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Lawrence Livermore Laboratory

BLAST FORECASTING GUIDE FOR THE SITE 300 METEOROLOGY CENTER

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ABSTRACT

These step-by-step procedures enable an occasional operator to run the Site 300 Meteorological Center. The primary function of the Center is to determine the maximum weight of high explosives that can be fired at Site 300 under any given meteorological conditions. A secondary function is to supply weather data for other programs such as ARAC (Atmospheric Release Advisory Capability). Included in the primary function are radar and theodolite operations for balloon tracking; calculation of temperatures for various altitudes using Oakland weather obtained from a teletype; computer terminal operation to obtain wind directions, wind velocities, temperatures, and pressure at various altitudes; and methods to determine high-explosive weight limits for simple inversions and focus conditions using pressure - versus - altitude information obtained from the computer. General information is included such as names, telephone numbers, and addresses of maintenance personnel, additional sources of weather information, chart suppliers, balloons, spare parts, etc.

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SECTION 1

INTRODUCTION

This document describes the operations performed at the Site 300 Meteorology Center. The Center determines the maximum weight of explosives that can be fired at Site 300 without causing excessive overpressure to occur in the surrounding communities. In addition, the Center supplies meteorological data for other programs such as Atmospheric Release Advisory Capability (ARAC).

Site 300 is a remote test Site used by the Lawrence Livermore Laboratory (LLL) since 1955 to detonate explosives. The Site occupies 10.8 square miles of hilly terrain about 50 miles east of San Francisco, Ca. The Site is located midway between the cities of Livermore and Tracy. Other than those two cities, the area immediately surrounding the Site is sparsely populated (see Fig. 1-1).

The Meteorology Center is situated on top of a 1230 ft hill in the north central section of Site 300. The Center contains two M-33 radar vans, an office trailer, storage facility, meteorology tower (temperature, wind velocity/direction instruments), instrument shelter, and a generator building. The Center commands a view of most of the Site 300 test areas. It is manned by one person who is responsible for the explosives limit forecast, recording weather data, and coordinating radar maintenance and facility/equipment repair. Operations at the Center are performed according to guidelines contained in the LLL Hazards Control Manual and this document.

Early in the testing program, it became apparent that loud sharp noises (overpressure), caused by reflected/refracted sound waves from explosives detonations, occasionally annoyed nearby citizens. A study was undertaken

by LLL to determine the magnitude and location of the overpressures (based on winds and temperature in/and around Site 300). Literature was researched, ^{1,2} calculations were made, explosives were detonated, and pressure measurements recorded. A computer program was developed to calculate the sound velocities above Site 300. These sound velocities were used with a series of nomographs to predict the magnitude, distance, and azimuth of an incident sound wave (overpressure). Using these new methods, excessive blast-generated overpressures have been eliminated, and the number of annoying sounds reported to LLL by local citizens has decreased to almost zero. Present operations at Site 300 do not violate any noise regulations pertaining to the State of California, San Joaquin or Alameda Counties, or the cities of Tracy and Livermore.

This document is divided into various sections. Sections 2 through 6 describe the standard procedures used in explosive weight limit forecasting. Section 7 describes the theodolite operation, which is used when the radar is inoperative. Section 8 describes support equipment with emphasis on the procedures for removal and installation of paper charts and paper rolls. Section 9 contains miscellaneous equipment information; i.e. how to use the electric timer connected to the Western Union Teletype; how to lower and raise the meteorology tower; and location of microbarograph stations in and near Tracy. Section 10 lists various sources of help such as telephone numbers of maintenance personnel; sources of supplies, etc.

Fig. 1-1. Map showing population within six miles of the center of Site 300.

REFERENCES

1. E. F. Cox, H. J. Plagge, and J. W. Reed, "Meteorology Directs Where Blast Will Strike," Am. Met. Soc., 35, No. 3, March 1954, pp 95-103.
2. R. Rothwell, "Sound Propagation in the Lower Atmosphere," J. Acoust. Soc. Am. 28, No. 4, July 1956, pp 656-665.

SECTION 2

METEOROLOGY CENTER PROCEDURES

The following outline describes the minimum steps necessary to open the Center, prepare radar system for operation, track a radar target, and shut down the Center before departure.

ARRIVAL

- Unlock Butler building, one radar van, and office trailer (See Figs 2-1 and 2-2).
- Turn on appropriate generator in generator building (Gen I for T-975 or Gen II for T-977, see Fig. 2-3).
- Turn on auxiliary heating/cooling unit (as required) located outside office trailer.
- Turn on lights and computer terminal inside office trailer and obtain a phone connection to computer (see Section 5 for appropriate computer operation).
- Remove TTAA and TTBB Oakland 72493 weather data (shown in Fig. 4-1) from Western Union Teletype and obtain ground temperature from chart in Instrument Shelter.
- Turn on radar (see Section 3).
- Prepare target, balloon, and balloon release mechanism for radar target tracking as described in Section 3.
- Plot temperatures (see Section 4).
- Follow procedures for radar target tracking described in Section 3.

DEPARTURE

- Turn off radar per Section 3 and lock radar trailer.
- Turn off generator in generator building.
- Lock Butler building.
- Make sure that Western Union Teletype is on and its' take-up reel is on, computer terminal is off, lights are off, office trailer is locked, and that outside auxiliary heater/cooler switches are off.

Fig. 2-1. Site 300 Meteorology Center, looking west.

Fig. 2-2. Site 300 Meteorology Center, looking east.

Fig. 2-3. Generators I and II located inside generator building.

SECTION 3

RADAR OPERATION

The Meteorology Center has two M-33 Radar Systems. Each radar system is contained in a single, mobile van. Power for each radar is supplied from individual generators located in the generator building. Either radar may be used to track the path of the balloon during ascent. Tracking data (slant range, azimuth, and elevation) are used in the computation of sound velocities above Site 300.

Remote balloon release procedures are followed when dense fog prevents optically locking the radar on target.

A theodolite (an instrument for measuring horizontal and vertical angles) is used as a back-up when both radar systems are inoperative. See Section 7 for theodolite operation.

Minor radar maintenance is performed by the radar operator. The names and telephone numbers of maintenance personnel have been included in Section 10 if radar maintenance is required.

RADAR START UP

- Turn on appropriate generator in generator building and allow radar to warm up for several minutes. (Green OFF light will illuminate immediately, and the orange READY light on Radar Control Panel, Fig. 3-1, will illuminate when radar is warm. (approximately 5 min).
- Open left door below Radar Control Panel and turn on Ventilation Blower Switch shown in Fig. 3-2.

NOTE

After generator is turned on, the following conditions should be observed inside radar van:

1. Green Power Indicator light on radar panel ON
2. LOW VOLTAGE and TRACK FILAMENTS switches ON
3. Low voltage and three phase lights ON
4. All fuse lights OFF

CAUTION

If wind is blowing more than 20 mph, add weights to back of radar antenna as shown in Fig. 3-3. If wind is very strong (40 mph), add twice as much weight. Do not turn radar antenna into a strong wind because wind can tilt antenna backwards allowing weights to fall off and damage optics.

- Turn on INDICATOR HV, TRACK SCANNER, EXCITATION, and HP SERVO switch, in that order (Orange READY light will come on indicating that radar is ready for operation.)
- Depress TRACK ON button (Red TRACK light comes on, orange READY and green POWER lights go out).
- Turn Tracking MIN-MAX knob to adjust current for 4.0 mA (40 on Track Meter Dial). Current may have to be readjusted after a few seconds.
- Adjust slant range to 80-90 yards on light wind days and 140 yards or more on high wind days. Use handwheel located on Radar Control Panel (see Fig. 3-4). Fig. 3-5 shows image that should be seen on A scope.
- Turn both Timer Control box switches ON (see Fig. 3-6).

TARGET AND BALLOON PREPARATION FOR RADAR TRACKING.

- Make radar target from aluminum foil (Fig. 3-7). Fasten target to tether line as shown, and crinkle foil so that it will provide good radio wave reflections.
- Locate balloon release mechanism, shown in Fig. 3-8, directly downwind and at maximum distance (determined by length of cable) from radar

antenna (so balloon will not go sideways when released).

CAUTION

Keep balloon release mechanism out of driveway.

- Connect 25 to 30 ft of tether line (previously attached to target) to balloon release mechanism and tie slip knot in end of tether line for balloon.
- Fill balloon with helium to approximately 30 in. diameter as shown in Fig. 3-9.
- Fold and tie balloon stem; fasten balloon to tether line connected to balloon release mechanism.
- Carefully allow balloon to rise to height of tether line.

RADAR TARGET TRACKING

- Adjust radar Azimuth and Elevation hand-wheel controls until tether line or balloon is viewed in eyepiece (see Fig. 3-10).
- Poise toe over floor Balloon Release and Timer switch (Fig. 3-6A) (Solenoid Release, Fig. 3-6B) while adjusting Elevation and Azimuth hand-wheel controls until balloon is viewed in eyepiece.
- Release balloon by depressing Floor Balloon Release and Timer switch or Solenoid Release (take foot off switch immediately so that switch won't be accidentally depressed again and shut off timer).
- Continually adjust Elevation and Azimuth hand-wheel controls to center aluminum target in eyepiece while observing "A" scope.
- When target is in center of eyepiece (or slightly above center) and blip on "A" scope is in gate (Fig. 3-5), turn AUTO TRACK to IN, see Fig. 3-10a (AUTO TRACK to ON, Fig. 3-10b).

- At the end of a 5-s audible warning, record slant range, azimuth, and elevation dial readings (in that order) on form (see Fig. 3-11). Dials may be spinning rapidly. Azimuth dial (Fig. 3-12a) is read as 594. Azimuth dial (Fig. 3-12b) is read as 542. Elevation dial (Fig. 3-12c) is read as 168. Slant range dial (Fig. 3-12d) is read as 90.

NOTE

30-s warning is a warble sound, whereas the minute warning is a steady tone. Record readings at the end of each warning sound/tone.

- Record slant range, azimuth, and elevation at the end of 1 min and after every minute until 16 min have elapsed. Enter time started on form.
- After 17-min (long) tone sounds, depress Floor Balloon Release and Timer switch (Fig. 3-6a) or Solenoid Release (Fig. 3-6b) so timer will be ready for the next timing cycle.
- Take radar out of automatic tracking by turning AUTO TRACK (Fig. 3-10a) to OUT or TRACK to OFF (Fig. 3-10b).

REMOTE BALLOON RELEASE PROCEDURES (Used under dense fog conditions)

Transmitter Pre-Operational Checks (see Fig. 3-13)

- Tighten antenna.
- Check that On-Off Switch is "OFF".
- Inspect case for damage.

Receiver Pre-operational Checks (see Fig. 3-13)

- Disconnect battery charger from receiver and connect receiver to battery box.
- Tighten antenna.
- Depress solenoid release; then depress solenoid test button to see if batteries are strong enough to operate solenoid release. Make sure all electrical cables are secure.

Transmitter Operation (see Fig. 3-13)

- Replace balloon release mechanism (shown in Fig. 3-8) with transmitter.
- Put transmitter ON-OFF switch to ON.
- Put transmitter on top of radar trailer (line of sight with receiver).
- Extend antenna to approximately 34 in.

Receiver Operation

- Put receiver in pre-selected position (see Fig. 3-14).
- Attach balloon tether line to solenoid.
- Recheck antenna (retighten if required).
- Extend antenna to max length.

Post-Release Procedure

- Disconnect cable from transmitter and reconnect cable to balloon release mechanism. Turn transmitter switch to "OFF."
- Return receiver and transmitter to trailer. Recharge batteries.

RADAR SHUTDOWN

- Lower antenna elevation (elevation dial to zero reading).
- Decrease current to minimum using Tracking MIN-MAX knob (Fig. 3-1).
- Depress TRACK OFF button.

NOTE

RED TRACK light goes out and orange READY
and green POWER lights come on.

- Turn off HP SERVOS, EXCITATION, TRACK SCANNER, and INDICATOR HV switches in that order.
- Turn Ventilation Blower switch OFF (leave cover door open in cold weather).
- Turn Balloon Release Power switch OFF.
- Remove weights (if used) from rear of antenna.
- Turn Generator off.

Fig. 3-1. Radar power control panel.

Fig 3-2, Location of blower ventilation switch.

Fig. 3-3. Adding weights to rear of radar antenna for strong wind conditions.

Fig. 3-4. Radar control panel (right side).

Fig. 3-5. Slant-range image on A scope.

Fig. 3-6a. Timer control box (T975).

Fig. 3-6b. Timer control box (T977).

Fig. 3-7. Aluminum target.

Fig. 3-8. Balloon release mechanism.

Fig. 3-9. Approximate size of filled balloon.

Fig. 1-10. Azimuth and Elevation Control Panel.

Fig. 3-10b. Radar control panel T977 (left side).

AM RADAR DATA

DATE _____

WIND _____

SKY COND. _____

TEMP. _____

TIME _____

ECP TIME		DATE	MODEM BOX
M	SR	AZ	ELEV.
5			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Fig. 3-11. Radar data record form.

(a)

Azimuth dial (read as 594)

(b)

Azimuth dial (read as 542)

(c)

Elevation dial (read as 168)

(d)

Slant-range dial (read as 90)

Fig. 3-12. Azimuth, elevation, and slant-range dials.

Fig. 3-13. Balloon remote release equipment.

Note: Locations A, B, and C, are marked by small wooden stakes.

Trailer 977				
Location	Slant Range yards	Azimuth mils	Elevation mils	String Length feet
A				
B				
C				

Trailer 975				
Location	Slant Range yards	Azimuth mils	Elevation mils	String Length feet
A	264	3994	64	70
B	93	5520	235	135
C	105	2050	65	52

Fig. 3-14. Balloon remote release locations and radar dial settings.

SECTION 4

TEMPERATURE PLOTTING

The following outline describes the steps necessary to obtain a temperature profile above Site 300 using data from the U.S. Weather Bureau, located in Oakland, CA. The estimated temperatures are used in the computation of sound velocities above Site 300.

- Obtain Oakland 72493 weather (TTAA and TTBB) from Western Union teletype (see Fig. 4-1).
- Enter OAK TTAA data on top portion of Blast Forecast Input form and enter OAK TTBB data on bottom portion of form as shown in Fig. 4-2.
- Add digits to TTAA data (meters) as shown (the teletype omits these digits) and then convert the meters to feet, using conversion tables on office desk.
- Plot OAK TTAA data (altitude vs pressure) on graph as shown in Fig 4-3. (For example, pressure of 1000 and 850 mbar occur at 427 and 4859 ft, respectively.) Note that the 700-mbar point occurs both on the left and right. This allows plotting of two lines on a small sheet, whereas it would take a much larger sheet to plot one continuous line.
- Connect points with straight lines. The line from 1000 to 700 mbar cannot bend up. Either the line is straight or it bends down at 850 mbar. (If line bends up, it has been plotted incorrectly.)
- Draw a line parallel to the bottom line where the 1500-ft level intersects the TTAA curve (1500 ft is the approximate altitude at the Site 300 Meteorological Center.)

- Plot OAK TTBB data (pressure vs temperature) on the same graph. If the third digit from the left is even, the temperature is positive; if the third digit is odd, the temperature is negative. (For example, the temperature is +10.4C° at 1000 mbar of pressure.)
- Connect all points with straight lines (use a different color to distinguish the TTBB line from the TTAA lines.)
- Either read Center temperature in degrees Celsius from meter located inside office trailer or read temperature in degrees Fahrenheit from gauge located inside the Instrument Shelter. Convert Fahrenheit temperature, obtained from the Instrument Shelter, to °C using Conversion Chart on desk or use $C = 5/9(F-32)$.
- Estimate temperatures at altitudes above Site 300 for morning (up to 12 noon) and afternoon (up to 4 pm) using the Site 300 temperature, Oak-land temperature, weather conditions, and adiabatic curve. If warming conditions prevail, the lower elevation temperature will increase so that the lower portion of the TTBB curve will tend to parallel the adiabatic curve.
- Modify the lower portion of the TTBB curve accordingly (see Fig. 4-3).
- Using TTAA curve (pressure vs altitude) and TTBB curve (pressure vs temperature), estimate the temperatures from 1500 to 14 000 ft above Site 300. This is accomplished as follows:
 - a. Locate desired elevation on bottom of Fig. 4-3 and draw a vertical imaginary line from this altitude up to the point where it crosses the TTAA curve. From this point, draw a horizontal imaginary line

over to the TTB curve. From this point, draw an imaginary vertical line straight down to the bottom.

- b. Read temperature to nearest 0.5°C.
- c. Enter this temperature on form (Fig. 4-2).
- d. Repeat steps a, b, and c above for all altitudes indicated on form.

USUS1 KELP 141200

OAK

72493 TTAA 64121 72493 99015 11834 00000 00130 10434 04501 85481
15480 21018 70102 06680 17520 50575 15180 18018 40748 25180
16514 30951 413// 19019

UJUS1 KELP 141200

OAK

72493 TTBB 6412/ 72493 00015 11834 11000 10434 22964 08000 33914
05600 44895 12080 55850 15480 66760 11480 77700 06680 88500 15180
99400 25180 11309 39980 22267 477// 33196 615// 44134 615// 55108
655// 66100 635//

PPBB 64120 72493 90012 00000 15003 16504 90346 20007 21514 20518
90789 19516 18017 17520 91123 17516 16513 15013 91468 15014 16511
18021 92035 17516 16515 16514 927// 19515 93059 19518 17526 16533
94139 17026 20025 22016 9502/ 23516 25012

Fig. 4-1 Oakland weather data obtained from Western Union teletype.

WIGWAG INPUT

DATE: 5-14-75

[illegible]

Fig. 4-2. Form used to record weather data obtained from teletype.

Fig. 4-3. Graph used in predicting temperatures above Site 300 Meteorology Center.

SECTION 5

COMPUTER OPERATION

The information obtained from tracking a radar target and the estimated temperatures above Site 300 are input parameters for computing the sound velocities above Site 300. At present, the CDC 6600 computer (G-Machine located in Livermore) is used to compute sound velocities. A computer terminal, located in the Office Trailer T-988, is connected to the G-Machine over leased telephone lines via an electronic coupler. A new micro-computer (LSI-11), and associated interface equipment, provides "on-site" computational support. If the G-Machine or the LSI-11 become inoperative, additional computation support is available. Input temperatures and tracking data can be called in to Livermore, B. Odell or H. Pfeifer, for processing on the CDC 7600 (R-Machine).

G MACHINE

- Turn front knob, Computer Terminal Power switch, counterclockwise to ON position, see Fig. 5-1.
- Turn phone-box PWR switch to ON position.
- Check that DUPLEX switch is in FULL position.
- Open phone box.
- Remove wall receiver attached to phone box and direct dial 021017 021018, 021019, or 021020. When phone makes an audible tone, place receiver in the cradle of the phone box and close phone box cover on receiver.

OR

dial 021022, 021023, 021024 or 021025 for modem operator. If this fails, dial special phone number 024219 and ask modem operator for box number and explain that you are doing the Blast Forecast for Vince Arganbright at Site 300. Either give your User number or Vince's User number 026700 (look at a previous computer printout for an example.) When phone makes an audible tone, place receiver in the cradle of the phone box and close phone-box cover on receiver.

- Type G on computer terminal (the computer will respond IDG); then type your user number, and A 316MHC so that it looks like

IDG 026700 A 316MHC

NOTE: If direct dial, use combination user number after MHC. This number is available in the Office Trailer.

- Depress RETURN, computer types 0000.05000 0019
- Type GRAB 2 / 1 .1 (RETURN)
- Computer types BANK = 0001.999 Donate 0001.950

ALL DONE

- Type WTLMT / 1 .1 (RETURN)
- Type T 977 (or T 975) time date
- Type in the radar or pibal data.

If you are unfamiliar with the G-machine, follow computer instructions (see Fig. 5-2 for an example of computer information).

- Type number 0 (RETURN)
- Type in the temperature calculations (RETURN)
- After computer types ALL DONE, you type TRIX AC / 1 .5 (RETURN)

- Computer types a period (.) you type a letter O (RETURN)
- Computer types NAME: You type WTOUT (RETURN)
- Computer types a period (.) you type NN (RETURN)
- Computer types a period (.) you type a letter T (RETURN)
- Computer will print out all necessary information to establish H.E. weight limit.
- After computer types a period (.) again, you type END (RETURN)
- After computer types ALL DONE, you type SAMTOP FINISHED BOX N / 1 .1 (RETURN)

Note: N is your box number.

- You type BYE (RETURN)
- Computer types BYE
- Turn front terminal switch clockwise to center; remove receiver from phone cradle and hang it up; close phone box, and turn off power switch.

LSI-11 MACHINE

- Turn switch on front of teletype counter clockwise.
- Turn both power switches located on upper left corner of computer rack to ON. (Left switch powers rack terminal strip, right switch powers the Disk Unit.)
- With above switches on, computer terminal will print prompt indicator \$(Dollar Sign) you type DX and hit the carriage return button (RETURN).
- Computer prints RT-11SJ V02C-02C
- Computer prints. (period prompt character). You type the following (DATE (space) 24-APR-78) (RETURN)

NOTE

To correct a character, type RUB OUT for each character to be erased. To erase entire line, use control U. This must be done before you use RETURN.

- Computer prints another (.) You type: TIME (space) 08:25:00 (RETURN)
- Computer prints another (.) You type: R (space) MUBAS3 (RETURN)
- Computer prints. MU BASIC/RT-11 V01-01C

CONFIGURATION FILE; OLD (O) NEW (N) OR NONE (RETURN)?

You type: O (letter O) (RETURN)

- Computer prints: FILE NAME -- You type in (USER) (RETURN)
- Computer prints: MU BASIC/RT-11 IS ON THE AIR!

PLEASE SAY HELLO

Your type: HELLO (RETURN)

- Computer prints: USERID: You type number: 00 (zeroes) (RETURN)
- Computer prints: PASSWORD: You type in the password (RETURN)
- Computer prints: WELCOME TO MU BASIC/RT-11.

READY

NOTE

Two modes are available, manual (GPROG2) and automatic (BLASF6). The manual mode is shown in Fig. 5-3 and is listed directly below. The automatic mode is shown in Fig. 5-4.

You type: OLD DX1: GPROG2-B00 (zeroes) (RETURN)

- Computer prints: READY

You type: RUN (RETURN)

- Computer prints: GPROG2 24-APR-78 MU BASIC/RT-11 V01-01C.

- Computer prints: TYPE: TIME DATE
you type: ? 0834 4-24-1978 (RETURN)
- Computer Prints: TIME, SR,AZ,EL
- You type in Radar data (? .5, 185, 5185, 830) per example in Fig. 5-3.
When data is complete, type 0,0,0,0 (RETURN)
- Computer prints: TYPE TEMPERATURES
You type in the first seven temperatures (RETURN) and then seven more
(RETURN)
- Computer prints: MAXIMUM ALTITUDE = 14040 AT 14 MINUTES
- Computer prints out sound velocities
- STOP AT LINE 9000
- READY
- To shut down equipment, turn off two power switches on rack and power
switch on TTY.

R MACHINE (Location: Bldg. 253, Rm 1916)

Type: R

Machine Responds: IDR

Type: 87 s A s 316MHC (RETURN)

Machine Responds: NIL

R 0005.563 Active None

Type: WIGWAG (RETURN)

Machine Responds: Do you need help?

Type: NO (RETURN)

Machine Responds: . (period)

Type: 1012 s 5-17-77 s 988 (RETURN)

↑ ↑ ↑
Time Date Trailer #

Machine Responds: . (period)

Type: .5, 314, 2743, 698, (RETURN)

etc.

Note: After last entry, i.e. 14, 2300, 2900, 432, (RETURN)

Type: 0 (zero) (RETURN)

Machine Responds: Do you need help with temps? etc.

Type: NO (RETURN)

Machine Responds: . (period)

Type 16.5, 14, 12, - - -3, (RETURN)

Machine Responds: Max Alt _____, Answer Printed?

Type: Yes (RETURN)

Machine Responds: ALL DONE

Type: ALLOUT RJET 17 WTOUT BOX (RETURN)

Machine Responds: ALL DONE

Bye out of R: Hit Control D.

NOTE

Pick up printout at printers

a. RJET 17 - B-253, Rm 1916

b. RJET 46 - B-255, Rm 115

Fig. 5-1. G-machine computer terminal inside office trailer T988.

IDG 026700 A 316MNC
0000.05000 0019
GRAB 2 / 1 .1
BANK= 0001.999 DONATE 0001.950

ALL DONE

WTMT / 1 1

DO YOU NEED HELP? WAIT FOR A '.' THEN TYPE YES OR NO
AND DEPRESS LINEFEED

YES

DEPRESS RETURN AFTER EACH LINE IS TYPED IN

A '.' INDICATES THAT YOU ARE TO TYPE THE NEXT LINE

IF THIS RUN IS A PIBAL; TYPE PIE, HOUR, MONTH, DAY, YEAR

EXAMPLE: PIE 1030 06 13 1974 (DEPRESS RETURN)

IF THIS RUN IS A RADAR RUN THEN

TYPE ECP, HOUR, MONTH, DAY, YEAR

EXAMPLE: ECP 1030 06 13 1974 (DEPRESS RETURN)

TO BACKSPACE DEPRESS CTRL AND TYPE X

TO DELETE THE TOTAL LINE DEPRESS CTRL AND TYPE Y

T88 0818 5-14-1975

TYPE TIME, SLANTRANGE, AZMITH, ELEVATION

TYPE A COMMA (,) AFTER EACH NUMBER

EXAMPLE: .5, 280, 1966, 313, (RETURN THEN)

1, 850, 2105, 427,

USE DECIMAL POINTS IF NEEDED

TYPE A 0 ON THE NEXT LINE AFTER RADAR DATA IS IN

TO ABORT RUN TYPE 999999 (SIX 9'S) THEN RETURN)

.5, 161, 482, 935,

1, 294, 1.95, 1155,

2, 518, 782, 1347,

3, 796, 426, 1264,

Fig. 5-2. Example of computer instructions for G-machine.

.
 4, 1120, 544, 1130,
 .
 5, 1515, 569, 981,
 .
 6, 1863, 543, 935,
 .
 7, 2267, 445, 883,
 .
 8, 2746, 315, 805,
 .
 9, 3276, 270, 747,
 .
 10, 3946, 235, 679,
 .
 11, 4700, 190, 627,
 .
 12, 5402, 165, 589,
 .
 13, 6125, 147, 557,
 .
 14, 6815, 145, 535,
 .
 15, 7473, 145, 520,
 .

0

USE TEMPERATURES FOR 1500, 2000, 3000, AND EACH
 THOUSAND FEET UP TO 14,000

TYPE TEMPS WITH DECIMAL PT. AND MINUS(-) IF NEEDED

EXAMPLE: 28.5, 28.9, 5, -10, -10.5,

14.5, 13.5, 10.5, 13.5, 15.5, 14, 13, 11, 9, 7, 4.5, 1.5, -1, -3,

MAXIMUM ALTITUDE= 12184 AT 15.0 MINUTES
 DO YOU WANT THE ANSWER PRINTED? TYPE YES OR NO

YES

AFTER THE COMPUTER PRINTS: ALL DONE

TYPE: TRIX AC / 1 .5 (RETURN)

WHEN COMPUTER PRINTS: . TYPE LETTER: O (RETURN)

WHEN COMPUTER PRINTS: NAME: TYPE: WTOUT (RETURN)

THE COMPUTER WILL THEN PRINT THE NUMBER OF LINES

WHEN COMPUTER PRINTS: . TYPE: NN

WHEN COMPUTER PRINTS: . TYPE: T

Fig. 5-2. (continued)

0918 5-14-1975

T88

TIME	ALT	VERT	AZMTH	DO
0.	1230	0	0	0.
0.5	1613	52	83	2.895
1.0	2029	64	78	3.683
2.0	2736	75	43	3.770
3.0	3489	71	23	7.633
4.0	4238	63	30	14.762
5.0	4961	55	32	25.609
6.0	5669	52	30	33.503
7.0	6414	49	25	43.436
8.0	7083	45	17	57.200
9.0	7808	42	15	72.052
10.0	8549	38	13	91.811
11.0	9371	35	10	113.601
12.0	10087	33	9	133.922
13.0	10784	31	8	154.884
14.0	11481	30	8	174.558
15.0	12184	29	8	193.025

ALT	WD	WV	TEMP
1500	263.4	5.8	14.5
2000	224.5	1.8	13.5
3000	200.9	3.3	10.5
4000	217.1	7.5	13.5
5000	208.9	8.8	15.5
6000	193.5	10.2	14.0
7000	176.9	15.1	13.0
8000	186.0	18.2	11.0
9000	180.7	22.1	9.0
10000	181.6	20.8	7.0
11000	186.7	19.9	4.5
12000	188.4	18.2	1.5

THE FOLLOWING DIRECTIONS HAVE A RETURN:

10
50
70
270
330

Fig. 5-2. (continued)

	✓ 10	30	✓ 50	✓ 70	90	110	130	150	170
1500	1119	1122	1124	1126	1126	1125	1121	1120	1117
2000	1117	1117	1117	1119	1116	1115	1132	1113	1112
3000	1114	1114	1113	1129	1110	1108	1154	1105	1103
4000	1125 ^Δ	1127 ^Δ	1126 ^Δ	1125	1122	1118	1140	1109	1105
5000	1132 ^Δ	1133 ^Δ	1132 ^Δ	1125	1125	1120	1121	1110	1106
6000	1132	1132	1129	1125	1119	1113	1107	1103	1099
7000	1138 ^Δ	1135 ^Δ	1129	1121	1112	1103	1096	1090	1088
8000	1140 ^Δ	1137 ^Δ	1131	1123	1113	1102	1092	1085	1080
9000	1142 ^Δ	1138 ^Δ	1130	1119	1106	1094	1082	1073	1069
10000	1136	1132	1125	1115	1103	1091	1080	1072	1067
11000	1130	1127	1121	1112	1101	1089	1078	1070	1064
12000	1121	1119	1114	1105	1095	1085	1075	1067	1061
	190	210	230	250	✓ 270	290	310	✓ 330	350
1500	1113	1110	1108	1107	1106	1107	1109	1112	1115
2000	1112	1111	1111	1111	1112 ^Δ	1113	1114	1115 ^Δ	1116
3000	1103	1103	1103	1105	1107	1108	1110	1112	1113
4000	1103	1101	1102	1103	1106	1110	1115	1119 ^Δ	1123
5000	1104	1103	1104	1107	1111	1116	1121	1126 ^Δ	1130
6000	1098	1099	1101	1106	1111	1117	1123	1128 ^Δ	1131
7000	1088	1092	1098	1106	1115 ^Δ	1123	1131	1136 ^Δ	1138
8000	1079	1081	1087	1096	1106	1117	1127	1134	1139
9000	1068	1073	1081	1093	1105	1116	1129	1138 ^Δ	1142
10000	1067	1071	1078	1089	1101	1113	1123	1131	1136
11000	1063	1066	1072	1082	1093	1105	1115	1124	1129
12000	1060	1062	1068	1076	1086	1097	1107	1115	1120

Fig. 5-2. (continued)

0618	5-14-1975	T88
1500	263.4	5.8
2000	224.5	1.8
3000	200.9	3.3
4000	217.1	7.5
5000	208.9	8.8
6000	193.5	10.2
7000	176.9	15.1
8000	186.0	18.2
9000	180.7	22.1
10000	181.6	20.8
11000	186.7	19.9
12000	188.4	18.2

Fig. 5-2. (continued)

```

SDX
RT-11SJ      V02C-02C

.DATE 24-APR-78

.TIME 08:35:22

.R MUBAS3

MU BASIC/RT-11 V01-01C

CONFIGURATION FILE: OLD (O), NEW (N) OR NONE (<CR>)? O
FILE NAME--USER

MU BASIC/RT-11 IS ON THE AIR!

PLEASE SAY HELLO

HELLO

USERID: 00
PASSWORD:

WELCOME TO MU BASIC/RT-11

READY
OLD DX1:GPROG2.B00

READY
RUN

GPROG2  24-APR-78  MU BASIC/RT-11 V01-01C

TYPE:  TIME      DATE

? 0835      4-24-1978


TIME,SR,AZ,EL
? .5,185,5185,830

? 1,367,5170,815

? 2,872,5494,787

? 3,1520,5754,634

? 4,2206,6002,571

? 5,2998,6210,508

```

Fig. 5-3. Example of computer instructions for LSI-11 machine (manual mode).

? 6.3920,6325,457

? 7.4760,6367,436

? 8.5513,6378,431

? 9.6378,30,428

? 10.7394,66,423

? 11.8410,103,418

? 12.9457,143,408

? 13.10700,180,394

? 14.11716,202,380

? 0.0,0.0

TYPE TEMPERATURES

? 16.5,15,12,9,8,7.5,6.5

? 5.3,5,2,-1,-4,-5.5,-6.5

MAXIMUM ALTITUDE = 14040.4 AT 14 MINUTES

0835 4-24-1978

TIME	ALT	VERT	AZMTH	DO
0.0	1230	0	0	0.000
0.5	1634	47	292	3.757
1.0	2020	46	291	7.569
2.0	3056	44	309	18.485
3.0	3889	36	324	36.560
4.0	4749	32	338	55.312
5.0	5532	29	349	77.943
6.0	6331	26	356	104.563
7.0	7157	25	358	128.203
8.0	8021	24	359	148.815
9.0	9035	24	2	172.392
10.0	10179	24	4	200.289
11.0	11296	24	6	228.301
12.0	12293	23	8	257.807
13.0	13339	22	10	293.363
14.0	14040	21	11	322.986

Fig. 5-3. (continued)

ALT	WD	WV	TEMP
1500	111.7	7.5	16.5
2000	116.7	8.2	15.0
3000	146.4	13.3	12.0
4000	191.5	20.6	9.0
5000	193.7	25.1	8.0
6000	193.5	27.9	7.5
7000	186.9	22.8	6.5
8000	190.1	22.3	5.0
9000	197.9	26.4	3.5
10000	197.5	28.8	2.0
11000	201.4	29.5	-1.0
12000	204.8	31.9	-4.0
13000	204.6	35.3	-5.5
14000	202.8	28.3	-6.5

THE FOLLOWING DIRECTIONS HAVE A RETURN:

10
50
70
90
330

	10	30	50	70	90	110	130	150	170
1500	1123	1119	1114	1111	1109	1108	1108	1110	1114
2000	1122	1117	1112	1108	1105	1104	1104	1106	1109
3000	1128	1122	1114	1107	1099	1094	1096	1089	1091
4000	1141	1139	1133	1124	1113	1101	1090	1080	1073
5000	1146	1145	1138	1128	1115	1100	1086	1074	1065
6000	1150	1148	1141	1130	1115	1099	1083	1069	1050
7000	1139	1136	1129	1119	1106	1093	1080	1070	1064
8000	1136	1133	1127	1117	1105	1092	1080	1069	1063
9000	1139	1139	1133	1123	1110	1094	1079	1066	1056
10000	1140	1139	1133	1122	1108	1091	1074	1060	1049
11000	1135	1135	1130	1120	1105	1088	1071	1056	1044
12000	1132	1134	1129	1119	1104	1086	1067	1050	1036
13000	1135	1136	1131	1120	1103	1083	1063	1044	1029
14000	1122	1122	1118	1108	1094	1078	1062	1047	1035

Fig. 5-3. (continued)

	190	210	230	250	270	290	310	330	350
1500	1118	1122	1126	1130	1132	1133	1132	1130	1127
2000	1114	1118	1123	1127	1130	1131	1131	1129	1126
3000	1096	1102	1109	1117	1124	1130	1133	1134	1132
4000	1071	1073	1079	1088	1099	1111	1123	1132	1138
5000	1062	1063	1070	1081	1095	1109	1123	1135	1143
6000	1056	1058	1065	1078	1093	1109	1125	1137	1146
7000	1062	1066	1073	1084	1097	1110	1122	1132	1138
8000	1060	1063	1069	1080	1092	1105	1117	1127	1133
9000	1051	1051	1057	1068	1082	1097	1112	1125	1135
10000	1044	1045	1051	1063	1078	1095	1111	1125	1135
11000	1037	1037	1043	1054	1069	1086	1103	1118	1129
12000	1028	1026	1032	1043	1059	1077	1095	1112	1125
13000	1020	1018	1024	1036	1054	1074	1094	1113	1126
14000	1020	1020	1033	1043	1057	1074	1090	1105	1115

STOP AT LINE 9000

READY

Fig. 5-3. (continued)

SDX (user types this line)
RT-11SJ V02C-02C

.DATE 5-JUN-76 (user types
these 3
lines)
.R MUBAS3

MU BASIC/RT-11 V01-01C

CONFIGURATION FILE: OLD (O), NEW (N) OR NONE (<CR>)? O (user types O)
FILE NAME--IUSER

MU BASIC/RT-11 IS ON THE AIR!

PLEASE SAY HELLO

HELLO (user types this line)

USERID: 00
PASSWORD: (user types in password)

WELCOME TO MU BASIC/RT-11

READY
RUN DX1:BLASF6-000 (user types this line)

RADAR#1 IS ON-LINE!

WAITING FOR BALLOON RELEASE!

BALLOON RELEASE OPEN AT 8:24:16:16

STORING DATA ON DISK!

*** MAN-TRK AT + .09 MIN; ADDR= 0
*** AUTO-TRK AT + .31 MIN; ADDR= 104
*** BALLOON RELS CLOSED AT + 16.02 MIN; ADDR= 7384

SLANT RANGE CONVERSION

POSSIBLE SLANT RANGE ERROR: 16.0169 7384

READ/CONV T,S,A,E DATA

Fig. 5-4. Example of computer instructions for LSI-11 machine (automatic mode).

TYPE: TIME DATE

? 0824 6-5-1978

(user types this line)

**TIME, SR, AZ, EL
-5, 217, 2424, 842**

1, 438, 2635, 735

2, 982, 2824, 624

3, 1564, 2914, 568

4, 2281, 2978, 498

5, 3061, 3031, 446

6, 3795, 3059, 419

7, 4541, 3072, 400

8, 5316, 3085, 387

9, 6156, 3092, 376

10, 6951, 3092, 367

11, 7709, 3089, 363

12, 8393, 3082, 361

13, 9061, 3079, 361

14, 9764, 3071, 359

15, 10424, 3063, 360

16, 11168, 3055, 359

TYPE TEMPERATURES

? 30, 28.5, 26, 23.5, 21.5, 18.5, 15.5

(user types these

? 12.5, 9.5, 6.5, 4.5, 2.5, .5, -1

two lines)

Fig. 5-4. (continued)

MAXIMUM ALTITUDE = 12795.4 AT 16 MINUTES

0824 6-5-1978

TIME	ALT	VERT	AZMTH	DO
0.0	1230	0	0	0.000
0.5	1709	47	136	4.351
1.0	2098	41	148	9.735
2.0	2924	35	159	23.785
3.0	3713	32	164	39.287
4.0	4444	28	168	59.616
5.0	5124	25	170	82.070
6.0	5782	24	172	102.976
7.0	6443	23	173	124.200
8.0	7145	22	174	146.154
9.0	7893	21	174	169.968
10.0	8582	21	174	192.567
11.0	9299	20	174	213.880
12.0	9968	20	173	233.027
13.0	10664	20	173	251.573
14.0	11342	20	173	271.288
15.0	12054	20	172	289.521
16.0	12795	20	172	310.298

ALT	WD	WV	TEMP
1500	316.4	8.7	30.0
2000	338.6	11.4	28.5
3000	349.1	15.1	26.0
4000	353.9	19.6	23.5
5000	356.3	22.1	21.5
6000	356.5	21.2	18.5
7000	357.2	22.5	15.5
8000	354.7	23.0	12.5
9000	351.8	21.1	9.5
10000	350.1	18.8	6.5
11000	346.9	19.8	4.5
12000	345.6	19.3	2.5

THE FOLLOWING DIRECTIONS HAVE A RETURN:

Fig. 5-4. (continued)

..... NONE
 HAVE A BLAST! NO RETURNS FOUND THIS TIME!

	10	30	50	70	90	110	130	150	170
1500	1138	1142	1147	1152	1156	1159	1161	1160	1158
2000	1127	1131	1137	1144	1151	1156	1160*	1162	1162
3000	1115	1119	1126	1135	1144	1152	1159	1163	1164
4000	1102	1107	1116	1126	1138	1149	1158	1164	1167
5000	1093	1098	1107	1119	1132	1144	1155	1163	1167
6000	1089	1095	1103	1115	1127	1139	1149	1156	1160
7000	1081	1087	1096	1108	1121	1134	1145	1152	1156
8000	1075	1081	1091	1103	1117	1130	1141	1148	1151
9000	1073	1079	1088	1100	1112	1124	1134	1140	1142
10000	1071	1077	1085	1096	1107	1117	1125	1131	1133
11000	1066	1073	1082	1093	1105	1116	1124	1129	1130
12000	1063	1070	1079	1090	1102	1112	1120	1124	1125

Fig. 5-4. (continued)

	190	210	230	250	270	290	310	330	350
1500	1155	1150	1145	1140	1136	1133	1132	1132	1134
2000	1160	1156	1150	1143	1136	1131	1126	1124	1124
3000	1162	1158	1151	1143	1134	1126	1119	1115	1113
4000	1166	1161	1153	1142	1131	1120	1110	1104	1101
5000	1167	1162	1154	1142	1130	1117	1106	1097	1093
6000	1159	1154	1146	1135	1123	1110	1100	1092	1089
7000	1156	1151	1142	1130	1117	1104	1093	1085	1081
8000	1150	1145	1135	1123	1110	1097	1085	1077	1074
9000	1141	1135	1126	1115	1102	1090	1080	1074	1071
10000	1131	1125	1117	1107	1096	1085	1077	1071	1069
11000	1128	1122	1112	1101	1090	1079	1070	1065	1064
12000	1123	1116	1107	1097	1085	1075	1067	1062	1061

STOP AT LINE 9000

READY

Fig. 5-4. (continued)

SECTION 6

FORECASTING EXPLOSIVE WEIGHT LIMITS

GENERAL

Two explosive weight-limit forecasts are normally prepared each day. However, several forecasts might be required if weather conditions are unstable or if the explosives weigh more than the forecast weight limit.

NOTE

A weekly firing schedule is published by the B-Division Shot Coordinator, in Building 871 (Ext. 238). This schedule provides shot numbers, Bunker numbers, explosives weights, and name of Project Engineer.

The explosives weight limit forecast is based on sound velocity profiles which are calculated using measured wind conditions in the immediate vicinity of Site 300. Examples of sound velocity profiles, with resulting overpressure (sound) wave propagation, are pictured in Fig. 6-1. The term "return" denotes that a sound wave has caused the pressure at a certain point to exceed pre-established pressure limits. An overpressure will occur if sound velocity increases with altitude, and exceeds the surface sound velocity.

In general, the principle involved in forecasting an explosives weight limit is based on not exceeding overpressure limits previously established for the surrounding communities. When an overpressure is created, it propagates through the existing air mass, and is sometimes reflected/refracted back to the surface. Changing sound velocities produce an 'umbrella' effect;

i.e. an increase in sound velocity with altitude results in a refraction of the sound energy. The magnitude of the velocity increase is inversely proportional to the weight of an explosive which can be fired, i.e. the greater the increase in sound velocity with elevation, the smaller the weight limit.

In a ground inversion condition, the sound spreads uniformly along the ground away from the source. The further from the source, the lower the sound pressure. In a focus condition, the sound is confined to a small area and is bounced back and forth between the inversion layer and the ground creating zones of silence as well as zones of concentrated pressure. Experience with explosive detonation at Site 300 shows that if the maximum pressure for these conditions is kept below certain limits, no property damage will result and citizen complaints will be minimal. These limits are:

- 400 ubars anywhere in the direction of concern for most focus conditions.
- 600 ubars in the 10, 50, 70, 90, or 130° directions for a 500 ft focus condition.
- 800 ubars in the 270 or 330° direction for a 500 ft focus condition.
- 800 ubars three miles from the source for a ground inversion.

SOUND VELOCITY PROFILES

Explosives weight forecasting analysis is based on the existence of three velocity profiles: (1) lapse, (2) inversion, and (3) focus. These are illustrated in Fig. 6-1. At least one technique, and most likely all three is required to evaluate the sound profiles obtained from tracking a reflector attached to an ascending balloon.

Condition I - Lapse

- No return on any of the pre-selected azimuths (10°, 50°, 70° 90°, 130°, 270°, 330°).
- Sound waves do not return to the earth.
- Explosive weight limit forecast is 1000 lb.

Condition II - Inversion

- Returns are noted on one or more of the preselected azimuths.
- Sound velocity at 500 ft, or 500 ft and 1000 ft, is greater than the ground level sound velocity. Sound velocities decrease above 500 ft and/or 1000 ft. Sound waves will strike the ground at all points in the azimuth.
- Explosive weight forecast is usually between 100 lb and 1000 lb.

Condition III - Focus

- Returns are noted on one or more of the preselected azimuths.
- Sound velocities decrease with altitude, increase, and then decrease. Reflected pressure waves are focused beyond a zone of silence. This type of condition can occur as low as 500 ft; however, the technique of forecast is different than Condition II.
- Explosive weight forecast is usually between 10 lb and 100 lb.

EXPLOSIVES WEIGHT FORECASTS USING SOUND VELOCITY PROFILES

Condition I (see Fig. 6-2).

Sound velocities decrease with altitude on all headings. Additional sound waves created by an explosion are propagated in all directions and are attenuated. Sound waves do not return to the earth. Note: If the highest sound velocity at altitude does not exceed the surface

velocity sound speed, no reflected waves will occur. This condition produces the most favorable firing conditions. Arbitrary weight limit is 1000 lb; may be higher if required.

Condition II (see Fig. 6-3).

Sound velocities increase to an altitude of 500 feet, and/or 1000 feet above the surface, then decrease. The computer printout gives sound speeds at the surface, 500 ft, 1500 ft, etc above the surface. (These are shown as 1500, 2000, 3000, etc above sea level on printout, (see Fig. 5-2). Example 1 is referred to as a simple ground inversion less than 500 ft deep. Example 2 is simple ground inversion greater than 500 ft deep.

Example 1 (simple ground inversion less than 500 ft deep)

Sample Printout

270° Direction	
<u>Altitude (ft)</u>	<u>Sound Speed (ft/sec)</u>
1500	1106
2000	1112
3000	1107

Analysis

- Inversion is 500 ft deep; i.e. velocity increases, then decreases.
- Determine number of fps/500 ft; this is $1112 - 1106 = 6$ fps.

- Use the 800 ubar, solid-line curve on Fig. 6-4 to determine H.E. weight limit.
- Go vertically from 6 (on bottom of Fig. 6-4) until intersecting 800 ubar, solid line curve. Read horizontally for H.E. weight limit. Answer: 135 lb.
- Since the Return was into 270°, you could multiply the result by 10; i.e. weight 1350 lb. [Note: 500 ft deep only]

Example 2 (simple ground inversion greater than 500 ft deep)

Sample Printout

130° Direction	
<u>Altitude (ft)</u>	<u>Sound Speed (ft/sec)</u>
1500	1121
2000	1132
3000	1154
4000	1140

Analysis:

- Determine number of fps/500 ft. $1132-1121 = 11 \text{ fps}/500 \text{ ft}$
 $1154-1132 = 22 \text{ fps}/1000 \text{ ft}$
or 11 fps/500 ft
- Inversion is deeper than 500 ft; i.e. velocity increases to 3000 ft (above mean sea level or 1500 ft above ground) then decreases.
- Use the 800 ubar broken line curve on Fig. 6-4 to determine H.E. weight limit.
- Since the average ft per sec is 11, go vertically from 11 until intersecting 800 ubar, broken line curve. Read horizontally for H.E. weight. Answer: 70 lb.

NOTE

If the surface, 500 ft, and 1500 sound velocities are within 3 fps, the three values may be averaged.

Condition III (see Figs. 6-5 and 6-6)

Sound velocities decrease with altitude, increase and then decrease. This condition may also be associated with Condition II. Condition III is observed most frequently, and requires the greatest degree of study to provide a weight forecast.

Example 3

Sample Printout

<u>Altitude (ft)</u>	10° Direction
	<u>Sound Speed (ft/sec)</u>
1500	1119
2000	1117
3000	1114
4000	1125
5000	1132
6000	1132
7000	1138
8000	1140
9000	1142
10000	1136
11000	1130

Analysis

- Determine number of fps/1000 ft by plotting data shown in Fig. 6-7. By inspection it is noted the greatest value is 11 fps/1000 starting at altitude 1500 ft above ground.
- Read slope from table on Fig. 6-8 (1125-1114 = 11; 11 fps/1000 = 14°).
- Find 14° slope on bottom of Fig. 6-9; go vertically until reaching the 1500 ft (altitude above ground). Three values are obtained : (1) Pressure - 250 ubar, (2) Focus Distance - 9 miles, Overhang - 5 ft.
- If the sound velocity decreases at 500 ft, then increases in the next 1000 ft, then decreases, this is known as a 500 ft focus. If this Return is in the 10, 50, 70, 90, or 130 degree direction, use the 600-ubar line on Fig. 6-4; otherwise use the 800 ubar line for the 270 or 330° direction. If the sound velocity increased 5 fps in 500 ft (beginning at 500 ft above the ground) with a return in the 70° direction, the answer is 82 lb.

NOTE

Overhang is a portion of the sound velocity profile (in feet) which exceeds the sound velocity at the surface.

- Read weight limit from Fig. 6-8 using 250-ubar pressure. Find 250-ubar on side of chart; go horizontally until intersecting the 400-ubar line, then read straight down. Answer: 32 lb.
- Check the various slopes to determine maximum weight limit. As a general rule, the larger the sound velocity difference,

the smaller the weight limit.

- Sometimes it is advisable to use a lower elevation as the 'base of focus'; i.e. it may be difficult to predict exactly where the change in velocity occurs.
- Averaging a velocity change is sometimes useful; i.e. + 3 fps/1000 + 4 fps/1000, and 5 fps/1000. This is 4 fps/1000 over a 3000 ft altitude. Investigate the predicted weight limit using the base of focus for each respective altitude.
- If a focus condition at higher altitude exists above a lower altitude focus (and exceeds the highest sound velocity in the lower altitude focus), this condition must be evaluated. If the higher altitude focus has lower sound velocities, no reflection of sound waves is possible.

NOTE

After the forecast has been prepared, call the West Control Point on Ext. 275 and give the weight limit.

AIDS TO FORECASTING

- If returns are in 10, 50, 70, 90, 130, and/or 330° directions and they are simple ground inversions (SGI), use 800 ubar chart.
- If return is in 270° and it is a SGI, use 800 ubar (and multiply by 10); i.e. weight from 800 ubar is 70 lb, use 700 lb limit.
- If focus condition exists at 500 ft and returns are in 10, 50, 70, 90, or 130° directions, use 600 ubar chart. Use 800 ubar chart for return in 270° or 330°.
- If the sound velocity never exceeds the ground velocity, a focus condition will not exist regardless of the sound velocity pattern with altitude.

- Watch for forecasted frontal passage; weight limits are usually very low before and during passage.
- Observe velocity patterns on either side of a heading having a 'Return'. This will aid in forecasting either an increase or a decrease in the weight limit (see Figs. 6-10 and 6-11).
- Check focus location: the distance (in miles) from Site 300 where the reflected overpressure pulse is expected to strike the ground.
- Estimate overhang: the distance (in feet) determines magnitude of the reflected overpressure pulse. A large overhang is indicated by a small slope; hence, a strong reflection of the incident overpressure pulse. Conversely, a small overhang with a big slope tends to reduce the magnitude of the reflected pulse.
- Use facsimile machine to help determine weather. For example, a low pressure area positioned in southern Nevada usually is an ideal day to fire 1000 lb of explosives.
- The Diurnal Pressure Change phenomena usually occurs in late morning; i.e. the recorded barometric pressure is increasing, then starts to decrease. The winds associated with the increasing - decreasing atmospheric pressure can affect the sound velocities; hence an unreliable forecast might be computed during these times.

Fig. 6-1. Examples of lapse, inversions, and focus conditions.

Fig. 6-2. Condition I. Sound propagation from a negative thermal gradient (sound speed decreases with altitude).

1. Condition I

In this condition, no zones of silence will be present and the sound will be characterized by a rumble of relatively long duration. The duration of the sound is caused by the sound rays reaching the listener at different times via multi direct and reflected paths.

Fig. 6-3. Condition II. Sound velocity increases for a short distance upward and then decreases with further height.

Fig. 6-4. Graph used to determine H.E. weight limit for simple inversion condition.

In this case, a zone of relatively little noise exists near the blasting location, with loud noise disturbance at more distant locations. A narrow zone in which the sound return is especially loud and sharp occurs outside the relatively quiet zone. This is a result of a bundle of rays returning to the ground at these points at nearly the same time forming a focus or "caustic". Beyond this zone of very loud noise, other sound rays are returning to the ground, but are lower in intensity and sharpness.

Horizontal plane showing sound return

Fig. 6-5. Condition III (and II). Sound velocity decreases, then increases for a short distance upward, and finally decreases.

In this case, there is a zone of noise surrounding the blasting site and proceeding in all directions. The noise in the zone nearest the blast site will be a rumble of relatively long duration. This atmospheric condition also results in a zone of very loud noise due to focusing of rays.

Fig. 6-6. Condition III (and II). With increase in altitude, the sound velocity successively increases, decreases, increases once more at a greater rate, and finally decreases.

fig. 6-7. Graph used to plot computer data (with pressure vs altitude) for focus conditions.

Fig. 6-8. Graph (400 ubar rule) is used to determine H.E. weight limit for focus condition.

Fig. 6-9. Nomograph used to determine pressure in ubars, focus distance in miles, and overhang in feet.

Fig. 6-10. Sound propagation from a positive wind gradient (sound speed increasing with altitude.)

Wind (U) & sound speed (V)
Wind & sound speed decreasing with altitude

Vertical plane showing sound propagation

Fig. 6-11. Sound propagation from a negative wind gradient (sound speed decreasing with altitude).

SECTION 7

GENERAL

The theodolite is an instrument for measuring horizontal and vertical angles (see Figs. 7-1 and 7-2). It is used for pilot balloon (PIBAL) tracking. Information taken from the theodolite is used in the computation of wind direction and velocity at various altitudes. The theodolite serves as a back-up for the radar.

NOTE

Good visibility is required when using the theodolite.

The balloon must be tracked for several minutes to obtain sufficient data for wind directions and velocities.

THEODOLITE SETUP AND OPERATION

- Place green theodolite in slots on stand as shown in Figs. 7-1 and 7-2.
- Fasten spring-loaded connector on stand to theodolite bottom so that theodolite will not fall off stand.
- Adjust leg levelers (3) if necessary. Bubble indicators (Fig. 7-3) should be centered when theodolite base is level.
- Remove both eyepiece dust covers (Fig. 7-3). Line up theodolite gunsight and eyepiece (Fig. 7-4) on tank shown in the upper left corner above Bunker 812 (see Fig. 7-5).
- Adjust base plate (Fig. 7-2) until azimuth dial reads 351 deg. This aligns the theodolite azimuth with true north. The gate of Bunker 812 is directly north of the theodolite stand.

- Turn theodolite so that it is pointing downwind. Set eyepiece selector (Fig. 7-2) for largest field of vision (least magnification).
- Have stopwatch, pencil, and clipboard with record sheet (see Fig. 7-6) readily available by theodolite as shown in Fig. 7-4. Use rubber band to hold record form on clipboard.
- Refer to Fig. 7-7 and fill J-30 balloon with 138 g of helium. This provides a calculated 600 ft/min balloon ascension. Filling instructions:
 - a. Place plastic fill tube over end of 138-g fill connector.
 - b. Place stem of balloon over other end of 138-g fill connector.
 - c. Turn on helium tank valve and turn regulator valve clockwise until gauge indicates 10 or more.
 - d. Allow balloon to fill until it lifts plastic fill tube to horizontal position, see Fig. 7-7.
 - e. Shut off helium supply and disconnect plastic fill tube from 138-g fill weight.
 - f. Allow balloon to empty slightly until it just floats in the air without ascending or descending.
 - g. Finish balloon stem shut, remove 138-g fill connector, and fasten balloon stem shut with rubber band.
- Carry balloon to theodolite stand, release balloon, and start stopwatch (see Fig. 7-8).
- Align gunsight and eyepiece with ascending balloon (see Fig. 7-4). Theodolite can be adjusted either by positioning it manually or by turning elevation and azimuth controls (see Fig. 7-1).

- Read elevation (top) and azimuth (bottom) indicator dials at end of 30 s and enter data (elevation and azimuth angles) on Pibal record sheet (Fig. 7-6).
- Realign elevation and azimuth controls on balloon and enter elevation and azimuth data on record sheet at end of 1 min and every minute thereafter for 16 min (or as many minutes as you can up to 16 min).

THEODOLITE REMOVAL AND STORAGE

- Remove center connector from theodolite; replace both eyepiece covers, and store theodolite in office trailer.
- Return clipboard and stopwatch to office trailer.

Fig, 7-1. Theodolite mounted on support stand,

Fig. 7-2. Major components of theodolite and support stand.

Fig. 7-3. Two theodolites stored in office trailer.

Fig. 7-4. Theodolite, stop watch, and clip board positioned on stand.

Fig. 7-5. Location of tank and Bunker 812 (used to determine true north).

30 G PILOT BALLOON

TIME STARTED _____

DATE _____

	V	H	DO
1M			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			

30 SECOND

--	--	--

T-75 (1230 MSL)

S	-	
1.2	2	
2.7	3	
4.2	4	
5.7	5	
7.2	6	
8.7	7	
10.2	8	
11.7	9	
13.2	10	
16.2	12	
19.2	14	
22.2	16	
25.2	18	

Fig. 7-6. Pibal data record form.

Fig. 7-7. Filling balloon for use with theodolite.

Fig. 7-8. Initial position for balloon release.

SECTION 8

CHART REMOVAL AND REPLACEMENT

WESTERN UNION TELETYPE

General

The teletypewriter, shown in Fig 8-1, provides a listing of meteorological data from selected U.S. Weather Stations. Atmospheric information; i e. pressure, temperature, wind direction and velocity, etc., from the Oakland Weather Station is used to predict the temperatures above Site 300. The predicted temperatures are used in preparing a blast forecast. Oakland weather information is transmitted over the teletype at 1200 Greenwich Mean Time (0400 Pacific Standard Time).

Teletype Paper Replacement

- Note positions of red, blue and yellow pins on electric timer (see Fig. 9-1). These pins control the power to the teletype.
- Turn take-up reel power switch "OFF" (see Fig. 8-2).
- Turn teletype "OFF". Switch is located on the lower right side.
- Remove remainder of roll; remove steel spool.
- Replace old roll with fresh paper roll (from shelf).
- Rethread paper as shown in Fig. 8-2.
- Lower cover.
- Place take up reel and main power switches to "ON" position.
- Check operation of paper; use linefeed and carriage return buttons on front of teletype.

Teletype Ribbon Replacement (see Fig. 8-2).

- Turn power and take up reel switches "OFF".
- Depress button above power switch and raise cover.
- Note path of ribbon (for use in rethreading).
- Replace ribbon.
- Lower cover.
- Turn power and take up reel switches "ON".

PRECISION MICROBAROGRAPH

General

A precision microbarograph is an automatic instrument for recording small and rapid changes in atmospheric pressure. A mechanical ink pen records the variations in pressure on a continuous cylinder chart. The readings are used to estimate the changes in winds and weather front approach/passage.

Microbarograph Chart Replacement (see Fig. 8-3).

- Move microbarograph to accessible location.
- Carefully release cover latch and move cover to 'open'.
- Rotate curved steel pin to lift needle from chart.
- Carefully lift drum (note knob) from base.
- Remove chart and write removal date on chart.
- Rewind (move lever on spindle base clockwise).
- Write installation date on new chart and place chart on drum.
- Replace drum and chart (make initial alignment for day and time).
- Lower needle close to chart; recheck alignment (day and time).
- Lower needle to chart.
- Add ink to needle if required (ink bottle on top of cabinet).
- Replace cover - watch out for needle.
- Latch cover.
- Carefully return barometer to top of cabinet.
- Barometric corrections for Livermore are listed on Vincens' desk.

WIND DIRECTION AND WIND SPEED RECORDER

General

The wind direction and wind speed strip-chart is used to record the measurements received from a wind speed (mph) and a wind direction (degrees) instrument. This information is tabulated and becomes part of the meteorological records for Site 300. Daily observations of the wind velocity and direction allows the forecaster to place the balloon downwind for ease in tracking the balloon after release.

Wind Direction and Wind Speed Recorder Chart Replacement (see Fig. 8-4).

- Note date (front of instrument) of last replacement. Replace chart every 2 weeks.
- Unscrew two knobs and open cover (use hook and string to hold cover up).
- Turn recorder "OFF" (switch is located inside, upper left corner).
- Note positions of switches on sides, i.e. Chart Feed - Slow, Range (mph) - .75 and Lights - ON.
- Raise ink needles - Use levers.
- Chart removal
 - a. Pull 3 or 4 inches of chart paper down and wind on bottom spool.
 - b. Use razor blade and cut chart; wind on bottom spool.
 - c. Remove bottom spool; use flow ball pen and record "OFF" and "ON" dates and time; i.e. 1145 PDT or PST., Oct. 26, 1977.

- d. Remove chart from metal spool (save spool).
- e. Remove chart from top spool - discard.
- f. Obtain new chart from shelf; mark date on front end of chart;
fold corners to a point, make sure chart has writing to
outside (to read it).
- g. Thread chart through guide, and attach to lower metal spool
(put chart through slot).
- h. Make sure chart is positioned to proper hour, i.e. 1015, 1045, etc.
- i. Lower needles to chart (check time where needles touch chart);
fill ink well.
- j. Turn recorder switch to "ON" - Check lower spool rewind.
- k. Lower front cover and lock external knobs.
- l. Record new "ON and CHANGE" dates on glass cover (use wax pencil).
- m. Put support string on top of cabinet.

RAIN GAUGE RECORDER

General

A bucket-type rain gauge is used to measure the quantity of rain that falls at a given place and time. An electrical pulse (depending on the quantity of water) is transmitted to a recorder where a mechanical ink pen records the measurement on a continuous cylinder chart (.01 inches/division).

Rain Gauge Chart Replacement (see Fig. 8-5).

- Unlock housing and lift to expose interior area.
- Move vertical rod, near chart, to front (this holds pen away from chart).
- Remove metal drum carefully (watch pen on lower lip of drum). Replace with new chart from shelf and record date. Save and date old chart. Rewind using key on top of drum (key turns hard).
- Replace drum and chart very carefully. Note the needle placement to assure proper hour of the day.
- Put ink (from bottle, left front) in pen if required.
- Reset recorder pen to Zero line.
- Return vertical rod to original position to allow needle to track on chart.
- Lower protective cover and latch.

TEMPERATURE AND RELATIVE HUMIDITY RECORDER LOCATED IN INSTRUMENT SHELTER

General

The instrument in the instrument shelter records temperature and relative humidity. Recorded values are tabulated and used for weather analysis. The current temperature reading is used to predict the temperatures used in the blast forecast.

Temperature and Relative Humidity Chart Replacement (see Fig. 8-6).

- Lower outside wooden door carefully.
- Open cover to recorder - latch is located on right side.
- Use lever to raise pens from chart.
- Pull center knurled knob "OUT".
- Remove chart and enter removal date (center of chart).
- Rewind timer using key kept in door of recorder.
- Replace winding key.
- Put in new chart and make sure chart is under the "guides". Note day and time orientation and enter "ON" date in center of chart.
- Push center knob "IN".
- Put ink in pens.
- Lower pens to chart (not touching).
- Reorientate chart using center knob.
- Lower pens to chart.
- Close recorder cover and latch.
- Raise wooden door - make sure its locked.
- Return chart to office.

FACSIMILE MACHINE

General

The printout from the facsimile machine is used to produce various weather maps and satellite pictures to observe weather patterns in, or approaching, the western part of the U.S. The machine is automatically set to receive transmissions throughout a 24 hour period and is set to GMT year round.

Facsimile Machine-Paper Replacement (refer to Fig. 8-7)

- Turn power switch OFF.
- Open front cover (unlock tabs).
- Install paper obtained from cabinet.
- Adjust take-up reel brake. Fwd - unlock; Rear - tension for take-up reel.
- Rewind tension cable (if required).
- Close front cover (lock tabs).
- Power switch ON.

COMPUTER TERMINAL

General

The computer terminal is a device used for the input (and output) of data into (out of) a computer. It is a mechanical-electrical device located in office trailer T-988. The computer terminal is used in conjunction with the ISI-11 or the G machine computer.

Computer Terminal - Paper Replacement (see Fig. 8-8).

- Turn power switch OFF.
- Raise the cover over terminal.
- Replace paper roll (use guides).
- Lower protective cover.
- Turn power switch ON.

Fig. 8-1. Western Union teletype.

Fig. 8-3. Precision Microbarograph.

Fig. 8-4. Wind direction and wind velocity recorder.

FIG. E-5. Rain gauge recorder.

Fig. 8.6. Temperature and relative humidity recorder (in the instrument shelter).

Fig. 8-7. Facsimile machine.

Fig. 8-8. Computer terminal

SECTION 9

MISCELLANEOUS EQUIPMENT

ELECTRIC TIMER

General

The electric timer is an instrument which is used to control the ON-OFF times of the Western Union Teletype. The timer contains a 24 - hr electric clock set to PST; 24 'pins' for selecting the hours of operation for the teletype and a buzzer which may be used for an audible reminder.

Electric Timer Operation (see Fig. 9-1).

The ON-OFF pins are positioned to provide power to the Western Union Teletype when weather data for Oakland and National Weather Summaries are transmitted over the network. Data from weather satellites, weather stations throughout the world, and other sources is continuously transmitted over the teletype network. When the timer pins are all the way out, the teletype is off. If a pin is all the way in (towards center), the teletype is on for that specific time. Normally the red pins are in for 0400 to 0900 hr (Oakland weather, etc); the blue pins are in for 1400 to 1500 hr (5 day forecast); the purple pins are in for 1500 to 1600 hr (daily forecast); and the yellow pin is in for 1130 hr (national weather summary).

NOTE

For a long weekend, install a full roll of paper in the teletype and place the blue, purple, and yellow pins on the timer in the off positions.

The ON-OFF buzzer switch can be used in conjunction with the timer. An audible sound will be heard when the "time-pin switch" position allows power to the teletype. If it becomes necessary to run the teletype other than the preset times, note the PST, and move the corresponding time-pin switch to the ON position, i.e. toward the center of the clock.

METEOROLOGY TOWER

General

Various meteorology instruments are mounted on the meteorology tower. Signals from these instruments are fed to recorders in the Office Trailer and to recorders in the ARAC Center in Livermore. The tower must be lowered and raised to service the instruments. If done properly, it is not a difficult task. However, if done improperly, it can become a very difficult task and can result in damage to the tower, support cables, instruments, and instrument cables.

Lowering the Meteorology Tower (see Fig. 9-2).

To lower the tower properly, the top section must be lowered into the middle section. Next, the top and middle sections are telescoped into the bottom section. The tower is then pivoted sideways and locked into any desired position. The following is a step-by-step procedure to lower the tower.

- Disconnect the grounding cable from the base of the tower, the radio wire from trailer 988, and the three guy wires from their posts.

Caution

When lowering the tower, keep all cables clear of telescoping tower because they can be frayed or sheared off.

- Turn Crank A (see Fig. 9-3) clockwise while pulling the cable attached to the upper hinge plate (see Fig. 9-4). The top sec-

tion of the tower will rise about 1 - inch and the hinge plate will move out. Maintain a "pull" on this hinge plate cable to prevent re-locking.

- Turn Crank A counter clockwise until the top section is telescoped into the middle section and the spring loaded latch is engaged. Release Cable.
- Turn Crank A clockwise while pulling onto the cable attached to the lower hinge plate (Fig. 9-5). (The top and middle sections of the tower will rise about 1 - inch and the lower hinge plate will move out.) Maintain a "pull" on this hinge plate cable to prevent re-locking.
- Turn Crank A counter clockwise until the top two sections telescope into the bottom section. Release cable.
- Remove Cotter Key and Safety Pin from base of tower (see Fig. 9-3).
- Release dog in ratchet on Crank B.
- Turn Crank B (see Fig. 9-3) counter clockwise until there is some slack in the tilt cable.

Caution

Make sure that the tilt cable stays on the pulleys.

- Push base of tower out with your foot.

WARNING

Keep firm hold on tilt Crank B so that it won't spin and allow tower to fall.

- Turn Crank B counter clockwise until tower is in desired position; lock dog in ratchet on Crank B to hold tower in position.

Raising Meteorology Tower

To raise the tower properly, the three sections are first cranked into a vertical position. The middle and top sections are then raised together until the middle section reaches a stop. The top section is then cranked up until it just passes the first stop. Then the Crank is reversed and the top two sections settle into position on their corresponding hinge plates. The following is a step-by-step procedure to raise the tower.

- Remove dog from ratchet while turning Crank B clockwise (see Fig. 9-3). Make sure that cables are on their pulleys and that cables wind evenly on take-up reel.

WARNING

Keep firm hold on tilt Crank B so that it won't spin and allow tower to fall.

- Turn Crank B clockwise until telescope tower is in vertical position.
- Insert Safety Pin (see Fig. 9-3) into base of tower and fasten with Cotter Key.
- Using Crank A, crank clockwise until the middle section reaches its stop.
- Pull top section release cable (see Fig. 9-5) and continue cranking clockwise until the top section reaches its first stop (see Fig. 9-6).

Caution

Do not allow the top section to go over 1 foot past the stop or it will tilt and jam in position.

- Turn Crank A counter clockwise until the two top sections of the tower rest on their flat hinge plates.
- Connect grounding cable, radio antenna wire, and guy wires.
- Tighten guy wires.

MICROBAROGRAPH STATIONS

Four microbarograph stations (sensors) are located in/near Tracy, Ca., and are used to measure the overpressures from a shot fired at Site 300. The sensors transmit a signal over individual telephone lines to the Electronics Building (B-141) in Livermore. A strip recorder is used to display the magnitude of the overpressure. If the measured overpressure exceeds 100 ubars, the Control Point Operator at Site 300 is notified.

The four sensor locations are:

Deuel Vocational Institute	(East of Tracy)
C & B Equipment Company	(East of Tracy)
Tracy Police Department	(Downtown Tracy)
Birdsall Chevrolet	(West Edge of Tracy)

Fig. 9-1. Electric timer (controls operation of Western Union Teletype).

Fig. 9-2. Meteorology tower showing various sections.

Fig. 9-3. Base of meteorology tower.

Fig. 9-4. Top section of meteorology tower.

Fig. 9-5. Middle section of meteorology tower.

Fig. 9-6. Location of stop for top section of meteorology tower.

SECTION 10
SOURCES OF HELP

EQUIPMENT REPAIR

Balloon Remote Release Repair

EE Shops218

Computer Terminal Repair

Electronics23869

Facilities Repair

Site 300 Resident Engineer(Joe Baker).....211

Shops Supervisor(Frank Harris).....211

Electrical(Bob Given).....211

Air Conditioning(Wayne Woods).....211

Plumbing(Herman Smith).....211

Carpenter(Hugh McPherson)...211

Rigger(Herman Smith).....211

Welder(Herman Smith).....211

Painter(Gideon Rueb).....211

Laborer(Bob Festich).....211

Custodian(Charles Coffee)...211

Maintenance Machinist(Horace Barr).....211

Facsimile Repair

Customer Service452-3229

Instrument Repair

EE shops218

Instrument Shops/Repair23869

Intercom Repair

EE shops Supv. (Phinas Wallace)218

EE Shops (Bill Belzer).....218

Modem (Electrical Coupler)

Electronics23869

Radar Repair

EE Tech Supt. (Len Swisher)284

EE Technician (Richard Whipkey)356

Telephone Repair

Business Services (Gene Thompson)217

Western Union Teletype Repair

East Bay Office452-3229

WEATHER INFORMATION

Oakland Weather Station562-8573

Oakland Office (RAOB)562-8573

Weather Central (LLL)

Marvin Dickerson (supv.).....	29100
Charles Veith	26236
Mike Alton	26237
Bob Sherwood	26232
Bay Area Weather	936-1212
Livermore Airport	443-0666
Road Conditions	654-9890
Time	767-8900

RADAR OPERATORS

Vince Arganbright	206 or 373
Byron Odell	29045
Harold Pfeifer	29049

SUPPLIES

<u>Item</u>	<u>Source</u>
Balloons	Procurement (Liv)
Radar Parts	Electronics (B-871)
Helium	Transportation (B-875)
String	Stores (B-875)
Aluminum Foil	Stores (B-875)
Masking Tape	Stores (B-875)
Rubber Bands	Stores (B-875)
Bottled Water	Stores (B-875)

Forecast Forms

Blast Forecast Input Sheet, LL-1856 (Rev 7/75)	Forms & Records
Pressure-Temperature Plot, LL-1856-4 (Rev 7/75)	Forms & Records
Velocity-Height Profile form, LL-1856-3 (Rev 7/75)	Forms & Records
Radar Data Record Form	Xerox

Paper

Facsimile paper (roll)	Procurement
Western Union teletype paper (roll)	Stores
Computer Terminal paper (roll)	Stores
Wind Velocity/Direction Strip Charts	Procurement
Precision Microbarograph (cylinder chart)	Procurement
Rain Gauge (cylinder chart)	Procurement
Temperature/Humidity Recorder (circular chart)	Procurement

HANDBOOKS FOR RADAR VANS

<u>Number</u>	<u>Name</u>	<u>Location</u>
TM 9-6093-1	Introduction and Theory of Operations	Radar Van, T-975
TS 44-33A-1	M33 Field Adjustments	Radar Van, T-975
TM 9-6092-1	Description of Fire Control Systems	Radar Van, T-975
TM 9-6093-4	Troubleshooting Fire Control System	Radar Van, T-975
TM 9-6093-10-1	Field Maintenance - Tactical Control Console	Radar Van, T-975
TM 9-6093-11-1	Ordnance Field Maintenance Tracking Console	Radar Van, T-975
TM 9-6093-14-16	Ordnance Depot Test Procedures	Radar Van, T-975
ORD 9SNL F-342	Console, Tactical Control	Radar Van, T-975
GF-2.80	Wiring Charts & Diagrams	Radar Van, T-975
TM 9-6093-13	Wiring Diagrams	Radar Van, T-975
TM 9-6093-13	Supplement to Above	Radar Van, T-975
	Schematics (M-33 and related components)	

Facsimile Recorder; Manual & Circuit Diagrams	Supply Shelf, T-988
Theodolite Manuals	File Cabinet, T-988
Foxboro Instruction Manual	File Cabinet, T-988
Sanborn Recorder Manual	File Cabinet, T-988
Mobil Microbarograph Drawings	File Cabinet, T-988
Blast Forecasting Archives	Storage Area, T-988