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FINAL REPORT

VELA UNIFORM PROGRAM

PROJECT DRIBBLE

SALMON EVENT

TATUM SALT DOME, MISSISSIPPI

22 OCTOBER 1964

part of an experiment in seismic decoupling at the nuclear level

SPONSORED BY THE ADVANCED RESEARCH PROJECTS AGENCY
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**Weather and Surface
Radiation Prediction
Activities**

WEATHER BUREAU RESEARCH
STATION
LAS VAGAS, NEVADA

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U. S. Department of Commerce
Weather Bureau

FINAL REPORT
of
WEATHER and SURFACE RADIATION PREDICTION ACTIVITIES
for the
SALMON EVENT - PROJECT DRIBBLE

by

Staff, Weather Bureau Research Station
Las Vegas, Nevada

Prepared for the U. S. Atomic Energy Commission
as part of the Project Dribble Safety Program.
This report does not constitute a formal USWB
scientific publication.

Las Vegas, Nevada
August 1965

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Abstract

The Weather Bureau provided weather planning and prediction for the radiological safety program of the Salmon event, Project Dribble. Observations of winds and weather conditions at the site began 20 months prior to the event. Wind and temperature soundings and weather and radioactivity forecasting facilities were added during the detonation and post-event drilling phases. The winds during the 4 weeks following the Ready date were sufficiently abnormal in direction and speed that the planned firing criteria were not met, resulting in delays and changes in criteria to accept a wider range of conditions.

CHAPTER I

INTRODUCTION

1.1 OBJECTIVES

The Salmon event was the first of three nuclear detonations programmed to be fired in a salt medium as part of Project Dribble. The primary objective of the project is to detonate a 5-kiloton tamped nuclear explosion (Salmon event) and a 100-ton decoupled nuclear explosion (Sand event) for the purpose of inferring the significance of decoupling at the 5-kiloton level and to study seismic propagation in the mantle from a nuclear explosion in the southeastern United States. The secondary objective of the project is to measure decoupling at the 100-ton level and to compare the seismic waves from a 100-ton tamped explosion (Tar event) with a 5-kiloton tamped explosion (Salmon event), all in a salt medium.

The Salmon event was fired at 1000 CST, October 22, 1964 at a depth of 2700 feet in the Tatum Salt Dome, Lamar County, Mississippi. Ground Zero was located in geodetic coordinates N 31° 8' 29", W 89° 34' 33". The radioactivity produced by the detonation was totally contained within the salt dome as planned for in the experiment. Although this containment was confidently expected, it was necessary to implement certain pre-shot safety measures to assure that the predicted ground motion and a possible venting of radioactivity would not constitute a hazard to the population or livestock in the vicinity of the site. Some of the safety measures implemented included:

1. The evacuation of all off-site people from around Ground Zero out to a distance of 1.6 miles.

2. The additional evacuation of off-site people in the predicted downwind sector out to 5 miles from Ground Zero with residents alerted for possible evacuation between the 5 and 10 mile areas. The downwind sectors or zones for which evacuation procedures were established were initially confined to the northern semi-circle about Ground Zero.
3. The utilization of aircraft to monitor the detonation and track any release of radioactivity should it materialize.

These safety measures established a requirement for a particular set of weather conditions in order to conduct the experiment. The acceptable meteorological conditions were as follows:

1. The winds in the layer from the surface to the predicted altitude of vertical mixing were to be from a quadrant between 080 and 260 degrees and directed into the northern semi-circle, preferably at speeds less than 10 knots.
2. Cloud ceilings would be sufficient to permit air operations at and below the predicted level of vertical mixing.
3. No precipitation would occur during the operation.
4. The convective stability at shot time would be sufficiently unstable to provide vertical mixing to a few thousand feet above terrain.

These conditions were in effect through October 20, 1964. Thereafter, condition one was deleted after the establishment of evacuation procedures for the southern semi-circle.

The primary objectives of WBRG, Las Vegas, Nevada, in support of the Salmon event were to provide a meteorological prediction service and meteorological observational program to assist the Test Manager and his Advisory Panel in: (1) the evaluation of the weather prediction relative to the acceptable meteorological conditions; (2) the assessment of the radiation levels predicted for an accidental release of activity; and (3) the coordination of radioactive cloud measurement activities should a venting materialize after the detonation. An additional objective of the Weather Bureau was (4) to measure, analyze, and disseminate meteorological data and information to participants in the Salmon program before, during, and after the experiment as well as provide a post-shot documentation of all Weather Bureau Services.

1.2 FUNCTIONS

Forecasts of meteorological elements pertinent to test activities and estimates of the total gamma dose in the passing cloud resulting from a possible venting were made available to the Test Manager and his Advisory Panel in both formal and informal briefings prior to the detonation. The Weather and Radiation Prediction Unit, (WRPU), was responsible for the interpretation of meteorological data and for advising test personnel on matters influenced by the state of the atmosphere. The unit worked in close cooperation with these individuals to insure that the Safety Program would have the benefit of the most accurate, up-to-date, and useful information possible.

1.3 ORGANIZATION

The WRPU was under the operational control of the Test Manager.

Responsibility for the weather service was delegated to the unit by the Scientific Advisor, with the Meteorologist in Charge, WBRS, Las Vegas, Nevada, acting as chief of the unit. Technical personnel were provided by the U. S. Weather Bureau.

From scheduled D-3 to the actual time of the event, the unit consisted of 9 meteorological technicians who manned the radiosonde and winds-aloft stations and processed data, 1 electronic technician who maintained equipment, and 4 meteorologists who were responsible for forecast of meteorological parameters and the preparation of radiation estimates.

CHAPTER II

PROCEDURE

2.1 OBSERVATIONAL PROCEDURES

The installation of meteorological equipment at the Dribble Site began in January 1963. The instrument positions were chosen so that their data would be most helpful in satisfying the safety requirements set forth in the Operational Safety Plan.

An M-33 radar upper-wind station and a meteorological observation trailer were installed two miles northeast of Ground Zero in the CP area. Three low level wind direction and speed instruments, designated Dribble Number 1, 2, and 3, were mounted on towers at heights of 65, 50, and 80 feet above terrain. The towers were situated one mile southwest, one-quarter mile northeast, and two miles northeast of Ground Zero respectively. Nine pibal positions were surveyed in along the circumference of each of three concentric circles centered at Ground Zero with radii of approximately 3, 5, and 10 miles. These stations were spaced at approximately 40 degree intervals along each circle starting from north. Two additional off-site pibal stations were established at the Columbia and Hattiesburg Airports, 17 miles northwest and 21 miles northeast of Ground Zero, respectively. The meteorological observation sites are illustrated in Figure 2.1.1.

Radio, telephone, and hard-wire telemetering were used to transmit data from the various instrument locations to a Weather Operations Trailer situated in the CP area. Radio communication was the primary means of

transmitting data from the off-site winds-aloft stations. Weather facsimile and teletype receivers were also installed in the Operations Trailer to receive regional and national information.

The meteorological observation program was initiated in January 1963 with the assignment of one meteorological technician to the site. The program included hourly surface observations, pibal observations, and T-sonde observations. These data were used to supplement existing Weather Bureau records from surrounding weather stations in the region in the compilation of a general climatology of the Dribble Site. In addition to this program, the spatial variation in the local winds was also examined during the 22-month period prior to the experiment by means of periodic simultaneous releases of pibal balloons from various locations comprising the pibal station array. It was concluded that the spatial variation of the winds above tree-top height at the site was negligible for most synoptic weather situations, and that pibal observations at Hattiesburg and Columbia Airports in conjunction with those from the CP would in most cases be adequate for operational use and provide optimum large area representation of existing wind conditions.

The bleed-down plant for Project Dribble was tested in late June and early July 1964. The meteorological observation program was then expanded and the observations used in the preparation of local meteorological forecasts for this operation.

The readiness date for the experiment was 1000 CST September 28, 1964. Commencing 10 days prior to this date, D-10, the following daily meteorological observations were made on a routine basis at the CP.

1. Upper winds at 3-hourly intervals from 0000 CST to 1500 CST.
2. Upper air pressure, temperature, and humidity observations at 0600 CST and 1000 CST.
3. Hourly surface observations on a 24-hour per day basis.

On the day of the shot, D-day, the schedule of observations was as follows:

1. Upper winds at hourly intervals from the CP commencing at 0000 CST.

The frequency of these observations was increased to every 20 minutes as the scheduled H-hour, 1000 CST, approached.
2. Upper winds at hourly intervals from both the Hattiesburg and Columbia Airports beginning at 0400 CST. The frequency of these observations was increased to every 30 minutes just prior to H-hour.
3. Upper air observations of pressure, temperature, and humidity at the CP as required commencing at 0400 CST.
4. Low-level wind observations from the three on-site tower positions as required.

2.2 ANALYSIS PROCEDURES

2.2.1 Climatological Analysis Procedures

As previously mentioned, the meteorological data collected commencing in January 1963 were used to compile statistics on the general site climatology. Since the period of these observations covered too

short a span of time to permit reliable statistical analysis, recourse was made to relatively long-term climatological records available from cities in close proximity to the site; notably, Jackson, Mississippi; Mobile, Alabama; and New Orleans, Louisiana. These cities are located approximately 90 miles to the north-northwest, east-southeast, and southwest of the site, respectively. A reasonable approximation of the general climatology of the site was obtained by subjective interpolation of these long-term records and the local observations.

An important element of the site climatology for the Salmon experiment was the frequency distribution of wind direction and speed as well as the cloud cover, cloud ceilings, and the occurrence of rain associated with the distribution. This type of analysis was performed for each month of the year. At the request of the Test Manager, composite statistics were compiled for the months of September and October which expressed the probability of winds blowing into the northern and southern semi-circle on any given day as well as the probability of favorable flying weather with each of these two wind regimes. The statistics were as follows:

1. The winds could be expected to blow into the northern semi-circle 1 day out of every 3 with favorable flying weather 1 day in 6 when such winds occur.
2. The winds could be expected to blow into the southern semi-circle 1 day out of every 2 with favorable flying weather 1 day in 3 when such winds occur.
3. Winds less than 10 knots could be expected to occur 1 day in every 5, and less than 5 knots, 1 day in 10.

2.2.2 OPERATIONAL ANALYSIS PROCEDURES

Teletype data and facsimile charts were the major source of information used in the preparation of the briefing forecasts. A Radar Report and Warning Circuit (RAWARC) supplemented the normal teletype data and provided radar reports concerning the precipitation field throughout the Southeastern United States. These data were plotted and analyzed whenever precipitation activity posed a threat to operations at the site. A regional streamline analysis of wind data for the 2,000, 5,000, and 10,000 foot-levels, supplemented by a surface analysis of the weather pattern as required, was performed locally to provide additional weather information.

During the operational phase of the Salmon experiment, the wind data obtained from local instrument positions were analyzed at each reporting time to define the existing wind field, determine the trajectory of activity should a venting occur, delineate the area which would be affected by such a release, and illustrate the arrival time of the activity at downwind locations. The temperature profiles were analyzed to determine the thermal stability and its effect on the cloud height.

2.3 WEATHER AND RADIATION BRIEFINGS

Formal weather briefings were presented to the Test Manager and his Advisory Panel at 1500 CST each afternoon in September beginning September 26. In October, afternoon briefings were held on the 5, 6, 7, 8, 11, 12, 16, 18 and 21st. On mornings during which attempts were made to conduct the experiment, (October 8, 12, 17 and 22) formal briefings were also presented at 0300 CST, H-7 hours. Beginning October 9, the Test Manager requested informal weather briefings at 0930 CST each morning.

Each formal briefing presentation consisted of graphic displays with the following content: (1) latest surface and 5000-foot streamline analysis when required to clarify the forecast; (2) surface prognosis and 5000-foot MSL streamline prognosis for H-hour; (3) forecast trajectories to H+12 hours for the 2000 and 5000-foot levels MSL; (4) forecast clouds, weather, and low-level winds for the period H-4 to H+8 hours; (5) upper-wind and temperature profiles for H-hours.

Radiation briefings were presented in conjunction with all formal weather briefings. The briefing material included a graphical display of the estimated arrival time peak dose rate in the passing cloud as a function of distance from Ground Zero for a possible venting condition. The orientation and extent of the area which would be affected by a release, determined from the predicted shot-time winds, were also displayed.

CHAPTER III

RESULTS

3.1 WEATHER CHRONOLOGY

3.1.1 WEATHER CHRONOLOGY FROM SEPTEMBER 28 TO OCTOBER 21, 1964

During the period from September 28 to October 21, the acceptable meteorological conditions listed on Page 2 were never all present on any day. This resulted in a delay in conducting the experiment until October 21, 1964. The following paragraphs are a brief description of the sequence of major weather patterns for this period and the unacceptable features of each pattern in regard to the prerequisite meteorological criteria.

Beginning September 26 and continuing through September 30, the Bermuda High, centered off the east coast, was the principle circulation system dominating the weather at the Dribble Site. This system resulted in southeasterly winds at the site but the air advected to it had a high moisture content which led to extensive shower activity and low cloud ceilings. This prevented the operational use of aircraft essential for the experiment.

From September 30 through October 4, the local weather was influenced by Hurricane Hilda. The hurricane moved out of the central Gulf of Mexico on September 30 on a northerly course and passed in the immediate vicinity of the site on October 4. This storm produced high winds, rain, and low cloud ceilings which prevented the operational use of aircraft. The storm also resulted in a high seismic background level which was incompatible with the objectives of the experiment. By October 5, the hurricane had moved

eastward into Georgia and northern Florida and the weather cleared. The local wind flow was controlled by the northerly pressure gradient in the rear of the storm and the winds were directed into the southern semi-circle. The winds were therefore not acceptable for conducting the experiment.

An anticyclonic circulation developed in the western United States on October 5 and by October 7, had moved eastward with the center extending from Kentucky to Texas. The northerly pressure gradient in the eastern portion of this system resulted in the maintenance of a wind flow into the southern semi-circle throughout this period. Although the weather was clear, the winds were not acceptable for conducting the experiment.

This anticyclone was predicted to move eastward and weaken on October 8. This movement would cause the pressure gradient to veer toward the south. As this occurred, a short wave trough of low pressure was predicted to deepen in the rear of this system which would further aid in the establishment of a southerly pressure gradient at the Dribble Site. The weather would be mostly clear. In view of these considerations, the Test Manager's Advisory Panel recommended that an attempt be made to conduct the experiment on the morning of October 8. At 0700 CST on October 8, the winds were light southerly to 4000 ft. MSL but west-northwesterly above that level. The upper level wind flow lowered during the course of the morning and by 1200 CST, the winds were northwesterly at all levels which failed to satisfy the wind direction criteria. The experiment was therefore canceled for the day.

The failure of the winds to persist from the south is attributable to the rapid weakening of the low level southerly pressure gradient in the rear of the anticyclone. The trough also deepened too far north of the site so that the pressure gradient at upper levels was west-northwesterly rather than southwesterly at the latitude of the Dribble Site.

A weak cold frontal passage occurred at the site on October 9 as the trough moved eastward across the east central United States. A northwesterly pressure gradient was established behind this trough. On October 9, an anticyclonic circulation formed in the Texas Oklahoma region. This system moved eastward into Kentucky and Ohio by October 11. The pressure gradient veered from northwest into the northeast with the movement of the anticyclone. Although the weather was clear, the winds were directed into the southern semi-circle and were not acceptable for conducting the experiment during this period.

By October 11, the next short wave trough had moved into the Great Plains. This trough was predicted to deepen and move eastward behind the anticyclone which by October 12 would be centered in the mid-Atlantic states. The net effect of these developments should result in the pressure gradient veering into the southeast at the latitude of the Dribble Site with some scattered high cloudiness. On the basis of this prediction, the Test Manager and his Advisory Panel recommended that an attempt be made to conduct the experiment on the morning of October 12. At 0700 CST on October 12, the winds were easterly veering to the southwest

with height. As the morning progressed, the winds dropped in speed to less than five knots and backed into the northeast. These winds were not directed into the northern semi-circle and the experiment was canceled for the day. The major synoptic change which occurred during the day was that the trough filled rapidly and resulted in the establishment of a large area of high pressure extending from the mid-Atlantic states into the Great Plains. At the latitude of the Dribble Site, the pressure gradient became northeasterly since the site was situated on the southern portion of this circulation.

Through October 14, the winds remained from out of the northeast. On this day, Hurricane Isbell moved into the Florida Keys. From October 14 to October 16 the pressure gradient was easterly and northeasterly as the hurricane traveled northward along the Atlantic seaboard. Rain and low cloud ceilings occurred at the site on October 14 and 15 during the passage of the hurricane to the east. Both the winds and the weather conditions were unfavorable for conducting the experiment during this period.

On October 16, a weak high pressure cell developed over eastern Texas and western Louisiana. It was felt that the weak high would drift slowly eastward and by mid-morning of October 17, the center of the high would be southeast of the site and result in the establishment of a southerly pressure gradient. The confidence factor in this forecast was low. However, the Test Manager's Advisory Panel recommended that the experiment be tentatively scheduled for the morning of October 17, subject to review at the 0300 CST weather briefing. At the time of

the 0300 CST weather briefing, the center of the anticyclone in the western Gulf had not moved eastward as fast as anticipated and was still situated southwest of the site. As a consequence, the pressure gradient and wind field were northwesterly with little prospect for improvement during the day. The experiment was therefore canceled for the day as a result of unacceptable winds. Similar conditions persisted on October 18 as the anticyclone remained relatively stationary.

A trough of low pressure moved into the midwest on October 18 and traveled eastward rapidly. A cold front associated with this system passed the site at 2300 CST on October 18. A massive anticyclone dominated the central and western part of the country behind this system. This anticyclonic circulation pattern remained relatively unchanged through October 21. These winds were directed into the southern semi-circle and were therefore not acceptable through October 20. Although permission had been received to implement the evacuation of people from the southern semi-circle on October 20, the evacuation procedure plan was not sufficiently established through October 21 to execute the experiment for a northerly wind flow, so that these winds were still unacceptable on that date.

Table 3.1 is a chronological summary of the causes for the delay in conducting the Salmon experiment from September 28 to October 21. The criteria shown in the table are unfavorable winds, low cloud cover, and precipitation.

3.1.2 WEATHER CHRONOLOGY FOR OCTOBER 22, 1964

The following paragraphs describe the development of the weather pattern which existed at the time of the detonation of Salmon and the meteorological forecasts issued to the Test Manager and his Advisory Panel prior to the event.

On October 21, the anticyclone over the central and western United States began to break down as a low pressure cell and associated frontal system moved down from central Canada. By mid-morning, the low was centered over central Michigan and the associated frontal system extended southward through Missouri into Kansas. The frontal trough had caused the anticyclone in the central and western United States to split into two cells, one centered over southern Idaho and the other, extending along the Gulf Coast from Texas into northern Florida. By October 22, the ridge along the Gulf was expected to move eastward and become centered over Florida. The low pressure system over Michigan was forecast to continue eastward to the New England Coast with the associated cold front trailing southwestward along the east coast into northern Mississippi then northwestward into a frontal wave over Oklahoma. The resultant pressure pattern was expected to produce southerly winds at low levels at the Dribble Site and also at 5,000 feet MSL as a ridge over southern Texas gradually flattened.

On the basis of these developments, a readiness briefing was held at 1500 CST on October 21. This forecast, valid at 1000 CST, October 22, is summarized as follows:

1. The predicted vertical temperature profile indicates that vertical mixing will occur to 5,000 feet MSL.
2. The winds at scheduled shot time (1000 CST) will vary from 230 degrees at 5 knots at the surface to 240 degrees at 10 knots at 5,000 feet MSL. As the day progresses the winds will become more southwesterly and with a slight increase in speed.
3. The weather is expected to be clear.
4. The wind trajectory for the 2,000 foot level is expected to be towards the north-northeast, and at 5,000 feet MSL, toward the northeast.

The briefing charts used in the presentation are illustrated in Figure 3.1.1.

A follow-on briefing was held at 0300 PST, October 22, The following revisions were made to the above forecast:

1. Vertical mixing can be expected to occur to 3,500 feet MSL.
2. The winds at scheduled shot time will vary from 190 degrees at 5 knots at the surface, to 250 degrees at 5 knots at 3,000 feet MSL and veer to 330 degrees at 5 knots at 5,000 feet MSL. The winds in the first few thousand feet will remain from the west-southwest at light speeds for the remainder of the day while the winds at the 5,000 foot level will be from the northwest and west-northwest.
3. The wind trajectory for the 2,000 foot level will be

directed towards the northeast, and at the 5,000 foot

vel, towards the southeast.

The briefing charts used in the 0300 CST briefing presentation are shown in Figure 3.1.2.

Meteorological conditions were adequate for conducting the Salmon event on the morning of October 22, and the device was detonated at 1000 CST. At the scheduled shot time, the winds through the first three thousand feet above the surface were from the west at 6 to 11 knots. Above 3000 feet the winds were light and variable. Unstable lapse conditions existed to 1500 feet MSL.

Figure 3.1.3 illustrates the shot-time temperature sounding. Figures 3.1.4 and 3.1.5 show the 0600 CST and 1200 CST surface maps for October 22. Figures 3.1.6 and 3.1.7 illustrate the 5000 foot streamlines at these times. These charts represent the most current regional information available prior to and immediately following the shot.

A complete tabulation of the meteorological observations for October 22 is available on request from WBRS, Las Vegas, Nevada. The tabulation has been omitted from this report since there was positive evidence of no release of activity as a result of the detonation.

3.2 WEATHER VERIFICATION

The weather forecasts were presented on a daily basis from September 26 to October 21. During this period, each day was a scheduled event day and particular emphasis was directed toward not missing any opportunity for conducting the Salmon event. The weather forecasts issued by WBRS accomplished this objective. October 8, 12, and 17 were the only three days in which there existed a marginal

possibility of satisfying the meteorological criteria and conducting the event. Attempts were made to conduct the experiment on these days. On October 8 and 12, the wind field deteriorated from favorable early in the day to unfavorable by the scheduled shot time. On October 17, the cancellation occurred at 0300 CST when it was evident that the favorable conditions would not materialize.

For the day of the shot, October 22, a comparison of the briefing wind forecast and the persistence wind forecast (winds at 0600 Z and 1800 Z) are compared with the observed winds at 1000 CST in Table 3.2.

3.3 RADIATION CHRONOLOGY

Prior to the event, the radioactivity which would be produced by the Salmon detonation was confidently expected to be contained within the Salt Dome. The only conceivable accident was the possible emission of small amounts of radioactivity in fine particulate and gaseous form through a crack or fissure in either the stemming system or the surrounding earthen encasement. This type of venting condition had been observed at Project Gnome, a previous nuclear detonation in a salt medium.

The hazard appraisal provided by the Radiation Prediction Unit for the Salmon event was for an accident condition postulated to be one-tenth of Gnome in regards to the total amount of fission product released. With this assumption, the predicted wind conditions and estimated vertical rise of effluent for Salmon were scaled to those observed for Gnome and used to adjust the Gnome radiation levels for the hazard appraisal prediction.

The hazard appraisal consisted of the peak external dose rate

levels in the passing effluent cloud. The orientation and estimated crosswind extent of the region through which the cloud would be advected by the predicted winds comprised part of the briefing material to illustrate the potential area of hazard to the Test Manager and his Advisory Panel.

The curve in Figure 3.3.1 illustrates the estimated arrival time dose rate levels presented at the final 0300 CST briefing on October 22 and valid at 1000 CST that morning. The meteorological conditions used to prepare these estimates were an effluent rise to 3500 feet MSL, an integrated wind shear of 40 degrees from the surface to this altitude, and a mean transport speed of five knots. The center-line bearing for any release of activity for the predicted wind conditions was estimated to be 40 degrees.

3.4 RADIATION VERIFICATION

On-site surface radiation data were provided by Reynolds Electrical and Engineering Company and Lawrence Radiation Laboratory. Off-site surface radiation data were provided by the U. S. Public Health Service. These data were supplemented by aerial survey measurements conducted by the EG&G and USAF aircraft.

The radiation measurements made by these organizations at and after the detonation of Salmon indicated that the activity levels remained at normal background. It is therefore concluded that if any release of activity occurred, it was extremely small and below detectable limits.

CHAPTER IV

POST-SHOT ACTIVITIES

Although no radioactive materials were released to the atmosphere as an immediate result of detonating the Salaon shot, there was a possibility at some later time of leakage of radioactive gases through small cracks in the overburden. For this reason, observational and forecasting support were maintained through October 25. The weather station complement was then reduced to one permanently assigned meteorological technician and remained unchanged until February 1965.

The drill¹-back operation had progressed to the point where it was believed that pockets of radioactive gases might be encountered by February 15, 1965. Three weather forecasters, four meteorological technicians, and one electronic technician were reassigned to the Dribble Site and a 24-hour per day, 7-day per week observational program and weather forecasting service were established. Daily weather briefings were presented from February 24 to March 6, and on other days on an as needed basis.

The bleed-down plant was operated throughout the day on March 6. The type and frequency of meteorological observations were essentially the same as those for shot day. The current wind data were used to deploy the ARMS aircraft and the surface mobile sampling equipment to measure radioactivity levels in the processed gases emitted from the plant. The plant operated efficiently and the radiation levels remained at background level at and immediately surrounding the plant. The sampling program was reduced thereafter.

The weather forecasting service was continued until March 16 when it was deemed no longer necessary. The meteorological observation program was maintained throughout the rest of March as core samples were removed from the cavity. The weather station complement was then reduced again to one permanently assigned meteorological technician.

TABLE 3.1

Chronology of the Causes for the Delay
in Conducting the Salmon Event

<u>Date</u>	<u>Unfavorable Winds</u>	<u>Low Cloud Cover</u>	<u>Precipitation</u>
9/28		X	X
9/29		X	X
9/30	X	X	X
10/1	X	X	
10/2	X	X	X
10/3	X	X	X
10/4	X	X	X
10/5	X		
10/6	X		
10/7	X		
10/8	X		
10/9	X		
10/10	X		
10/11	X		
10/12	X		
10/13	X		X
10/14	X		
10/15	X	X	
10/16	X		
10/17	X		
10/18	X		
10/19	X		
10/20	X		
10/21	X		

X indicates cause

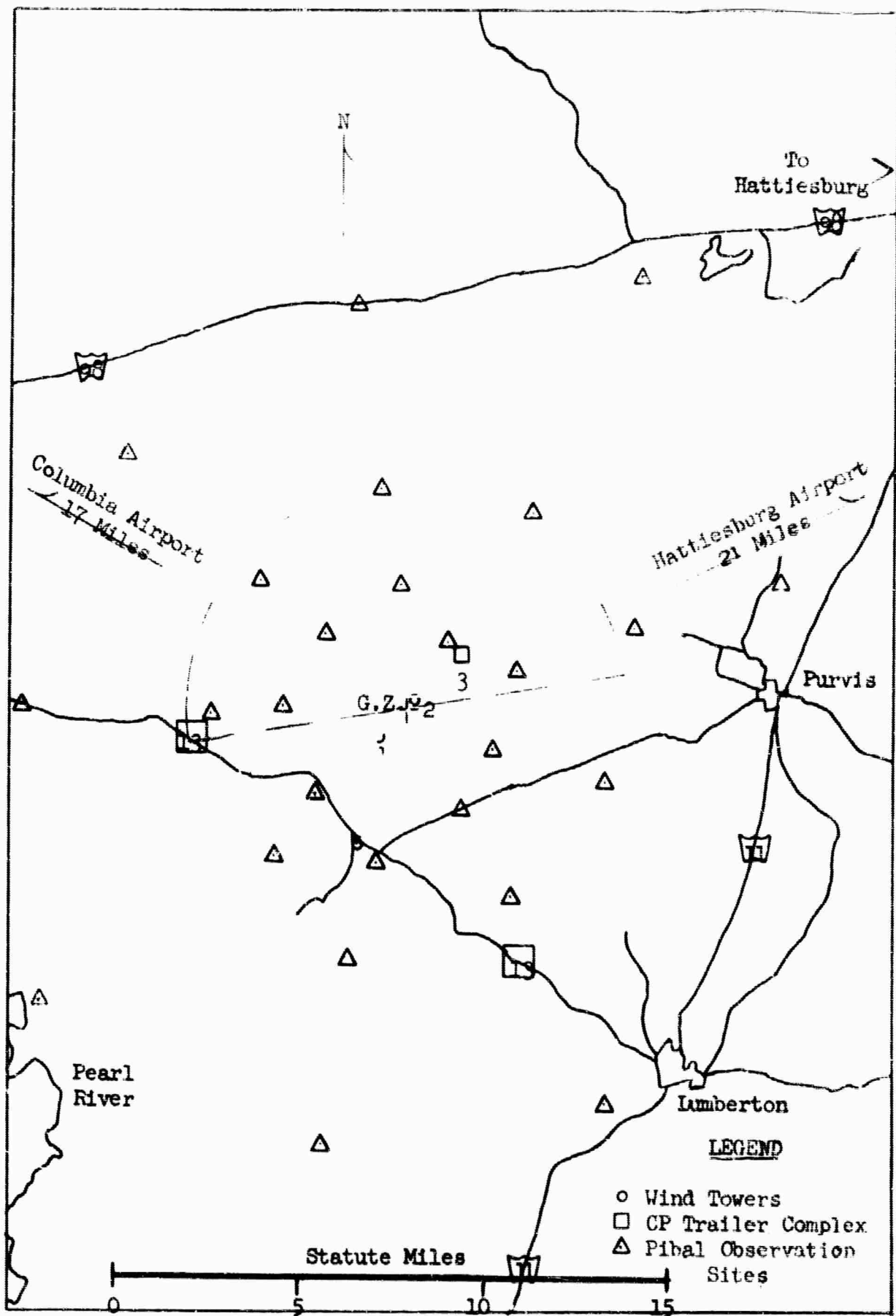


Figure 2.1.1 Meteorological Observation Sites

Event Name: Project DRIBBLE
Salmon Event

Briefing Date: 10/22/64
Briefing Time: 0300 CST
Valid Time : 1000 CST

Briefing Date: 10/21/64
Briefing Time: 1500 CST
Valid Time : 22/1000 CST

Event Date: 10/22/64

Event Time: 1000 CST

Radar Run : 1000 CST		0600 Z		Error		1800 Z		Error	
Height MSL (1000')	Observed Wind Dir Spd	Predicted Persistence		Predicted Persistence		Predicted Persistence		Predicted Persistence	
		Wind Dir Spd	Wind Dir Spd	Wind Dir Spd	Wind Dir Spd	Wind Dir Spd	Wind Dir Spd	Wind Dir Spd	Wind Dir Spd
10	050 03	280 10	280 06	130 07	130 03	280 10	320 09	130 07	090 06
9	360 07	270 05	270 07	090 02	090 00	270 10	330 10	090 03	030 03
8	360 06	270 05	250 06	090 01	110 00	270 10	310 08	090 04	050 02
7	010 03	360 05	Calm	010 02	---	260 10	280 06	110 07	090 03
6	160 04	360 05	050 03	160 01	110 01	260 10	260 07	100 06	100 03
5	190 05	330 05	020 05	140 00	170 00	240 10	260 09	050 05	070 04
4	220 06	270 05	350 06	050 01	130 00	240 10	260 08	020 04	040 02
3	260 08	250 05	290 07	010 03	030 01	240 10	260 08	020 02	000 00
2	280 09	240 05	250 10	040 04	030 01	230 05	260 10	050 04	020 01
1	280 07	230 05	220 12	050 02	060 05	230 05	260 09	050 02	020 02
Sfc	280 06	190 05	210 03	090 01	070 03	230 05	250 06	050 01	030 00

NOTE: Directions in Whole Degrees
Speeds in Whole Knots

TABLE 3.2 Wind Forecast Verification

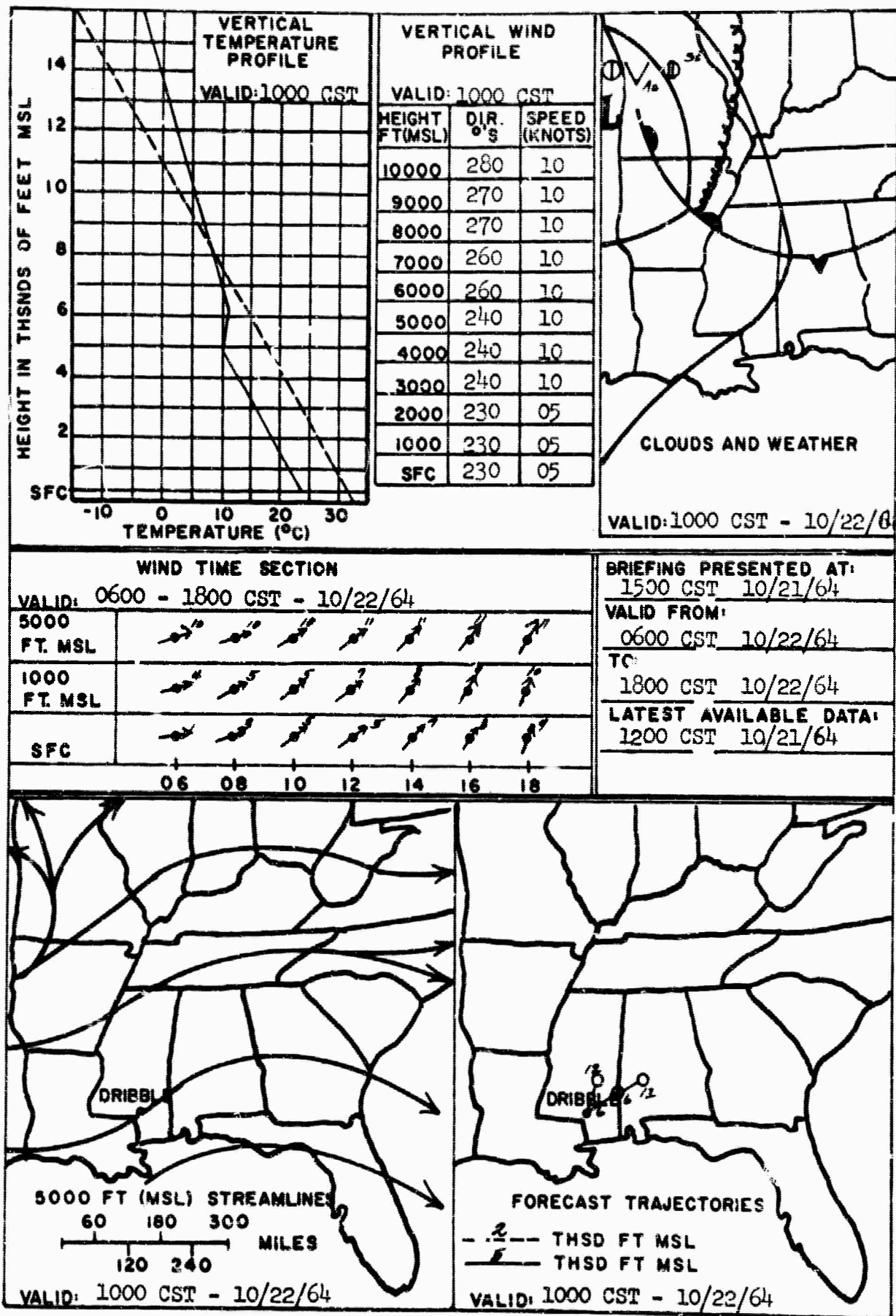


Figure 3.1.1 Briefing Chart - 1500 CST, October 21, 1964

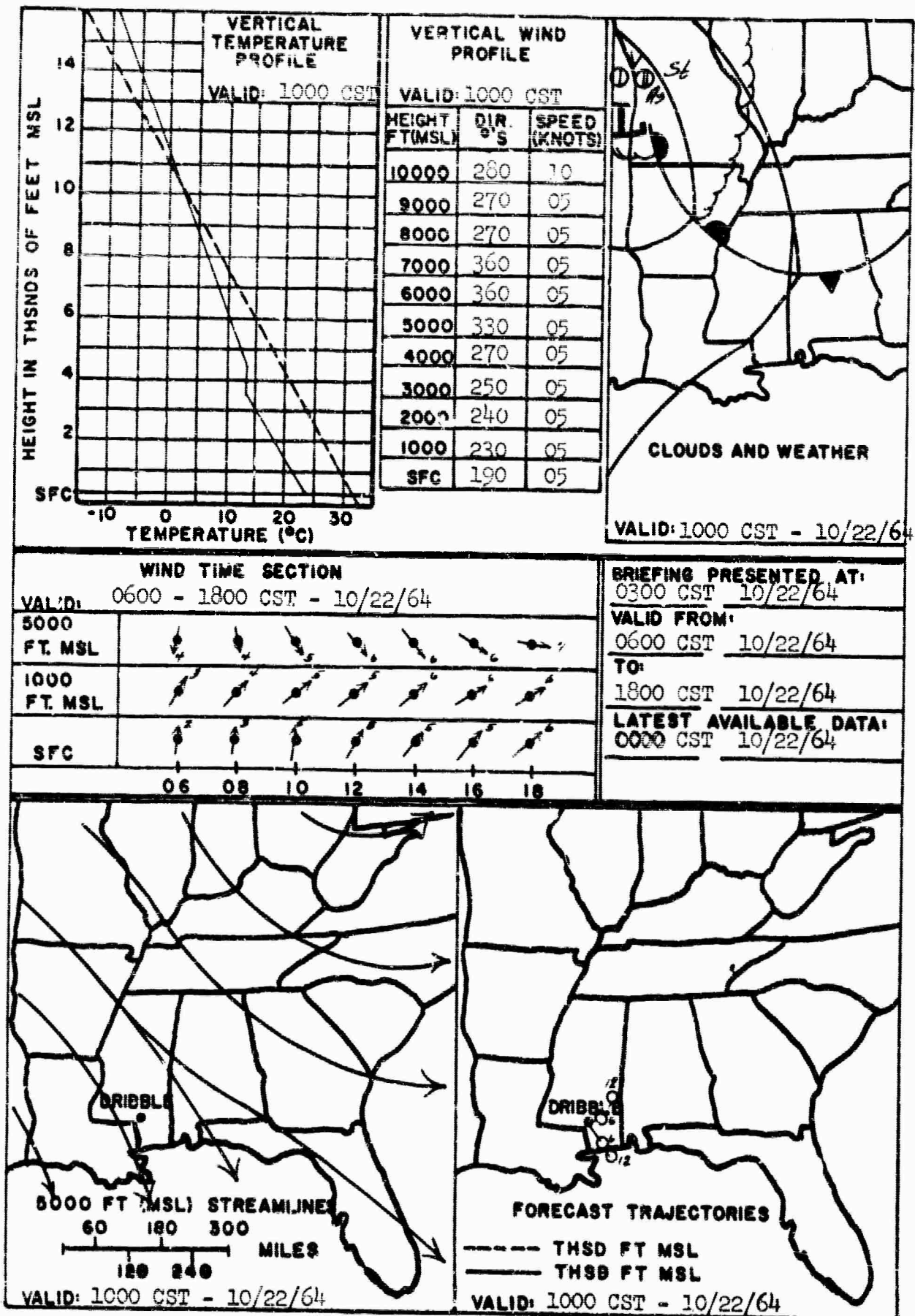


Figure 3.1.2 Briefing Chart - 0300 CST, October 22, 1964

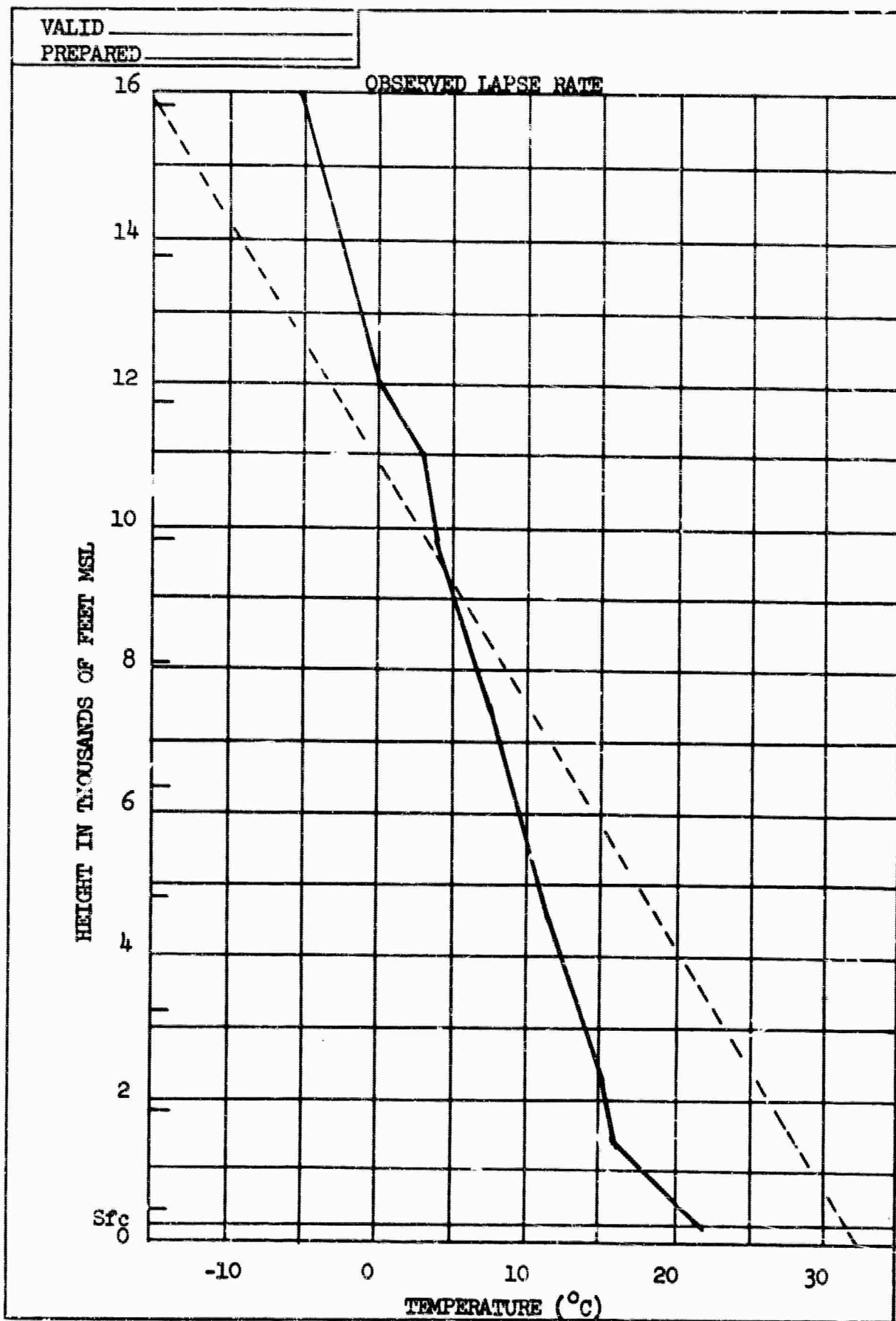


Figure 3.1.3 Vertical Temperature Sounding - 1000 CST October 22, 1964

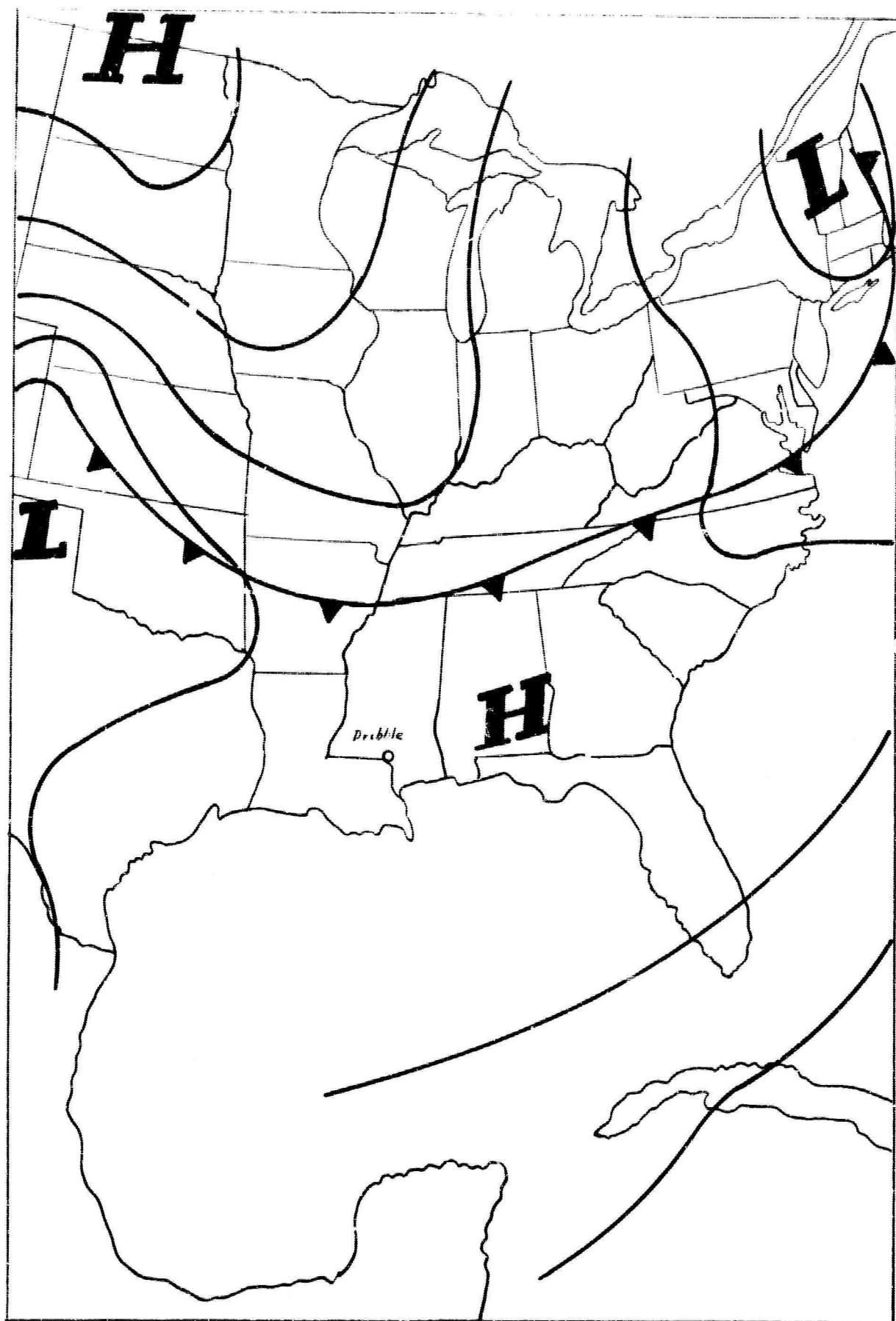


Figure 3.1.4 Surface Analysis - 0600 CST October 22, 1964

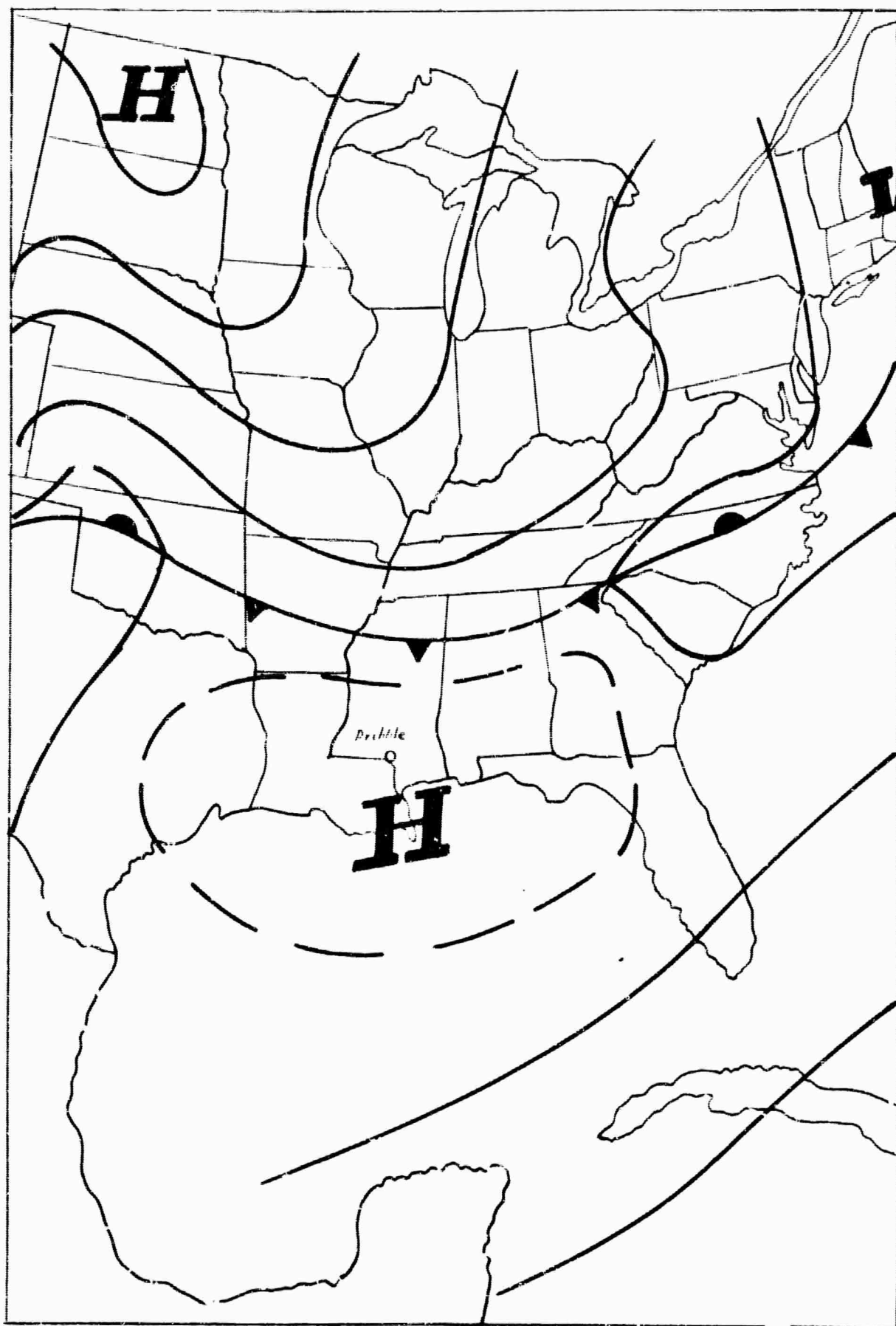


Figure 3.1.5 Surface Analysis - 1200 CST October 22, 1964

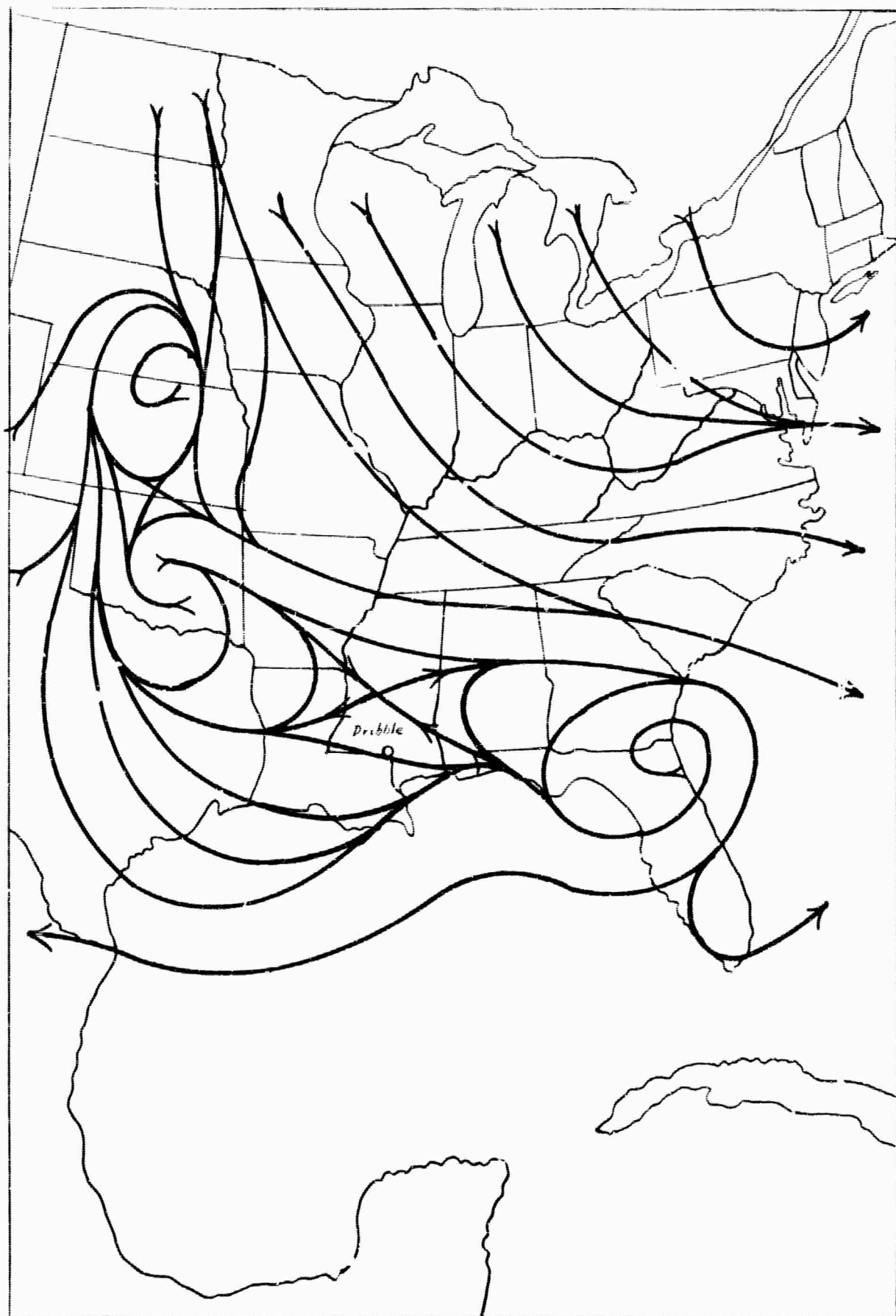


Figure 3.1.6 5,000-foot MSL Streamline Analysis - 0600 CST October 22, 1964

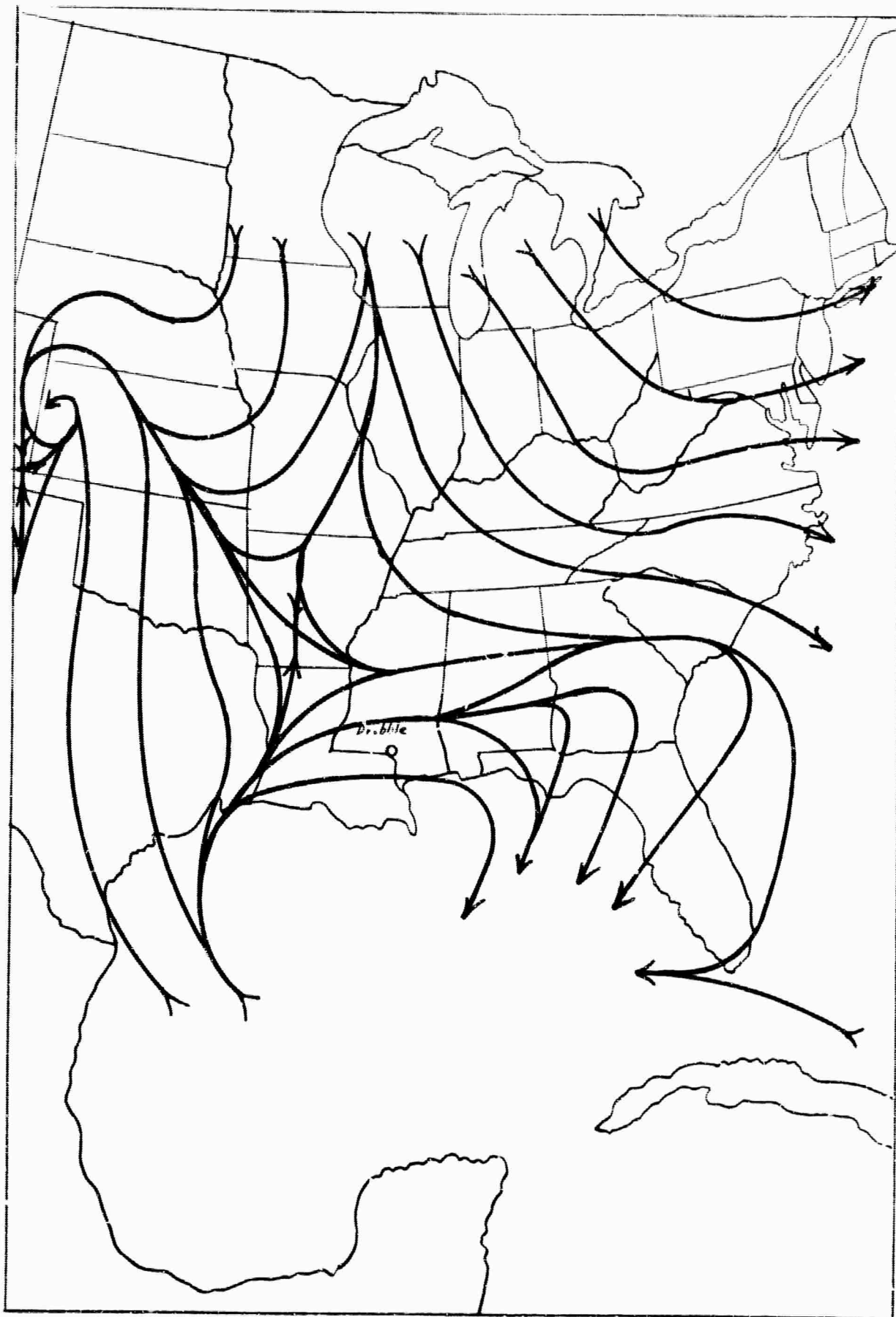


Figure 3.1.7 5,000-foot MSL Streamline Analysis - 1200 CST October 22, 1964

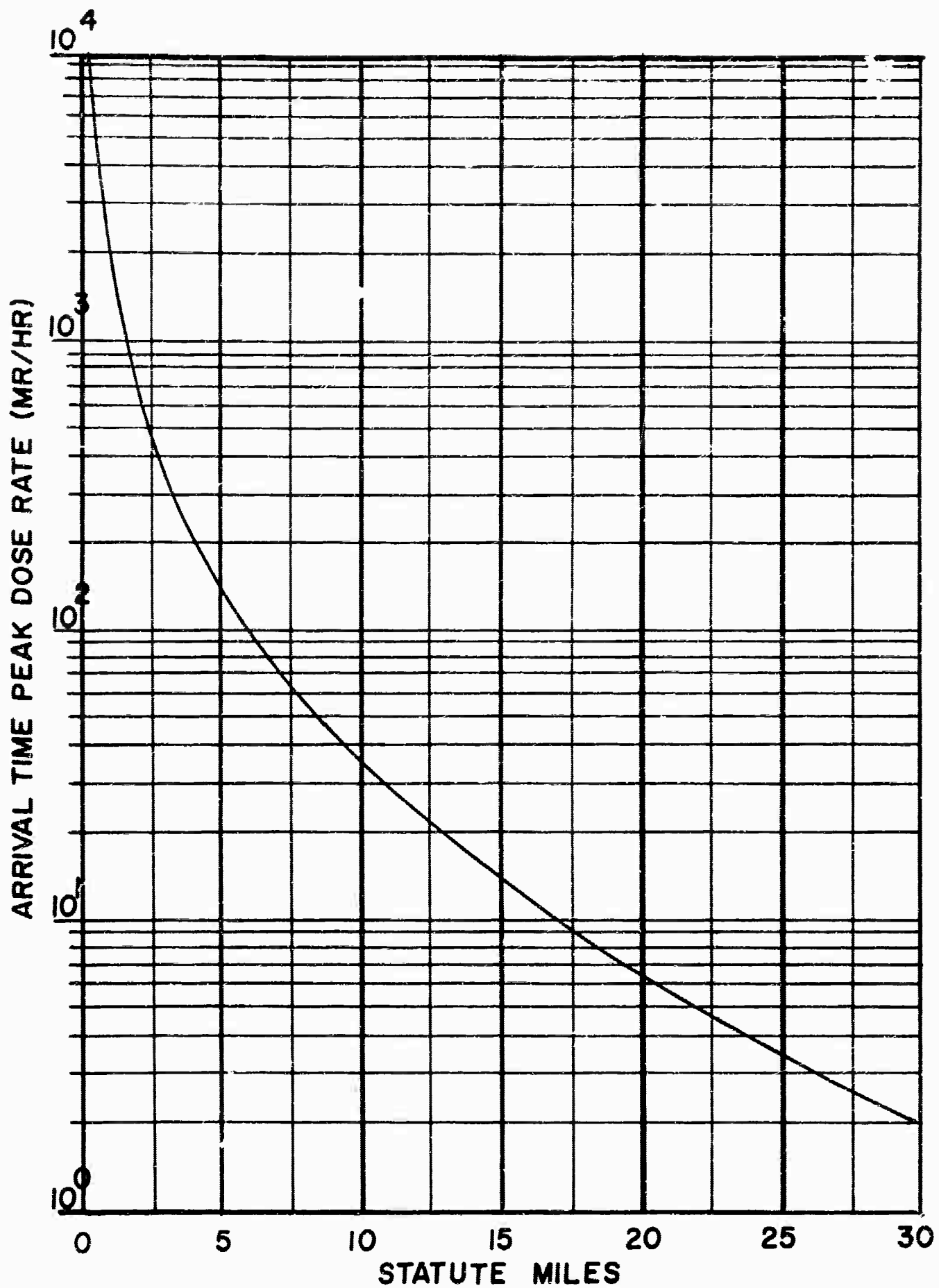


Figure 3.3.1 Estimated Arrival Time Peak Dose-Rate During Cloud Passage

TECHNICAL AND SAFETY PROGRAM REPORTS SCHEDULED FOR ISSUANCE
BY AGENCIES PARTICIPATING IN PROJECT DRIBBLE

SAFETY REPORTS

<u>Agency</u>	<u>Report No.</u>	<u>Subject or Title</u>
USWB	VUF-1020	Weather and Surface Radiation Prediction Activities
USPHS	VUF-1021	Final Report of Off-site Surveillance
USBM	VUF-1022	Pre and Post-Shot Safety Inspection of Oil and Gas Facilities Near Project Dribble
USGS	VUF-1023	Analysis of Geohydrology of Tatum Salt Dome
USGS	VUF-1024	Analysis of Aquifer Response
REECo	VUF-1025	On-Site Health and Safety Report
RFB, Inc.	VUF-1026	Analysis of Dribble Data on Ground Motion and Containment - Safety Program
H-NSC	VUF-1027	Ground Water Safety
FAA	VUF-1028	Federal Aviation Agency Airspace Advisory
H&N	VUF-1029	Summary of Pre and Post-Shot Structural Survey Reports
JAB	VUF-1030	Structural Response of Residential-Type Test Structures in Close Proximity to an Underground Nuclear Detonation
JAB	VUF-1031	Structural Response of Tall Industrial and Residential Structures to an Underground Nuclear Detonation.

NOTE: The Seismic Safety data will be included in the USC&GS Technical Report VUF-3014

TECHNICAL REPORTS

<u>Agency</u>	<u>Report No.</u>	<u>Subject or Title</u>
SL	VUF-3012	Free-Field Particle Motions from a Nuclear Explosion in Salt - Part I
SRI	VUF-3013	Free-Field Particle Motions from a Nuclear Explosion in Salt - Part II
USC&GS	VUF-3014	Earth Vibration from a Nuclear Explosion in a Salt Dome
UED	VUF-3015	Compressional Velocity and Distance Measurements in a Salt Dome

IRL	VUF-3016	Design and Operation of a Chemical Processing Plant for Controlled Release of a Radioactive Gas from the Cavity of a Nuclear Explosion in Salt
IRL	PNE-3002 *	Response of Test Structures to Ground Motion from an Underground Nuclear Explosion
SRI	VUF-3017	Feasibility of Cavity Pressure and Temperature Measurements for a Decoupled Nuclear Explosion
LPL	VUF-3018	Background Engineering Data and Summary of Instrumentation for a Nuclear Test in Salt
WES	VUF-3019	Laboratory Design and Analyses and Field Control of Grouting Mixtures Employed at a Nuclear Test in Salt
IRL	VUF-3020	Geology and Physical and Chemical Properties of the Site for a Nuclear Explosion in Salt
EG&G	VUF-3021	Timing and Firing

* This report number was assigned by SAN

In addition to the reports listed above as scheduled for issuance by the Project DRIBBLE test organization, a number of papers covering interpretation of the SALMON data are to be submitted to the American Geophysical Union for publication. As of February 1, 1965, the list of these papers consists of the following:

<u>Title</u>	<u>Author(s)</u>	<u>Agency(s)</u>
Shock Wave Calculations of Salmon	L. A. Rogers	IRL
Nuclear Decoupling, Full and Partial	D. W. Patterson	IRL
Calculation of P-Wave Amplitudes for Salmon	D. L. Springer and W. D. Hurdlow	IRL
Travel Times and Amplitudes of Salmon Explosion	J. N. Jordan W. V. Mickey W. Helterbran	USC&GS AFTAC UED
Detection, Analysis and Interpretation of Teleseismic Signals from the Salmon Event	A. Archambeau and E. A. Flinn	SDC
Epicenter Locations of Salmon Event	E. Herrin and J. Taggart	SMU USC&GS
The Post-Explosion Environment Resulting from the Salmon Event	D. E. Rawson and S. M. Hansen	IRL
Measurements of the Crustal Structure in Mississippi	D. H. Warren J. H. Healy W. H. Jackson	USGS

All but the last paper in the above list will be read at the annual meeting of the American Geophysical Union in April 1965.

LIST OF ABBREVIATIONS FOR TECHNICAL AGENCIES

BR LTD	Barringer Research Limited Rexdale, Ontario, Canada	RFB, INC.	R. F. Beers, Inc. Alexandria, Virginia
ERDL	Engineering Research Development Laboratory Fort Belvoir, Virginia	SDC	Seismic Data Center Alexandria, Virginia
FAA	Federal Aviation Agency Los Angeles, California	EG&G	Edgerton, Germeshausen & Grier, Inc. Las Vegas, Nevada
GIMRADA	U. S. Army Geodesy, Intelli- gence and Mapping Research and Development Agency Fort Belvoir, Virginia	SL	Sandia Laboratory Albuquerque, New Mexico
H-WSC	Hazleton-Nuclear Science Corporation Palo Alto, California	SMU	Southern Methodist University Dallas, Texas
H&N, INC	Holmes & Narver, Inc. Los Angeles, California Las Vegas, Nevada	SRI	Stanford Research Institute Menlo Park, California
II	Isotopes, Inc. Westwood, New Jersey	TI	Texas Instruments, Inc. Dallas, Texas
ITEK	Itek Corporation Palo Alto, California	UA	United Aircraft El Segundo, California
JAB	John A. Blume & Associates Research Division San Francisco, California	UED	United Electro Dynamics, Inc. Pasadena, California
IRL	Lawrence Radiation Laboratory Livermore, California	USEM	U. S. Bureau of Mines Washington, 25, D. C.
NRDL	U. S. Naval Radiological Defense Laboratory San Francisco, California	USC&GS	U. S. Coast and Geodetic Survey Las Vegas, Nevada
REECO	Reynolds Electrical & Engineering Co., Inc. Las Vegas, Nevada	USGS	U. S. Geologic Survey Denver, Colorado
		USPHS	U. S. Public Health Service Las Vegas, Nevada
		USWB	U. S. Weather Bureau Las Vegas, Nevada