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PROJECT MANAGER'S REPORT

U. S. ATOMIC ENERGY COMMISSION
PLOWSHARE PROGRAM

PROJECT SEDAN

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MAY 1963

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PROJECT SEDAN


PROJECT MANAGER'S REPORT

PLOWSHARE PROGRAM

MAY 1963

Prepared by
U. S. ATOMIC ENERGY COMMISSION
Nevada Operations Office

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PREFACE

This report is concerned with the administration, operational planning, safety, engineering, construction, and logistics performed by NVOO in support of the technical and scientific experiments carried out under Project Sedan.

Included are a summary of the technical and scientific purposes of the experiment and an account of the field test and its result. Detailed information about the technical aspects of Project Sedan is not included; the reader is referred to the technical reports on the project prepared by Lawrence Radiation Laboratory and other participants.

Listed below are the agencies and contractors that participated in the Sedan experiments. They are referred to in this report by the listed abbreviations;

- U. S. Air Force USAF
- U. S. Army Corps of Engineers, Waterways Experiment Station... WES
- U. S. Army Pictorial Center USAPC
- U. S. Atomic Energy Commission/U. S. Bureau of Mines. USAEC/USBM
- Boeing Company BC
- Brigham Young University BYU
- U. S. Bureau of Mines USBM
- U. S. Coast and Geodetic Survey USC&GS
- Division of Biology and Medicine, AEC DBM
- Division of Military Application, AEC DMA
- Division of Peaceful Nuclear Explosives, AEC DPNE
- Edgerton, Germeshausen & Grier, Inc. EG&G
- Federal Aviation Agency FAA
- Federal Services, Inc. FSI
- U. S. Geological Survey USGS
- Geotechnical Corporation GEOTECH
- Holmes & Narver, Inc. H&N
- Lawrence Radiation Laboratory, University of California LRL
- Lookout Mountain Air Station LMAFJ
- U. S. Marine Corps. USMC
- U. S. Naval Radiological Defense Laboratory USNRDL
- Nevada Operations Office, AEC NVOO
- U. S. Public Health Service USPHS
- Reynolds Electrical & Engineering Co., Inc. REECo
- Sandia Corporation SC
- San Francisco Operations Office, AEC SAN
- Space Technology Laboratories, Inc. STL
- University of California at Los Angeles UCLA
- U. S. Weather Bureau USWB




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Sedan Crater - Looking SE Across Other Area 10 Craters



INTRODUCTION

The Atomic Energy Commission established the Plowshare program to provide research and development directed toward peaceful uses of nuclear explosives in applications such as large civil engineering projects, development of natural resources, production of isotopes and power, and scientific studies. Project Sedan was the first in a series of experiments to develop the AEC's nuclear excavation technology and was conducted at the Nevada Test Site.

The objective of the Sedan experiment was to obtain the scaling exponent for yields of about 100 kilotons at greater than optimum depth of burial to facilitate scaling of crater dimensions in the megaton range. Theory and empirical experience indicate that scaling laws for crater formation are variable depending upon the yield of the detonation. It has been shown that for 1-kiloton detonations crater dimensions vary as the $1/3.4$ power of the yield. Theory indicates that with larger detonations, scaling should gradually change to the $1/4$ power. This difference in scaling could represent sizable differences in megaton crater sizes.

The experiment involved the detonation of a 100 kiloton device buried in alluvium at a depth of 635 feet. Based on low yield crater dimensions and radioactivity entrapment relationships, it was estimated that this high-yield detonation would produce a crater 1200 to 1400 feet in diameter and 250 to 300 feet deep with less than 4 percent of the radioactive material produced being redeposited as local fallout.



PART I

PLANNING, ORGANIZATION, AND AUTHORITIES





CHAPTER I

PLANNING

On May 8, 1962, the President of the United States authorized the conduct of Project Sedan. Subsequently on May 15, 1962, SAN authorized NVOO to proceed with Sedan preparations on parallel schedules with a readiness date of July 6, 1962, and an alternate date of September 1962.

On July 3, 1962, SAN, upon receipt of Headquarters approval, authorized NVOO to proceed with the execution of Project Sedan, including the detonation on July 6, 1962.

A. SITE EVALUATION AND INVESTIGATION

The site selected for Project Sedan was in Area 10 of the Nevada Test Site. This area was used for previous high explosive and nuclear cratering detonations. Based on data from previous holes drilled in this area, it was determined that alluvium exists to a depth of approximately 1100 feet. Immediately underlying the alluvium is a weakly cemented ash flow gradually changing to a more compact tuff similar to that found in the Rainier Mesa. The coordinates of surface zero were N 884,000, E 681,000 as defined by the NTS grid coordinates.

B. OPERATIONS

A brief explanation is given here of the major aspects of operations. Each of these items is more fully explained in appropriate sections of this report.

1. Engineering and Construction

Holmes & Narver, Inc., was the architect-engineer for the project and received AEC approved construction criteria for the technical programs from the LRL Technical Director.

2. Support

Reynolds Electrical and Engineering Co., Inc., handled general support to project participants.

3. Emplacement, Arming and Firing

The nuclear device was assembled, emplaced and armed by LRL with Sandia Corporation (Livermore) assisting as necessary. EG&G accomplished the timing and firing requirements from CP-1.

4. Technical Programs.


Technical Programs were performed by LRL, SC, USC&GS, USGS, WES, EG&G, UCLA, BYU, NRDL, BC and USMC and were sponsored by the Technical Director.

5. Safety Programs

The Project Manager sponsored the following programs directed toward assuring public health and safety for the detonation region:

- (a) Radiation (On-Site and Off-Site)
- (b) Industrial Safety
- (c) Fallout Prediction and Weather Forecasting
- (d) Seismic

These programs are fully explained in Part Four of this report.



6. Public Information Program

The public information program was coordinated with the AEC and described the objectives and procedures to be followed in implementing commission policy on NTS.

7. Classification and Security

Classification guidance was furnished by SAN. NTS security was under the jurisdiction of the Project Manager's security staff. Federal Services, Inc., provided the necessary guard services.

C. VELA-UNIFORM PARTICIPATION

Vela is a short title of a DOD research and development program directed toward developing and improving U. S. capability for detecting and identifying underground and high altitude nuclear detonations. That phase of Vela which is concerned with underground detonations is known as Vela-Uniform.

In Project Sedan six Vela-Uniform programs were planned for execution on a noninterference basis with the scheduled experiment. These programs are described in Part 2, Chapter I.

CHAPTER II ORGANIZATION

A. MEMORANDUM OF AGREEMENT

As a result of the directive from A. D. Starbird, Director, DMA, to Manager, SAN, dated April 7, 1958, a Memorandum of Agreement, No. AT(29-2)-769, between SAN and ALO (now NVOO) was approved in October 1958. The nature and extent of the services and support are fully described and defined in this agreement.

In general, NVOO was to assign the Project Manager, who would be operationally responsible to the Manager, SAN, for the execution of demonstrations in accordance with program objectives and approved criteria.

B. PROJECT MANAGER

In accordance with the SAN-ALO(NVOO) Agreement, the Project Manager was to provide over-all project management in the direction and execution of Plowshare field operations; provide for and assure operational safety; provide field support (including engineering and construction); plan and carry out community relations activities; administer NVOO contracts and agreements with participating Government Agencies. In the absence of the Project Manager, all matters were referred to the Deputy Project Manager (Figure 1).

NEVADA TEST SITE ORGANIZATION
MODIFIED FOR SEDAN EVENT

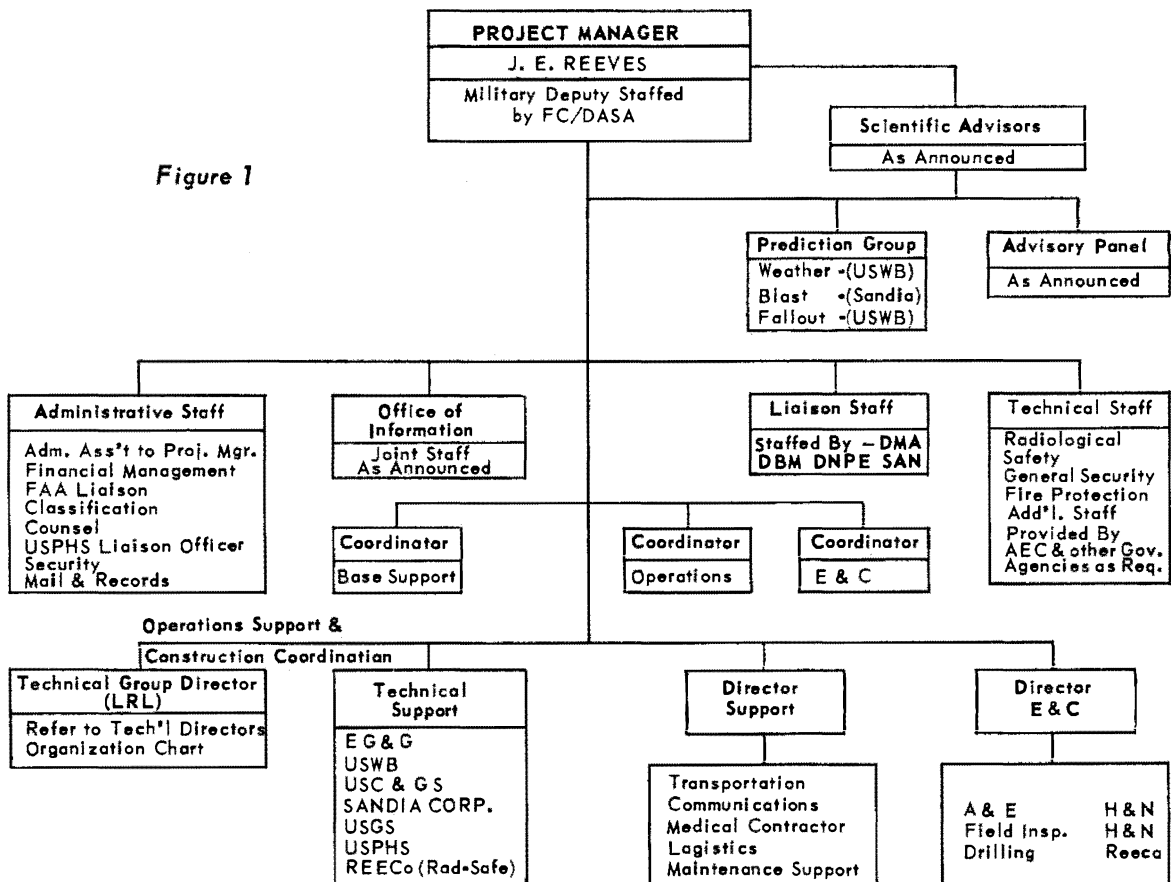


Figure 1



CHAPTER III

PROJECT HISTORY AND AUTHORIZATIONS

May 8, 1962 President authorized the conduct of Project Sedan.

May 15, 1962 SAN authorized NVOO to proceed with Project Sedan preparation on parallel planning schedules with readiness dates of July 6, 1962, and September 1962.

May 18, 1962 Technical Director's Concept for Project Sedan.

May 1962 Technical Reporting Plan for Project Sedan.

June 4, 1962 Operational Safety Plan.

June 6, 1962 Technical Director's Operation Plan.

June 6, 1962 Plowshare Chart of Accounts.

June 8, 1962 Planning Directive (PL-3-6-62) - Project Sedan.

June 22, 1962 Planning Directive (PL-3-6-62) - Project Sedan, Revision I.

June 22, 1962 DPNE advised of the NTS Off-Site Radiation Exposure Guide for Sedan.

June 28, 1962 Project Manager's Special Instructions and Schedule of Events - Project Sedan.

July 2, 1962 Planning Directive (PL-3-6-62) - Project Sedan, Revision II.

July 3, 1962 Classification Guidance - Project Sedan.

July 3, 1962 SAN authorized NVOO to proceed with the execution, including detonation of Project Sedan on July 6, 1962.

July 6, 1962 Project Sedan detonation.



PART II

SCIENTIFIC AND TECHNICAL PROGRAMS





CHAPTER I

SCIENTIFIC

Project Sedan was the first of a projected series of cratering detonations designed to develop the techniques of nuclear excavation over the next four to five years. Its purpose was to extend knowledge of cratering effects to the 100 kt range of yields. Most nuclear excavation projects such as harbors and canals will require the use of nuclear explosives in the range of 100 kt to 10 mt. Previous cratering experience has been limited to 1-kt and smaller explosions. Serious questions have been raised regarding the methods of using these low yield data to predict the results of high yield explosions. Sedan was designed to answer several of these questions as well as provided data on safety problems related to radioactivity, seismic effects and air blast.

A. PHENOMENOLOGY

The depth of burst chosen for Sedan was 635 feet. Previous data had indicated that this depth would result in a crater of almost maximum dimension while allowing less than 4 percent of the radioactivity produced by the explosion to redeposit as local fallout. This amounts to less than 2-kt equivalent fission activity. The location chosen was Area 10 at the Nevada Test Site (Figure 2), near several other nuclear craters (Jangle U and Teapot Ess) and much high explosive cratering work (Scooter, Stagecoach).

The 100-kt explosive used for Sedan was a thermonuclear device in which less than 30 percent of the energy release came from fission. Measures were taken to reduce the radioactivity induced by the neutrons from the thermonuclear portion of the yield to a level well below the fission product activity.

Technical programs accompanying the detonation included air blast and seismic monitoring both on-site and off-site. Scientific photography from six camera stations was planned to determine surface motion and cloud dimensions. Fallout trays and collectors were positioned throughout the planned fallout sector and bio-environmental plots were laid out to study radiation effects caused by the explosion. Radioactive pellets were emplaced in holes near the shot point to study particle trajectories. Tarpaulins, trays and measuring rods were distributed to measure and document the distribution of the throwout and dust (Figures 3 through 6).

The device was emplaced in a 36-inch diameter cased hole together with a series of detectors to determine device performance. The hole was backfilled with dry sand.

Sedan was detonated at 1000 hours PDT on July 6, 1962. A roughly hemispherical dome 600-800 feet in diameter rose to a height of 290 feet at 3 seconds at which time venting of incandescent gases occurred, resulting in a bright flash (Figure 7). The material continued to rise to a height of about 2,000 feet (Figure 8). As this tremendous volume of earth fell to the ground, a base surge was formed that expanded radially to a distance of approximately 2.5 miles crosswind and 2 miles upwind (Figures 9 and 10). The main cloud rose to a height of about 12,000 feet above the desert floor, where it was topped by inversion conditions in the atmosphere.

The crater formed had a maximum apparent depth of about 320 feet and an average apparent diameter of 1200 feet. The lip ranged from about 20 to almost 100 feet in height above the original grade (Figures 11 through 18). Dispersion of throwout material is shown in Figures 19 and 20.

The cloud was carried downwind by a meanwind of about 17 knots from 185°. Intense fallout was confined to within approximately 2 miles upwind and crosswind, and 4 miles downwind of ground zero. Although the radioactivity deposited at longer ranges downwind was greater than expected, the intensities were moderate considering the large amount of dust carried by the cloud. The maximum infinite doses at 50 and 199 miles were about 2r and 200mr respectively.



Area 10 Craters
Scale - 1" = 700'

- | | |
|------------------|---------------------------------|
| A. Sedan | D. Teapot |
| B. Scooter | E. Stagecoach (Station 1003.02) |
| C. Buster-Jangle | F. Stagecoach (Station 1003.03) |

Figure 2 - AERIAL VIEW OF AREA 10 CRATERS



Figure 3 - SEISMOGRAPH INSTALLATION



Figure 4 - CAMERA BUNKER



Figure 5 - PUTTING RADIOACTIVE SAMPLES DOWN HOLE



Figure 6 - EJECTA STUDY DEBRIS TRAPS



*Figure 7 - GROUND ZERO FROM STATION
NO. 6*



Figure 8 - SEDAN - ZERO TIME



Figure 9 - GROUND PHOTO OF BASE SURGE



Figure 10 - AERIAL PHOTO SHOWING BASE SURGE



Figure 11 - SEDAN CRATER - AERIAL VIEW LOOKING NW



Figure 12 - SEDAN CRATER - AERIAL VIEW LOOKING SE



Figure 13 – INSIDE SEDAN CRATER



Figure 14 – VIEW FROM RIM OF SEDAN CRATER



Figure 15 – AERIAL VIEW SHOWING LIP OF SEDAN CRATER



Figure 16 - LIP OF SEDAN CRATER



Figure 17 - SEDAN CRATER - VIEW FROM RIM



Figure 18 – SEDAN CRATER – EDGE OF RIM



Figure 19 – THROWOUT FROM SEDAN DETONATION



Figure 20 -

BOULDER FIELD RESULTING FROM SEDAN EXPLOSION

Ground shock intensities were much less than expected, based on previous experience in tuff and alluvium. Accelerations of 0.1 g were recorded at a distance of approximately 1.5 miles from ground zero.

Radiochemistry analysis of cloud samples indicates a yield for the Sedan device of 100 ± 15 kt. Hydrodynamic and time-of-arrival yield measurements give a yield of 110 ± 20 kt. Preliminary integration of the fallout pattern indicates that about 10 percent of the radioactivity produced appeared as local fallout.

B. AIR BLAST STUDIES

Air blast stations in the caustic range (80-150 miles) recorded peak pressure as follows:

STATION	DISTANCE FROM SEDAN	PRESSURE
Coldale, Nevada	N 60° W 117 Miles	0.320 millibar
Deep Spring, California	W 110 Miles	0.555 millibar
Bishop, California	W 128 Miles	no data-calibration problem
Tam's Place, California	W 7° N 148 Miles	0.750 millibar
Argus, California	W 50° S 123 Miles	0.376 millibar
China Lake, California	W 45° S 137 Miles	0.828 millibar
Valley Acres, California	232 Miles	0.106 millibar

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These pressures were due primarily to the ducting of the blast wave in the ozonosphere. Winds from 80,000 to 150,000 feet were easterly, with speeds up to 104 knots. Preliminary analysis shows that attenuation of the blast due to burial averaged about 5.7 but was less than 3.5 for the maximum pressure recorded.

Of the nine close-in air blast gauges, only three have been recovered to date. However, data less useful than anticipated have resulted because one gauge was broken another was over-ranged and the third gave a signal amplitude which was too large. Attempts will be made to recover most, if not all, of the remaining gages.

C. PHOTOGRAPHIC COVERAGE

Good results were obtained from three of the camera stations, but all data from the three closest stations were lost when the shielding doors failed to close and radioactive dust entered the station. Additional photographic coverage from the top of the Bren tower and from aircraft was also obtained. Unfortunately, the fiducial flash bulb located at surface zero failed to go off at zero time, so the films do not have an absolute time reference. Analysis of these films for surface and cloud motion has not been completed at this date.

D. VEGETATION STUDIES

Preliminary results of studies dealing with the close-in effects of the Sedan detonation on vegetation indicate that within a radius of 2,000 feet from ground zero, the vegetation was completely destroyed by cratering and blast with the original soil surface covered by a foot or more of radioactive throwout. From about 2,000 to about 5,000 feet, vegetation has been damaged by blast and throwout. About 50 percent of the shrubs present in this area were blown away, but due to summer dormancy the percentage of plants killed will not be known until spring. From 5,000 to more than 10,000 feet from ground zero, vegetation and soil were heavily blanketed by radioactive dust derived from the base surge cloud. No damage was apparent to the vegetation. However, an early onset of summer dormancy may have resulted.

Further research is now in progress to:

- (1) Study recovery of vegetation damaged, but not destroyed, by the blast and throwout;
- (2) study re-establishment of vegetation in areas where the original vegetation was completely destroyed,
- (3) study effects of exposure of plants to gamma radiation and large deposits of radioactive dust from the base surge cloud.

E. FALLOUT STUDIES

Fallout collections from 74 of the 92 stations have been obtained. Samples were processed with respect to size fractions and the data is now being evaluated. Radiochemistry analysis is being done on representative samples to determine specific radio-nuclides which will permit an estimate of the isotopic fractionation.

Aerial and ground radiological surveys were made to determine the distribution of Sedan fallout deposited on the ground from 5 to 200 miles from ground zero. These surveys gave the following readings reduced to H + 24 hours:

RANGE	RADIATION LEVEL
(miles)	(mr/hr)
3	400
15	150*
30	40
45	17
60	7
90	1.7
120	0.8
150	0.6
180	0.4
* Estimated. No data available in the 10 to 20 Mile Range	

The dose rate contours show the fallout pattern to be asymmetric with a steep gradient west of the midline with a very gradual gradient on the east.

Gamma ray energy spectral measurements were made several days after Sedan by aerial survey at 100 feet above the ground surface and the following radio-nuclides were tentatively identified: I131; TE132; I132; W187; BA140; and LA140.

A limited fallout collection program was conducted to aid in the continued Plowshare hydrologic studies being carried out by the USGS. The samples have been recovered and the analysis has begun.

F. MASS DISTRIBUTION PROGRAM

The mass distribution program has recovered approximately half of their tarpaulins to date and have determined the 1 and 10 lb/ft² isopack lines. Further field work to recover more stations is continuing as radiation levels permit. None of the Co⁶⁰ pellets emplaced before the shot to determine particle trajectories have been recovered to date.

The above data are preliminary and in many cases incomplete. In addition, it should be recognized that important qualifications may have been inadvertently omitted in preparing this summary. For these reasons the above results should be used with great caution. For more accurate data it is recommended that the particular program participants be contacted directly.

G. VELA-UNIFORM PROGRAM

The Vela-Uniform program has been participating on all underground nuclear detonations conducted under the Storax series at the Nevada Test Site. The Sedan event was one of this series. Projects conducted in conjunction with the experiment are discussed in the paragraphs which follow.

1. Project 1.4

United States Coast and Geodetic Survey (USC&GS) recorded strong motion seismic data at eleven stations positioned along two roughly parallel lines on opposite sides of the Yucca Fault. These stations extended southerly from ground zero and ranged from approximately 1.1 to 14.2 kilometers distant.

Displacement and acceleration predictions for this event were based on a 1961 USC&GS Interagency Report, "Operation Plowshare, Project Scooter, Surface Motion from a Cratering Shot in Desert Alluvium." Accelerations in general were low by almost an order of magnitude; displacements on deep alluvium east of Yucca Fault agreed well with the scaling formula; and displacements West of Yucca Fault were low by a factor of about four. Amplitudes followed the predicted amplitude-distance relationships except at the closest (1.1 km) station, where results were relatively low. The vertical components of motion were considerably smaller than horizontal components.

[REDACTED]

2. Project 1.7

Space Technology Laboratories (STL) recorded the surface displacement spectrum at a series of discrete frequencies between 1 and 300 cycles per second. Instrumentation was as follows:

2 gages, 1 radial, 1 vertical, 1500' radius, S42° 57'W.

3 gages, 1 radial, 1 vertical, 1 tangential, 2500' radius, S42° 57'W.

2 gages, 1 radial, 1 vertical, 4000' radius, S42° 57'W.

2 gages, 1 radial, 1 vertical, 5500' radius, S42° 57'W.

No results can be given inasmuch as five of the gages have not yet been recovered.

3. Project 8.1

United States Coast and Geodetic Survey (USC&GS) recorded seismic measurements on film tape and lineograph at five stations at distances ranging 149 to 1440 km from ground zero.

4. Project 8.4

Geotechnical Corporation (Geotech) attempted to detect and identify the event with 34 stations located throughout the country. All 34 stations were equipped with both long and short period seismometers. Of these stations, 27 positive, 1 possible and 6 negative detections were made with the short period equipment. With the long period equipment, 25 positive, 3 possible and 12 negative detections were made.

5. Project 9.2

U. S. Army Pictorial Center (USAPC) provided photographic coverage.

6. Project 9.3

Lookout Mountain Air Station (LMAFJ) also provided photographic coverage.



PART III

PROJECT MANAGER'S ADVISORY PANEL



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CHAPTER I

ADVISORY PANEL

The Scientific Advisory Panel for Project Sedan was informed on July 5, 1962, at 1600 PDT, by the USWB that southwesterly winds of 15 knots would occur over NTS with nearly neutral stability up to 16,000 feet MSL. It was predicted that an isothermal layer from 16,000 to 18,000 feet MSL would limit cloud rise to below that height. A 10,000 foot MSL trajectory was indicated for three days following D-Day. The cloud would move behind a shower system moving eastward across the country; however, the accuracy of the precipitation forecasts and trajectory were not high enough to assure that no portion of the cloud would be subject to precipitation while moving over western and midwestern states. The probability of the cloud being subjected to precipitation was lower than would have been true under the climatological normal for the summer season. This forecast, as given, was basically the same on the morning of the event during briefings at 0630 PDT and 0930 PDT, July 6, 1962 (Figures 21 through 26).

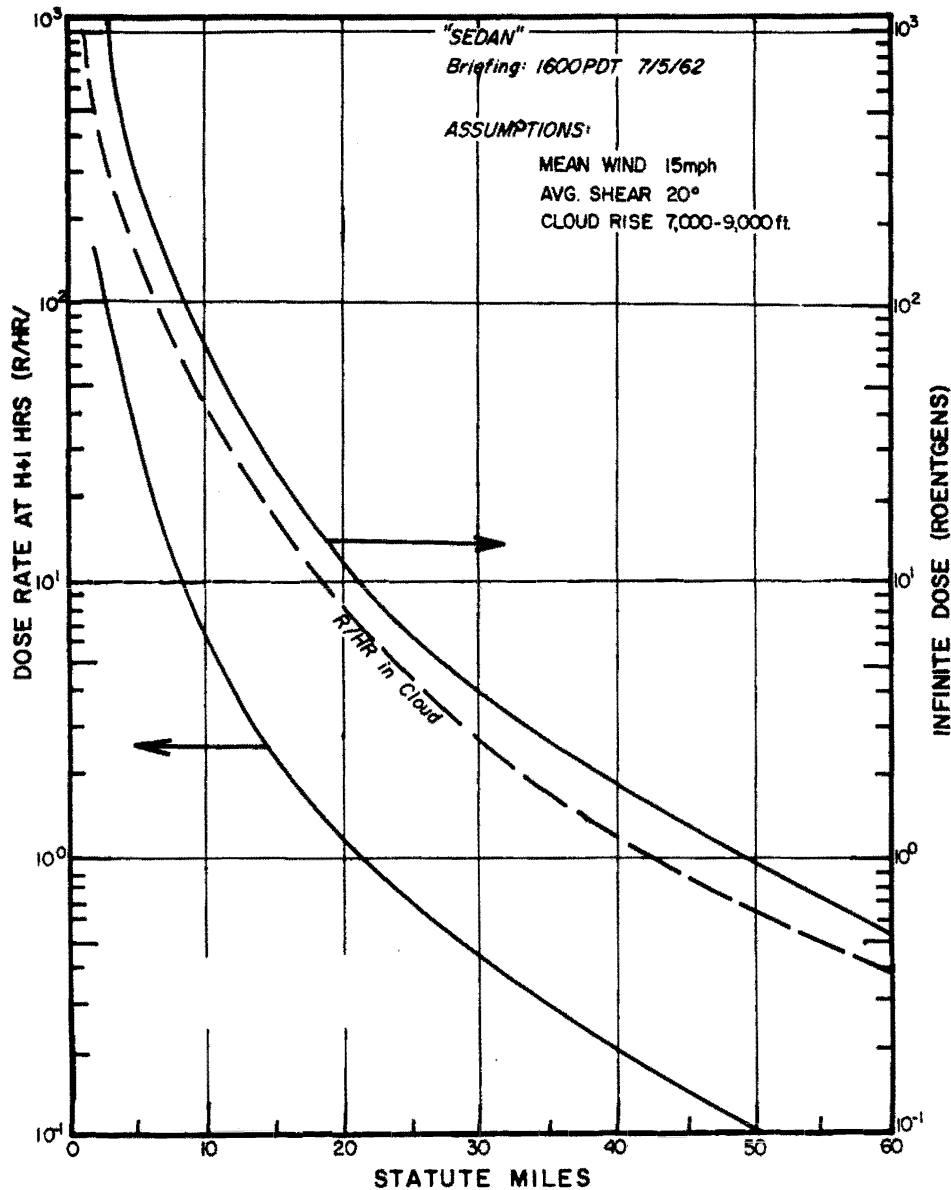
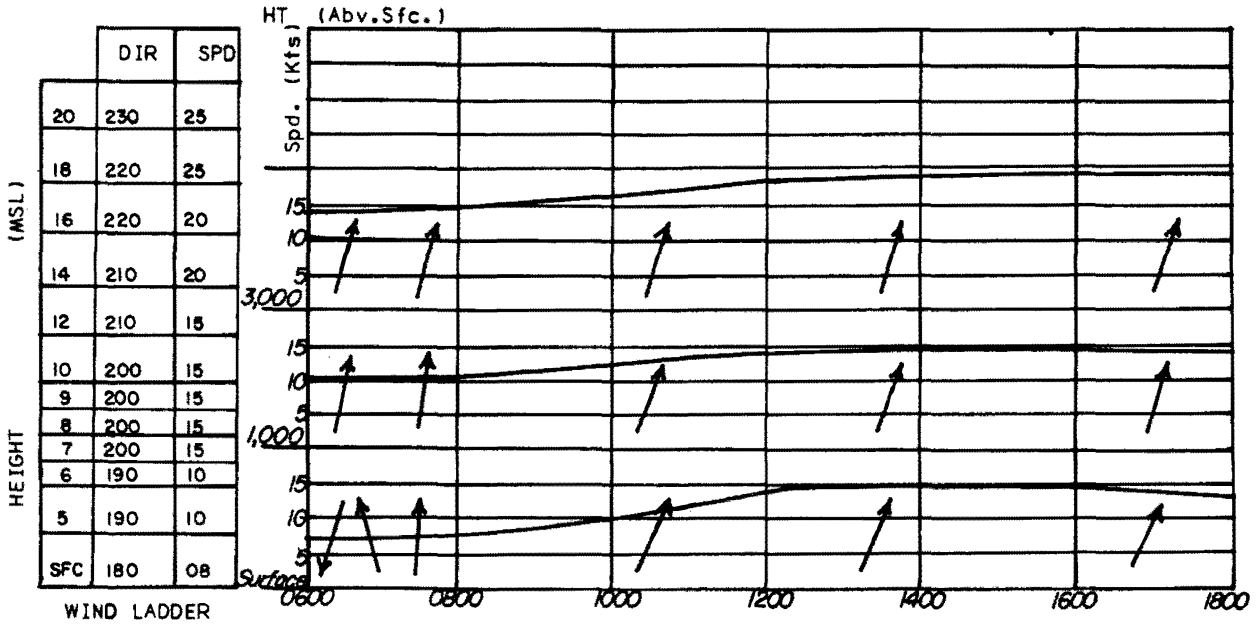


Figure 21 - SEDAN BRIEFING, 1600 PDT, JULY 5

[REDACTED]

BRIEFING FORECAST for 1600 PDT 7/15/62
 VALID from 0600 PDT 7/6/62 to 1800 PDT 7/6/62
 Latest Available Data 1800Z 7/5/62



VALID 0900 PDT 7/6/62 WIND TIME SECTIONAL (Time: PDT)

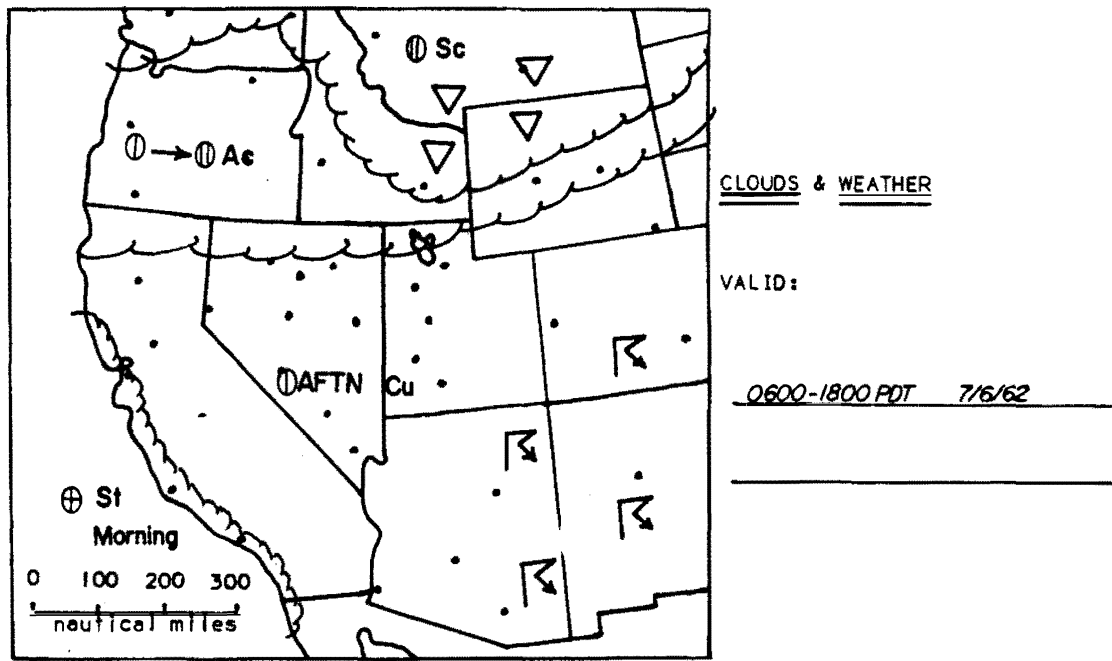


Figure 22 - CLOUD AND WEATHER PATTERN FOR PERIOD 0600 TO 1800 PDT, JULY 6

"Briefing Forecast for 1600PDT 7/5/62"

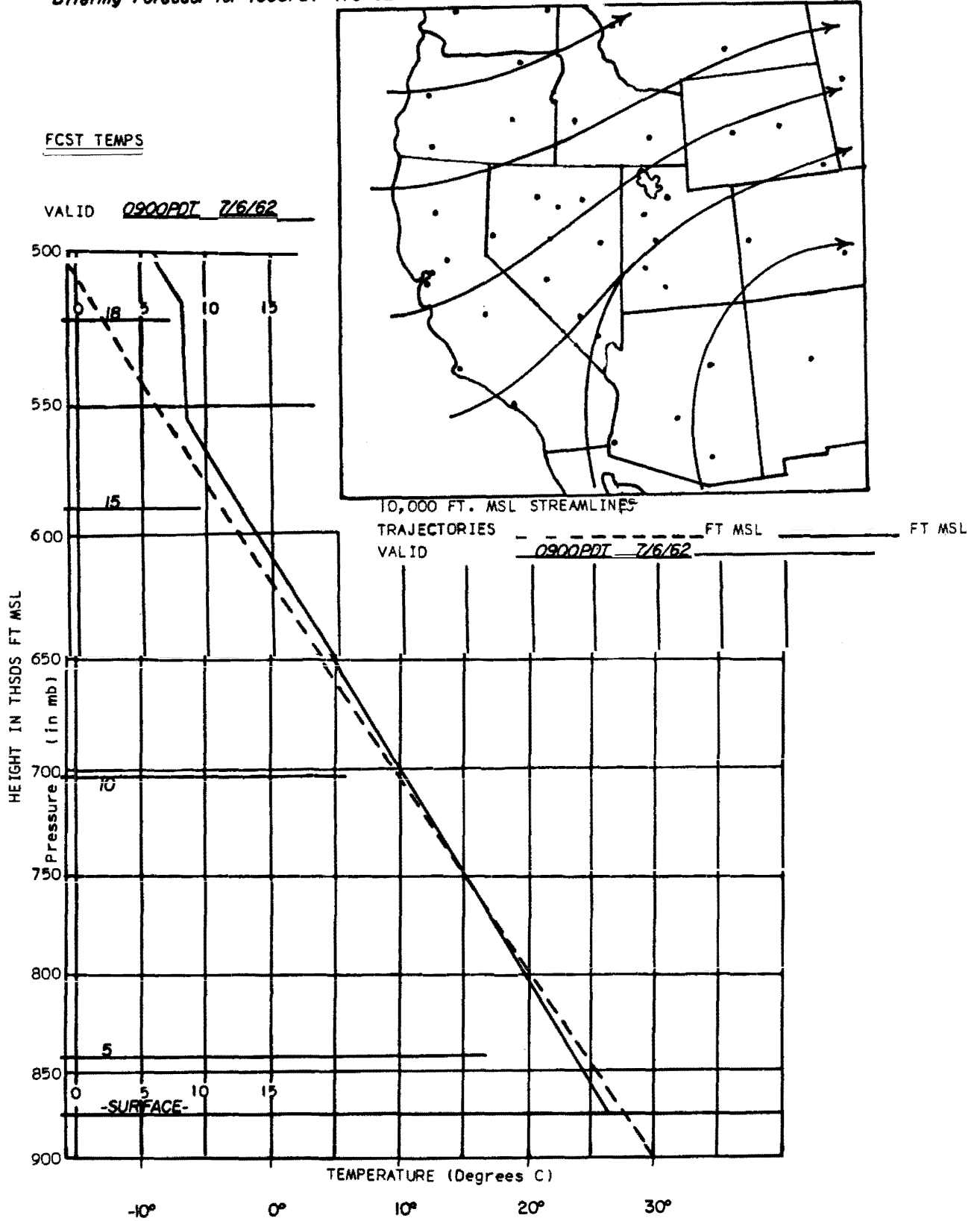


Figure 23 - BRIEFING FORECAST FOR 1600 PDT, JULY 5

U Nelson
BRIEFING FORECAST for 1600PDT 7/5/62 VALID from 1000PDT 7/6/62 to 1000PDT 7/9/62

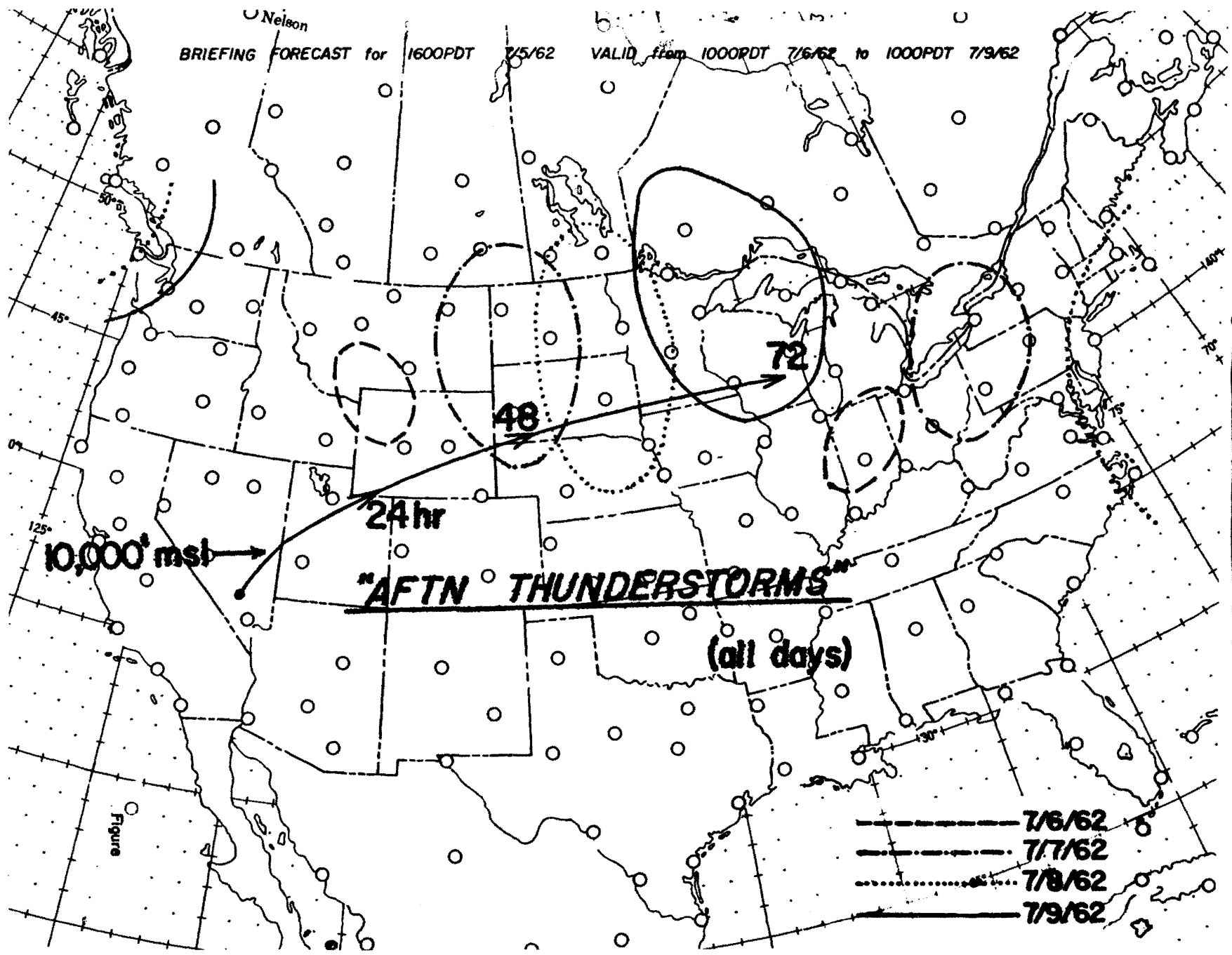
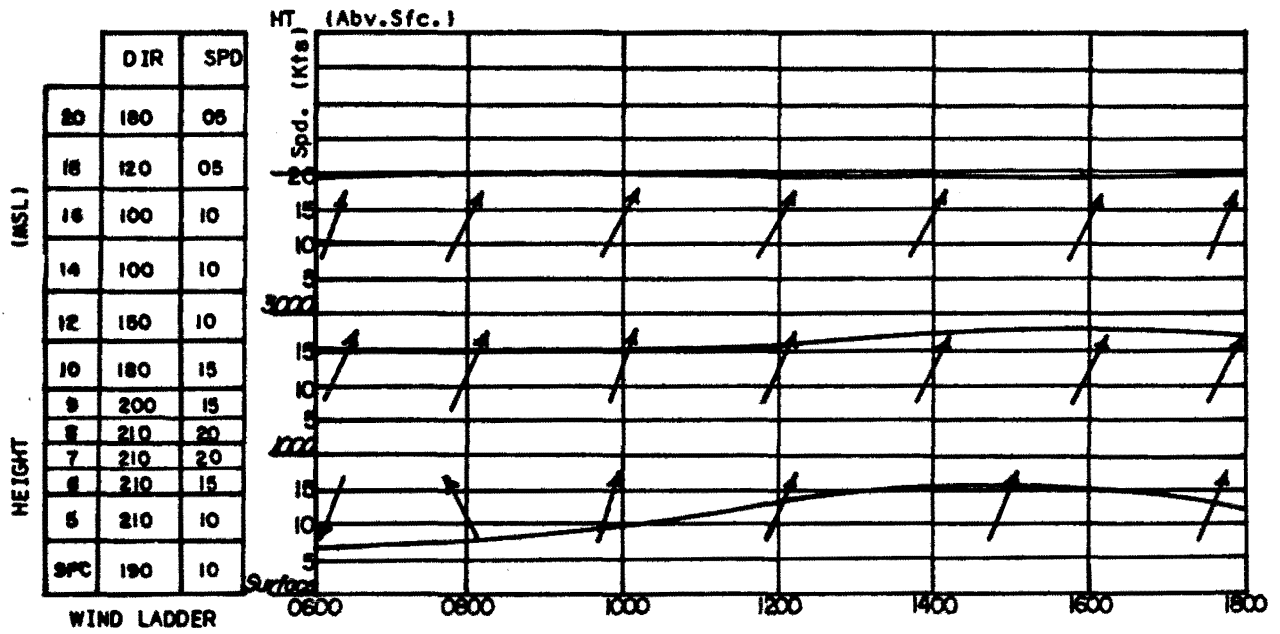


Figure 24 - PROGNOSTIC PRECIPITATION AREAS AND TRAJECTORIES

[REDACTED]

BRIEFING FORECAST for 0630PDT 7/6/62
 time date
 VALID from 0600PDT 7/6/62 to 1800PDT 7/6/62
 time date time date
 Latest Available Date 0600Z 7/6/62
 time date



VALID 0900PDT 7/6/62 WIND TIME SECTIONAL (Time: PDT)

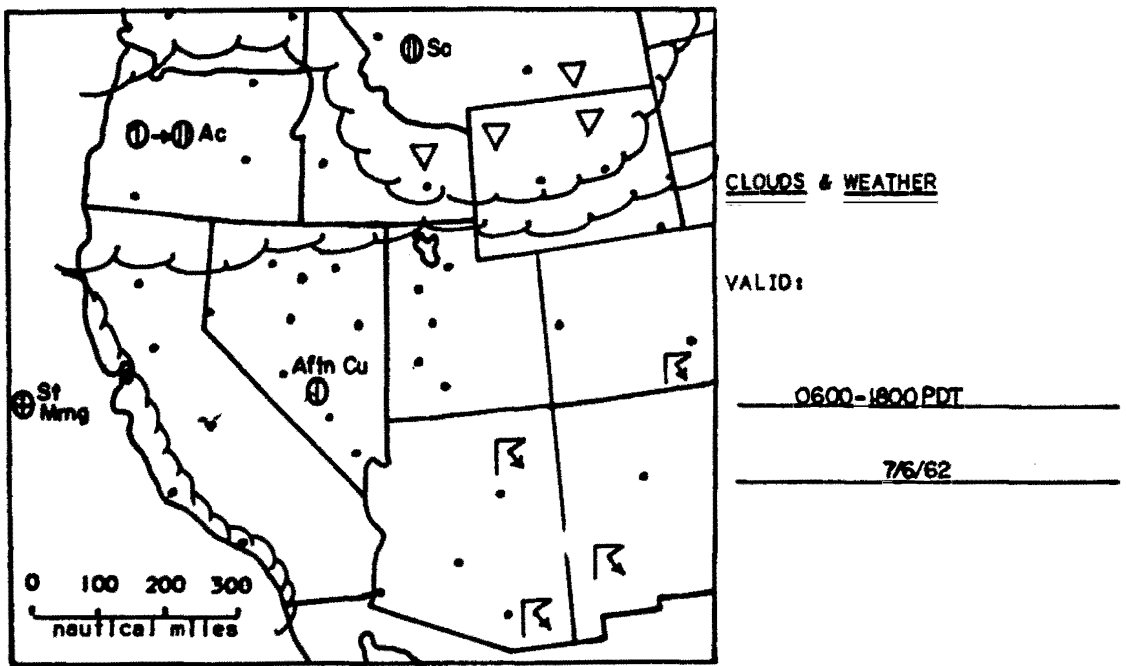


Figure 25 - BRIEFING FORECAST FOR 0630 PDT, JULY 6 (Sheet 1 of 2)

"Briefing Forecast for 0630PDT 7/6/62"

FCST TEMPS

VALID 0900PDT 7/6/62

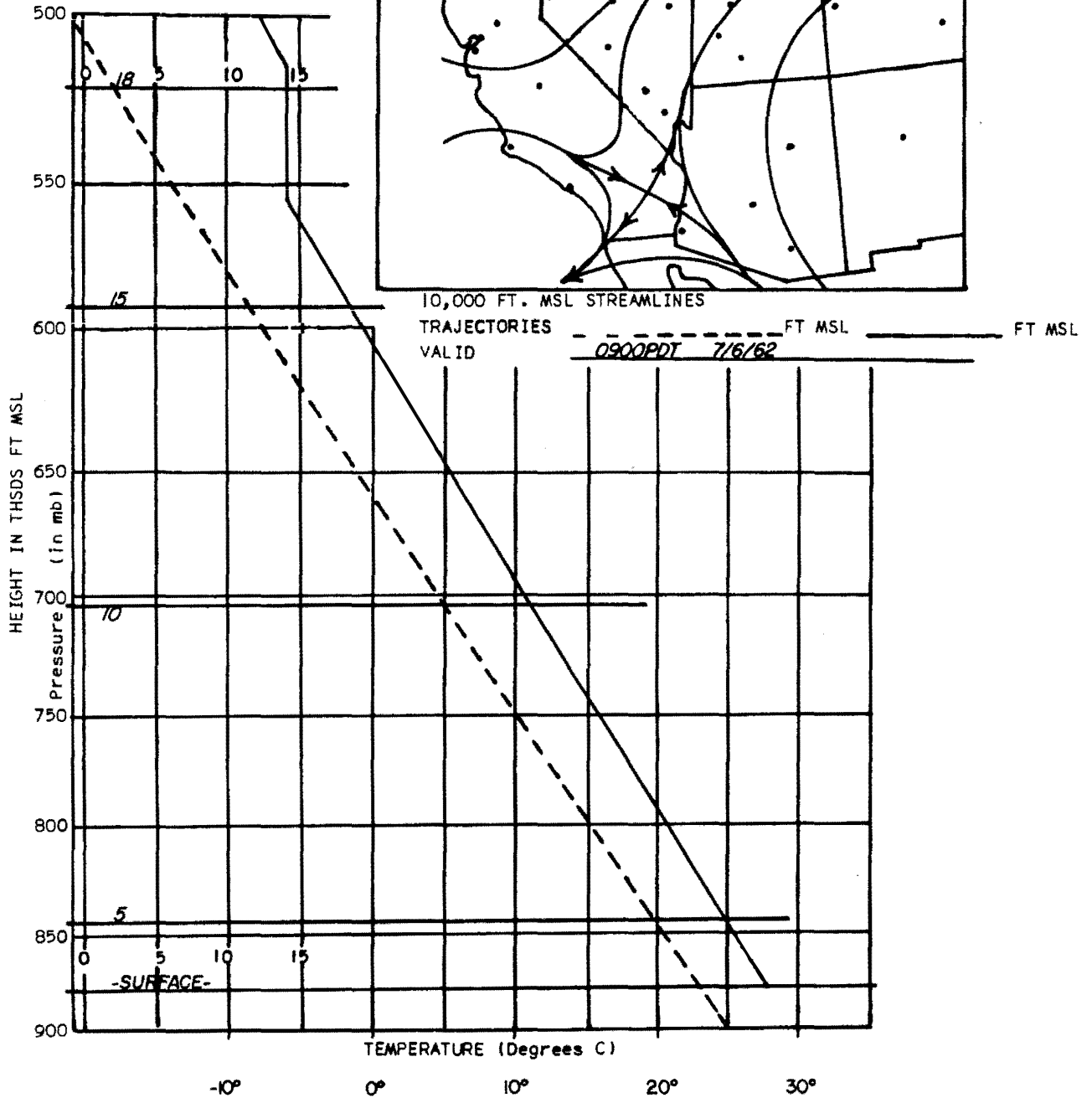


Figure 26 - BRIEFING FORECAST FOR 0630 PDT, JULY 6 (Sheet 2 of 2)

The fallout briefings at 1600 PDT, July 5, 1962; 0500 PDT and 0930 PDT, July 6, 1962, were based on the following assumptions:

- (1) 120 kt total yield.
- (2) Cloud rise 7,000 to 9,000 feet above the surface.
- (3) Deposition fraction, 8 percent of the fission yield and activated materials.
- (4) Particle size-activity distribution similar to that which occurred in the Teapot ESS detonation. The forecast hodograph, valid for 1000 hours PDT, July 6, 1962, indicated a mean wind speed of about 15 miles per hour and 20 degrees of directional shear through the layer from surface to 7,000 to 9,000 feet.

Based on the above assumptions the predicted fallout readings are shown in Figures 21 and 27. Figure 21 shows the estimates of radiation exposure along the centerline of the fallout pattern, forecast at the briefing of 1600 PDT, July 6, 1962. At 40 miles, H + 1 hour dose rates were expected to reach 0.18 r/hr from fallout, 1.7 r/hr in the cloud at the surface during cloud passage (dashed line), and 1.7 r infinity dose resulting from residual fallout. The centerline of the fallout pattern was forecast to be along a bearing of 20 degrees from ground zero.

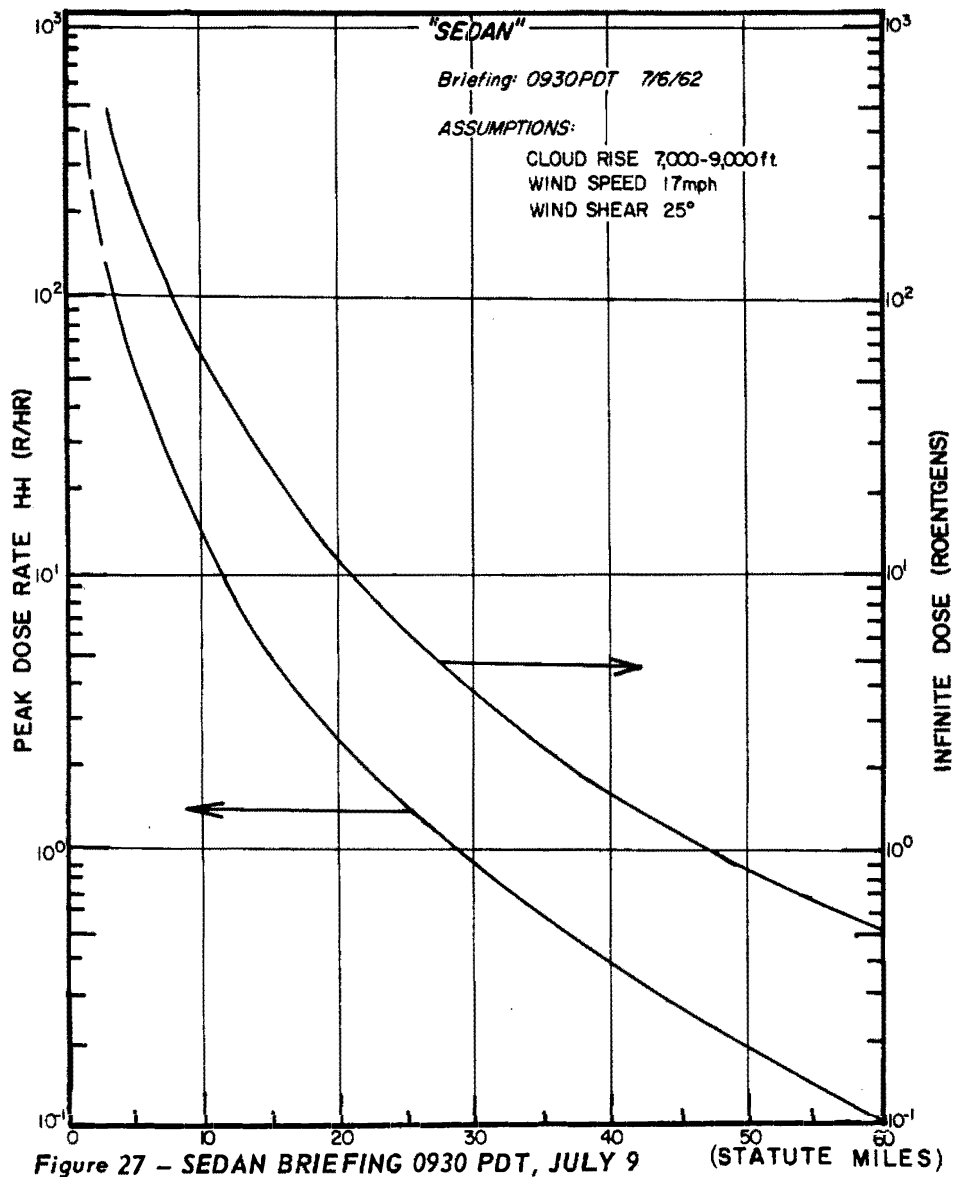


Figure 27 - SEDAN BRIEFING 0930 PDT, JULY 9 (STATUTE MILES)

[REDACTED]

Radiation forecast for the briefing of 0500 PDT, July 6, 1962, was essentially the same as stated above, except that the centerline of the fallout pattern was predicted to be along a bearing of 40 degrees from ground zero.

At the 0930 PDT briefing on July 6, 1962 H + 1 hour dose rates of 0.4 r/hr were expected at 40 miles due to fallout, and infinity dose values at that distance were expected to reach 1.7. The centerline of the fallout pattern was forecast to be along a bearing of 25 degrees from ground zero.

The Panel evaluated the predictions furnished by the Weather & Fallout Prediction Units and made the recommendation to the Test Manager to proceed with the execution of the shot. The recommendation of the Panel was accepted by the Test Manager and Sedan was detonated at 1000 hours, July 6, 1962.



PART IV

SAFETY PROGRAM





CHAPTER I

PANEL OF SAFETY CONSULTANTS

Since the Sedan detonation did not take place immediately contiguous to private lands or facilities, it was not deemed necessary to convene a meeting of the Panel of Consultants to review all safety considerations. Several members of the Panel of Consultants, however, were requested to comment on the "Operational Safety Plan - Project Sedan - Plowshare Program." Although the consultants had several pertinent comments and suggested revisions to the safety plan, the consensus was that there would be no hazard from ground motion to public or private facilities other than possible minor spalling in private mines at the Nevada Test Site.

Ronald F. Beers, Inc., NVOO Seismic Contractor, evaluated possible seismic effects from the Sedan event and made the following statements:

"Because the Sedan shot is to be made in unconsolidated sediments (desert alluvium), at a depth designed to crater, surface wave effects are not predicted to exceed those of body waves

"For surface waves, the effects we predict are similar to those of 'ground roll' frequently observed in seismic exploration on a smaller scale. The surface waves may be any of several types: Rayleigh, Love, hydro-dynamic, or other types. These surface waves are characterized by relatively longer periods, larger amplitudes and lower attenuation with distance, compared with P and S body waves. These factors account for our view that surface waves resulting from the Sedan shot may produce larger amplitudes of ground motion than body waves

". it is concluded that the only areas of potential danger are the Bren Tower, the Area 15 Tunnels, the Climax Mine and the Crystal Mine.

"The Bren Tower represents a special case which calls for further analysis. The Area 15 Tunnels, Climax Mine and Crystal Mine should be evacuated during the shot as there will probably be some minor spalling. Other than spalling, there should be no serious damage to these workings."

Predictions of the structural response of the Bren Tower to the predicted ground motions are discussed in more detail in Chapter 4, "Special Safety Measures."

The observed values of ground motion for Project Sedan were somewhat less than the predicted values and as predicted, no adverse effects on public safety, The Bren Tower, Area 15 Tunnels, Groom Mine, Climax Mine or Crystal Mine resulted from ground motion.





CHAPTER II

WEATHER AND SURFACE RADIATION PREDICTION

The meteorological observational program for Project Sedan began at 0600 PDT and ended at 2330 PDT July 6, 1962. The on-site observational network included radar stations at BLY and Frenchman Flat, which reported winds aloft data, and a radiosonde station at Yucca Flat, which reported winds and temperature aloft data (Figure 28). The off-site observational network consisted of wind sounding stations situated at Coyote Summit, Tonopah Test Range, Hiko, Beatty, and Diablo, Nevada and Shoshone, California, which reported winds aloft data. Additional stations recorded double-theodolite wind observations at Warm Springs, Currant Summit and Panaca, Nevada and at Spanish Fork and Garrison, Utah.* The meteorological data from the local U. S. Weather Bureau stations were transmitted by telephone and teletypewriter to the CP-1 command post for analysis during the Sedan operation. In addition to local weather data, regional forecast meteorological information was obtained from Mercury Weather Station, Mercury, Nevada, via National Teletypewriter and facsimile facilities.

The forecast given in the briefing of 0630 PDT July 6, 1962 and valid for the period 1000 to 1800 PDT of that day is summarized as follows:

(1) Nearly neutral thermal conditions from the surface to 16,000 feet MSL with a stable (isothermal) layer from 16,000 to 18,000 feet MSL.

(2) Surface winds from 190° at 10 knots veering to 210° at 15 knots in the afternoon. The winds aloft will be from 210° at 15 to 20 knots from 5,000 to 9,000 feet MSL backing to 100° at 10 to 15 knots in the layer 9,000 to 16,000 feet MSL. At 18,000 feet MSL the winds will be 120° at 5 knots and at 20,000 feet MSL the winds will be 180° at 5 knots.

(3) Mostly clear skies will prevail throughout the day in Nevada.

A 10,000 feet MSL wind trajectory for time intervals of 24, 48 and 72 hours after detonation as well as the predicted location of precipitation areas for these periods was also presented to the Test Manager and his advisory panel. These forecasts were as follows:

(1) Scattered shower activity will occur in southeastern Idaho, northwestern Wyoming and southwestern Montana on July 6. This shower system will be approximately 400 miles downwind from the Sedan cloud at shot time and the system will be moving eastward ahead of the cloud. The shower system is expected to continue moving eastward across the Dakotas on the 7th, Minnesota on the 8th, and the northern Great Lakes area on the 9th. The Sedan cloud is expected to move east-north-eastward trailing behind the shower area and is not expected to catch up with the shower before Monday the 9th.

(2) The accuracy of precipitation forecasts and trajectory forecasts is not high enough to assure that no portion of the cloud will be subjected to precipitation in passing over the western and midwestern states. However, the possibility of such an occurrence in this situation is lower than the climatological normal for summer season, and the cloud will be traveling in a dry air mass.

*Records are available from the U. S. Weather Bureau Research Station, Las Vegas.

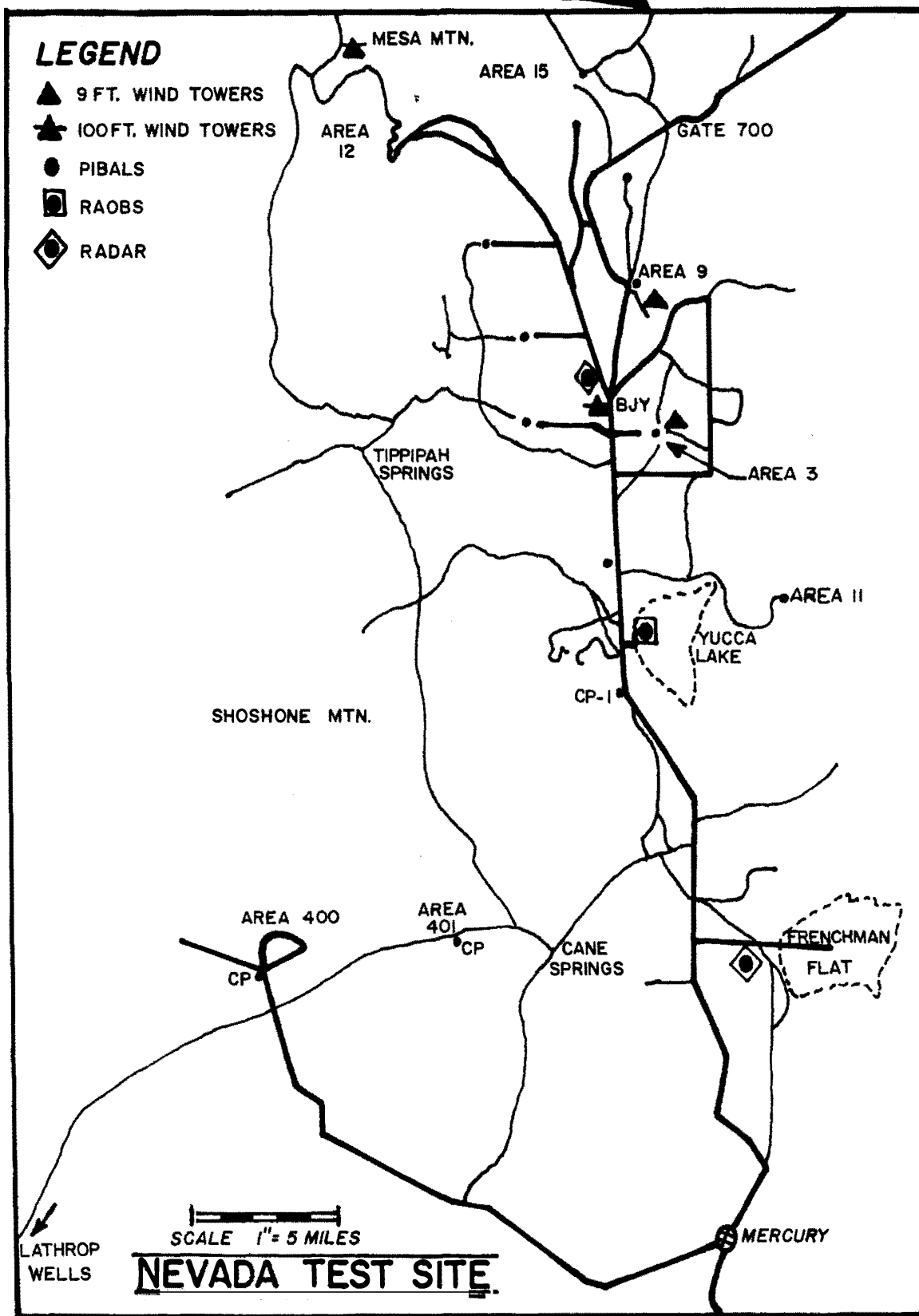


Figure 28 - ON-SITE METEOROLOGICAL NETWORK

[REDACTED]

Since the Sedan event was designed as a cratering experiment, venting of both solid particulates and gaseous products was expected to occur following the detonation. Pre-shot radiation estimates were based on the assumption that the deposition of solid particulates would produce a geographically extensive fallout pattern and that emersion within the passing nuclear cloud could significantly contribute to the total external gamma exposure. It was assumed that the distribution of radioactivity as a function of particle size for Sedan would be similar to that resulting from the Teapot Ess detonation. With the above assumption, it was possible to apply Teapot Ess dose rate-distance curve as a basic prediction model. Experience had shown that this approach produced a reasonable estimate.

Aircraft measurements indicated that the top of the Sedan cloud reached an altitude of from 17,000 to 18,000 feet MSL shortly after the detonation, or 13,000 to 14,000 feet above the terrain in Area 10. However, the atmospheric layer below 16,000 feet MSL is believed to have contained most of the activity.

Gaseous products and fine particulates vented from ground zero and passed over monitors off-site situated at Diablo, Nyala, and Moorman Ranch. The geographical locations of these positions are shown in Figure 29.

With the exception of Moorman Ranch, monitors were situated to the left and right of the cloud trajectory respectively, and observed the dose-rate levels during the period of cloud passage. Emersion in the cloud contributed significantly to the external gamma exposure. Two roving monitoring teams reported peak dose rates due to cloud passage approximately along the cloud trajectory, one at 38 miles and the other at 106 miles from ground zero. Utilizing these data, an approximate peak dose rate due to cloud passage for the center line of the trajectory was determined and is shown by the observed curve in Figure 30.

Since it is impossible to check the accuracy of these two widely scattered observations, the determined peak dose rate for the center line of the trajectory may be in considerable error.

A map of the predicted orientation and radiation exposure levels within the infinity dose deposition pattern is shown in Figure 31.

The predicted infinity dose-distance curve due to the deposition of solid particulates (Figure 32) was greater than the observed infinity dose-distance curve out to 10 miles and less than the observed curve by approximately a factor of 2 at greater distances. Post-shot integration of Sedan pattern indicated that 10 percent, instead of the predicted 8.5 percent, of the fission products and activated materials was deposited in the pattern, which appears to account for a portion of the prediction error.

The predicted dose rate, due to cloud passage, appeared to be less than the observed dose rate out to 32 miles from ground zero and greater than the observed dose rate at larger downwind distances (Figure 30). The hot line bearing of the cloud was 5 degrees east of north; the hot line bearing from the 0925 PDT sounding was 25 degrees. The observed and predicted wind speed was 17 miles per hour. The cloud rose to a maximum altitude of approximately 13,000 feet above the terrain while the maximum cloud rise of 9,000 feet above terrain was predicted.

The H + 1 hour dose rate patterns shown in Figures 29 and 33 are believed to be representative of the H + 1 hour deposition pattern for Sedan. A figure of 10 percent of the fission products and activated materials redeposited appears to be a reasonable estimate for the Sedan detonation.

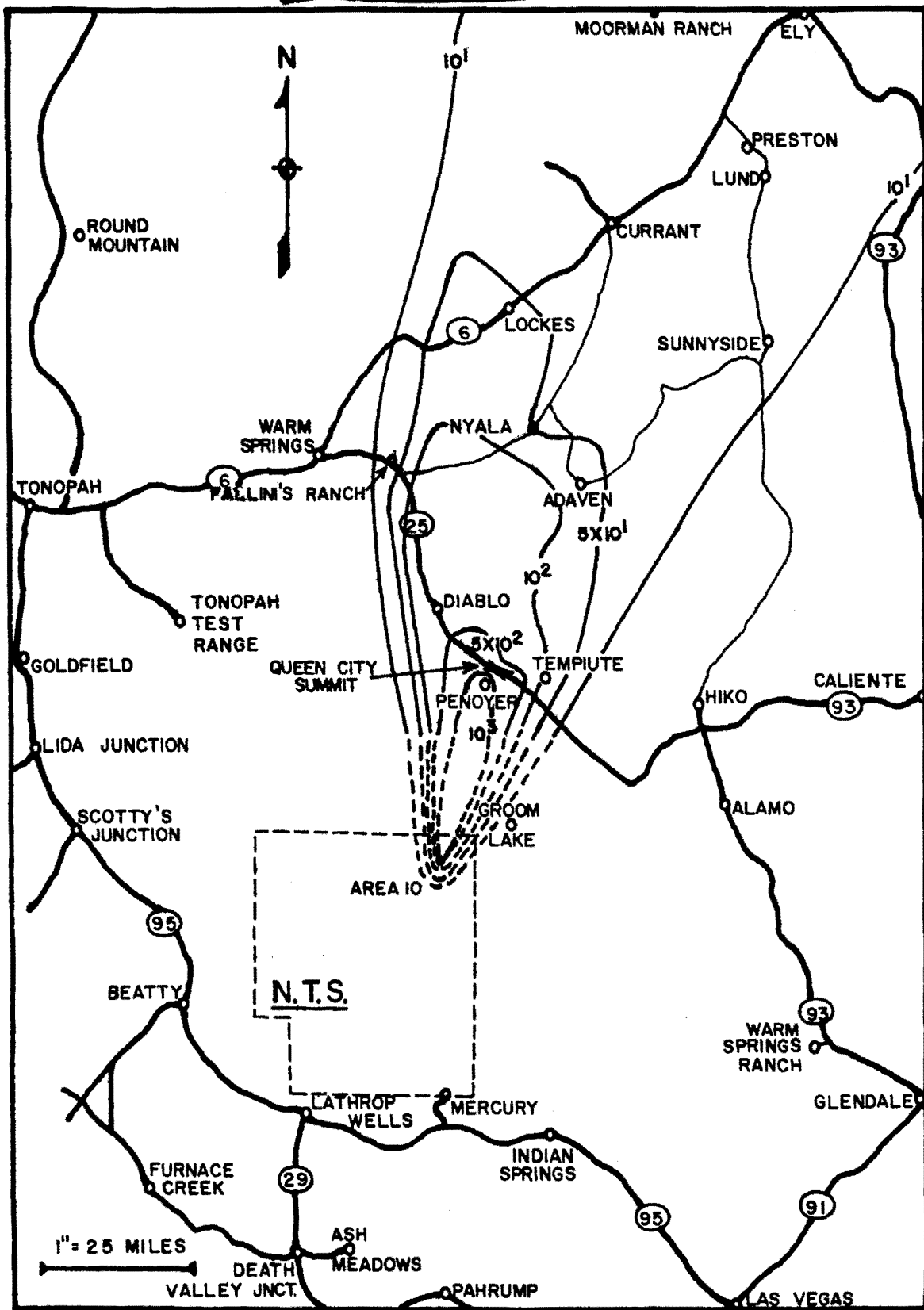


Figure 29 - EXTENDED H PLUS 1 HOUR DOSE RATE PATTERNS
(Dose Rate Contours in mr/hr)

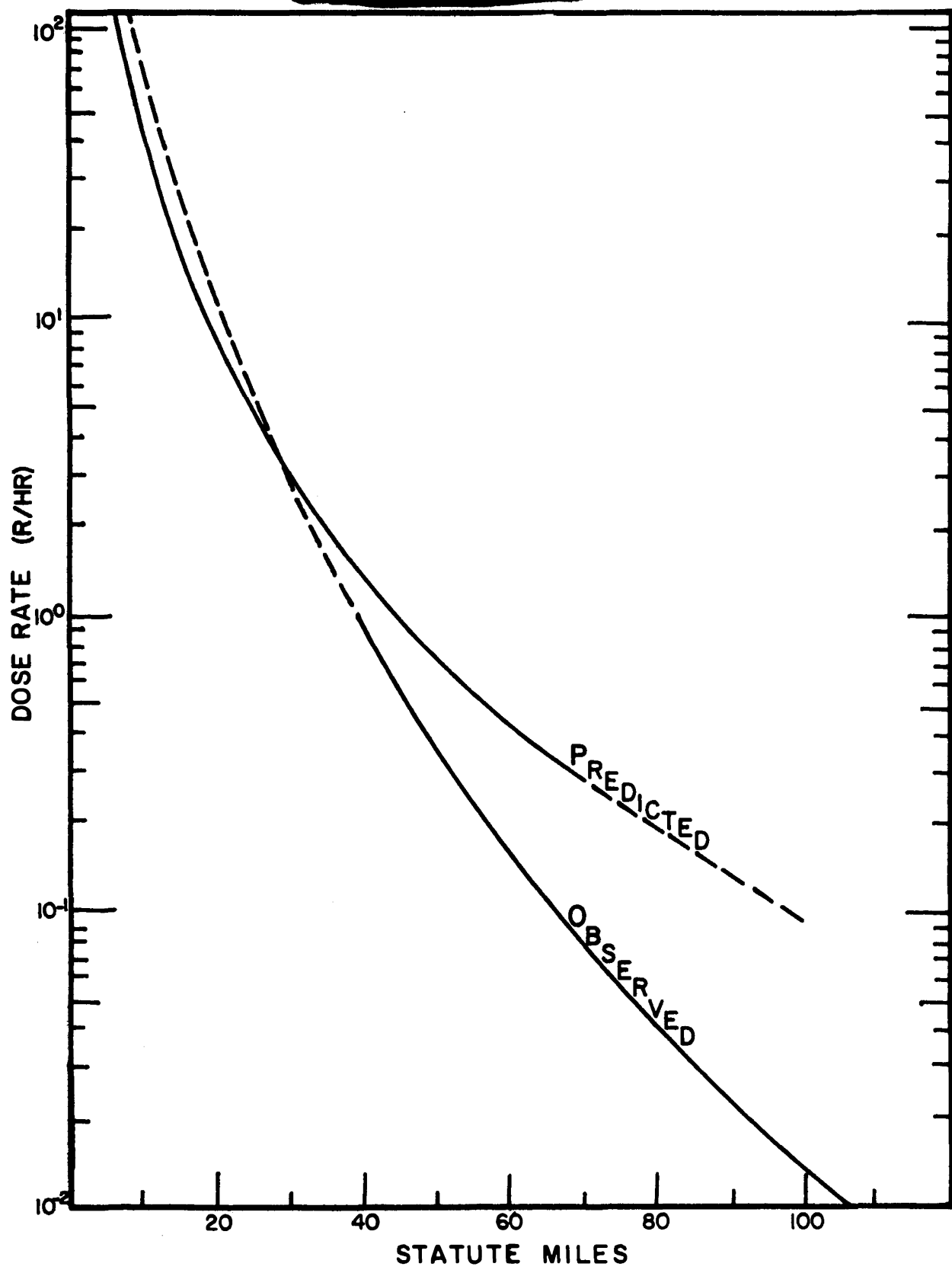


Figure 30 - PEAK DOSE RATES vs DISTANCE AS A RESULT OF CLOUD PASSAGE

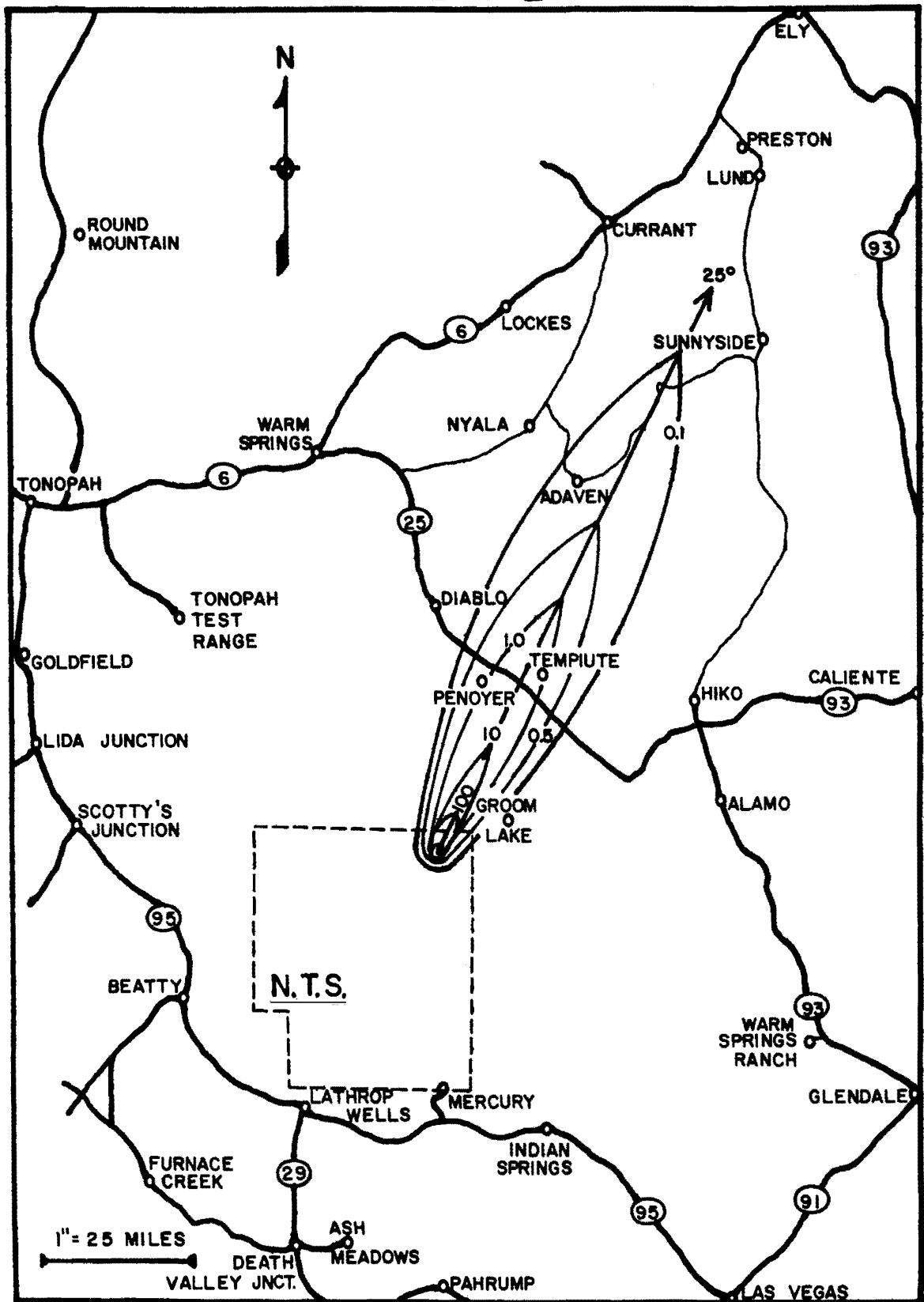


Figure 31 - PREDICTED INFINITY DOSE SURFACE DEPOSITION PATTERN IN ROENTGENS

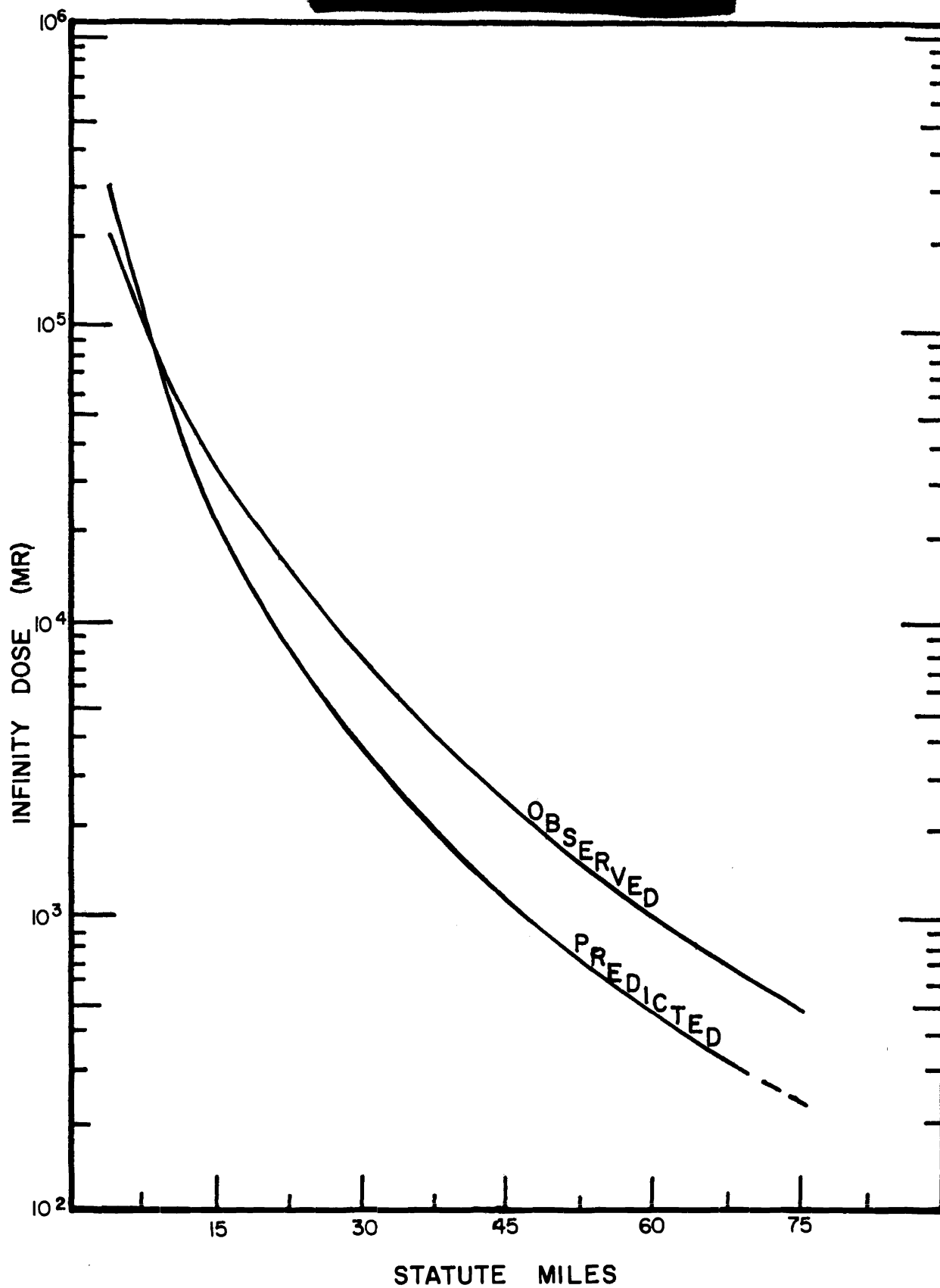


Figure 32 - PREDICTED AND OBSERVED INFINITY DOSE DISTANCE CURVES

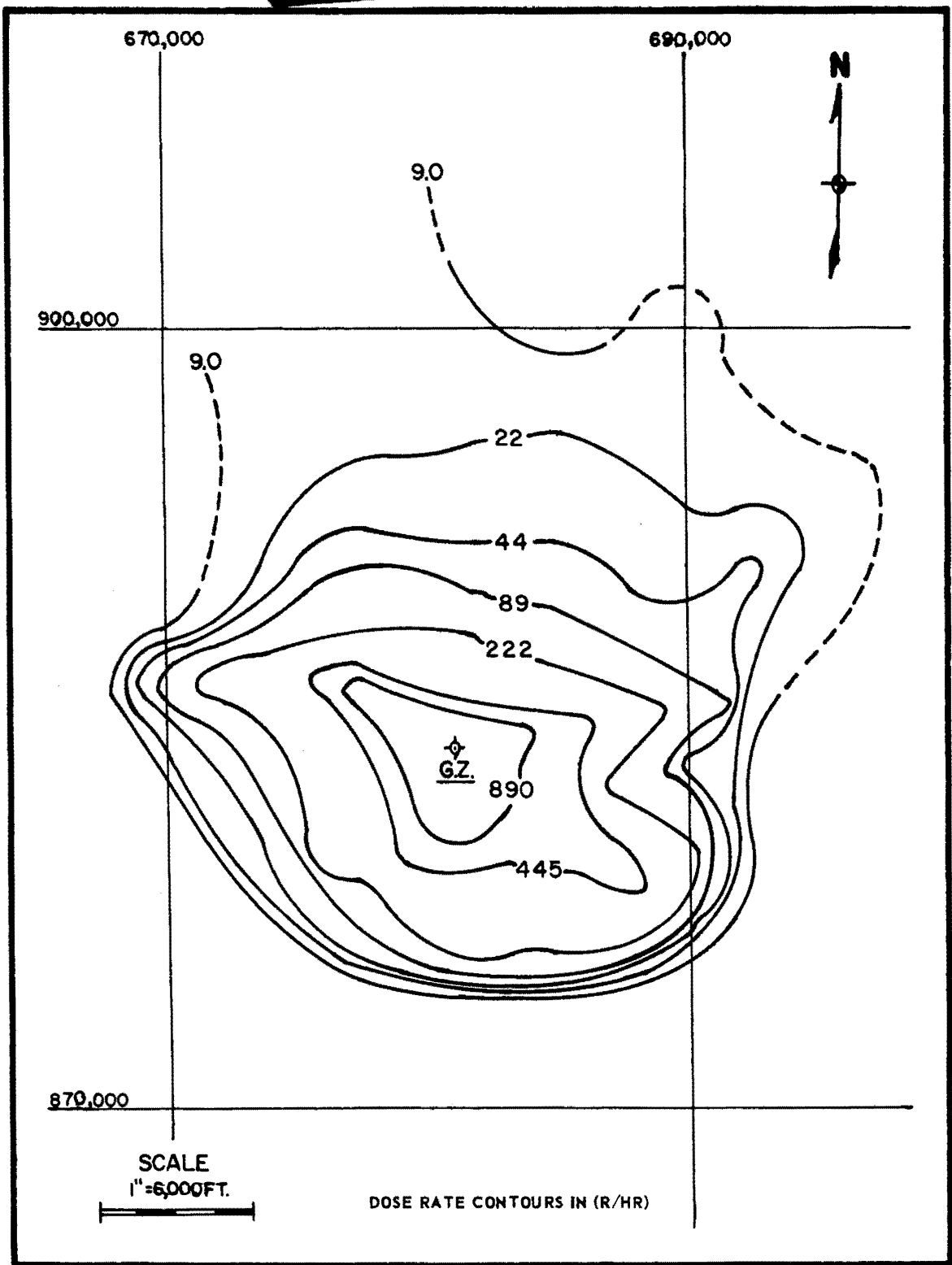


Figure 33 - H PLUS 1 HOUR DOSE RATE PATTERN IN THE VICINITY OF GROUND ZERO



CHAPTER 3

RADIATION SAFETY

A. ON-SITE

Reynolds Electrical & Engineering Co., Inc., Radiological Safety Division, provided on-site rad-safe and industrial hygiene support for Project Sedan. These activities were conducted as outlined in the "Operational Safety Plan - Project Sedan - Plowshare Program" and included pre-shot preparations, direct support at shot time and post-shot experiments in accordance with NTS-SOP Chapter 0524, as amended.

The on-site radiological support program, which includes various phases of radiation safety, established exclusion area control, minimized the radiation exposure of participating personnel and observers, and prevented the spread of radioactive contamination.

Initial radiological data were obtained by hard-wire telemetry read out at the CP-2 Rad-Safe facility. The initial survey began at H + 1 hours when dust conditions subsided to a point of acceptable visibility. Party monitors entered the area and reported dose rates at preselected locations.

Measurements indicated that significant radioactive fallout from the nuclear explosion was deposited in a circular pattern around ground zero and was contained within the boundaries of the Test Site. It was determined from this survey that the 10 mr/hr contour extended approximately 5.5 miles in breadth, east and west. The breadth of the 10,000 mr/hr contour was approximately 3.5 miles. At H + 20 hours, a complete definition of the area of significant fallout was easily discernable. The 1,000 and 10,000 mr/hr contours assumed a distinct circular shape. The diameter of the 1,000 mr/hr isodose rate contour was approximately 4.5 miles, and the diameter of the 10,000 isodose rate contour was approximately 2.25 miles.

Traffic to an adjacent area was diverted until a main access road across the east side of the pattern was decontaminated to acceptable limits. Radiation area control was effected by utilizing a rad-safe check station positioned on the principal access road into the test area. Radiation monitoring personnel were available at this facility for party monitoring and area surveillance. Radiation warning signs and barricades were appropriately positioned on all access roads into the area.

REECO Rad-Safe Base Operations Stations were established at the Test Director's Forward Control Point and at Indian Springs Air Force Base prior to the detonation. They were equipped and standing by to:

- (1) Perform radiological surveys and provide emergency support.
- (2) Provide and issue anticontamination clothing and equipment.
- (3) Issue protective instruments and dosimetric devices.
- (4) Operate area control check stations.
- (5) Perform personnel, equipment and vehicle decontamination.

All personnel entering the radiation control area were issued appropriate dosimeters, anticontamination equipment, and accompanied by certified radiation monitors. Upon leaving the area, personnel and equipment were checked for contamination and decontaminated if necessary. As an added safety factor, roving radiation monitors constantly patrolled the perimeter of the radiation area to assure that no unauthorized personnel entered the area and to assure that all authorized personnel were accompanied by a certified radiation monitor.

[REDACTED]

The major decontamination project was the cleaning of approximately 7 miles of the Area 51 access highway. On July 10, 1962, it was determined that normal decay would permit the re-opening of the road after 30 days. The AEC requested that the road be decontaminated and re-opened by 0900 hours, July 11, 1962. With the support of tanker and fire trucks using high-pressure water, the contaminated dirt and fallout debris were washed from the road. Approximately 60,000 gallons of water were used in this process. Road radiation levels were reduced from 1.2 r/hr to 150 mr/hr. A radiation survey was made at 0900 hours on July 11, 1962, and the road was officially reopened at 1100 hours the same day. The wheels of vehicles traveling the road after the decontamination process read less than 5 mr/hr. Before decontamination, wheel readings were as high as 100 mr/hr.

Personnel gamma film badge packets were exchanged for 378 personnel who entered the radiation exclusion area during the period July 7, 1962 through August 13, 1962. There were no radiation exposures above the maximum operational limit of 3 rem/quarter. All personnel entering the radiation exclusion area were issued self-reading pocket dosimeters. These dosimeters were logged out to the individual and logged back in when he left the radiation area. Dosages were recorded and used as a supplemental daily record to the film badge record.

B. OFF-SITE

The U. S. Public Health Service off-site radiological safety organization, in cooperation with other agencies charged with related public safety activities, was responsible for providing complete documentation of any radiation exposure to the off-site population resulting from the Sedan operation. This included the establishment of a procedure, outlined in "Operational Safety Plan - Project Sedan - Plowshare Program," for taking appropriate action to limit exposure of off-site populations to values established as safe criteria for Project Sedan. The basic objectives of the off-site radiological safety program were to:

- (1) Determine the extent of airborne surface and subsurface contamination off-site resulting from the operation.
- (2) Maintain a comprehensive record of radioactivity associated with the operation, including negative data.
- (3) Insure continuing protection of public health, which included the collecting and sampling of various types of media such as water, milk, soil, vegetation and animal tissue samples as required.
- (4) Effect emergency measures should an unacceptable situation develop.
- (5) Conduct necessary public information activities in surrounding communities to maintain public confidence in the safe conduct of the operation.
- (6) Investigate incidents that might possibly be attributed to the operation.
- (7) Distribute and collect film badges.
- (8) Provide mobile monitoring teams in selected populated places near the operation site.
- (9) Locate air sampling equipment and continuous recorders and secure local personnel for operation of the sampling stations.

In order to keep any exposure to the off-site population at a minimum, several precautionary measures were taken by the Off-Site Radiological Safety Organization. With the aid of Nevada State Highway Patrolmen, road blocks were set up at Hancock Summit (1102 hours to 1620 hours)

[REDACTED]

and Twin Springs Turn Off (1130 hours to 1645 hours) on Highway 25 during cloud passage. The people living at Diablo, Penoyer Ranch and Koyen's Mill were relocated during cloud passage. The Diablo population left from 1145 to 0030 hours, Penoyer Ranch from 1000 to 2300 hours and Koyen's Mill from 1054 to 1620 hours. In addition, the people at Twin Springs Ranch, Casey's Ranch, Nyala, Jim Sharp's ranch and Roy Sharp's ranch were asked to stay indoors for the period of cloud passage. An off-site monitor remained with the people during this time.

During the Sedan event, two aerial monitoring teams and 18 ground monitoring teams were employed on a mission of radiation surveillance in the off-site area. Aerial monitors carried EG&G aerial monitors, Radiac AN/PDR-39 survey meters, Eberline E-500-B survey meters, Beckman MX-5 survey meters and Precision Model III scintillators with an added transistorized amplifier feeding an Esterline-Angus strip chart recorder. Ground monitors carried Radiac AN/PDR-39 survey meters, Eberline E-500-B survey meters, Beckman MX-5 survey meters, Precision Model III scintillators, Eberline RM-5 recorders and assorted air, vegetation and water sampling equipment.

Due to the density of the cloud only 4 passes were made through the cloud proper with the airplanes. The rest of the time was devoted to cloud positioning. A pass over the top of the cloud at 21,000 feet MSL gave a reading of only 1 mr/hr at 1115 hours. A flight through the edge of the cloud over Area 13 at 8,500 feet at 1046 hours yielded a 500 mr/hr reading. A second and third pass at 16,000 feet at 1327 hours and 1330 hours gave peaks of 1.2 mr/hr and 0.5 mr/hr respectively. Both passes were made on an east west line 10 miles south of the Queen City Summit. A final eastwest pass at 12,500 feet over Currant at 1710 hours gave a peak reading of 30 mr/hr.

Cloud positioning by aerial monitors and cloud arrival times recorded at specific locations by ground monitors indicate the cloud traveled northward at about 20 miles per hour. The cloud moved northward on a bearing of 5 degrees for about 40 miles to the vicinity of Queen City Summit and then swung toward the east traveling on a bearing of 20 degrees. The main body of the cloud crossed Highway 25 four miles west of Queen City Summit and Highway 6 four miles southwest of Currant. A "finger" of the cloud crossed Highway 6 about 12 miles southwest of Lockes and then apparently rejoined the main body somewhere north of Duckwater. Aerial monitoring last located the cloud as it crossed Highway 50 between Eureka and Ely. At this point it was 35 to 40 miles wide, having narrowed down a bit from a 55 mile width in the Currant vicinity.

It seems reasonable to conclude that none of the off-site population in the vicinity of the Project Sedan test site received significant amounts of radiation either internally or externally.



CHAPTER IV

SPECIAL SAFETY MEASURES

As outlined in "Operational Safety Plan - Project Sedan - Plowshare Program," a pre- and post-shot inspection of the Groom, Climax and Crystal Mines was conducted by USBM and USAEC for Project Sedan. The purpose of this survey was to document the pre- and post-event physical condition of all existing privately owned mining properties that might conceivably sustain physical damage from the Sedan event.

The pre-shot physical condition of the facilities was observed and plotted on maps. The Climax and Crystal Mine workings were revisited on August 15, 1962. The Groom Mine was not revisited as the owners were on the property and did not report any damage or submit a claim.

The post-shot examination of the Climax and Crystal workings indicated no physical damage which could be positively attributed to the Sedan event. A rock fall that could have been caused by the Sedan Event was observed in the Climax Mine Goldfield Adit at the bifurcation of the adit. At this point a minor amount (approximately 1 cu/yd) of rock had fallen from a steeply dipping fault zone since the pre-shot inspection on July 1, 1962. This fall could have been caused by natural deterioration of the mine workings as is normal in fault zones composed of gouge, breccia and rock.

No damage was observed that would be positively attributed to the Sedan event. It can be concluded that future projects of similar nature and in a like environment can be pursued with a minimum probability of damage to comparable mine workings.

The Federal Aviation Agency (FAA) issued a Notice to Airmen (NOTAM) requesting all pilots contemplating flight within an area bounded by Indian Springs, Nevada; Milford, Utah; Ely, Austin, and Tonopah, Nevada between the hours of 0930 and 1600 PDT on Friday, July 6, 1962, to contact the FAA for safe routing advisories. Broadcast of the NOTAM was started at 0500 PDT. Shortly before 1400 PDT a B-50 tracking aircraft flew in the cloud area along airway V 1516-28 at altitudes of 16,000 to 23,000 feet. As a result, the entire area was opened at 1400 PDT. The major airway affected by this closure was V 244/V 1516-28 between the Tonopah VOR and Wilson Creek VOR. This is a route serving San Francisco and Denver.

The Bren Tower was the only major structural facility located near the detonation site. The Bren Tower, a 1,500 feet vertical structure, is located approximately 6 miles southwest of the detonation site. The maximum acceleration at the Bren Tower was predicted to be 0.04g. The Bren Tower was designed to withstand approximately a 119 mile an hour wind and, therefore, no damage was anticipated. Several members of the Safety Panel of Consultants evaluated the possible effects to and structural response of the Bren Tower.

Dr. George W. Housner, consultant, on the basis of an examination of the erection drawings for the Tower and acceleration recordings made in the vicinity of the Tower, made the following remarks:

"Ground motion will produce relative motion of the guy anchors and the Tower base. I estimate that the Tower and guy system could withstand several inches of relative displacement without danger of collapse.

[REDACTED]

"It is my understanding that the fundamental period of the Tower has been measured and found to be 10 seconds. This means that earthquake ground motion such as that recorded at El Centro, California, May 18, 1962, which had a maximum ground acceleration of 0.3g, would produce vibrations of the first mode of the Tower whose maximum amplitude would be approximately 0.05g. Such oscillations would not endanger the Tower, assuming, of course, that the Tower has been properly designed and constructed."

Ground motion at the Bren Tower due to the Sedan detonation was less than predicted. The recorded values of strain and the calculated values of cable loading indicate that the Tower was not being unduly strained from ground motion during the detonation. The maximum cable load was less than 10 percent of the rated breaking point and the maximum stress at the Tower leg was less than 1 percent of the yield point. Therefore, it is safe to assume that no damage to the Bren Tower was caused by the Sedan detonation.

[REDACTED]

CHAPTER V

CONCLUSIONS

Project Sedan was executed after approximately a two month preparation period. If additional time had been allowed in preparing for the execution of this event, it is believed that many pertinent experiments could have been designed and included in this project, thereby increasing our knowledge of the phenomenology of cratering detonations at this yield. Concurrent with the planning for Project Sedan, preparations were initiated for the execution of Projects Small Boy, Little Feller I, Little Feller II and Johnie Boy. These concurrent preparations necessarily interjected various complexities into the proper execution of the Sedan Event. The foregoing statements were put to participants in the Operational Safety program for Project Sedan and specific comments solicited as to any effects the above had on their participation in this event. The resultant comments are as follows:

(1) The concurrent planning of Small Boy, Johnie Boy, Little Feller I and Little Feller II presented no complexities or problems to Roland F. Beers, Inc. However, carefully planned, instrumented observations of ground motion, if correlated with a contained event of comparable yield in the same medium and in the same area, would probably have permitted a direct comparison, with a minimum number of variables, of ground motion effects in a medium presenting theoretical difficulties.

(2) The concurrent planning of Small Boy, Johnie Boy, Little Feller I and Little Feller II presented no complexities or problems to Hazleton-Nuclear Science Corp. Had sufficient time allowed for thorough planning of experimental features, additional studies of leaching as a function of particle size, leaching media and time could have given improved indication of the potential hazard of various radionuclides as related to dissolution and contamination of water supplies.

(3) If a scheduled time lapse of a few days had existed between this event and succeeding events, additional U.S. Weather Bureau personnel and equipment could have been placed in more strategic locations for safety considerations. Probably no additional U.S. Weather Bureau effort, however, would have been involved if Project Sedan had been completed within the alternate time frame of September 1962.

(4) The concurrent planning of Small Boy, Johnie Boy, Little Feller I and Little Feller II required no additional effort on the part of the U.S. Public Health Service. In many ways Public Health Service problems were simplified by having all of these events scheduled within the July time frame. The Public Health Service would have had no further experiments to propose for Project Sedan if the alternate date of September 1962 had been selected. Of course, it may have been desirable to consider more the impact of iodine in Utah. However, it is doubtful that adequate funds could have been provided to do an extensive study even in September of 1962 since the whole problem of iodine research must be conducted over a longer period of time and would undoubtedly entail considerably larger amounts of funds and staff.

(5) The concurrent planning of Small Boy, Johnie Boy, Little Feller I and Little Feller II presented no complexities or problems to the U.S. Geological Survey. Even in the short time span allowed for planning the execution of Project Sedan, several agencies concerned themselves with portions of the following experimental procedures although, even collectively, all agencies could not cover all aspects in the short planning time frame. It would have been advantageous to the USGS if additional information were obtained from the following:

(a) Verify preliminary calculations by post-shot sampling and analysis of distribution on the land surface of radioactivity in the prompt fallout, in terms of both gross activity and activities of a few selected nuclides that are potentially the most hazardous to man.

[REDACTED]

(b) Post-shot sampling and analysis of particle size distribution of the fallout material correlated with geographic pattern of the fallout and with both gross radioactivity and that of the selected key nuclides

(c) Post-shot sampling and analysis of the solubility of the radioactive compounds, in regard to gross activity and that of the selected key nuclides.


The USGS is obtaining useful data on infiltration rates and the surface hydrology of pre- and post-shot Sedan. Had sufficient time and funds allowed, it would have been desirable to obtain similar data on the subsurface hydrology of nuclear craters both pre- and post-shot.



PART V

PUBLIC INFORMATION




CHAPTER I
PUBLIC INFORMATION PROGRAM

A. PLANNING PHASE

Initial plans for a public information program for Project Sedan incorporated an open policy such as was followed for Project Gnome, including issuance of essentially all available unclassified information before and after the event, issuance of still and motion picture photography, permission for on-site news media observation of the event, and arrangements for post-shot observation of the results.

B. EXECUTION PHASE

A decision at a high national level was made to limit issuance of information before and after the event, to withhold issuance of photographs of any kind, and to restrict shot observation to participating personnel.

C. ISSUANCE OF INFORMATION

An informative four-paragraph text announcing the Sedan event was approved for issuance and was issued two days prior to the event. Following the event, it was confirmed by a locally prepared announcement which was issued in three segments on the day of the shot. The announcement went into matters such as crater size, cloud rise, off-site effects including radiation levels, closing a highway, temporary movement of a few people out of the cloud path, and other details. A public announcement summarizing findings and events to that date and saying, "Preliminary reports indicate that Sedan will prove to be a significant contribution to earth-moving technology," was issued from Las Vegas on July 7, one day after the shot.

D. PHOTOGRAPHS

Issuance of still and motion picture photography of the Sedan event was authorized November 28, 1962, and issuance to news media was accomplished the same day. By White House direction, no photographs or still footage were issued showing formation or dispersion of the dust cloud resulting from the detonation.

E. SUMMARY

A AEC Headquarters-prepared summary of Sedan results and findings to date was issued on October 3, 1962.



PART VI

ENGINEERING, CONSTRUCTION AND SUPPORT





CHAPTER I

ENGINEERING AND CONSTRUCTION

A. BACKGROUND AND SCOPE OF WORK

Design for Sedan experiment was initiated in May 1962 when preliminary criteria from Lawrence Radiation Laboratory (LRL) were received.

Architect-Engineering and technical supervision of construction were performed by Holmes & Narver, Inc. (H&N). Construction and support functions were accomplished by Reynolds Electrical and Engineering Company, Inc., (REECO), the support contractor. On May 8, 1962, H&N was authorized by AEC to proceed with the work according to LRL criteria.

Due to the compressed construction period of 57 days, from May 9, to July 4, drilling operations required a 3-shift, 7-day per week work schedule, and construction of surface facilities required, generally, a 10-hour, 7-day per week work schedule.

B. DESIGN

Design for the Sedan experiment began immediately after receipt of LRL criteria, May 8, 1962, and was completed on July 2, 1962. A total of 29 drawings was completed during the design period. Jobsite standard specifications were used, where required, for construction operations.

1. Underground

The principal underground design features of Project Sedan were:

- (a) A cased hole, 36 inches ID, 670 feet total depth
- (b) Satellite hole No. 1, 10-3/4 inches in diameter, 725 feet deep, partially cased with 9-inch casing.
- (c) Satellite hole No. 2, 8-5/8 inches in diameter, 650 feet deep, partially cased with 6-1/4 inch casing.
- (d) Satellite hole No. 3, 8-5/8 inches in diameter, 400 feet deep, partially cased with 6-1/4 inch casing.
- (e) Four holes drilled by Waterways Experiment Station (WES). Hole No. 1 was 300 feet deep; holes No. 2, 3, and 4 were 200 feet deep.

2. Surface

The principal surface design features were:

- (a) Rehabilitation of approximately five miles of existing roads, and construction of approximately five miles of new access roads.
- (b) Design and installation of concrete foundations for trailer-mounted hoist and headframe, and installation of cased hole collar.
- (c) Installation of hoist, headframe, and all accessory items including wire rope support beam.
- (d) Design and installation of concrete pads for cerise, chartreuse, and turquoise shacks. Design and construction of cerise shack, and moving and relocation of three existing shacks from Station U-10r to Station U-10h.

[REDACTED]

(e) Installation of six camera bunkers, timber supports, sandbags, lead brick, and portable gasoline engine driven generators.

(f) Design and erection of two 50-foot high, 6 x 24 foot antenna platforms and installation of antenna supports.

(g) Design and erection of two 15-foot high microbarograph towers and installation of portable gasoline engine driven generators required for signal response.

(h) Design and erection of three mechanical oscillator stations.

(i) Installation of reed gages and BRL gages at scientific and photo bunkers.

(j) Installation of photo blast targets.

(k) Installation of fallout trays, watch glasses and water pools.

(l) Rehabilitation of Station 10-300 diagnostic bunker including installation of pressurization system and air conditioning system.

(m) Installation of coaxial cable and signal cable to the various scientific, photo, and diagnostic stations.

(n) Installation of electrical power and lighting wiring and equipment required at the site.

(o) Survey for all site work including horizontal and vertical control and down-hole survey, and survey requirements for aerial surveys.

C. CONSTRUCTION

Construction operations for Project Sedan began May 9, 1962, with the spudding in of the emplacement hole, station U10h. Surface construction work began June 25, 1962. All pre-shot construction was completed on July 5, 1962, and the event took place at 1000 hours July 6, 1962. Details of construction activities are described in the paragraphs which follow.

1. Drilling Activities

The Sedan Operation Plan called for 4 drilled holes consisting of the emplacement hole, Station U10h and 3 satellite holes. Drilling of U10h began May 14, 1962, and was completed June 24, 1962. Original criteria required a hole 48 inches in diameter, cased to 36 inches, and drilled to a depth of 670 feet. Seven revisions to the initial criteria affected the drilling schedule, depth of hole, or cementing requirements.

The total depth of the hole was 710 feet. The revised depth of the hole was 644 feet, accomplished by plugging the hole with colemanite cement grout designed by the Halliburton Oil Well Cementing Company.

The drilling history of U10h indicates that the major problem was loss of circulation, which caused a 10-day delay. A 4-day delay resulted when the 36-inch casing became stuck at 140 feet on the original attempt. It was necessary to remove the casing, ream the hole, and rerun the casing.

For measurement of yield of the device used in the Sedan event, satellite hole U10h-1 was drilled 25 feet from zero to the same depth at which the detonation was to take place in U10h. U10h-1 was cased with 10-3/4 inch casing to a depth of 40 feet, drilled 9 inch diameter from 40 feet to 655 feet.

Two additional satellite holes, U10h-2 and U10h-3, both 6-1/4 inch holes, were drilled to 650 feet and 400 feet respectively. They were used as part of the soil exploration project by the Waterways Experiment Station.

[REDACTED]

2. Waterways Experiment Station (WES) Scientific Holes

During drilling activities related to the emplacement hole and three satellite holes, WES drilled four scientific holes required for the WES Soils Experiment. Holes No. 1 and 3 were drilled to a total depth of 200 feet, and holes No. 2 and 4 were drilled to a total depth of 300 feet and 433 feet, respectively. The holes varied from 7-7/8 to 8-3/4 inches in diameter and were located along a line N45° W from ground zero. These drilling operations were entirely under supervision of LRL and were not a part of H & N or REECO responsibilities.

3. Road Construction

Rehabilitation of all roads in the vicinity of ground zero was necessary. Ten miles of new road suitable for four-wheel drive vehicles was constructed. Roads adjacent to U10h were watered for dust control of the area and protection of scientific equipment.

4. Surface Facilities

Surface facilities at U10h emplacement hole included a 20-ton trailer-mounted hoist, 63 foot headframe, wire rope support beam and concrete foundations and hole collar. Prior to and concurrent with the construction of these facilities, the scientific coaxial cables were made up and were ready for final emplacement. Instrumentation of scientific cables was accomplished under supervision of the User Agency.

5. Scientific Photography

The scientific photography program required several surface facilities. On June 26, excavation was started for six camera bunkers of a prefabricated concrete type, each protected by a revetment, consisting of sandbags placed on a timber frame with lead-brick lining. Four of the six stations were placed on June 28 and the remaining two were placed by July 1. Revetments, including timber, sandbags, and lead bricks, were completed on July 3. The lead weighted doors for the bunkers required some modifications to permit positive latching. However, three of them did not function.

Coaxial and signal cables were installed between June 27 and July 2. A 5,000 watt gasoline engine driven generator was placed at Photo Station No. 1 and a 3,000 watt gasoline engine driven generator was placed at Photo Stations No. 2 through 6 on July 3. Final closure of the photo stations was accomplished at 2345 hours, July 5, 1962.

Four types of photo targets were utilized for the scientific photography program. Types A and B were vertical targets constructed of two sheets of plywood, 4 x 8 feet x 3/4 inch thick, set at a 90 degree angle and bolted to three 4 x 4-inch posts 14 feet long. Type C targets were constructed of a single sheet of plywood, bolted to two posts. With the posts grouted in 4-foot deep holes, the tops of these targets were 10 feet above ground level. The target types were determined according to the pattern painted on each type.

The fourth type of target was a horizontal type air coverage target, triangular in shape, fabricated from a 4 x 8-foot plywood sheet, cut diagonally, and butted and fastened along the 8 foot length sides. This formed a target having an 8 foot base and a length of 8 feet from base to apex. The targets were laid directly on the ground with the apex facing ground zero.

The targets were arranged in an array along two intersecting, 90 degree bearing lines, centered on ground zero and rotated 45 degrees from a north - south line. Type C targets were spaced at 100-foot intervals for a distance of 1,000 feet along the northeast and northwest bearing lines. Types A, B, and C, and air coverage targets were utilized along the southeast and northwest bearing lines, spaced at varying intervals to 5,000 feet. A lane along each bearing line from ground zero to photo stations was cleared and graded and the targets were placed in 4-foot deep auger-drilled post holes and grouted in solidly.

[REDACTED]

6. Air Blast Measurements Program

The air blast measurements program conducted by Sandia Corporation consisted of nine self-recording ground gage (BRL) stations located along a southeast radial at ranges varying from 1000 feet to 15,500 feet. The BRL gages were installed and calibrated on July 5.

7. Structures Response Program

Three mechanical oscillator stations were fabricated for the structures response program. Each consisted of an I-beam base, steel bar-stock legs and axle, and a 10-inch diameter pipe filled with concrete. The concrete-filled pipe, or "mass" was centered at 61 inches above the top of the base. Station No. 1 was located 50 feet north of USC&GS Station No. 18, and bolted to a reinforced concrete foundation. Stations No. 2 and 3 were located adjacent to Station No. 9-300 in Area 9. Station No. 3 was bolted to the top of existing Generator Station No. 9-63. The long axis of each station was directed toward ground zero. Strain gages and associated recording equipment were furnished and installed by the user. Each station was provided with 110V power and timing signals.

8. Antenna Platform

Three antenna platforms, each 50 feet high, were selected southeast of Bunker 10-300. Each platform was 6 feet wide and 24 feet long, supported on wood poles and braced with steel bracing. Each platform was constructed of wood planking secured to a structural steel frame. These structures were required for Project R05.04.

9. Microbarograph Stations

Microbarograph program required the construction of two wooden towers each 15 feet high, moving the towers to the sites, and clearing an area of 50 feet radius at each site. A portable gasoline engine driven generator, required for signal response, was installed at each tower. The stations were completed July 5, 1962.

On D-1, user-furnished depth charges were installed on the towers. Firing of the depth charges was controlled from CP-1 by instrumentation lines.

10. Station 10-300


Much of the scientific instrumentation was installed in an existing bunker designated as the 10-300 building; however, considerable rehabilitation and modification were necessary to adapt it to this event. These modifications included providing an entrance for instrumentation cable, installation of air conditioning, and pressurization of the bunker to prevent the entrance of contaminated gases. Diagnostic and photo trailers were installed adjacent to the 10-300 bunker and a small tower was constructed for telemetry antennae.

11. Ecological Studies

The Ecological Studies Program included the marking and flagging of mammal trapping stations installed along seven base lines radiating from ground zero, three extending to 10,000 feet, one to 12,000 feet, and three to 18,000 feet.

12. Relocation of Buildings

Three existing "shacks" were moved from Station U10r and placed on new concrete pads adjacent to Station U10h on June 28. A fourth shack was constructed at the site. This "Cerise" shack was 10 feet x 12 feet of wood frame and plywood construction, and mounted on skids. All shacks except the cerise shack were removed from the site prior to shot time. The cerise shack was expended.



13. Shock Spectrum Measurements

As a portion of the Vela Uniform Program, nine reed gage canisters were installed in four pits along a 5,000 foot line southwest from ground zero. Pits for the cans were originally excavated on a northeast line but were relocated after a change in DOD criteria.

14. Miscellaneous Construction Activities

Under the Biology and Hydrologic Study Program, four each 1-1/2 cubic yard earth samples from California and Nevada were obtained and stationed as directed by the user.

As part of the fallout studies, approximately 100 fallout trays, 100 watch glasses, and 24 plastic water ponds were installed in accordance with the user's directions.

Because of the large amount of instrumentation necessary for the Sedan event, many miles of field wire and instrumentation cable were laid by the support contractor. These temporary installations usually were connected into the permanent signal cable facility at the 2-353 building. A portion of the permanent signal cable facility is owned and maintained by Bell Telephone Company and some difficulty was encountered in making final check outs of the system. Bell personnel were responsible for the permanent facilities, the support contractor's personnel installed the temporary cables, and LRL personnel were responsible for the final operation. This required considerable coordination effort.

In connection with the Rad-Safe program, approximately 500 miles of field wire and Belden cable were laid. This wire was laid to the RAMS (Remote Area Monitoring System) units and to the REECo Rad-Safe telemetry units, some of which were five miles away. As the field wire and cable were laid on top of the ground, a great amount of difficulty was caused by chipmunks chewing the insulation and by vehicle traffic causing damage to the lines. This necessitated much repair, some replacement, and almost constant patrol of the cables.

D. FINAL TESTS AT EMPLACEMENT HOLE

The downhole operation began at 0500 hours, July 5, and at 0910, the user package was placed on the hole collar pad. The canister, coaxial cables, and diagnostic equipment were "married" at 1030 hours. The full load was transferred to headframe and hoist, and the user equipment was lowered 80 feet into the hole, then withdrawn due to a technical difficulty. After correction was made, the equipment was relowered and bottomed out at 1655 hours.

The second dry run was completed at 1830 hours. The bottom of the hole was then stemmed with 180 bags of colemanite, and the balance of the hole was filled with dry sand. This operation was completed at 2120 hours. The headframe and hoist were removed from the site at 2035 hours. The final dry run was started at 2230 hours. Button-up continued until 0600 on July 6, when the area was cleared.

The project Sedan event took place at 1000 hours July 6, 1962.

E. CONCLUSIONS

Project Sedan engineering and technical supervision of construction were accomplished during the period May 8, 1962, and the eve of the event, July 5, 1962. Within these 59 days, approximately 4700 manhours were consumed in the preparation of design drawings, surveying, drilling, field inspection, and other associated efforts. As the work accelerated the daily man-hour requirements increased rapidly.

[REDACTED]

In contemplating the engineering and construction efforts accomplished within the short time span schedule for the Sedan Event, it is assumed that any similar crash program could be consummated. This assumption is based on the fact that all phases of Project Sedan, from preliminary design to user readiness, were performed rapidly and with excellent continuity and cooperation. However, to accomplish the Sedan requirements it was necessary to borrow a number of personnel from other projects, concurrently in design or under construction, and assign them to Sedan on a full time or part time basis. This action, though essential to the Sedan event, created problems in these other areas. The compressed Sedan schedule had a decided impact on the efforts being concentrated on at least four other events - Johnie Boy, Little Feller I and II, and Small Boy. This impact, as in most crash programs, concerned the physical volume of work that could be accomplished by available seasoned personnel as well as the procurement of specially fabricated materials.

Survey Department personnel were severely over-taxed by the addition of the 2946 manhours required for the Sedan Program. Drilling Department personnel expended 416 manhours, a portion of which can be attributed to revisions to the original criteria. Field inspection required 426 manhours; preliminary and final design totalled 885; and 25 hours were spent on research and reports.

Emplacement and satellite holes required close scheduling of drilling rigs and equipment. Although the four scientific holes were drilled with WES equipment, the scheduling and coordination of the entire Sedan drilling operation required considerable attention.

Procurement, on a priority basis, of hole casing and construction materials added a considerable work load to procurement procedures and inshop fabrication inspection. Because of the compressed schedule, it was sometimes necessary to issue purchase orders before completion of design. Many of these purchases were made in accordance with criteria taken directly from the user's drawings and sketches. This resulted in a large number of fabrication changes when revisions were made to the criteria.

Field inspection personnel were heavily burdened because of the accelerated schedule. Inspectors were required to observe and report on several concurrent projects under construction at many distant sites within the forward area.

Each of the above had a decided effect on Small Boy progress, mainly because of the complexity of many of the Small Boy structures which required considerable attention, and the shift of some of the manpower to the Sedan Program. Johnie Boy and Little Feller I and II were also affected, principally by the reduction of survey and inspection personnel.



CHAPTER II

SUPPORT

All general support requirements of each agency were handled according to the NTS Standard Operating Procedures and were coordinated by the Base Support Coordinator's office.

The ordinary support functions of Motor Pool, Supply, Housing, Feeding, and the Health, Medicine and Safety facilities were provided as normal operations of the support contractor. Due to the size of the Sedan event, additional medical personnel were on duty at CP-1 and CP-2; however, operations were routine. The Feeding Division at the three observation areas served 500 customers.

A. COMMUNICATIONS SUPPORT

Communications support for the Sedan event included the following:

(1) Six base stations were installed near ground zero for use by the arming party and Rad-Safe.

(2) Television coverage was provided by two repeater systems - one system having a six inch telephoto lens and the second system having a one inch wide-angle lens. The combination of these two systems provided coverage of detail and the general area.

(3) Public address systems were installed at News Nob and the two official observer areas.

(4) A high frequency, long-haul radio facility was provided; however, this requirement was cancelled at D-1.

(5) Air-borne support included installation of a base station in a C-47 aircraft for the University of California. VHF transceivers were installed in cloud-tracking aircraft used by U. S. Public Health Service.

(6) Additional equipment installations included 16 each high band VHF 25 watt mobile units, one each 60 watt base station, and 14 each low band VHF 100 watt mobile units.

(7) Existing facilities in CP-1, at the Smokey, Jr. facility, CP-12 and the Las Vegas and Mercury communications centers were utilized during the Sedan event as well as the signal cable facilities and engineering service.

(8) Personnel support included the following:

(a) Eight seismic station operators and eight microbarograph station operators were provided to Sandia Corporation.

(b) Six technicians were loaned to the U. S. Weather Bureau to take pibal readings on- and off-site. Also, four additional personnel maintained meteorological services on-site.

(9) Support of the U. S. Public Health Service, U. S. Weather Bureau, U. S. Coast & Geodetic survey and Department of Defense necessitated the utilization of eight repeater stations located off-site in Nevada, Arizona, California and Utah. In addition, three mobile repeaters were used in Nevada State Highway 25 and maintenance support was provided by two radio repair vehicles.



B. AERIAL SURVEYS

Aerial survey work was accomplished by American Aerial Surveys, Inc., under an H&N purchase order. Pre-shot work included low-level contour surveying of a one-mile-square area centered on ground zero, and single-pass surveying of the strips centered on the baseline radials from ground zero to photo stations. Post-shot stereo photos of the area were required by the user. Grid markers were placed by the Support Contractor in the mile-square area and along radials, prior to pre-shot survey work. Pre-shot and post-shot surveys were completed on June 27 and July 9, 1962, respectively.

C. CONCLUSIONS

Construction effort on the Sedan Project was compressed into an exceedingly short time interval as a result of the early detonation schedule. The last drill rig was moved off Satellite Hole No. 3 location on June 27. This cleared the area for full scale construction activities only eight days prior to the shot date of July 6. Three of these days were premium time days. Criteria for the Remote Area Monitoring System, which required approximately five hundred miles of surface cabling, were not released until June 23, and difficulty was encountered in defining the locations for the precast concrete camera bunkers. As a result, a rather intensive level of construction activity was required during the last week prior to the shot on July 6. For example, on July 1, 70 percent of the surface facilities, 50 percent of the 10-300 diagnostic bunker, and 35 percent of the work on the camera bunkers had yet to be accomplished.

Seventy-four percent of all labor costs, exclusive of drilling, charged against Sedan work orders through the week ending July 8 were charged within that last week. This means that, with the exception of drilling activities which proceed around the clock on a continuous basis until completion, the level of effort in the final week of the shot date amounted to approximately 2.85 times the accumulated total of all preparations made previously from the beginning of work in May.

An extensive amount of overtime was required in order to conform to the accelerated schedule, and construction activities progressed at a somewhat less than optimum level of efficiency.

In Logistics, the Housing facilities were functioning above designed capacity at the time of the Sedan event. The participants of Sedan and other events were housed during this period but had the date for Sedan been two months later, the overcrowded conditions would not have existed.

The Supply Department was operating at a greatly accelerated pace during the period of the Sedan event. It was necessary that procurement and material handling be geared to fill the requirements of all events being prepared at the time. It is difficult to estimate how much additional burden was placed on the Supply Department or to estimate the effects on other programs because of Sedan's early completion date. It is apparent that the short procurement lead time increased the cost of materials and made timely supply of materials and equipment extremely difficult.

While there was no significant impact on the Equipment Maintenance and Parts Department, their experiences were similar to those of other Logistics departments.

The Feeding facilities were operating at their peak through the July 6th period. Little additional impact was felt by the Feeding Department because of the advanced scheduling of Project Sedan.

[REDACTED]

There was no significant degree of additional effort required by Safety, as a result of the accelerated schedule for Sedan. The program was geared for peak support activities during this period. This event was phased into the schedule without difficulty.

Preparations for the Sedan Event were not significantly different from those made for any nuclear test. The routine programming includes preparations to cope with maximum credible hazards. The Sedan event behaved as predicted and there were no safety support requirements that might not be expected to be associated with any nuclear test.

The fact that other programs in other areas of the Test Site were concurrently underway on a crash basis had little effect on Sedan preparations and, in fact, contributed greatly to the state of readiness which was necessary in order to cope with the Sedan schedule. It is difficult to judge the extent to which these other concurrent projects were hampered due to the Sedan activities, but it is felt that the effects were not serious.



PART VII

SECURITY





CHAPTER I

SECURITY PARTICIPATION

The initial security coverage of the Sedan event at the NTS consisted of two security stations at ground zero. These control stations were activated on June 28, 1962, and were continued in force until D-day. Twenty guards were deployed as road block stations and sweep patrols on D-day starting at 0300 to clear and secure the demonstration and surrounding areas. The following is a breakdown of stations established at the times indicated:

- (1) H-4 hours: A muster station on the circular road into Area 10.
- (2) H-2 hours: The muster station on the circular road into Area 10 moved south on the Mercury Highway to a point north of the CP near the Yucca Airstrip.
- (3) H-4 hours: The gate 700 Control Station was moved into position.
- (4) H-2 hours: The gate 700 Station moved northeast to the junction of the Area 13 and Area 51 road.
- (5) H-4 hours: A control station at the junction of the Mercury Highway and Area 14 road.
- (6) H-4 hours: A control station at the junction of the Orange Road and Tippipah Road in Area 1.
- (7) H-2 hours: A control station for screening purposes at "News Knob."
- (8) H-2 hours: Security Stations were arranged for control of closed areas (Figure 34).

The Mercury Highway and the Orange Road were closed to all unauthorized traffic at 0600 on D-day. Both roads were reopened by 1200 hours to all areas except Areas 9 and 10, which remained under Security control.

A Security air sweep of all areas was flown on D-day prior to arming of the device. This sweep covered areas impossible for motorized patrols to reach.

Completion of the air and ground sweeps of all areas involved was accomplished at approximately H-2. When the arming party left the demonstration area, the Test Manager was notified the areas were entirely clear of all personnel.

Emergency procedures were as follows:

- (1) Personnel in the tunnel area were to be out of tunnels during H-hour and prepared for possible evacuation.
- (2) Evacuation of all areas, if required, was to be accomplished by Security personnel at the direction of Test Manager. Routes were to be determined by Rad-Safe monitors.

Postshot security was established by three manned Security Stations and the utilization of security barricades. These stations remained in effect until deactivated on July 17, 1962, at 1800 hours.

The event did not offer significant security problems except in the area of postshot security. It was necessary to control an extensive area for several days. Radiation from the shot prevented travel on the main routes to Area 51, making it necessary to open the Pappoose Lake barricade and allow travel on that road. Unless some relief is obtained from the present classification policy concerning underground debris, it will be necessary to enclose the Sedan crater in the same manner as the Johnie Boy crater, when radiation levels permit necessary fence construction.

★ LOCATIONS OF MUSTER STATION FROM H-W UNTIL H HOUR.

◇ ROADBLOCKS FROM H-2 UNTIL H HOUR.

✱ LOCATIONS OF MUSTER STATION FROM H-4 TO H-2.

▾ ROADBLOCKS FROM H-4 TO H-2.

● GROUND ZERO.

SEDAN OPERATION

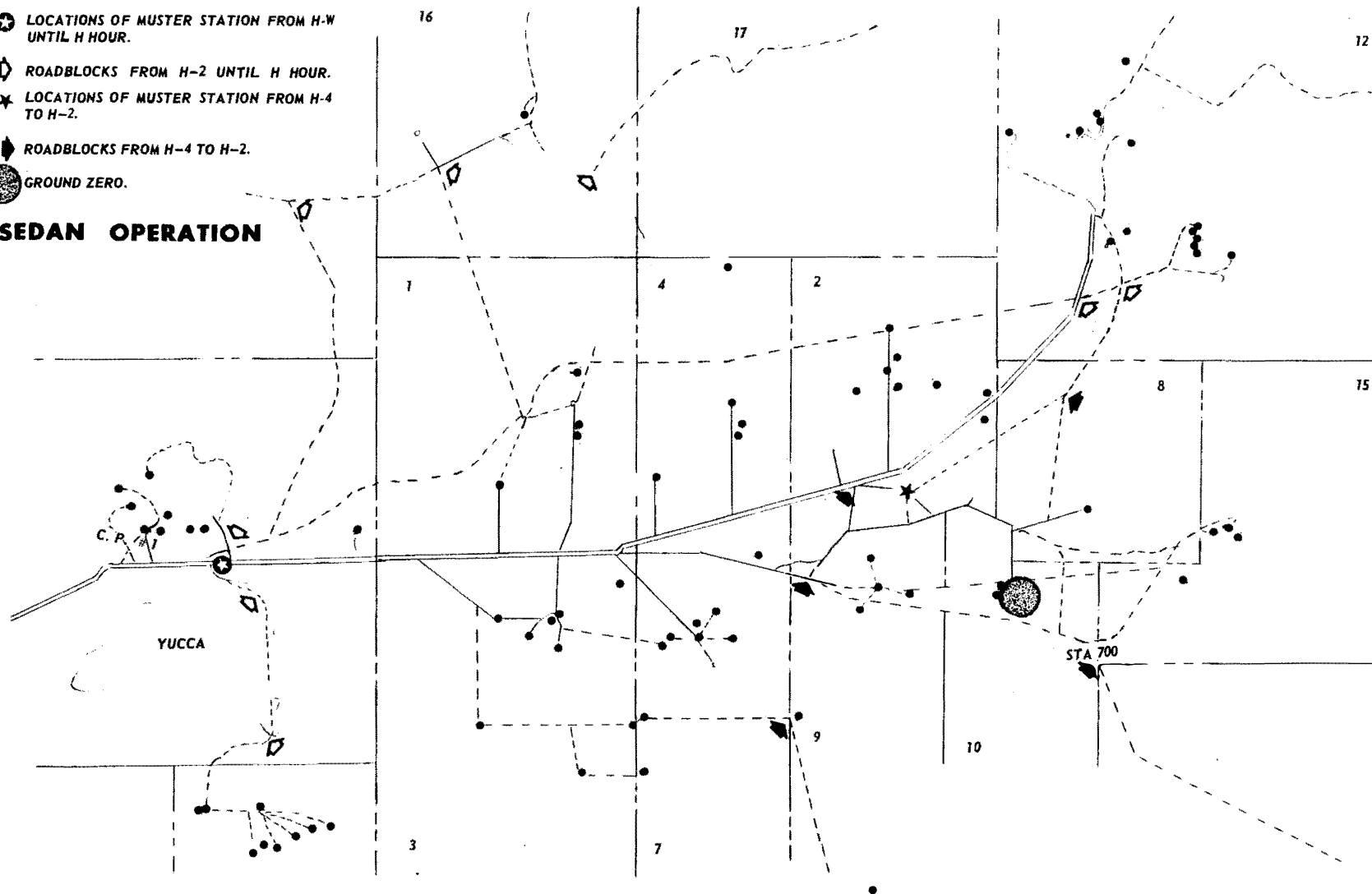


Figure 34 - SECURITY STATIONS FOR SEDAN EVENT



CHAPTER II

CLASSIFICATION

Classification Guidance for Project Sedan was the responsibility of SAN and was covered by the following publications:

(1) "Project Sedan Classification Guide," dated July 3, 1962, was issued by SAN with the approval of the Division of Classification.

(2) "Project Sedan Debris Classification Guidance," dated August 3, 1962 was forwarded by SAN in teletype to NVOO with the approval of the Division of Classification.



PART VIII

COSTS



[REDACTED]

CHAPTER I

PROJECT COSTS

The following schedules give a summarization of Project Sedan costs incurred by the organizations funded under the Plowshare Program. Costs associated with participation by the Civil Effects Test Organization and the Vela-Uniform program, the only group involved which were not Plowshare funded, are therefore not included. Further, estimated costs of the postshot exploration program, which is planned for the second half of FY63, are not included.

This section was prepared by the Special Projects Division, San Francisco Operations Office from official Plowshare Cost Reports and the financial records of that office. Inquiries concerning additional detail of the financial side of Project Sedan should be directed to the San Francisco Operations Office, 2111 Bancroft Way, Berkeley 4, California.

PROJECT SEDAN

Summary of Costs

<u>Program</u>	<u>Total Costs</u>
<u>Scientific Programs and Technical Support</u>	
Scientific Programs	\$ 609,309
Technical Support	505,976
<u>Safety and Security</u>	62,250
<u>Logistical and Operational Support</u>	128,863
<u>Engineering and A-E Field Operations</u>	42,923
Total Project Sedan	<u>\$1,349,321</u>

SCHEDULE I - *Project Sedan*

Costs of Scientific and Technical Support Programs
Including Associated Construction

<u>Program</u>	<u>Costs</u>
<u>Scientific Programs</u>	
Air Blast Measurements (SC)	\$ 31,199
Scientific Photography (LRL)	56,292
Structural Response Measurements (LRL)	210,751
Crater Studies (LRL)	28,355
Geological Studies (USGS)	11,000
Fallout Studies (NRDL)	10,600
Radiochemical Analysis (LRL)	61,382
Close-In Yield Measurements (LRL)	103,433
Device Performance Measurements (LRL)	96,297
Total Scientific Programs	<u>\$ 609,309</u>

Schedule I (Continued)

<u>Program</u>	<u>Costs</u>
<u>Technical Support</u>	
Technical Coordination (LRL)	\$ 56,580
Explosive Assembly and Arming (LRL)	674
Explosive Emplacement and Common Scientific Facilities (REECo)	439,979
Grouting and Grout Development (WES)	8,743
Total Technical Support	<u>\$ 505,976</u>
TOTAL	<u><u>\$1,115,285</u></u>

SCHEDULE II

Project Sedan

Costs of Safety and Security Programs
Including Associated Construction

<u>Program</u>	<u>Costs</u>
<u>Safety and Security</u>	
Weather Prediction Services (USWB)	\$ 4,955
Off-Site Radiation Safety (USPHS)	45,087
Microbarograph Measurements (SC)	5,236
Security Services (FSI)	6,972
Total Safety and Security	<u>\$ 62,250</u>

SCHEDULE III

Project Sedan

Costs of Logistic and Operational Support

<u>Program</u>	<u>Costs</u>
Transportation (REECo)	\$ 241
Communications and Signal Facilities (REECo)	61,940
On-Site Radiation Safety (REECo)	27,484
Deactivation and Roll-up (REECo)	38,216
Common to Support Programs (REECo)	982
Total Logistic and Operational Support	<u>\$128,863</u>

[REDACTED]

SCHEDULE IV

Project Sedan

Costs of Engineering and A-E Activities

<u>Program (H&N)</u>	<u>Costs</u>
Project Design	\$ 6,685
Field Engineering	3,794
Engineering Research and Reports	346
Project Studies and Investigations	955
Special Services	31,143
Total Engineering and A-E Activities	<u>\$ 42,923</u>

SCHEDULE V

Project Sedan

Summary of Costs by Participants

<u>Participant</u>	<u>Costs</u>
Federal Services, Inc.	\$ 6,972
Holmes and Narver, Inc.	42,923
Lawrence Radiation Laboratory	411,693
Reynolds Electrical and Engineering Co.	786,336
Sandia Corporation	29,889
U. S. Army Waterways Experiment Station	6,255
U. S. Geological Survey	11,000
U. S. Naval Radiological Defense Laboratory	10,600
U. S. Public Health Service	38,698
U. S. Weather Bureau	4,955
TOTAL	<u>\$1,349,321</u>



PART IX
BIBLIOGRAPHY



CHAPTER I
PROJECT SEDAN REPORTS

Listed below are the technical and safety program reports issued or planned for publication by Plowshare sponsored agencies participating in Project Sedan:

USPHS	PNE-200	Off-Site Radiation Safety
USWB	PNE-201	Analysis of Weather and Surface Radiation Data
SC	PNE-202	Long Range Blast Propagation
RE ECo	PNE-203	On-Site Rad-Safe
AEC/USBM	PNE-204	Structural Survey of Private Mining Operations
FAA	PNE-205	Airspace Closure
SC	PNE-211	Close-In Air Blast From a Nuclear Event in NTS Desert Alluvium
LRL-N	PNE-212	Scientific Photography
USC&GS	PNE-213	Seismic Effects From a High Yield Nuclear Cratering Experiment in Desert Alluvium
LRL	PNE-214	Fallout Studies
LRL	PNE-215	Structure Response
LRL	PNE-216	Crater Measurements
Boeing	PNE-217	Ejecta Studies
LRL	PNE-218	Radioactive Pellet Trajectory Studies
USGS	PNE-219	Hydrologic Effects on Distribution Coefficients
USGS	PNE-221	Infiltration Rates Pre and Post Shot
UCLA	PNE-224	Influences of a Cratering Device on Close-in Populations of Lizards
UCLA	PNE-225	Part I – Characteristics of Fallout from a Deeply Buried Nuclear Detonation from about 3 to 150 Miles from Ground Zero Part II – Aerial Radiometric Surveys
BYU	PNE-226	Close-In Effects of a Subsurface Nuclear Detonation on Small Mammals and Selected Invertebrates
UCLA	PNE-228	Close-in Effects of an Underground Nuclear Detonation on Vegetation
NRDL	PNE-229	Some Radiochemical and Physical Measurements of Debris from an Underground Nuclear Explosion
NRDL	PNE-230	Naval Aerial Photographic Analysis
LRL	PNE-231	Rad-Chem Analysis
LRL	PNE-232	Yield Measurements



EG&G	PNE-233	Timing and Firing
WES	PNE-234	Stability of Cratered Slopes
LRL	PNE-235	Seismic Velocity Studies
UCLA	PNE-236	Food Chain Relationship of I ¹³¹ Following Two Nuclear Tests In Nevada





PART X

CONCLUSIONS AND RECOMMENDATIONS





CHAPTER I

CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

Project Sedan was executed after approximately a two month preparation period. If additional time had been allowed in preparing for this event, it is believed that many pertinent experiments could have been designed and included in this project to increase our knowledge of the phenomenology of cratering detonations at this yield. However, significant information was obtained to extend the knowledge of cratering effects to the 100-kiloton range of yields. The experiment will provide valuable data in the development of nuclear excavation techniques over the next four to five years.

Concurrent with the planning for Project Sedan, preparations were initiated for the execution of Projects Small Boy, Little Feller I, Little Feller II and Johnie Boy. These concurrent preparations interjected various complexities into the proper execution of the Sedan event. Specific details concerning these complexities are found in the conclusions of Chapter V of Part IV, and Chapters I and II of Part VI.

Although the radioactivity deposited at longer ranges downwind was greater than expected, the intensities were moderate considering the large amount of dust carried by the cloud.

Ground shock intensities were much less than expected, based on previous experience in tuff and alluvium.

The safety measures outlined in the "Operational Safety Plan - Sedan event," revised July 2, 1962, were complete enough to handle all possible safety hazards.

Engineering, construction, and support for Sedan were completed in accordance with the planning schedules, directives, technical criteria, and established cost ceiling.

B. RECOMMENDATIONS

For future projects of the magnitude of Project Sedan, sufficient time should be permitted to thoroughly plan and execute the experiment in such a manner as to gain the greatest amount of knowledge under the most economical and safe conditions.

Every effort should be made to avoid the scheduling of additional top priority projects, within a relatively short period of time, along with a project of the magnitude of Sedan.

A master schedule should be prepared well in advance of the execution of future projects. This schedule should indicate the type of participation by all agencies, along with pertinent dates, efforts, estimates, etc., and be approved by a high level group. In addition, this group should approve all changes in the master schedule.

If future Plowshare events like Sedan are conducted at NTS, every effort should be made to obtain a policy permitting on-site observation by news media representatives. This would further the objectives of the Plowshare Program by giving insight into the possibilities and problems of the earth-moving concept. It would also avoid rather bitter criticism of the Commission still being voiced by some newsmen for closing the peaceful purposes event.