitude studies.
3. AWS personnel based at Indian Springs will make additional low-altitude pilot balloon observations at the firing point.
4. Following detonations, additional pilot balloon observations may be made at appropriate points, to be established, in the anticipated path of the cloud.

4B.3.7 Airplane Travel through the Cloud

Commercial, private, and military planes may operate throughout the area which will be crossed by the cloud. The AFOAT planes will provide us with adequate information to enable us to advise commercial airlines, CAA, and Air Force units if conditions should be hazardous. CAA and the commercial airlines operating in the vicinity will be advised by the Rad-Safe Group in advance as to the possibilities of the situation and will be told that they will be given adequate warning should cancellation or rerouting of any flights be necessary. It is anticipated that some member of the group will travel on at least certain of the commercial flights in the vicinity and that he will be equipped with film badge and pocket dosimeter. The number of flights when this procedure will be used is not yet known. Examination of the aerial schedules indicates that no serious problems should be encountered and that there are no scheduled flights across the area at any time when the cloud is expected to be significantly hot.

4B.3.8 Communications

Rad-Safe headquarters at Nellis Base will have adequate telephone facilities for sending and receiving long-distance and local telephone calls. In addition there will be:

1. Special phone connections with the control point and with Indian Springs.
2. Radio communication with the control point and with Indian Springs.
3. Radio communication with the C-47 and other AFOAT-1 planes.
4. Portable radio stations to be established probably at Caliente, Moapa, and Dodge City. The extent to which these stations can communicate with headquarters in Las Vegas or with the mobile units is at present not known. They will all be located adjacent to telephone facilities. They will at least be able to communicate directly with the C-47 and other AFOAT-1 planes.
5. The majority, if not all, of the vehicles operated by the mobile-monitoring units will be radio-equipped for communication among themselves, with their local bases, or with the C-47, in so far as this is feasible.
6. At least one of the vehicles operating out of the control point will be radio-equipped.

Detailed plans for communication, including assignment of wavelengths and frequencies, are still being worked out by AEC Communications Division.

[redacted]

4B.4 PERMISSIBLE LEVELS OF EXPOSURE TO EXTERNAL RADIATION

4B.4.1 Operating Personnel

The basic permissible level for workers within the AEC has been established at 0.3 r per week. On an over-all basis we do not anticipate violating this level, although we are prepared to permit individuals to acquire several weeks' exposure in a relatively short time. It has previously been agreed that people involved with Operation Greenhouse can acquire exposures up to 0.6 r at any time without obtaining prior permission. If larger exposures are anticipated, the individuals concerned are expected to discuss the matter with Rad-Safe personnel in advance. Permission may be given for single exposures as large as 3.0 r at one time. The individual will then be required to abstain from further exposure until such time as he has cooled off to the level where his extended dose would not be greater than 0.3 r per week. There will be comparatively few workers at Operation Greenhouse who, having acquired as much as 3.0 r, will be permitted to acquire further exposure prior to their return to continental United States.

The same general philosophy will be used for all those concerned with Operation Ranger, with the exception that workers planning to involve themselves subsequently in Operation Greenhouse will be limited to a maximum of 2.0 r. This will mean that practically all workers will arrive at Operation Greenhouse ready for whatever work might be called for.

4B.4.2 General Public

In considering the levels of radiation to which the general public might permissibly be exposed, we have tried to keep in mind the somewhat delicate public-relations aspect of the affair. It is felt that an uncompromising attempt to follow arbitrary levels could possibly result in more harm than good. The guiding principle, therefore, is the rather simple desire to assure ourselves that no one gets hurt. It is felt that figures must be used as general guides but that no drastic action which might disturb the public should be taken unless it is clearly felt that such action is essential to protect local residents from almost certain damage. It is assumed that any member of the general public may receive external exposure up to 25 r without danger. This is no greater exposure than many people receive in an only moderately complete X-ray examination. Exposures between 25 and 50 r certainly demand more consideration, and where there is danger of exposure within this range thought will be given to requesting people to stay in their houses, change clothes, take baths, etc. For areas where exposure above 50 r may occur, consideration must of necessity be given to evacuating personnel, but such a step should not be taken unless it is firmly regarded as essential.

It should be understood that the dosage levels which have been given will be the dosage calculated for a four-week period starting at shot time. It is obvious that the most intense exposure will be acquired within the first 12 or 24 hr. From this it would appear that, even were evacuation decided on, by the time a plan actually could be put into effect, the milk would have already been spilt. It should also be obvious that no exposure levels of the magnitude considered above are anticipated. Should hot spots be created, however, it is felt that we are prepared to meet the situation.

4B.5 EVACUATION

The necessity for evacuation is regarded as highly improbable. Plans for such an eventuality, however, must be made. It is anticipated that Gen. Cooney will request the Surgeon General to alert the commander of either the Sixth or Fourth Army so that there may be available a mobile field hospital which can be brought into the area to provide housing should a large-scale evacuation be needed. Such an operation would be coordinated with the Security Service, who will in like manner bring to the area necessary military police personnel for the protection of evacuated property. A mobile field hospital, according to Gen. Cooney, can provide shelter for as many as 1500 people, which is essentially the entire population of the largest town in the vicinity.

[redacted]

4B.6 FOOD-AND-WATER MONITORING

Possible contamination of food supplies does not at this time seem to constitute a problem. The possibility of contaminating Lake Mead or other water supplies is of importance only over a fairly long-range period. The group will satisfy itself before the operation is concluded that no significant danger has been done to any local water supplies and that no one is expected to drink water contaminated beyond permissible levels. Special thought will be given to Lake Mead and the surrounding area.

4B.7 REPORTS

Reports as to the completeness of the preparations of the Rad-Safe Group will be made to J Division, to Dr. Bradbury, and to Capt. Tyler from time to time prior to the operation. During the operation, with the shots following each other as closely as they are scheduled, there will be little opportunity to furnish written reports. Frequent verbal reports, however, will be made to the proper individuals, and it is anticipated that all responsible officials will at all times be kept fully informed of the current situation. At the conclusion of the operation a preliminary report will be submitted to J Division, this to be followed by a final report covering all activities of the Rad-Safe Group.

4B.8 MEDICAL AND FIRST-AID CARE

Dr. H. O. Whipple and a trained first-aid man will be available at the control point. They will have all necessary first-aid supplies available and in a state of readiness. An ambulance will be kept at the control point, and arrangements have been made for the care in Las Vegas of anyone seriously injured.

4B.9 ROAD BLOCKS

Members of the AEC Protective Service plan to establish road blocks on highway 95 at an appropriate time prior to each shot. Additional road blocks can be established if necessary.

4B.10 HOUSING

The members of the Rad-Safe Group concerned with operations at the site itself will be housed and fed at Indian Springs. The Rad-Safe headquarters group and the mobile monitors will at times be a somewhat floating population. During part of their operations they will live in hotels or motels in Caliente, Cedar City, or whatever locality is indicated. The project manager in Las Vegas has been requested to obtain housing in that city to accommodate a total of 35 people for the duration of the operation.

4B.11 STATE OF PREPAREDNESS

At the date of writing, Jan. 18, 1951, it is anticipated that the Rad-Safe Group will be prepared to carry out all necessary operations, with preliminary work completed by the time of the target date.

[redacted]

Appendix C

I. SUMMARY OF RAD-SAFE OPERATIONS AT THE NEVADA TEST SITE*

4C.1 EXPOSURE

Dosage records were kept on a total of 182 persons who entered the hot area at one time or another. On the average, pocket dosimeters read higher than the corresponding film badges, thus keeping on the immediate safe side in regard to personnel exposure. From the pocket-dosimeter readings, the following exposure ranges showed the most heavy representation:

Exposure range, r	Number of persons
1.0–2.0	39
2.0–3.0	9

The contractor personnel received the largest percentage of high exposures.

The maximum tolerance allowed for Greenhouse personnel was 2.0 r and for non-Greenhouse personnel, 3.0 r. One non-Greenhouse person, H. A. Bohne of the McKee company, received an exposure in excess of the maximum tolerance level. His pocket dosimeter gave a reading of 3.031 r. R. B. Patten of the Los Alamos Scientific Laboratory was the only Greenhouse person to receive an exposure above the allowed 2.0-r level. He received a total exposure of 2.129 r. Special consideration was given in this case. On February 5, Patten had an exposure of 2.095 r, but, since he stated that he would be an observer only at Greenhouse and would receive no exposure, special permission was granted by Thomas N. White, allowing Patten more exposure.

Although no serious threat of high exposure from induced activity arose, thick leather gauntlet gloves were worn on all occasions where such exposure was remotely possible.

The highest activity seemed to be on the planted films and plates which read 135 mr/hr 4 hr after the fifth detonation.

4C.2 CONTAMINATION

No serious amounts of contamination were found on men or equipment.

The bulldozer used in the work on the blockhouse had contamination of 30 to 40 mr/hr on its return to the control point. Ordinary hosing down reduced this to background. Vehicles had, on the average, 1 to 10 mr/hr of contamination located on the wheels, fenders, and floorboards. Vacuum cleaning and washing down reduced all vehicles to background with the exception of one truck which had been thoroughly cleaned previously and later reentered the area. A total of 48 Rad-Safe vehicle contamination certificates covering 54 vehicles was issued.

Personnel booties were the only items receiving significant contamination and then only immediately after the shot. There were no cases of skin contamination and only a few cases of personal shoes becoming contaminated when moisture accompanied the exposure. All the shoes were readily decontaminated by cleaning or by natural decay.

No detectable activity was found on seven head of cattle picked up after the January 28 shot.

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*Prepared by Carl Buckland, Los Alamos Scientific Laboratory, Feb. 16, 1951.

[redacted]

4C.3 RESPIRATORY PROTECTION

Respirators were issued to all persons entering the target area when the background rose higher than 2 mr/hr. Plastic hoods with respirators were issued to bulldozer operators. On one occasion, when a dud was reported, Chem-ox masks as well as plastic hoods were issued to the initial survey party.

4C.4 BACKGROUND LEVELS

The hottest area entered was at the 100-yd mark, which at 0707 on the January 28 shot gave a reading of 16.0 r/hr.

The background reading at the control point reached a maximum of 1 mr/hr at 0750 on the February 2 shot. Respirators were given to the guards stationed at Dusty I and II. An evacuation plan was drawn up after this experience.

On the February 6 shot, a dust cloud settled in the valley south to southwest of the control point on the south side of the mountains. An immediate survey by vehicle indicated only 0.2 mr/hr at 1100. At 1530 the activity had dropped to background. Air samples taken by Harry Schulte at 1200 read twice background.

The highest point of activity found by the blockhouse perimeter fence was 55 mr/hr at 1000 on February 10. The size of the permanent fence was approximately 400 by 600 yd. Radiation signs have been posted.

There were evidences of fused soil, although none of these fused samples was found to be activated as was the case with the Trinity samples.

4C.5 RECOMMENDATIONS

1. Ample shower facilities and "hot" undressing space should be planned for future installations.
2. The dosimeters are good only as a guide. For this reason, darkroom space is desirable in order to give immediate on-the-spot film-badge results.
3. An excess number of vehicles and personnel for handling emergency or unforeseen monitoring duties must be provided.
4. Contaminated laundry service for 800 lb of clothing per day should be furnished. Otherwise the stock supply will have to be fantastically high.
5. The monitoring personnel should always work on a shift basis.
6. Meter repair at the site should be a major consideration.
7. A briefing room must be made available.

4C.6 ROLL-UP

The personnel of the Alpha group were the last persons to leave the contaminated area. Their departure time was 1730 on February 10. Prior to this the McKee company removed all traces of the experiments and cleaned up the area in general. All loose papers were burned in order that no security risk should exist.

II. ACTIVITIES VS. DISTANCE AS A FUNCTION OF TIME*

Tables 4C.1 through 4C.5 present activities vs. distance as a function of time for the five shots at Operation Ranger. All the values in these tables below 20 mr/hr were measured with Geiger-Mueller type-2610A survey instruments. Those values above 20 mr/hr were measured with high- and low-range Juno ionization-type meters. In all instances, whenever it was at all possible, the same individual made the survey.

*Prepared by Edwin Bemis, Los Alamos Scientific Laboratory, Feb. 15, 1951.

[redacted]

Table 4C.1—Activities vs. Distance as a Function of Time, Shot A*

Direction	Distance, yd	Time	Reading, mr/hr
West	4000	0651	0
	3500	0652	0.06
	3000	0654	0.50
	2500	0657	0.60
	2000	0659	1.0
	1500	0700	0.5
	1000	0703	1.2
	900	0704	2.0
	800	0706	6.0
	700	0707	10.0
	600	0708	16.0
	500	0709	30.0
	400	0710	80.0
	300	0711	200.0
	200	0712	350.0
	100	0713	600.0
	0	0714	750.0
	0	1030	500.0
South	100	0716	600.0
	200	0717	300.0
	300	0717	200.0
	400	0718	85.0
	500	0718	45.0
	600	0719	25.0
	700	0719	15.0
	800	0720	6.0
	900	0721	4.0
	1000	0722	3.0
	1500	0723	1.0

*All readings were made on the shot day, Jan. 27, 1951.

[redacted]

Table 4C.2—Activities vs. Distance as a Function of Time, Shot B_1

Date	Distance,* yd	Time	Reading, mr/hr
Jan. 28	4000	0642	0
	3500	0643	0.10
	3000	0644	0.70
	2500	0646	1.2
	2000	0649	1.1
	1500	0651	1.2
	1000	0653	13.0
	900	0655	26.0
	800	0656	50.0
	700	0658	90.0
	600	0700	160.0
	500	0701	300.0
	400	0702	800.0
	300	0705	2300.0
	200	0706	8000.0
	100	0707	16000.0
	100	1400	9000
	0	1400	8000
Jan. 29	100	0900	1000
Jan. 30	100	1100	600
Jan. 31	100	0700	100

* All distances are west of ground zero.

[redacted]

Table 4C.3 — Activities vs. Distance as a Function of Time, Shot E*

Direction	Distance, yd	Time	Reading, mr/hr
West	4000	0629	0.3
	3500	0631	0.1
	3000	0634	0
	2500	0635	0
	2000	0637	0
	1500	0639	0
	1000	0641	5
	900	0642	3
	800	0643	5
	700	0645	6
	600	0646	14
	500	0648	50
	400	0649	110
	300	0651	250
	200	0652	350
	100	0653	500
	0	0654	550
	1500	0945	0
	1000	0951	1
	900	0953	2
	800	0954	2
	700	0955	4
	600	0957	10
	500	0959	18
	400	1000	38
	300	1003	50
	200	1004	100
	100	1006	190
	0	1008	230
	1000	1529	0
	900	1531	1
	800	1532	1
	700	1533	3
	600	1535	5
	500	1537	11
	400	1538	24
	300	1540	50
	200	1541	70
	100	1543	110
	0	1544	130
East	100	0722	350
	200	0721	190
	300	0720	75
East	400	0718	25
East	100	1051	160
	200	1049	90
	300	1047	50
	400	1045	32
	100	1607	100
	200	1605	60
	300	1603	48
	400	1601	21
North	100	0707	300
	200	0710	225
	300	0711	100
	400	0712	40
	100	1042	180
	200	1040	100
	300	1035	50
	400	1030	38
	100	1615	110
	200	1613	60
	300	1612	50
	400	1610	27
South	100	0659	300
	200	0700	250
	300	0701	160
	400	0702	50
	500	0703	20
	600	0730	11
	700	0731	7
	800	0732	4
	900	0732	2
	1000	0733	0.5
	1500	0734	0.04
	100	1053	190
	200	1055	110
	300	1057	50
	400	1059	41
	100	1553	120
	200	1551	65
	300	1550	50
	400	1549	27

*All readings were made on the shot day, Feb. 1, 1951.

[redacted]

Table 4C.4—Activities vs. Distance as a Function of Time, Shot B_2

Date	Direction	Distance, yd	Time	Reading, mr/hr
Feb. 2	West	4000	0637	0.4
		3500	0638	0.2
		3000	0641	0.8
		2500	0843	0.05
		2000	0644	0.1
		1500	0648	1.3
		1000	0848	11.0
		900	0649	17
		800	0850	50
		700	0852	90
		600	0653	200
		500	0654	500
		400	0655	1,100
		300	0858	5,000
		200	0857	10,000
		100	0658	15,000
		0	0708	18,000
		1000	1538	8
		900	1538	14
		800	1539	25
		700	1541	48
		600	1542	55
		500	1543	120
		400	1544	320
		300	1545	2,500
		200	1547	4,500
		100	1548	6,500
		0	1550	7,000
Feb. 3	West	1000	0849	4
		900	0901	8
		800	0903	11
		700	0905	20
		600	0907	43
		500	0909	50
		400	0910	140
		300	0915	350
		200	0916	2,200
		100	0917	3,500
		0	0919	3,700
Feb. 3	West	1000	1446	2
		900	1448	4
		800	1449	9
		700	1452	18
Feb. 3	West	600	1457	32
		500	1500	50
		400	1502	110
		300	1504	270
		200	1507	1,700
		100	1510	2,600
		0	1513	3,000
	East	100	1020	1,800
		200	1019	270
		300	1018	100
		400	1017	50
		100	1539	1,500
		200	1541	650
		300	1543	80
		400	1546	50
	North	100	1043	1,700
		200	1042	230
		300	1040	90
		400	1038	50
		100	1556	1,300
		200	1559	170
		300	1800	60
		400	1603	37
	South	100	0922	4,700
		200	0925	2,900
		300	0928	1,500
		400	0927	210
		500	0928	70
		800	0930	50
		700	0933	25
		800	0937	12
		100	1517	3,000
		200	1519	2,200
		300	1529	420
		400	1531	160
Feb. 4	West	1000	0830	0.7
		900	0832	1.5
		800	0833	3
		700	0835	8
		600	0837	15
		500	0839	35

[redacted]

Table 4C.4 — (Continued)

Date	Direction	Distance, yd	Time	Reading, mr/hr
Feb. 4	West	400	0840	50
		300	0842	120
		200	0844	250
		100	0845	410
		0	0849	425
		1000	1435	1
		900	1437	1
		800	1439	3
		700	1441	6
		600	1442	11
		500	1445	26
		400	1448	50
		300	1450	90
		200	1452	190
		100	1454	290
		0	1500	300
	East	100	0947	240
		200	0949	90
		300	0950	50
		400	0951	27
		100	1527	270
		200	1525	80
Feb. 4	East	300	1523	50
		400	1520	21
	North	100	1004	200
		200	1006	80
		300	1007	50
		400	1009	23
		100	1539	150
		200	1537	60
		300	1535	42
		400	1531	16
	South	100	0931	490
		200	0930	340
		300	0928	180
		400	0927	70
		500	0926	48
		600	0923	15
		700	0922	10
		100	1504	340
		200	1508	240
		300	1510	140
		400	1512	60

[redacted]

Table 4C.5—Activities vs. Distance as a Function of Time, Shot F

Date	Direction	Distance, yd	Time	Reading, mr/hr
Feb. 6	West	4000	0631	0.06
		3500	0634	0.15
		3000	0637	0.16
		2500	0639	0.3
		2000	0641	0.6
		1500	0643	10.0
		1000	0646	165
		900	0650	250
		800	0650	400
		700	0651	750
		600	0652	1,500
		500	0653	5,000
		400	0655	8,000
		300	0656	12,500
		200	0658	15,500
		100	0658	12,500
		0	0703	8,000
		2000	1343	0
		1500	1346	6
		1000	1353	50
		900	1358	70
		800	1401	120
		700	1402	220
		600	1403	430
		500	1405	2,600
		400	1406	4,900
		300	1407	5,200
		200	1409	5,250
		100	1410	5,000
		0	1412	4,910
	East	100	1443	2,000
		200	1442	330
		300	1441	170
		400	1440	100
	North	100	1454	2,700
		200	1453	1,500
		300	1452	290
		400	1445	150
	South	200	0704	7,500
		300	0705	3,000
		400	0706	2,000
		500	0707	600
		600	0708	350
		700	0708	250
		800	0709	150
		900	0709	90
		1000	0711	50
		1500	0715	5
Feb. 6	South	100	1413	5,000
		200	1414	4,900
		300	1416	3,300
		400	1417	1,900
		500	1418	1,000
		600	1420	180
		700	1422	110
		800	1423	60
		900	1424	50
		1000	1427	40
Feb. 7	West	1000	0908	31
		900	0910	50
		800	0912	50
		700	0915	100
		600	0916	170
		500	0917	370
		400	0918	2,000
		300	0920	2,800
		200	0921	3,200
		100	0922	2,700
		0	0923	1,900
		1000	1514	20
		900	1515	37
		800	1516	60
		700	1518	60
		600	1519	110
		500	1520	240
		400	1521	430
		300	1522	1,700
		200	1523	2,200
		100	1524	1,800
		0	1525	1,500
	East	100	1001	290
		200	1002	150
		300	1003	70
		400	1005	50
		100	1544	190
		200	1543	90
		300	1542	70
		400	1541	60
	North	100	1019	340
		200	1020	210
		300	1021	120
		400	1022	70
		100	1545	240
		200	1546	120
		300	1547	70

[redacted]

Table 4C.5 — (Continued)

Date	Direction	Distance, yd	Time	Reading, mr/hr
Feb. 7	North	400	1549	55
	South	100	0935	2,100
		200	0936	1,800
		300	0938	1,300
		400	0939	700
		500	0941	130
		600	0943	80
		700	0945	50
		800	0946	46
		900	0947	27
		1000	0953	17
		100	1526	1,300
		200	1527	1,150
		300	1528	800
		400	1528	400
		500	1529	150
		600	1529	70
		700	1530	60
		800	1531	33
		900	1532	19
Feb. 8	West	1000	0851	10
		900	0851	17
		800	0852	31
		700	0853	50
Feb. 8	West	600	0854	50
		500	0854	100
		400	0855	190
		300	0855	280
		200	0856	320
		100	0856	270
		0	0857	200
	East	100	0933	100
		200	0932	50
		300	0930	46
		400	0928	25
	North	100	0945	120
		200	0944	70
		300	0943	60
		400	0940	41
	South	100	0917	190
		200	0917	160
		300	0916	110
		400	0916	50
		500	0915	50
		600	0914	42
		700	0912	23
		800	0911	12

Appendix D

SUPPLIES USED AT OPERATION RANGER BY THE RAD-SAFE GROUP

The supplies used by the Rad-Safe Group at Operation Ranger were evaluated at $77,000.00. These are listed in Tables 4D.1 to 4D.11 in their various groupings. In addition to those listed in the tables there were 273 2-r model and 80 10-r model dosimeters each with 8 chargers used at the Nevada Test Site; there were 52 types of shop tools put in use, totaling 349 pieces; and for decontamination there was a 100-ft garden hose, a decontamination kit, 6 sponges, and 4 cases of Tide.

Table 4D.1 — Electrical Appliances and Other Electronic Supplies*

Electrical appliances	Quantity	Other electronic supplies	Quantity
Power supply Rectane regulator	1	Batteries	159
Vacuum cleaner	2	Bulbs	16
Lamp, Flexo	8	Tubes	3
Lamp, bench	4	Flashlights	29
Generators	4	Cord	260 ft
Hot plate	1	Electric tape	4 rolls
Lantern, electric	1	Rotary converter	1
		Light with cord	1

*In all, 67 separate items making a total of 1044 pieces.

[redacted]

Table 4D.2—Air-sampling Supplies

Item	Quantity
Pump	3
Sampler	1
Cones	25
Bags	4 doz
Impactors	3
Slides for impactors	1 set
Filter paper	8 doz
Bottles	100
Applicators	12
Resin solution	2
Motor	1
Tripod	1
Filter Queen	1
Box for Filter Queen	1
Electrostatic-precipitator unit	1
Electrostatic-precipitator tubes	12
Electrostatic-precipitator electrodes	4
Caps for tubes	12
Charts for Esterline-Angus	15
Ink recorder	5
Pen elements	5
Recorder	1
Ditto	3
Plant, electric power	1
Drum, steel	1
Filter	1
Gauge	1

[redacted]

Table 4D.3—Remote-area* Monitoring Supplies

Item	No. per area
Monitor, remote	6
Recorder	5
Cable W/GM	5
Cable for recorder	5
Inking kit	5
Instruction book	5
Pen No. 8510	5
Paper chart	10†

*Considered remote areas are those at Kirtland Air Base, N. Mex.; Durango, Grand Junction, and Denver, Colo.; and Salt Lake City, Utah.

† Ten rolls distributed among the five areas.

Table 4D.4—Medical Supplies*

Item	Quantity
First-aid kit	1
Snake-bite kit	1
Blankets	2
Band aids	106
Scalpel handle	1
Scalpel blades	6
Tweezers	2
Soap	100 bars
Pillows	2

*In all, 134 separate items making a total of 7993 pieces.

[redacted]

Table 4D.5—Miscellaneous Supplies

Item	Quantity
Signs	169
Map of U.S.A.	1
Sodium bisulfate	4 lb
Water bag	12
Plywood	5 pc
Permatex	1 tube
Tube, copper	20 ft
Tubing kit	1
Taps	5
Funnels	2
Kleenex	72 boxes
Masking tape	12
Tacks	6 boxes
Rope	200 ft
Cans	4
Clip boards	24
Ice pick	1
Paint	1 can
Paint thinner	1 can
Garbage can	1
Paint brushes	7
Steel plates	14
Cardboard boxes	60
Total	623

Table 4D.6—Protective Clothing and Equipment

Item	Quantity
Booties	1575
Coveralls	475
Caps	499
Gloves	862
Goggles	420
Aprons	3
Boots, hip	3
Masks	18
Respirators	475
Jackets	36
Pants	24
Hoods	6
Total	4396

[redacted]

Table 4D.7—Weather Equipment

Item	Quantity
Tripod	1
Theodolite ML	1
Scale, K&E	1
Curve, French	1
Dietzgen protractor	1

Table 4D.8—Stenographic and Clerical Supplies

Item	Quantity*	Item	Quantity*
Portfolio, paper	1	Duplicating machine	1
Yellow tablets	8	Ink	6 bottles
Pencils	333	Binder paper	12 pkg
Typewriters	3	Erasers	14
Onionskin	1 ream	Cartridges for ball points	6
Bond, yellow	1 ream	Lead refills	4 pkg
Cellulose, acetate	6 rolls	Staples	1 box
Ditto	7 boxes	Rulers	6
Staplers	5	Blackboards	2
Notebooks	58	Chalk	1 box
Clips	260	Scotch tape	6 rolls
Paper, duplicating	12 reams	Pencil sharpeners	2
Bond	500 reams	Pen holders	12
Tablets, white	14	Pen points	24
Tabs	6 boxes	Carbon	3
Pen lights	12	Expanding envelopes	10
Plain cards	560	Binder cases	6
File box	49	Frames, letter	4
Ditto fluid	1 gal		

*Total number of pieces, 1957.

[redacted]

Table 4D.9—Survey Meters

Meter	Quantity
Model MX-5	8*
Model 48-A	6
Model 100	7
Model 2680	10
Model 263-A	16
Model Juno	20
Model MX-6	11
Model 2610	24
Watts	1
Model T	1
Total	104

*Each model had two sets of earphones.

Table 4D.10—Special Project Supplies

Item	Quantity
Drivers, stake	2
Stakes, iron	250
Stakes, wooden	75
Bricks, lead	26
Blocks, wood	304
Frames, wood	150
Boxes, aluminum	192
Plates, lead	4
Bases, cylinder	7
Tops, cylinder	7
Bars, lifting	2
Total	1019

Table 4D.11—Film Equipment and Accessories

Item	Quantity
Film badges	1028
Plates for badges	50
Film	5 gross
Distilled water	5 gal
Rope	50 ft
Film box	1

[redacted]

Appendix E

REPORT ON RANGER OPERATION FALL-OUT*

4E.1 RESPONSIBILITY

In connection with the recent operations at Nevada Test Site, Group H-5 was given two responsibilities: (1) to study the air-borne contamination at or near ground level within a radius of 100 miles of an atomic-bomb shot and (2) to test various types of equipment and techniques for obtaining the preceding information for use in later weapons tests. Because of the comparatively short time for preparation for this operation, the greater emphasis was placed on the second of these objectives.

4E.2 EQUIPMENT

A mobile sampling unit was assembled in a truck which operated at a distance of 50 miles or more from the point of detonation. This mobile unit contained a power supply and four pieces of air-sampling equipment: (1) a high volume sampler, (2) a Filter Queen, (3) an electrostatic precipitator, and (4) a cascade impactor.

A second unit consisted of a power supply, pump, cascade impactor, and recording Filter Queen sampler located at a distance of 20 miles or less from the point of detonation.

4E.3 TECHNIQUES

The truck proceeded to a point on a road where the cloud could reasonably be expected to cross, based on the best available weather data prior to the shot. After the shot, information regarding the path of the cloud was to be relayed to the truck, and the truck was to proceed to the most likely point at which air-borne contamination might be expected. The four air samplers were set up, and collection was started. Observations were made on wind direction and surface contamination, and other useful information was obtained. On shots 3 and 4, this procedure was modified, and an attempt was made to follow the cloud visually from Indian Springs.

The second sampling unit was set up on the basis of wind directions prior to the shot and was started running at a point of likely contamination within a 20-mile radius of the shot. This unit and its personnel were based at Indian Springs, and the sampler was set up the night before the shot. In most cases, it was necessary to set up this unit many hours before the actual shot time, and, as a result, the probability of collecting a sample was rather small.

4E.4 FIELD DATA

Complete notes on the Group's activities for each day and details of sampling methods are available in the H-5 files. The following are brief extracts of information for interpretation of the sampling results.

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*Prepared by Group H-5.

[redacted]

For shot 1 the close-in sampler was set up 13.3 miles from Indian Springs on a road leading due north from the base. The sampler was started at 8:50 P.M., January 26, and ran for 12.9 hr. The truck sampler, following report of activity by monitoring team 149, sampled in Sector King #9 at the pass leading into Desert Valley. The first set of samples was started at 12:15 P.M., January 27, and ran for 2¼ hr. The second set of samples was started at 2:45 P.M. and ran for 1 hr.

For shot 2 the close-in sampler was set up 22 miles north of Indian Springs Base and was started at 9:30 P.M., January 27. The impactor ran for 12.35 hr. Because of poor communications and conflicting information regarding the cloud movement, no samples were collected by the truck unit.

For shot 3 the close-in sampler was set up at Range Control tower 5 miles north of Indian Springs and was started at 10:00 P.M., January 31. The impactor ran for 9⅕ hr, but, due to an erroneous prediction of the cloud path, no material was collected by the unit.

The truck sampler for shot 3 proceeded to a point 10 miles west of Indian Springs after the shot. Sampling was done at a point at which a maximum reading was obtained on the overhead cloud. As a result of an easterly surface which came up after sampling was begun, no significant material was collected. Sampling began at 7:00 A.M. and continued for 5½ hr.

For shot 4 the close-in sampler was set up beside a road 10 miles west of Indian Springs. Sampling was begun at 2:30 A.M., February 2, and ran for 7¾ hr. An attempt was made to follow the cloud from Indian Springs with the truck sampler. The equipment was set up and sampling was started at 10:30 A.M. on February 2 in the center of Love No. 6 in the sheep range. Sampling continued for 2 hr.

For shot 5 the close-in sampler was set up 10 miles west of Indian Springs beside the road. Sampling began at 3:20 A.M., February 6, and continued for 8 hr. The truck sampler left Indian Springs immediately after the shot and proceeded to Charleston Peak. Sampling began two miles past the lodge at 8:00 A.M. and continued for 2¾ hr.

4E.5 RESULTS

4E.5.1 Preparation and Counting of Samples

Most of the data obtained are shown in the figures and tables attached to this report. Results are reported in counts per minute since the counter geometry and efficiency were not known for the material. The high-volume sampler, which collected the largest sample of air (70 cu ft/min), naturally was most successful in collecting contamination. However, no samples were collected on the second shot, and only a very small amount of material was collected on the third shot. Two successive samples were collected on the first shot. Only on the fourth shot was any significant quantity of material collected by the cascade impactor near Indian Springs. The samples collected near the top of Charleston Peak (shot 5) contained the greatest quantity of active material on all the sampling units.

Counting of samples was done only following the return to Los Alamos. The cascade-impactor samples were counted directly. The electrostatic-precipitator samples were washed out of the precipitator tubes and plated on metal disks. Three 2-in. circles were cut from each of the Filter Queen papers and were counted directly. The filters from the high-volume sampler were ashed in the laboratory, plated, and then counted. Successive counts were made on the high-volume samples and on some of the cascade-impactor samples.

4E.5.2 Decay Curves

The decay curves on the four high-volume samples containing significant material are shown in Fig. 4E.1. As can be seen, fairly good straight lines were obtained when the data were plotted against time on log-log paper. These lines have an average slope of −1.02, which is in fair agreement with the predicted[1] slope of −1.2.

Decay curves on the five stages of the cascade impactor from shot 5 are shown in Fig. 4E.2. Here, again, straight lines are obtained on log-log paper having a slope somewhat

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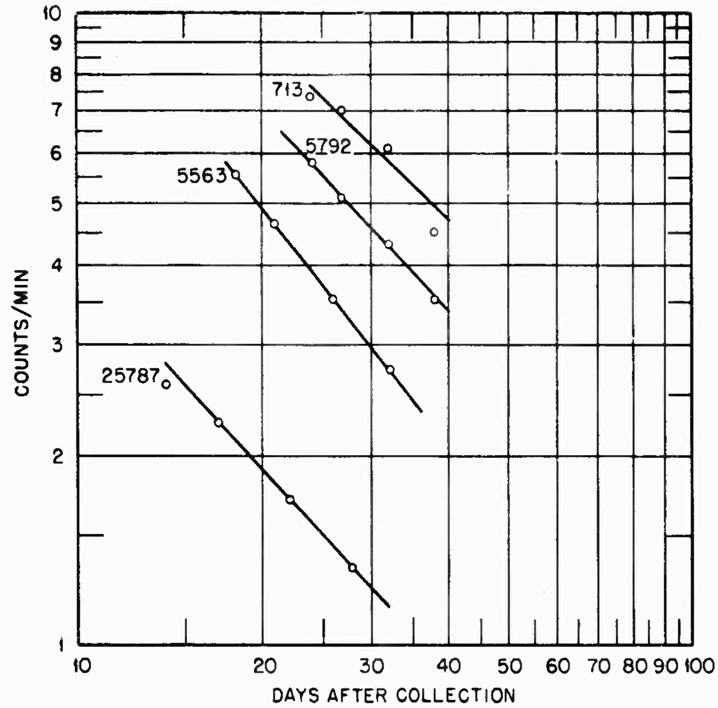

Fig. 4E.1—Decay curves on material collected on three shots by high-volume sampler.

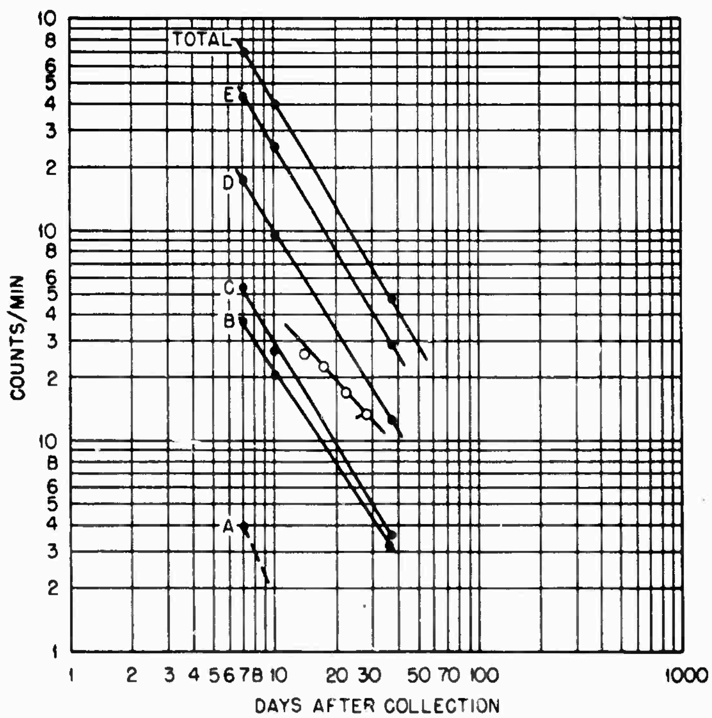

Fig. 4E.2—Shot 5: decay curves on five impactor stages and total. ○, high-volume sampler data.

[redacted]

greater than that obtained from the high-volume sampler which is shown for a comparison. The fact that the slopes for all stages of the impactor are essentially the same is quite significant in that it shows that the material of very small particle size (stage E) has essentially the same composition as that of very large particle size (stages A and B). The slopes of all these curves indicate that the material collected and counted probably consisted largely of fission products. If any activated dust was obtained, it had decayed to insignificance before the samples were counted.

4E.5.3 Sampling Efficiency

Figures 4E.3 to 4E.5 show the results obtained on the three shots in which significant material was collected by the truck-mounted samplers. These results are expressed in counts per minute per cubic meter of air to permit a comparison of the various samplers. It can be seen from these figures and from Table 4E.1 that there is a considerable difference in the efficiency of collection of the various units. The two samplers utilizing filtration—the high-volume sampler and the Filter Queen—produced very similar results. The electrostatic precipitator collected considerably more material per unit volume of air, and the cascade impactor collected somewhat less material per unit volume. The high sampling efficiency of the electrostatic precipitator was somewhat unexpected since such great differences have not previously been obtained in air sampling of other atmospheric contaminants. One possible explanation lies in the extremely small particle size of the material collected.

The high-volume sampler collects enough material so that it is possible to measure decay rates with a fair degree of accuracy. The Filter Queen, although giving results quite consistent with those obtained with the high-volume sampler, possesses no particular advantages and presumably will not be used in future tests. The electrostatic precipitator will be used again because of its apparent high sampling efficiency. The cascade impactor, although showing a somewhat lower sampling efficiency than the other units, is the only one capable of yielding information regarding particle size and will be retained for use in future tests for this reason.

4E.5.4 Particle Size

Two cascade-impactor samples contained sufficient material to make a good estimate of the particle size of the collected dust. One of these was collected near Indian Springs following shot 4. The other was collected at an elevation of 9000 ft on Charleston Peak following shot 5. From the data obtained, Fig. 4E.6 was prepared showing the size distribution of the material collected. In both cases, more than 50 per cent of the sample was on the fifth stage of the impactor, indicating a very small particle size. Under such conditions, the point for the fifth stage of the impactor always falls considerably to the left of the actual distribution line on the figure. This is true because the median particle size collected on this stage was considerably less than that predicted from studies on laboratory dusts.

From these data, it is found that the median particle size collected on Charleston Peak was 0.3 μ and that at Indian Springs it was 0.7 μ. Both of these represent a very finely divided aerosol, and it is quite consistent that the more distant sample should show the smallest median particle size. Particles of a size represented by approximately 99 per cent of this material collected have a negligible settling rate. Presumably this material does not represent fall-out but is material in the cloud itself. In preparing these size-distribution results, it is necessary to make an assumption regarding the density of the material collected. In this case, a density of 2.5, the approximate density of ordinary soil, was assumed. After it was noted that the cloud movement was slightly different than that predicted on shot 5, a small sampling unit using Whatman No. 41 paper was hastily assembled. This was put into operation at Indian Springs Base 2 hr after the shot. The data collected by this sampler are also plotted on Fig. 4E.5.

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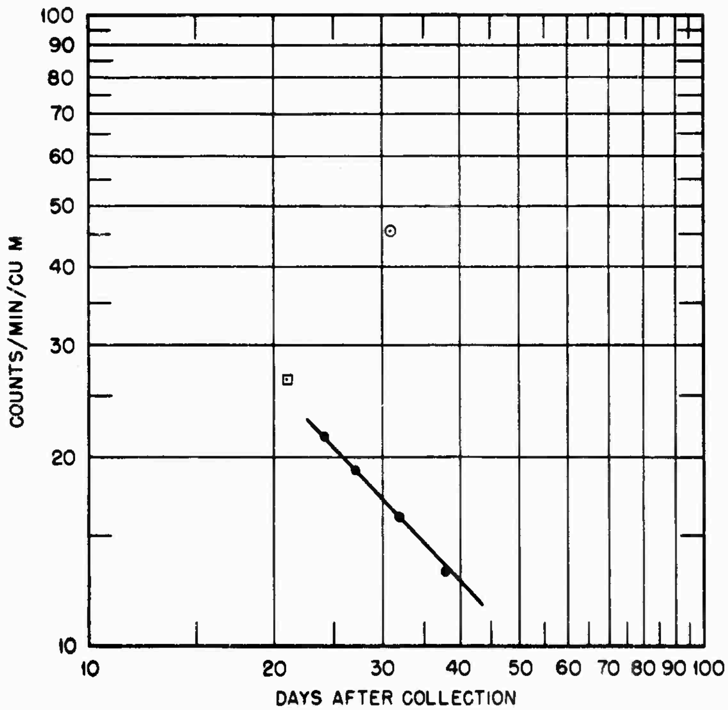

Fig. 4E.3—Decay curve on material collected on shot 1. ●, high volume; ⊙, electrostatic precipitator; ⊡, Filter Queen.

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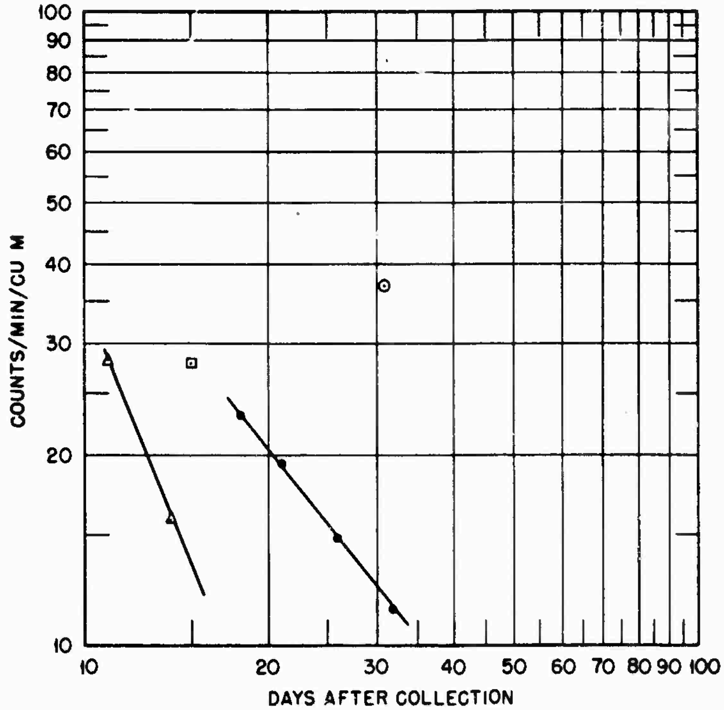

Fig. 4E.4—Decay curves on material collected on shot 4. ●, high volume; ⊙, electrostatic precipitator; ⊡, Filter Queen; △, cascade impactor.

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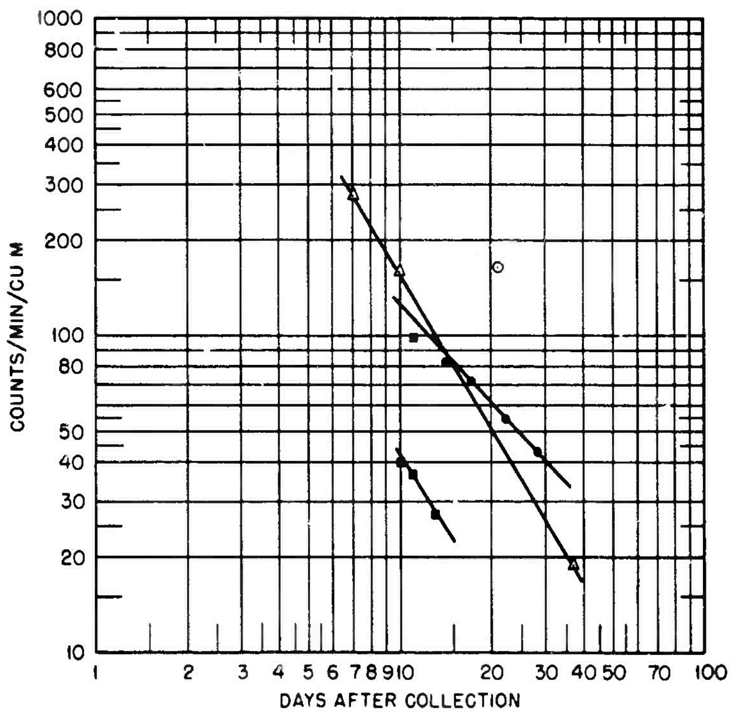

Fig. 4E.5—Decay curves on material collected on shot 5. ●, high volume; ⊙, electrostatic precipitator; ⊡, Filter Queen; △, cascade impactor; ■, filter sampler at Indian Springs.

[redacted]

Table 4E.1—Volumes of Air Sampled, Cubic Meters, as Shown by Truck-mounted Samplers

Sampling rate, cu m/min		1.98	0.14	0.0175	0.085
Shot No.	Days after collection	High volume	Filter Queen	Cascade impactor	Electrostatic precipitator
1		268	19.1	2.88	16.2
1		119	8.5		
3		356	25.4	3.15	15.3
4		238	17.0	2.10	10.2
5		307	20.5	2.54	13.2
		Air concentrations, counts/min/cu m			
1	24	21.6	23		60
1	24	6.2	6.1		
3	19	0.1	10.7	2.5	
4	24	16.4	15.7	4.5	51
5	24	50	44	38	104

[redacted]

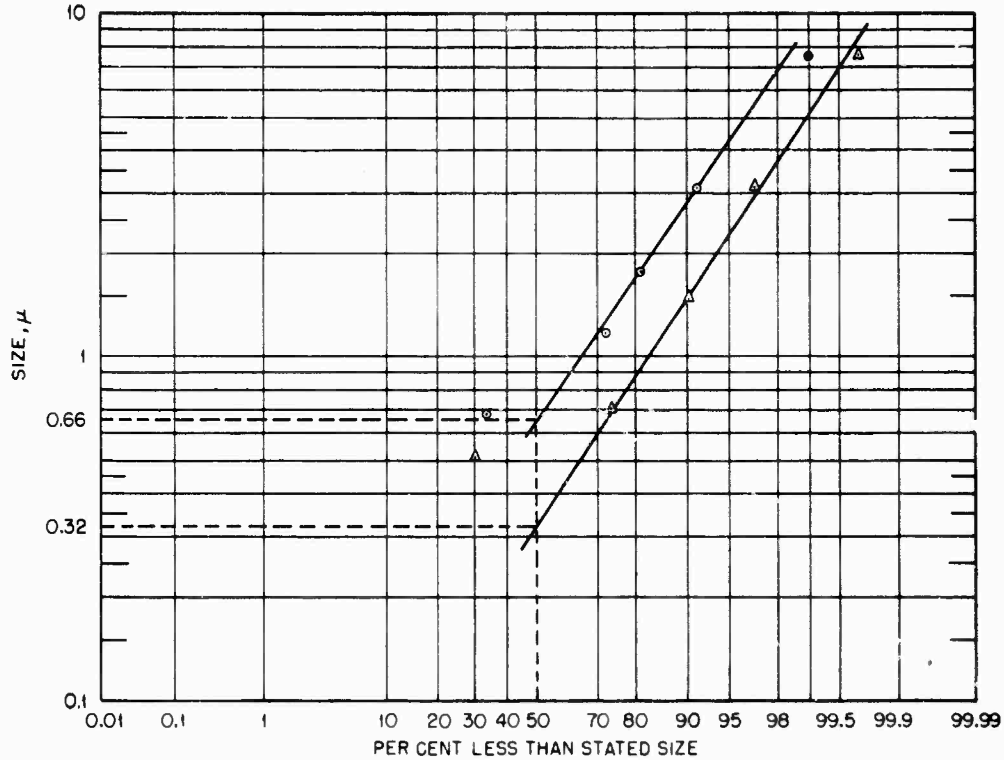

Fig. 4E.6— Cascade-impactor samples. Particle-size distribution: Indian Springs (shot 4): ⊙, median size, 0.66; σ_g, 3.3; Charleston Peak (shot 5): △, median size, 0.32; σ_g, 3.4.

[redacted]

4E.6 DIFFICULTIES

A number of difficulties were experienced in the collection of these data. There were very serious problems in communication. This problem will not be discussed further since the whole subject of communications for health and safety is under review at the time of writing. One of the greatest difficulties was the lack of knowledge of the terrain. It was necessary to take vehicles over roads which the operators had not previously traversed, and, in some cases, points selected on the map as the best ones for sampling were found to be inaccessible. Changes in wind direction sometimes necessitated very rapid shifting of sampling points, which could not be done in an unfamiliar area.

Some difficulty was experienced in obtaining accurate weather data. The most significant data from the standpoint of Group H-5 were those concerning the direction and velocity of winds at various heights. Complete information on this was available only at Nellis Field, and, as a result of communication difficulty, it was not always possible to obtain the up-to-date information needed. Transportation presented a considerable problem to the unit operating close to the detonation point. It was not until the fourth shot that a satisfactory vehicle was obtained to tow the trailer containing the sampling equipment. Also, because of the location of the tests near the practice bombing range, it was only possible to set up the sampler and to disassemble it at certain times. This caused serious difficulty, particularly when shots were fired on successive days. In spite of these difficulties, considerable data were obtained, and they are surprisingly consistent within and with predicted values.

4E.7 RECOMMENDATIONS

Plans are already under way for improved equipment for the next tests at Nevada Test Site. It seems likely on a basis of the results obtained that the electrostatic precipitator will be used because of its high sampling efficiency. The high-volume sampler will be used because of the large amount of material collected, and the cascade impactor will be used to obtain information regarding particle size. Several other units will be tested in the immediate future and may be added to the equipment. In particular, thought is being given to a sampling unit operating at an even higher sampling rate. Also, it is highly probable that the molecular filter developed at California Institute of Technology will be used. This molecular filter should have a higher sampling efficiency than any other filter material presently available and will also yield information regarding the particle size of the gross material collected.

A jeep should at all times be available to the unit operating close (within 20 miles) to the detonation point. In addition to the material in the trailer, which will be set up in the field prior to the shot, a portable sampling unit should be installed in the jeep itself. This unit would proceed to the control point immediately prior to the shot. After the shot, it should proceed with the first group of monitors into the crater area for the purpose of obtaining samples of the air-borne dust in the crater area. The unit should remain in the vicinity of the control point for at least 12 hr after the shot and should be utilized to study air-borne contamination in this general vicinity. It was found at the last shot that a large quantity of suspended dust moved into an adjoining valley some hours after the shot. The hazard from such shifts could be assessed conveniently with the mobile unit.

A second truck equipped with air-sampling equipment could well be used in the field. This would more than double the possibility of collecting fall-out material since the two trucks could be based at points which bracket the predicted fall-out area. However, in addition to the problem of obtaining such a truck, the problem of available personnel would probably govern the desirability of this addition. Group H-5 would not have enough available personnel to man two trucks and a close-in unit. However, if civilian-defense or other personnel is available, it would be possible to place one H-5 man in each truck and use other personnel as helpers.

Much more significant results could have been obtained if it had been possible to count the collected samples earlier. A week elapsed between the time of collection and the first counting of any samples. It is suggested that facilities for counting of samples be provided at some point

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in the general area. Also, the possibility of providing counting equipment which can be mounted in the truck will be explored. With the aid of such counting equipment, better estimates can be made of the sampling time required, and it might be possible, in some cases, to collect a series of successive samples.

The truck should be equipped with a recording-type Geiger counter to procure a record of the exact time of passage of the cloud. This would permit better correlation of the data and more productive sampling. The question of access to weather data has already been discussed. Presumably such data will be more readily available in future tests.

Other types of lightweight power supplies are also being investigated for use in field sampling. The very heavy power unit carried in the trailer places a considerable limitation on the location of the sampling point for this unit. If a lightweight power supply can be developed, it will be possible to sample at places more likely to yield significant data. It is hoped that, prior to the next set of tests, an opportunity to explore the terrain in considerable detail will be given the personnel. It will be particularly important to learn the conditions of all roads open to the truck and of such trails and open country that can be traversed by a jeep. This will permit better access to sampling points and will also permit quick changes in sampling locations as wind directions vary.

Air samplers could be located in a number of communities within a radius of 100 miles from the shot area. These units would be started immediately after the shot and run for 12 hr. The feasibility of this step is dependent on the availability of personnel and on the value of the data which would be secured.

Beta-counting equipment should be installed in the Group H-5 count room. Samples were all counted by Group H-4 who gave the utmost cooperation in this. However, it was necessary for them to do this work in addition to their regular work. For this reason fewer decay curves were run than would be desirable on future tests. Also a study should be made of counter geometry and efficiency with this material.

4E.8 SUPPLEMENTARY DATA

A sample of snow was collected in Tech Area at Los Alamos on the day following shot 4. The snow was melted, plated, and counted, giving a result of 1200 counts/min/liter. The significance of this result is somewhat doubtful in view of the possibility of local contamination.

Six water samples collected from Lake Mead were also analyzed, with negative results. Radioactivity in snow in various portions of the United States was reported. An extensive study was made in New York State by the New York Operations Office. Their results ranged from 0 to 25,000 beta disintegrations per minute per liter of melted snow and are presented in a recent report.

Air samples were collected by the Hanford Works at various locations in the Rocky Mountain area. Their results are not available at the present time.

Appendix F

I. METEOROLOGICAL OBSERVATIONS AT OPERATION RANGER*

4F.1 INTRODUCTION

For a complete discussion of over-all Air Weather Service participation in Operation Ranger, reference is made to the document on file in the Health Division Office.[2] The following report on participation of Group H-1 weather personnel in Operation Ranger has been in part extracted from the report on meteorological aspects of Operation Ranger.[3]

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*Prepared by R. E. Heft; report dated Apr. 17, 1951.

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4F.2 OBSERVATION

T/Sgt. George L. Clark was designated noncommissioned officer in charge of the weather-observation section at the control point. The duties of the section involved taking surface- and upper-wind observations on a limited, scheduled (1900 to 0700 PST) basis. On shot days, additional upper-wind observations were taken immediately before and after shot time, and cloud-track and rate-of-rise data were taken using two theodolites on a measured base line at the control point. S/Sgt. Melvin Richards of the Kirtland AFB Weather Detachment worked with T/Sgt. Clark at the observation station. Future operations will undoubtedly have a full-scale weather-observing section at the control point, as the nucleus of such a section is already in operation at the test site and clearance proceedings for the requisite personnel have been initiated.

4F.3 BRIEFING

Cloud-position forecasts based on wind-forecast data issued 2000 PST the evening before shot time, revised in accordance with trends indicated by the 0400 PST wind observations, and finally revised in accordance with the post-shot 0700 PST winds when necessary were prepared for the ground-monitoring group. In addition, two mobile pibal teams were deployed to positions beneath the cloud at time of passage for the purpose of determining low-level wind influence on fall-out. (The information thus obtained, however, proved of little value, first, because of the almost total lack of fall-out from higher portions of the cloud and, second, because the horizontal distribution of the cloud (because of the wind dispersion effect) quickly became so large as to completely mask any influence the local low-level winds may have had in determining fall-out area.) In future operations it is expected that information obtained from the Ranger tests concerning the relation between the areas of ground fall-out and the vertical wind distribution, burst height, and burst energy may be used to predict the ground distribution of induced activity (i.e., the activated-dust fall-out pattern).[3]

4F.4 INFORMATION

At the request of Maj. Russell, Capt. Heft prepared for Dr. Clark for each of the various tests a table of pressure, temperature, humidity, and density at ground zero and at burst height above ground zero. These values were determined from observational data by interpolation in time and space.

After each shot, observed upper-air data were relayed to CWO Blair M. Younkin at Los Alamos. From the data, a pressure-height curve was prepared for use by J Division personnel in analysis of photo data.

Subsequent to the operation a determination was made of areas of possible and probable rain-out by intersecting meteorologically determined trajectories with reported rain or snow areas.[3]

With respect to informational support of future operations, it is hoped that each requirement can be met as it arises.

II. REPORT ON THE WIND FACTOR IN LOCAL-AREA FALL-OUT*

4F.5 INTRODUCTION

This discussion applies only to fall-out of dust particles introduced into the lower atmosphere as a result of the burst. For such particles, the height to which they are lifted by the

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* Prepared by R. E. Heft, report dated May 17, 1951.

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initial surge determines the bearing from ground zero at which they again reach the ground, and their rate of fall determines the distance out along the bearing line at which they reach the ground. To determine the directions of the bearing lines corresponding to various heights, a resultant wind from the ground to the height in question is constructed. The direction of the resultant wind is then the direction of the bearing line for that particular height. The length of the resultant-wind vector then gives the distance which a particle falling throu... unit layer in 1 hr would traverse before reaching the ground. If a particle should require 2 h... fall through the unit layer, it would traverse two lengths of the resultant-wind vector, etc.

If we now plot bearing lines and rates-of-fall lines on a single chart, we have a coordinate system on which a graph of ground fall-out observations could be made and the initial heights and rates of fall of the particles determined, or, given the initial heights and rates of fall, we could predict the location of ground fall-out. Such graphs have been made for the five cases of this operation and will be found in Figs. 4F.1 to 4F.5. The graphs are to the scale of the photo reproduction of the aeronautical chart used by the ground-monitoring group.

4F.6 DUST PARTICLES

Presumably the size of the dust particles introduced into the atmosphere is a characteristic of the location of the burst, and the height to which the particles are lifted is determined by the height and energy of the burst. Hence by using the data from the present operation for which several energies and two burst heights are available we may begin to determine the relation between the burst height and energy and the height to which the dust particles are raised. It may be hoped that these relations may be useful in future operations for predicting, within the limits of error of the method, the location of local-area ground fall-out.

4F.7 FACTORS AFFECTING CALCULATION

The wind field was assumed constant in space and time. This assumption is not absolutely necessary since by drawing streamline charts for the area for various altitudes and for times before and after time zero it would be possible to take into account the changing field.

The terrain was assumed for the present discussion to be a plane at the level of ground zero. This assumption is also not an essential one since terrain variation could be indicated by terminating bearing lines at points of intersection with elevated terrain and bunching isolines of fall rate at the terminus.

Nonturbulent flow was assumed in that all vertical motions were assumed to be due to gravitational forces. No way of correcting for this factor is known, but it may be of interest to note that vertical motions of the lower levels of the atmosphere are at a minimum during the period just before dawn when the atmosphere reaches it maximum stability.

It should be noted that the successful application of the method depends on the wind field varying in an unspectacular fashion with height, for an extremely variable wind field usually means that the direction in which the bearing lines change for different elevations is not uniform, and as a consequence the coordinates of our system are not uniquely defined. This situation occurred to some extent on shot 5, and the 6000- and 8000-ft bearing lines could not be used.

REFERENCES

1. "The Effects of Atomic Weapons," p 253, Los Alamos Scientific Laboratory, Government Printing Office, Washington, D. C., June 1950.
2. D. H. Russell, Weather Support Project Ranger, Mar. 1, 1951.
3. R. E. Heft, Report on Meteorological Aspects of Operation Ranger, Feb. 17, 1951.

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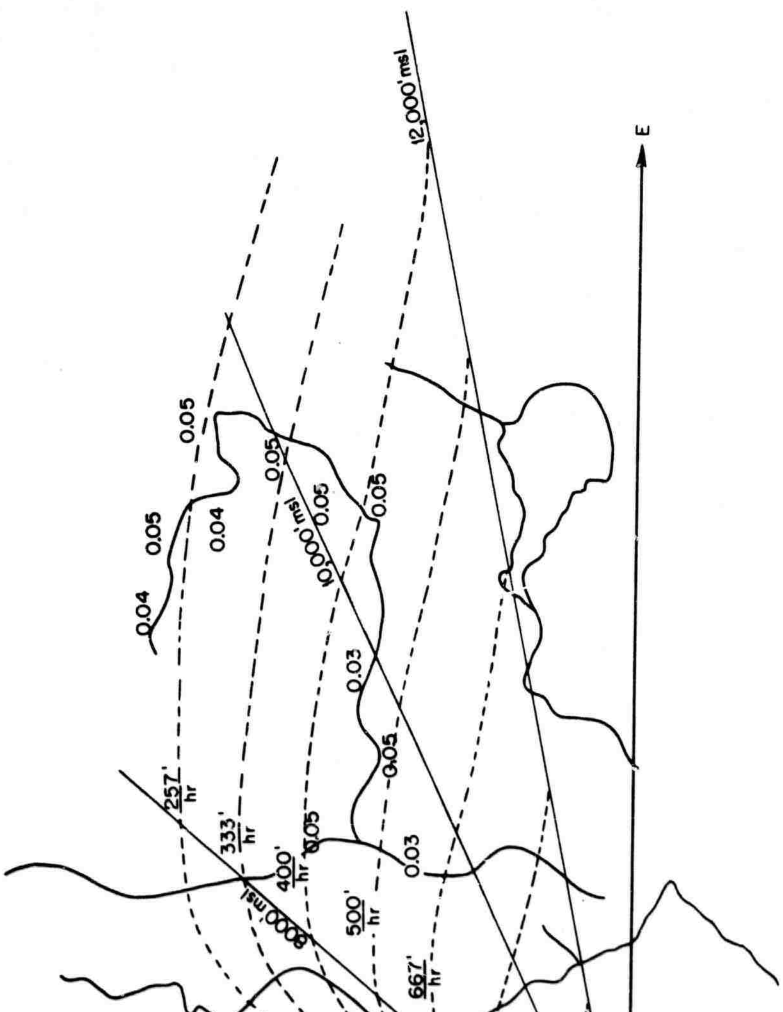

Fig. 4F.1—Case I, Jan. 27, 1951. Radial lines: resultant wind vector from surface to indicated height. Dashed curves: isolines of rate of fall. Solid curves: roads monitored. Decimal numerals: observed activity in milliroentgens per hour.

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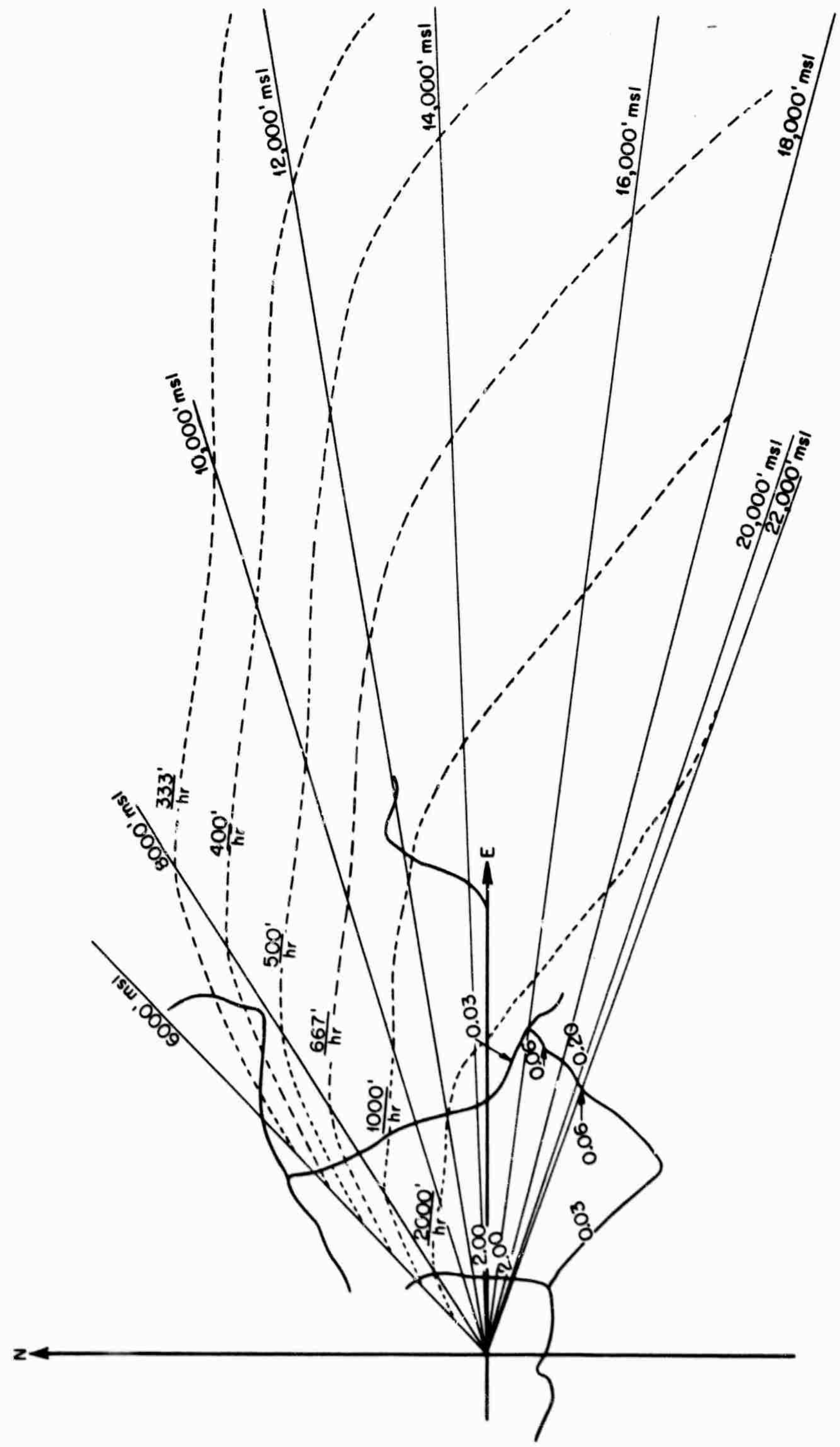

Fig. 4F.2—Case II, Jan. 28, 1951. See case I for legend.

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Fig. 4F.3—Case III, Feb. 1, 1951. See case I for legend.

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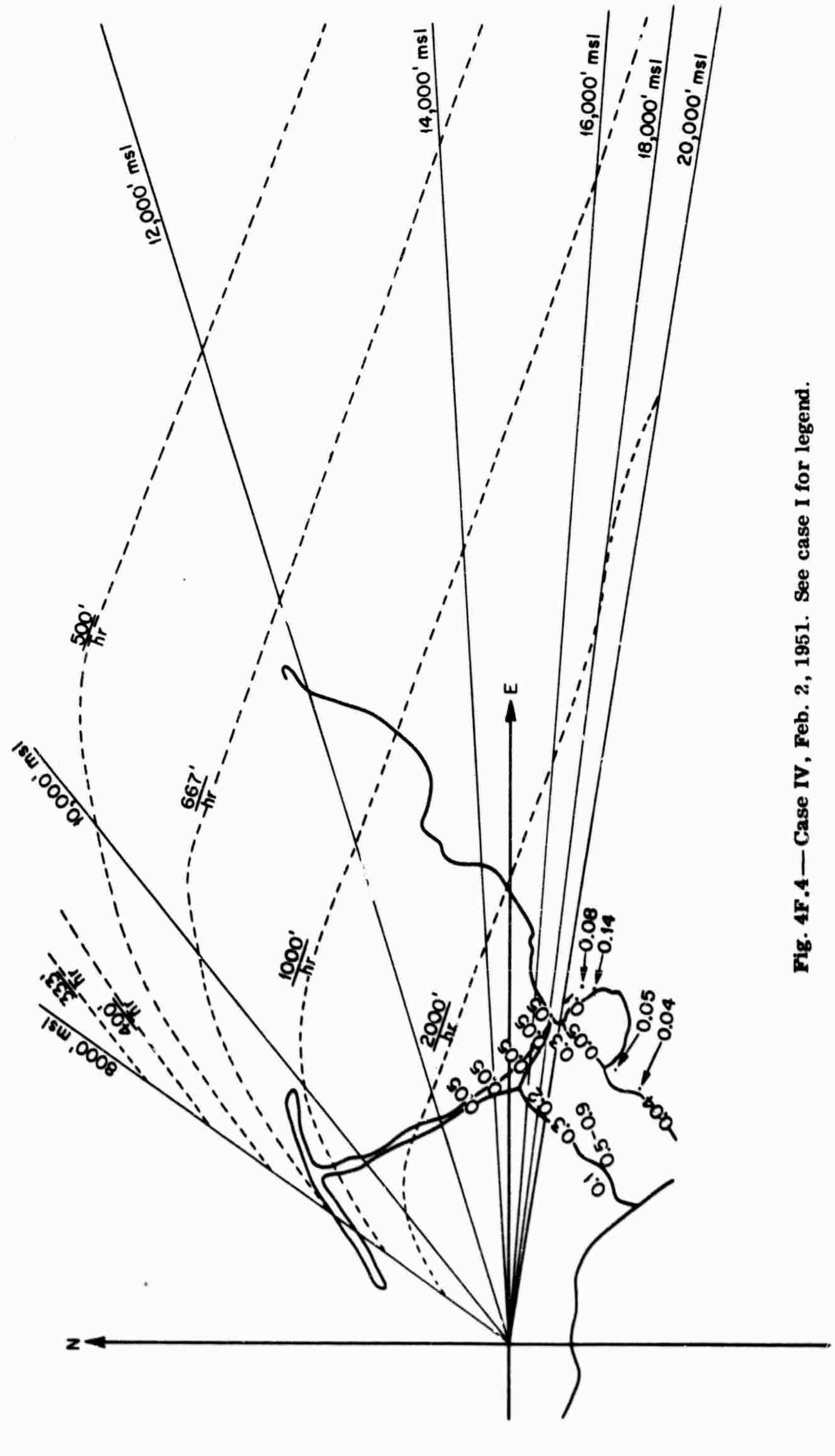

Fig. 4F.4—Case IV, Feb. 2, 1951. See case I for legend.

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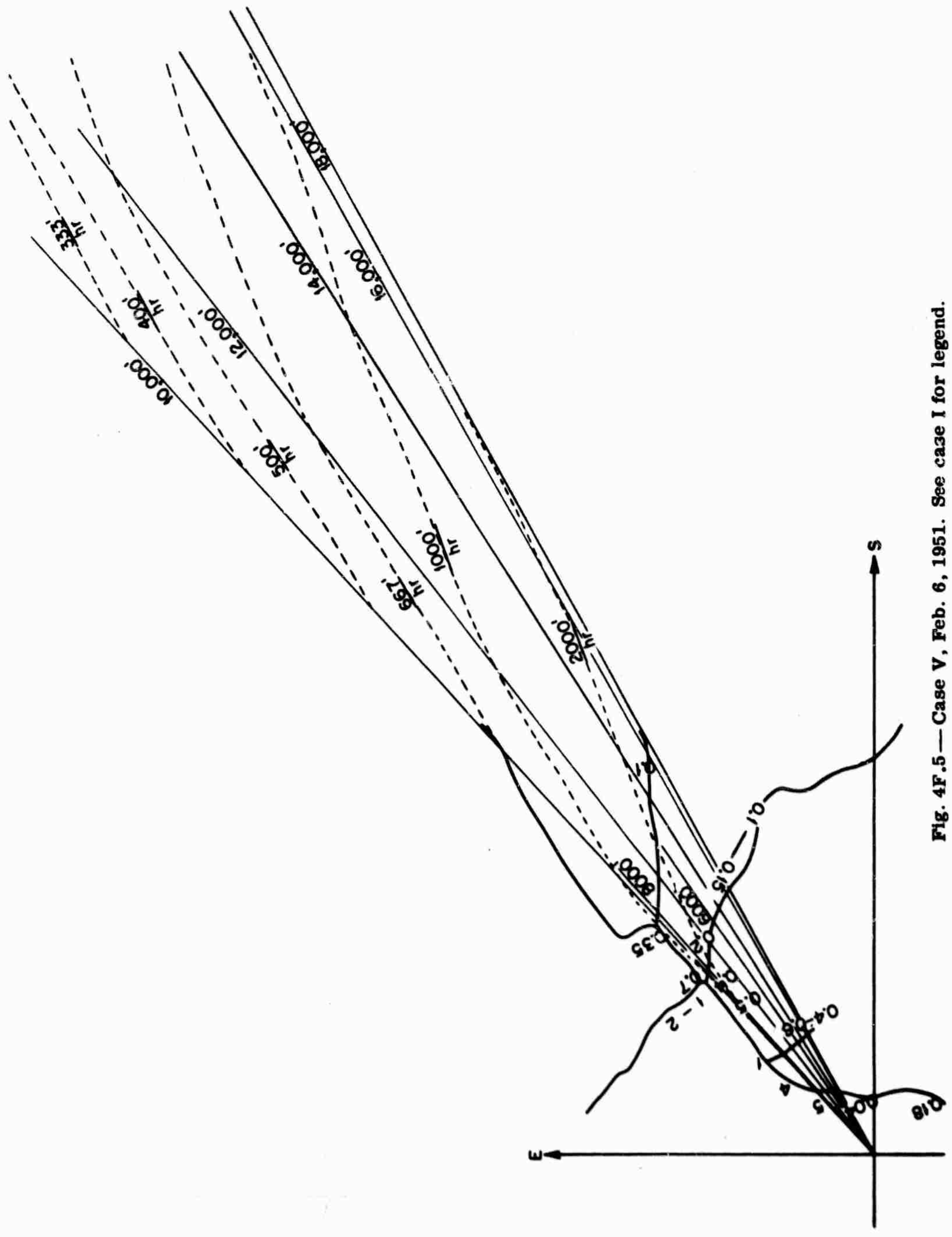

Fig. 4F.5—Case V, Feb. 6, 1951. See case I for legend.

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Appendix G

DESCRIPTION OF SHOTS

The dry run, simulating actual conditions as closely as possible, was held on the morning of January 25. As far as regional monitoring was concerned this was primarily a test of communications. The ability of the mobile monitoring teams to communicate with headquarters both by telephone and by radio was shown to be unsatisfactory. Some improvements were made subsequently, but it cannot be said that we were ever entirely satisfied with the results. At the control point itself, complete confusion was the order of the day. It should be pointed out to the credit of Carl Buckland, Ed Bemis, Glenn Vogt, and others that the reasons for the confusion were spotted very accurately and that, in so far as the lack of space permitted, matters subsequently proceeded in a thoroughly orderly fashion. It is hoped that no subsequent operation will be carried out without a similar dry run in advance, so that rough spots may be eliminated.

The first actual detonation was on the morning of Saturday, January 27. Almost ideal weather conditions prevailed, with the wind carrying the cloud generally in an easterly direction. It was immediately obvious to those watching the sky from Nellis Air Base 65 miles away that this was no dud. Monitoring teams were able to penetrate to ground zero within 1½ hr of shot time. The highest levels found were only 750 mr/hr. The members of the mobile teams covered the entire area to the east and northeast. Their only reward was obtaining a few readings showing levels of two or three times background. This was somewhat disappointing to those who were looking for excitement but thoroughly reassuring to all people with the responsibility for the safety of the public and for the continuation of the operation itself. It was further realized that the rather strict meteorological criteria which had been laid down previously could now be relaxed. Originally it was the understanding that a shot could not be fired unless the winds were generally blowing from a point somewhat to the south of due west. It was realized that this relaxation gave far greater promise that the entire program stood a good chance of being completed by the target date of February 15.

The second shot was fired on the morning of Sunday, January 28. This detonation with its higher yield produced radiation intensities at ground zero of greater than 16 r/hr. It was again shown, however, that planes could land and take off from the lake bed almost immediately after a shot and that the photo stations could be approached without the slightest danger. In spite of the higher intensities of radiation on the ground, the size of the area showing significant residual activity was approximately the same. Following this second shot it was also shown that the hot area around ground zero was definitely asymmetrical. This subject will be discussed in detail in a subsequent report, but it certainly becomes obvious for the benefit of civilian defense that the area around any nuclear detonation must be surveyed from a number of different directions if rescue teams, etc., are to be safeguarded. Just as with the first detonation, the mobile monitoring teams found very little more than traces of contamination. There certainly was not the slightest evidence that any condition dangerous to health or property, other than in the shot area itself, had been produced.

By the day after this second shot it was perfectly obvious that all personnel—scientific, monitoring, and supervisory—had about reached the limit of endurance. Many people had gone 48 hr and longer without sleep while working steadily under extreme tension. To the credit of all concerned, it must be pointed out that there were essentially no evidences of short temper, and there certainly was no complaining. More important perhaps is the fact that there were no accidents of any consequence. It is to be devoutly hoped that it will never again be necessary to tempt fate in the same way.

The third and fourth shots were on February 1 and 2. One significant point in connection with the fourth shot was that the wind was blowing out of the north, carrying the cloud directly toward the Spring Mountains. This range rises to an elevation of approximately 12,000 ft and

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is the center of a newly developed recreation area. After the fourth shot, levels of 8.0 mr/hr were recorded at approximately the 9000-ft point on these mountains, the highest level of radiation found anywhere up to that time. At the same place later on the same day this level had dropped by a factor of more than 10, suggesting that the previous reading was influenced by material still suspended in the air. It was this fourth shot which also produced at least two broken store windows in Las Vegas. For this reason very careful consideration was given to the probable effects of the blast from the proposed fifth shot. On Sunday, February 4, a public announcement was made urging people to stay away from windows at the time of any subsequent blast.

The fifth shot was scheduled for the morning of February 5 but had to be postponed because of mechanical difficulties. It seems probable that, had these mechanical difficulties not arisen, meteorological conditions might also have necessitated a postponement. The fifth and final shot, therefore, was fired on Shrove Tuesday, February 6. Again the wind was blowing from the north, and the lower portion of the cloud practically invested Charleston Peak. During the morning, levels as high as 14 mr/hr were recorded on the mountain, but again it was apparent that this level was found while material was still air-borne. Within 2 hr the level was down to 0.7 mr/hr.

Roll-up procedures were carried out without incident. The regional monitoring teams carried out a final survey of their respective areas, showing no hot spots or areas of significant activity. Monitoring was continued at the shot area through Friday, February 9. The shot area itself was fenced, although levels of activity were dropping so fast that this seemed almost unnecessary. By Monday, February 12, the last members of the group were safely back in Los Alamos.

AEC, Oak Ridge, Tenn., A38983

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