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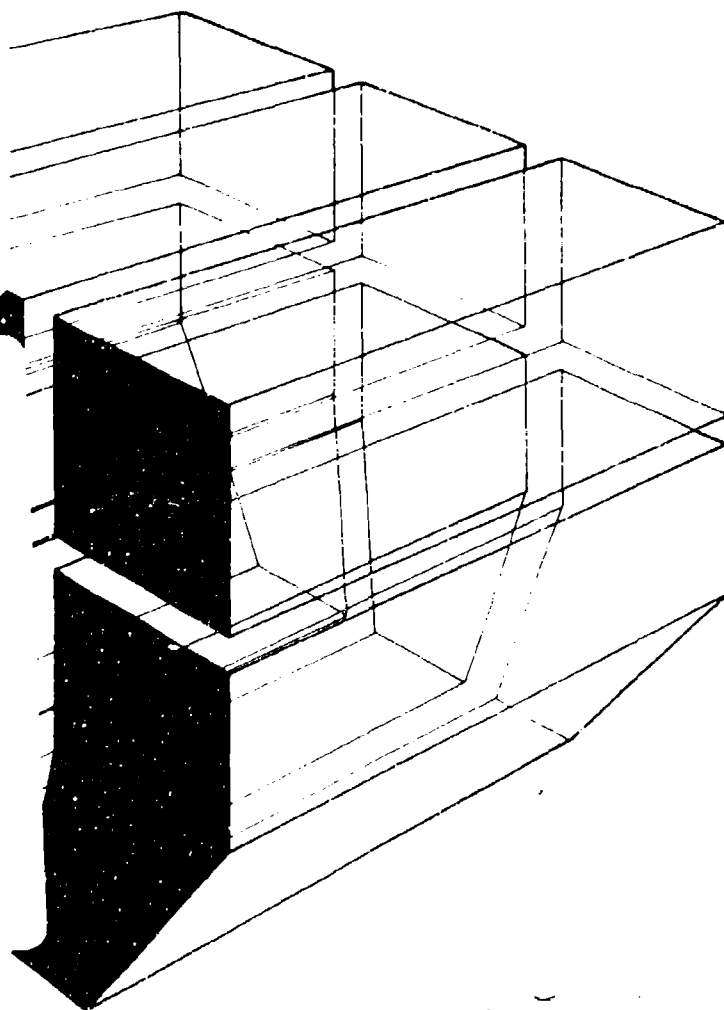
Prediction of Noise Impact Within and  
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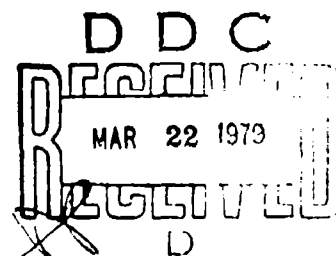
ACOUSTIC DIRECTIVITY  
PATTERNS FOR ARMY WEAPONS

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by  
P. D. Schomer  
L. M. Little  
A. B. Hunt



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| 20. ABSTRACT (Continue on reverse side if necessary and identify by block number)<br>This report describes tests conducted by this investigation on 12 types of Army heavy weapons at Fort Sill, OK, and the development of precise sound-pressure level contours (directivity patterns) for Army weapons currently in use. The data obtained during these tests was also used to compile tables relating the charge weight to an equivalent weight of C-4 plastic explosive.<br>405 3.79 - next page |                                                      |                                                                                                |

Block 20 continued.

cont.

→ In addition, this investigation determined that elevation has little influence on weapon directivity patterns; the major factor affecting weapon directivity patterns was the muzzle brake, which causes directivity patterns to become almost circular. The exceptions were recoilless rifles. Weight equivalency tables were found to be a function of tube size, with the longest tubes being the quietest, since the charges within them are the most contained.

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## FOREWORD

This research was conducted for the Directorate of Military Programs, Office of the Chief of Engineers (OCE), under Project 4A762720A896, "Environmental Quality for Construction and Operation of Military Facilities"; Task 03, "Pollution Control Technology"; and Work Unit 001, "Prediction of the Noise Impact Within and Adjacent to Army Facilities." The QCR number is 1.03.011. Mr. F. P. Beck, DAEN-MPE-I, was the OCE Technical Monitor.

The work was performed by the Environmental Division (EN), U.S. Army Construction Engineering Research Laboratory (CERL). Dr. R. K. Jain is Chief of EN. Appreciation is expressed to M. L. Scala for her assistance in writing this report.

COL J. E. Hays is Commander and Director of CERL, and Dr. L. R. Shaffer is Technical Director.

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## ACOUSTIC DIRECTIVITY PATTERNS FOR ARMY WEAPONS

### 1 INTRODUCTION

#### Background

The impact of noise on man is increasingly recognized as a major source of annoyance. Studies of the effects of noise clearly show that people repeatedly exposed to high noise levels exhibit increased irritability and discomfort, severe nervous tension, loss of ability to concentrate, impaired aptitude to perform even simple tasks, and loss of sleep.<sup>1</sup>

U.S. Army Construction Engineering Research Laboratory (CERL) investigations into the prediction and assessment of noise impact on and adjacent to Army facilities have identified blast noise, rotary-wing aircraft, vehicles, and fixed sources as major noise sources, with blasts and rotary-wing aircraft selected as the major problems.

CERL is attempting to develop methods to predict the impact of blast noise. Important to this prediction method is the compilation of noise contours; these contours can be drawn to a distance scale compatible with a map of an installation and its surroundings, and can be used as an overlay to graphically show the noise impact of base operations. Given the operations, and/or types of weapons and their charges and locations, and frequency and time of operations, noise contours can help predict how changes in operations and different weapons and locations will affect blast-noise impact on installation environs.

In Predicting Community Response to Blast Noise,<sup>2</sup> CERL identified blast statistics, human and community response, and weapons contours as the data required to improve blast-noise impact prediction. In 1973, CERL measured blast propagation at Fort Leonard Wood, MO to develop

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<sup>1</sup> Shultz, T. J., Noise Assessment Guidelines Technical Background, Report No. TE/NA 172 (Department of Housing and Urban Development, 1972), pp 81-87.

<sup>2</sup> Schomer, P. D., Predicting Community Response to Blast Noise, Technical Report E-17/AD773690 (U.S. Army Construction Engineering Research Laboratory [CERL], December 1973).

blast propagation statistics.<sup>3</sup> Psycho-acoustical tests have also been conducted<sup>4</sup> and a community attitudinal survey is underway.<sup>5</sup>

### Objective

The overall objective of this study is to predict blast-noise impact of artillery, demolition, and other blast operations within and adjacent to Army facilities.

Specifically, the objectives of this report are to (1) develop precise sound-pressure level contours (directivity patterns) for Army weapons currently in use, (2) develop tables relating the weight of charge to an equivalent weight of C-4 plastic explosive, and (3) present these contours and tables in a form suitable for use in manual and automated blast-noise prediction methods at Army installations.

### Approach

Noise measurements of 12 types of Army heavy weapons were made in July 1976 at Fort Sill, OK. Charge size and elevation of the weapons were varied. Sixteen measurement microphones were placed in two concentric circles at 250 and 500 m (Figure 1) around the weapons being tested. One omnidirectional 5-lb charge of C-4 immediately adjacent to the weapon being tested was detonated after every three shells fired. The purpose of these C-4 firings was to correct for the effects of wind and terrain upon blast propagation at the site.

Data was collected at the site with an Ampex PR-2200 14-track tape recorder and Nagra DJ scientific tape recorders. Subsequent data reduction was performed in the laboratory to determine, by microphone, positive and negative peak values for each blast, as well as frequency weight and measures. Data was transcribed into a digital format and then put into a minicomputer where weapons data was corrected by C-4 data; appropriate tables and contours were then developed.

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<sup>3</sup> Schomer, P. D., R. J. Goff, and L. M. Little, The Statistics of Amplitude and Spectrum of Blasts Propagated in the Atmosphere, Volumes I and II, Technical Report N-13/ADA023475 and ADA032361 (CERL, November 1976).

<sup>4</sup> Young, J. R., Measurement of the Psychological Annoyance of Simulated Explosion Sequences, DACA 22-74-C-0008 (Stanford Research Institute, January 1975 and February 1976).

<sup>5</sup> Community Attitudes Survey, OMB 49-R0148 (CERL, April 1979).

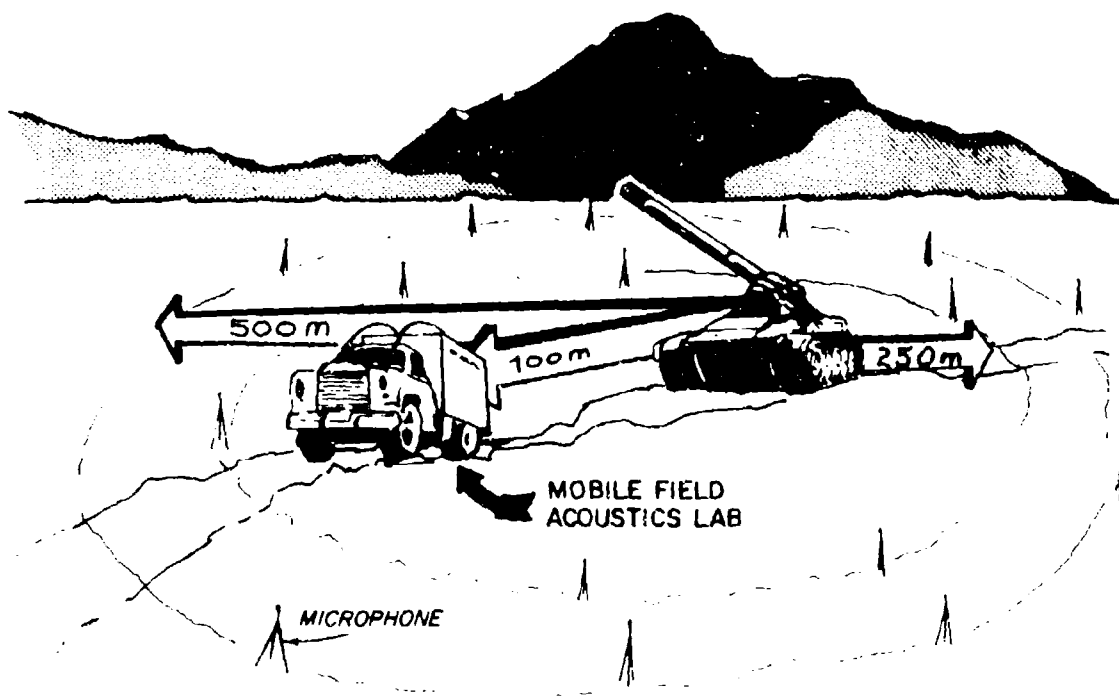


Figure 1. Location of measurement microphones.

#### Mode of Technology Transfer

The weapons contours and weight equivalency tables will be incorporated into CERL's Blast Noise Contour program. The Blast program itself is transferred to the field for official use by TM 5-803-2 (proposed), Environmental Protection: Planning in the Noise Environment, and by proposed AR 210-20, Master Planning.

## 2 DATA COLLECTION

Measurements were performed at Fort Sill in the south-central portion of Oklahoma. Fort Sill is the Army field artillery center and an extensive inventory of weapons is available there (one tank, the 152-mm Sheridan, was brought from Fort Hood, TX for the tests). The test site -- weapons ranges in a grassy field -- was accessed via a paved road. Because little training was ongoing at this site, it was a safe and convenient location for noise measurement.

### Test Sequence

During the Fort Sill test, 13 weapons were measured for blast noise. Table 1 lists these weapons, the days on which testing was performed, and the event numbers assigned to each particular weapon.

The main body of the test used C-4 plastic explosive as an undirectional calibration source. The test sequence consisted of one blast of C-4 followed by three shells from the weapon under test. The sound-pressure level contours emanating from the C-4 allowed correction for the effects of wind or terrain. This sequence was a compromise designed to place the weapon blast as close as possible to the C-4 blast without undue expense of resources or time. This investigation reasoned, given the speed of firing and changing weather, that the contour produced by the C-4 after two weapon blasts would not change greatly.

Table 1

#### Weapons Tested

| <u>Type</u> | <u>Blast No.</u> | <u>Day</u> | <u>Name of Gun</u>         | <u>Model</u> |
|-------------|------------------|------------|----------------------------|--------------|
| 1           | 1-23             | 12         | 8-in. self-propelled       | M110A1       |
| 1           | 569-599          | 28         | 8-in. self-propelled       | M110A1       |
| 2           | 24-65            | 13         | 105-mm tank                | M60          |
| 3           | 76-104           | 14         | 4.2-in. mortar             | M30          |
| 4           | 105-133          | 14         | 81-mm mortar               | --           |
| 5           | 481-524          | 27         | 106-mm recoilless rifles   | M40A1        |
| 6           | 438-480          | 26         | 90-mm recoilless rifles    | M67          |
| 7           | 394-437          | 26         | 105-mm howitzer            | M102         |
| 8           | 124-177          | 19         | 155-mm howitzer            | M109         |
| 9           | 200-245          | 20         | 8-in. howitzer             | M110         |
| 10          | 246-290          | 21         | 152-mm Sheridan (tank gun) | M551         |
| 11          | 525-568          | 27         | 155-mm howitzer            | M114         |
| 12          | 350-393          | 22         | 155-mm howitzer            | M109A1       |

### Measurement Apparatus

Microphones were deployed in two concentric rings with radii of 250 and 500 m, respectively, around the weapon (C-4) being measured. The inner ring had six microphones placed at  $60^\circ$  intervals around the firing point. The microphones were oriented so that one was directly in front and one directly behind the weapon, with two each on the left and right sides of the gun. The outer ring consisted of nine microphones at  $30^\circ$  intervals with a center microphone directly behind the gun. (No microphones were placed in front, or  $30^\circ$  either side, of the front of the weapon because of the possible damage to them from incoming shells and the danger involved in setting them up.)

Four types of microphone systems were used for measurements: the B&K 4921 outdoor microphone system, the B&K 141-B field microphone system, the B&K 2209 sound-level meter system, and the B&K 2631 FM carrier system. With the exception of the B&K 4921, all systems were operated with external microphone cartridges. (Figure 2 shows the equipment at each station.) The B&K 4921 and B&K 141 stations were powered by lines running from a van which served as a mobile field acoustics lab. The attended stations and the FM carrier system were self-contained.

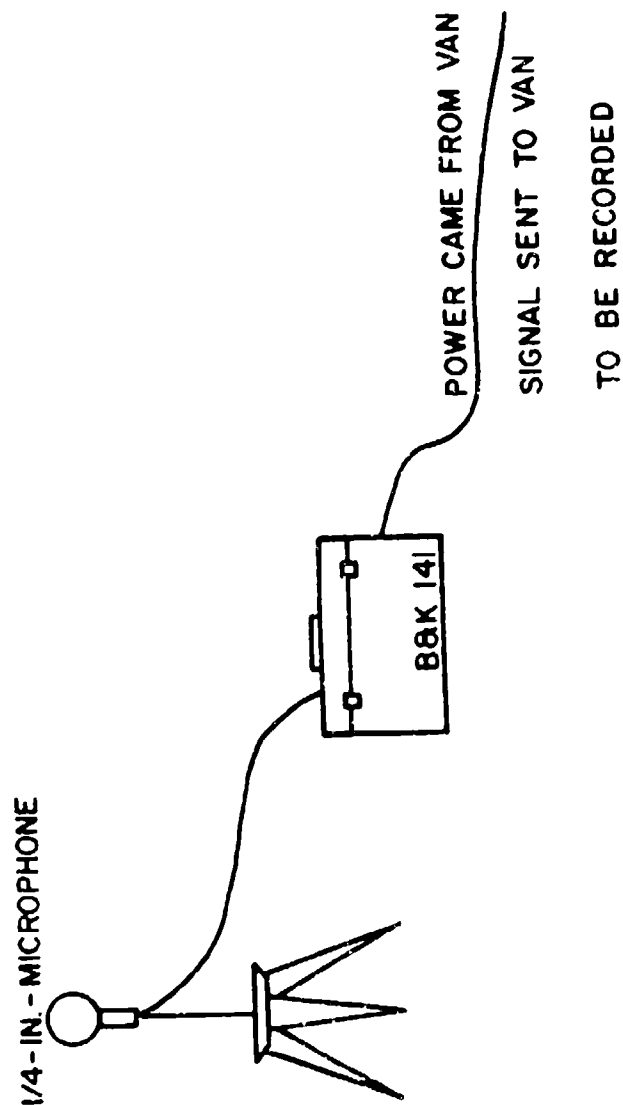
An accelerometer station was also deployed; it consisted of three accelerometers oriented with respect to three mutually perpendicular axes. At first, the accelerometer station was placed 30, 60, or 90 m south of the blast site each day. However, after the first few days, it was found that if the station was always placed at 30 m, it registered the air wave almost exclusively, with little or no register of the ground wave.

Stations 33F, 36F, 3F, 9F, and 18F were the sound-level meter stations attended by field personnel. The peak sound level was measured on the sound-level meters at each station, and the flat-weighted output recorded on the Magra DJ tape recorder. In addition, a B&K 2631 FM carrier system with a B&K 4145 microphone specially sealed to measure low frequencies was used at station 18F.

Remote-controlled B&K 141 stations were placed at stations 6F and 12F, and operated by personnel at stations 3F and 9F, respectively. At station 27N, a B&K 1/4-in. microphone was used to allow the measurement of high frequencies and amplitudes.

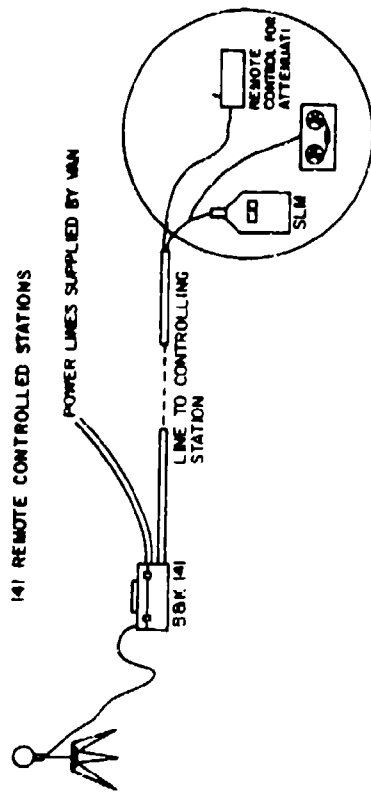
Stations 33N, 3N, 9N, 15N, 21N, 21F, and 15F were B&K 4921 microphone systems powered by the mobile lab. The output from these stations, the signals from the FM carrier system, and the signals from the 1/4-in. microphone were recorded on the 14-channel Ampex PR 2200 FM tape recorder. Signals from the three B&K accelerometers (mounted in three dimensions to a cement block); the time code generator; and the wind

B 8 K 141 WITH 1/4-IN. MICROPHONE

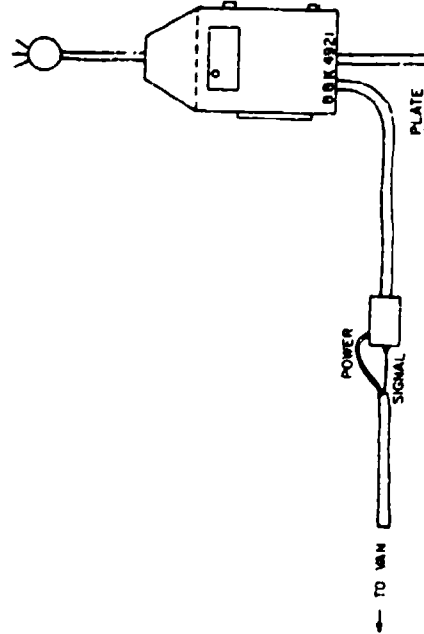


a. Station 27N

Figure 2. Fort Sill test equipment.

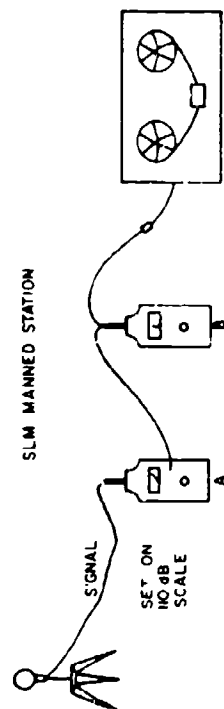


b. Stations 6F and 12F

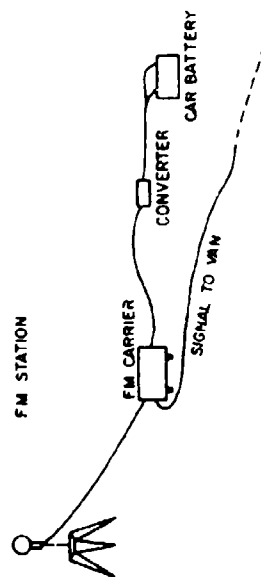


c. Stations 15F, 21F, 31I, 91I, 15N, and 21N

Figure 2. (Cont'd).



d. Stations 18F, 33F, 36F, 3F, and 9F



e. Station 19F

Figure 2. (Cont'd).

direction and speed apparatus were also recorded on the Ampex PR 2200 during testing.

### Calibration

Calibration was performed (1) at the beginning of every new tape, (2) at the end of each tape and/or day, (3) when changes were made in equipment or equipment placement, or (4) when equipment malfunctioned. The unattended stations controlled by the mobile lab were set up first and were the first stations calibrated after setup of all stations was completed. This allowed all stations equal warm-up time before calibration.

The unattended stations were calibrated with B&K 4220 pistonphones in two groups of five and four, respectively.\* A 15-sec recording of the tone was made at a tape speed of 60 in./sec on the Ampex PR 2200. The B&K 4921 was calibrated using 30 dB of gain in the 4921 and 0 dB of gain in the Neff DC amplifier in the mobile lab. Adjustments were then made so that a 4-V peak-to-peak signal corresponded to the 124-dB root-mean-square (RMS) produced by the pistonphone. For most measurements, the B&K 4921 gain was reduced to 10 dB. This allowed measurement of sound-pressure levels of 150 dB peak without overloading the tape recorder. The Neff gain was increased for lower sound levels. For very low signal levels, the B&K 4921 gain was increased to 20 dB.

The FM system was calibrated using a pistonphone and all gain adjustments were performed in the mobile lab. During testing, the system used a 1-Hz cutoff.

The B&K 141 at station 27N was calibrated with its gain set for 40 dB and the Neff amplifier set for 0 dB. As with the B&K 4921, the B&K 141 was adjusted to produce a 4-V peak-to-peak signal at the mobile lab. The B&K 141 gain was decreased to 30 dB for measurements. The mobile lab was able to decrease the B&K 141 gain to 20 dB or 10 dB, if necessary. For signals over 150 dB, the gain was reduced to 20 dB.\*\* The attended stations were calibrated after the unattended stations. A pistonphone tone at least 1 minute in length was recorded on tape, followed by a detailed list of calibration settings, data, and any other information considered necessary by the investigators.

---

\*To allow calibration, the B&K 4921 outdoor microphone system windscreens and rain covers were removed and its microphone calibrated with a normal grid; however, the rain covers and windscreens were used during the testing.

\*\*This station was the most difficult to calibrate because of the problem of holding the pistonphones steady on the 1/4-in. microphone in the wind.

At the attended stations, two sound-level meters were used to increase the dynamic range of the peak readings. The output of the 1/2-in. microphone was channeled to sound-level meter A, which was calibrated by the pistonphone for 124 dB. The output of sound-level meter A was sent simultaneous to the input of sound-level meter B and to the Nagra DJ tape recorder. After sound-level meter A was calibrated, it was set to the 110-dB scale. (Sound-level meters have the same output range regardless of scale setting; the meters' range registers 17 dB above full scale. Since the signal at the attended stations was over 120 dB, the output of sound-level meter A was effectively increased 10 dB. Sound-level meter B was then calibrated to read 134 dB. This arrangement of the two sound-level meters allowed the peak to be read over a 20-dB range. Therefore, adjusting sound-level meter A allowed the upper level of the range to be varied.)

The B&K 141 stations at 6F and 12F were calibrated according to the following procedure: B&K 141 was set for 20 dB of gain and the attenuator control at the adjacent attended station was set for 0 dB. The Nagra attenuator was set for 3 dB and B&K 141 was adjusted so that the meter on the Nagra measured -10 VU. The sound-level meter was adjusted to 124 dB. The calibration tone was recorded into the Nagra for at least 1 minute, followed by a list of settings and necessary information.

### 3 DATA REDUCTION

Each event, i.e., each C-4 or gun blast, was recorded simultaneously at 16 separate stations. Depending on the recording station, data was stored on either an Ampex PR-2200 14-channel FM recorder or a Nagra DJ single-track AM recorder. Each tape channel's data was then reduced individually.

Figure 3 is a block diagram of equipment used in data reduction. The B&K 7502 Digital Transient Recorder, which acted as a delay line, received information from the tape. Each time a blast registered on the tape, the 7502 sent out a trigger signal which activated a special circuit. This circuit then relayed a trigger signal to an oscilloscope and to two CERL Model 270 noise monitors; the signals were sent such that the blast occurred in a preset window. This allowed the monitors to analyze the complete signal. Another trigger signal was sent to the noise monitors to signal the end of the data collection. After the monitors received the stop signal, and before another signal was relayed, a pause was allowed to enable the noise monitors to sample the noise level on the tape. The noise sample and the blast signal were both measured for the same time interval. The noise monitors then relayed this information (in  $L_{eq}$  form), and the sample-length time to a pair of Wang 600 calculators.<sup>eq</sup> At the beginning of each channel's analysis, equipment settings for calibration and measurement were entered into the calculator's memory. The calculators then computed the sound-exposure levels of blast noise and supplied a printout of the sound-exposure level of blast minus noise, and of noise level alone (all calculations were on an energy basis). Two noise monitors and two calculators were used in parallel so each blast could be measured with A, D, C, and flat weightings.

Positive and negative peaks were measured visually on the oscilloscope and their values entered into the calculators. The calculators used the previously given calibration values to compute positive, negative, and peak-to-peak values for each blast; this information, along with the blast number, was then printed.

Signals were checked visually for any clipping due to oversized inputs to the tape recorder. (It was not possible to overload the noise monitors or the calculators since none of the other equipment being used in the analysis was capable of inputting an excessive signal.)

The noise monitors were originally calibrated by inputting the pistonphone calibration tone from the tape recording and entering 124 dB as the pistonphone's RMS sound-pressure level. The noise monitors then calculated the appropriate gain constant to be used during data analysis. Any change in equipment settings from the calibration settings

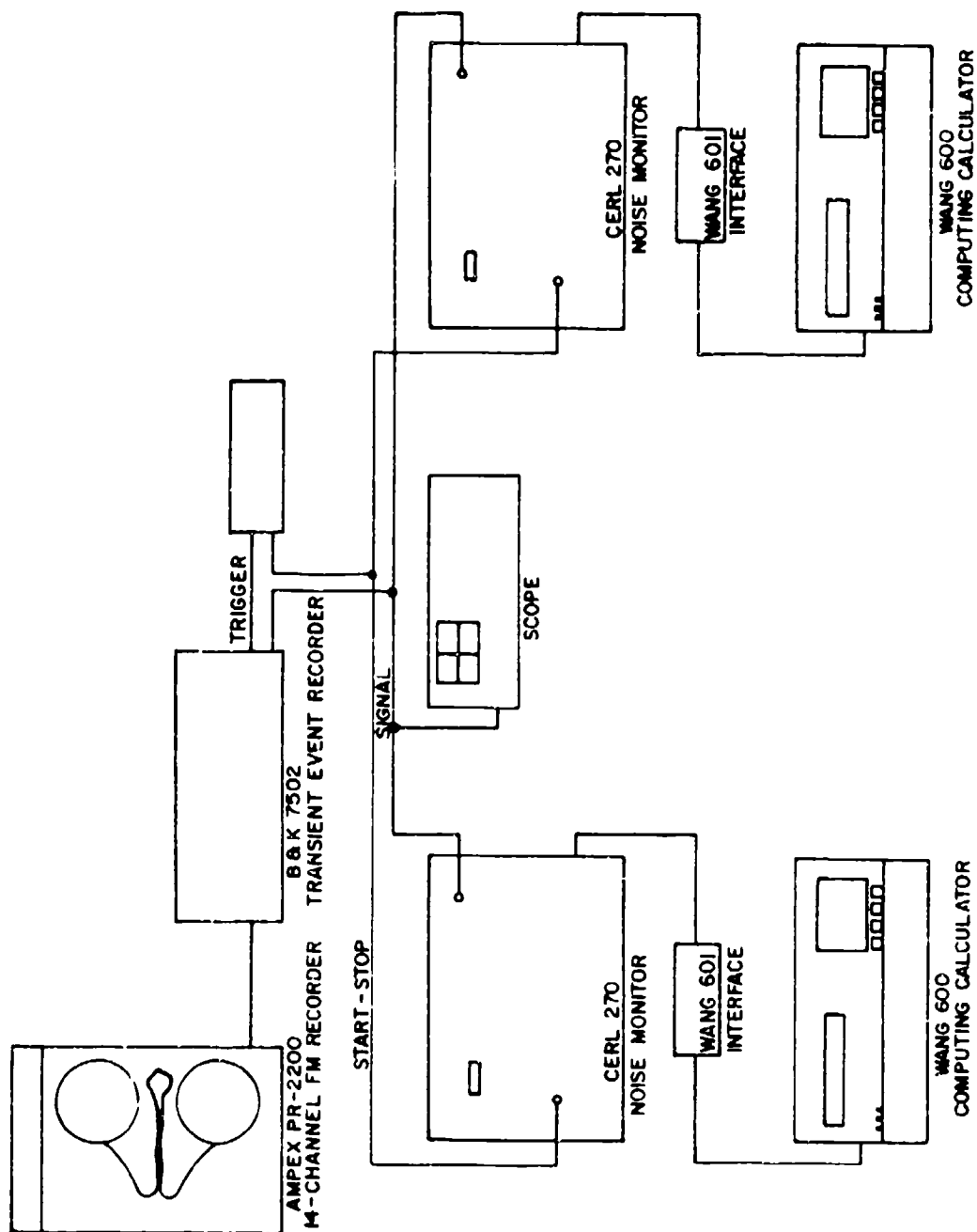


Figure 3. Block diagram of equipment used in data reduction.

and any changes made during the measurement period were entered into the calculators at the appropriate time. Necessary adjustments were made by the calculators.

Information listed on printouts produced by the Wang calculators was punched directly onto computer cards and stored on magnetic tape for easy retrieval by the Nova 1200 minicomputer during analysis.

This reduction, for each event at each station, produced the following:

|                   |               |
|-------------------|---------------|
| Flat-weighted SEL | Peak-to-peak  |
| A-weighted SEL*   | Positive peak |
| C-weighted SEL    | Negative peak |
| D-weighted SEL*   |               |

In addition, logbooks kept by the investigating team during the tests described:

1. The day and time of each event.
2. Whether the event was a C-4 blast or a weapon blast.

If the event was a weapon blast, the team logged (1) the type of weapon, (2) the type and size of the propelling charge, (3) the elevation (if applicable), and (4) the range of the weapon's projectile (if applicable). If the event was a C-4 blast, the team described (1) the amount of C-4 used to produce the blast (pounds), and (2) whether the blast was on or above the ground (see Appendix A).

---

\*Data recorded at stations using a Nagra recorder was not reduced to A- and D-weightings because filters were not available to adjust for the frequency shift between the Nagra's original recording speed (1.5 in./sec) and the playback speed (15 in./sec).

#### 4 DATA ANALYSIS

Data reduced from recordings was first analyzed to determine the values necessary to correct for the effects of weather and terrain on noise levels. After these correction values were established, weapon-noise directivity plots and weight equivalency tables were developed.

##### Correction Values

Five pounds of C-4, when exploded under ideal weather and terrain conditions, transmits sound equally in all directions. The resulting noise-propagation pattern is circular.<sup>6</sup> The effect of inhomogeneous weather and terrain conditions, therefore, can be determined by observing how propagation patterns differ from the circular.

For the purpose of this study, it was assumed that:

1. Weather and terrain effects on C-4 noise-propagation patterns do not vary drastically over a short time (typically, 15 minutes).
2. The effects of weather and terrain on C-4 noise and gun noise are the same.

It was further assumed that once the effects of weather and terrain on C-4 blast noise were determined, they could be used to predict and correct for -- and therefore eliminate -- the effects of weather and terrain on gun noise.

As described in Chapter 1, each weapon firing (event) occurred within 15 minutes of a 5-lb C-4 calibration explosion. Data recordings for each event (C-4 and weapon) were made at 16 separate stations and reduced (Chapter 3). To determine the correction value for each weapon-firing event at each station, it was first necessary to identify the C-4 calibration explosion nearest to it in time.

Each C-4 event was analyzed to determine the difference from the ideal caused by weather\* and terrain. This difference was then used to

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<sup>6</sup> Schomer, P. D., R. J. Goff, and L. M. Little, The Statistics of Amplitude and Spectrum of Blasts Propagated in the Atmosphere, Volumes I and II, Technical Report N-13/ADA033475 and ADA033361 (CERL, November 1976).

\*Weather conditions during testing for each day (by hour) are listed in Appendix B.

correct the noise-level data for the weapon-firing event nearest in time to the C-4 explosion.\* In this manner, correction values for the effects of weather and terrain on each event at each station were determined.

### Noise Contours\*\*

Reduced noise-level data was used to plot, against time, noise levels at each station for (1) each weapon type, and (2) each C-4 event. Both corrected and uncorrected data were plotted. This was done to:

1. Facilitate spotting errors in data recording and/or in the transcription or reduction of data.
2. Support this investigation's assumption that weather and terrain effects could be averaged over a short time.

These plots also showed that noise levels at all stations changed in a consistent manner, regardless of the position of the station, the type of weapon (C-4), or time.

Corrected, reduced noise-level data was then graphed vs angle on a polar plot (see Figure 4 for an example). Inner-ring data (dashed line) was plotted separately from outer-ring data (solid line).

The polar plots were not developed to determine how loud an event was at a point, but how noise levels varied with angle. The deviation at each angle for each event was determined from a single reference point (rear of the gun) and plotted. These plots are the weapon directivity patterns.

Separately plotted inner- and outer-ring contours were then compared. The comparison showed that both contours, for similar test events, typically varied less than  $\pm 1.5$  dB from each other. Because of this close comparison and since the noise contours for the inner and outer ring each contained points absent in the other (Chapter 2), the plots of both rings were combined for identical events, i.e., events with the same weapon (C-4), charge size or type, elevation, and range

\*As a check, C-4 events were analyzed and corrected using this method. They produced nearly perfect circular patterns.

\*\*Though analyses were done for both F- and C-weighted SEL, contours were produced for C-weightings only to weighting recommended by the Environmental Protection Agency (EPA) and approved by Department of Defense (DOD).

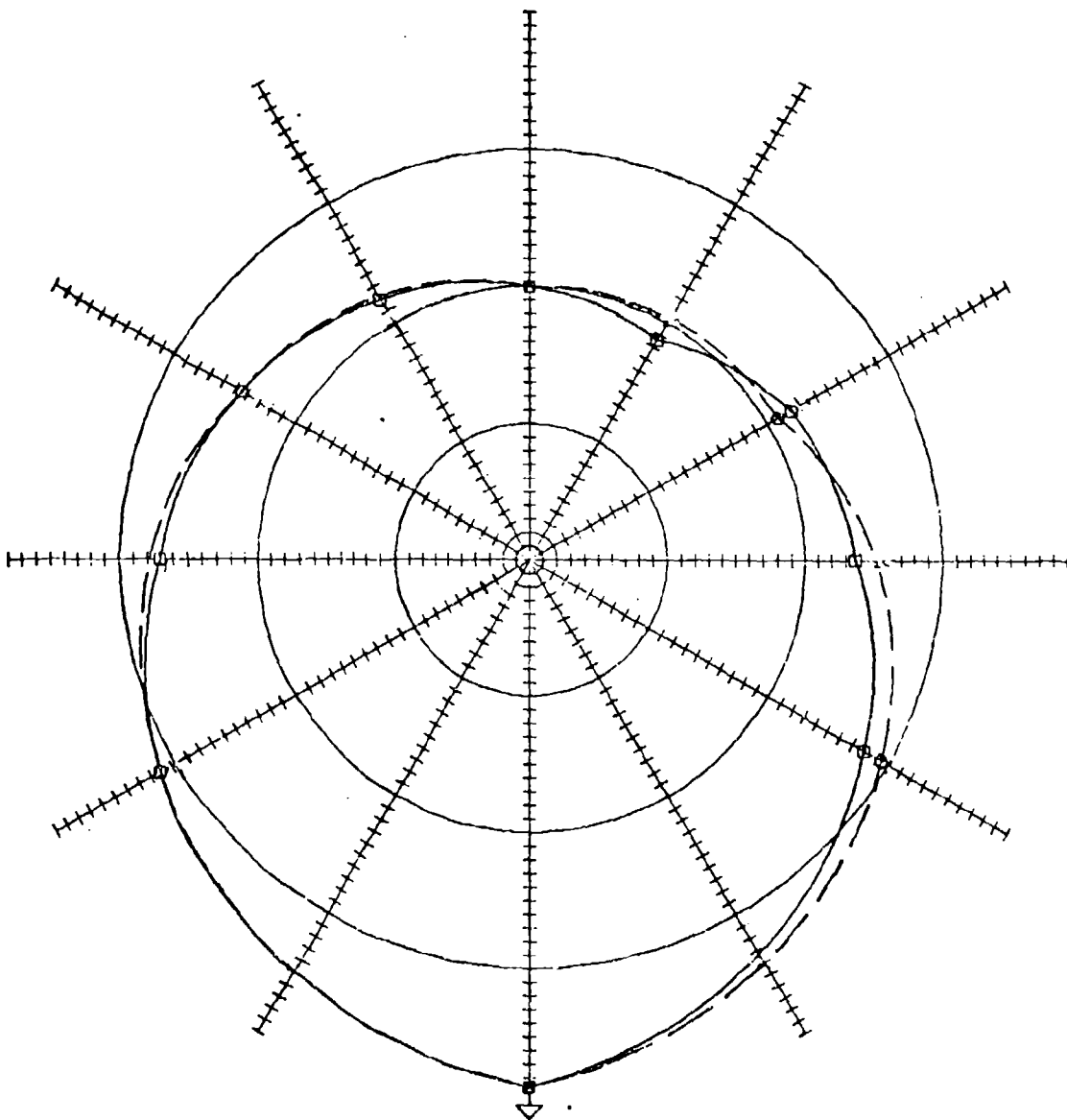


Figure 4. Polar plot example.

(Appendix C). The resulting contours showed that variation in charge size, elevation, or range did not consistently or significantly ( $\pm 2$  dB, typically) alter the noise contours.

Next, all contours for the same weapon (C-4) for varying events, i.e., at varying charge sizes and types, elevations, and ranges, were combined (see Appendix D). In addition, energy average\* in dB and the average differences in dB from the rear of the gun were compiled for each station. The average difference from the rear of the gun vs angle and the average difference from C-4 vs angle are found in Appendices C and D.

#### Weight Equivalency Tables

To develop appropriate weight equivalency tables, the energy average of the reduced noise-level data from the inner-ring stations was determined for each event of identical charge size and type, but varying elevation and range. These averages were then plotted against charge weights. When plotted, these averages showed that there was a logarithmic relationship between sound level and charge weight. All further calculations were therefore done using logarithm of weight. Appendix E lists the resulting weight equivalency tables.

Charge weight was also plotted against F- and C-weighted SEL (Figures 5 and 6)\*\*. These plots show that weapons which were in the same barrel-length group (Table 2) lie along the same line. Equation parameters for individual weapons and for grouped weapons are shown with their respective  $r^2$  in Tables 3 and 4.

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\*By this method, dB are converted to energy (J), averaged, and then converted back to dB.

\*\*A 270 oz, five white bag charge for the 8-in. M110 gun was not plotted since the charge was nonstandard. The 450 oz, seven white bag charge was not plotted because of indications of excess attenuation caused by the C-weighting.

+The standard error is a measure of the amount of variation of the data about the prediction model. The  $r^2$  is the multiple correlation coefficient squared; when multiplied by 100, it is the percent of the variation in the data which is explained by the equation.

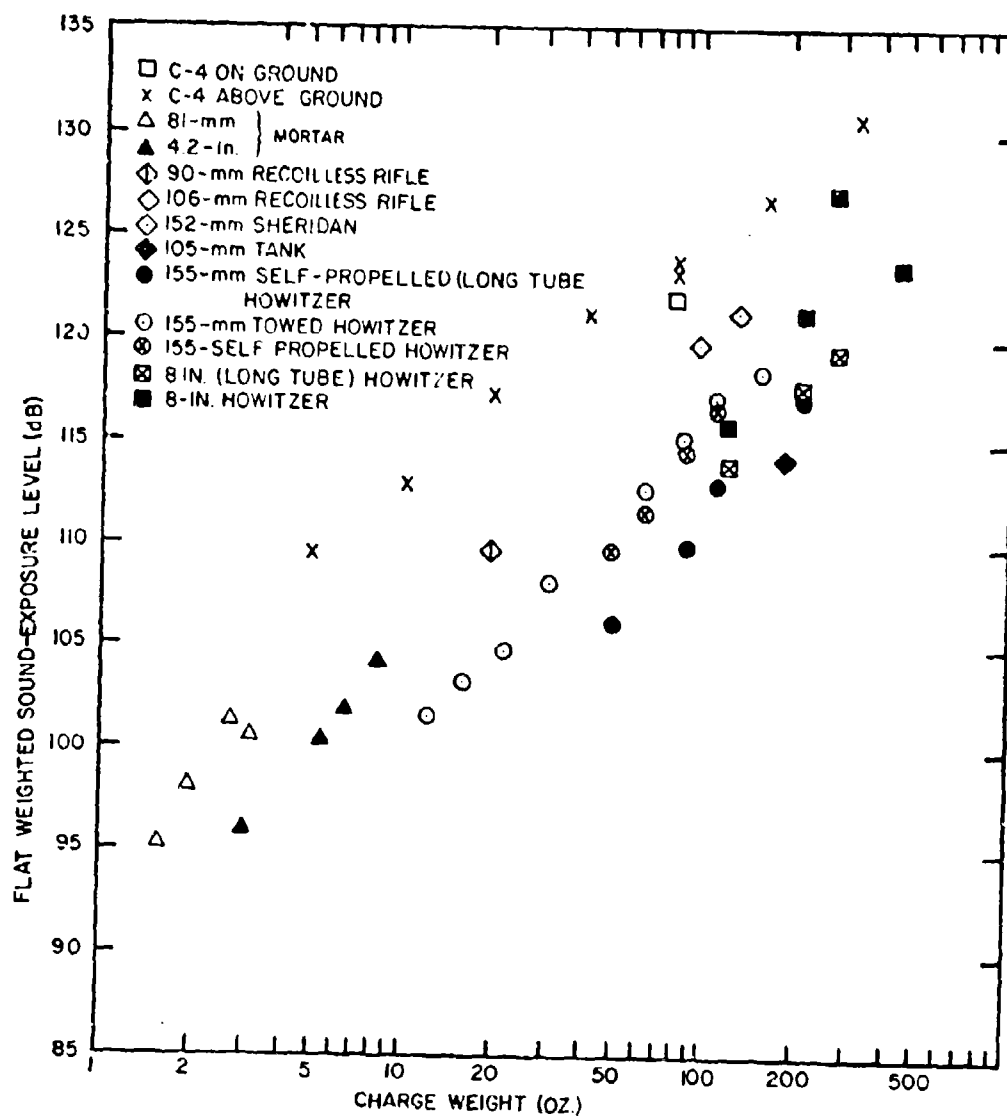


Figure 5. Flat-weighted SEL vs C-4 charge weight. Groupings are by tube length; point representing an 8-in. gun with a 270 oz. charge is a nonstandard charge.

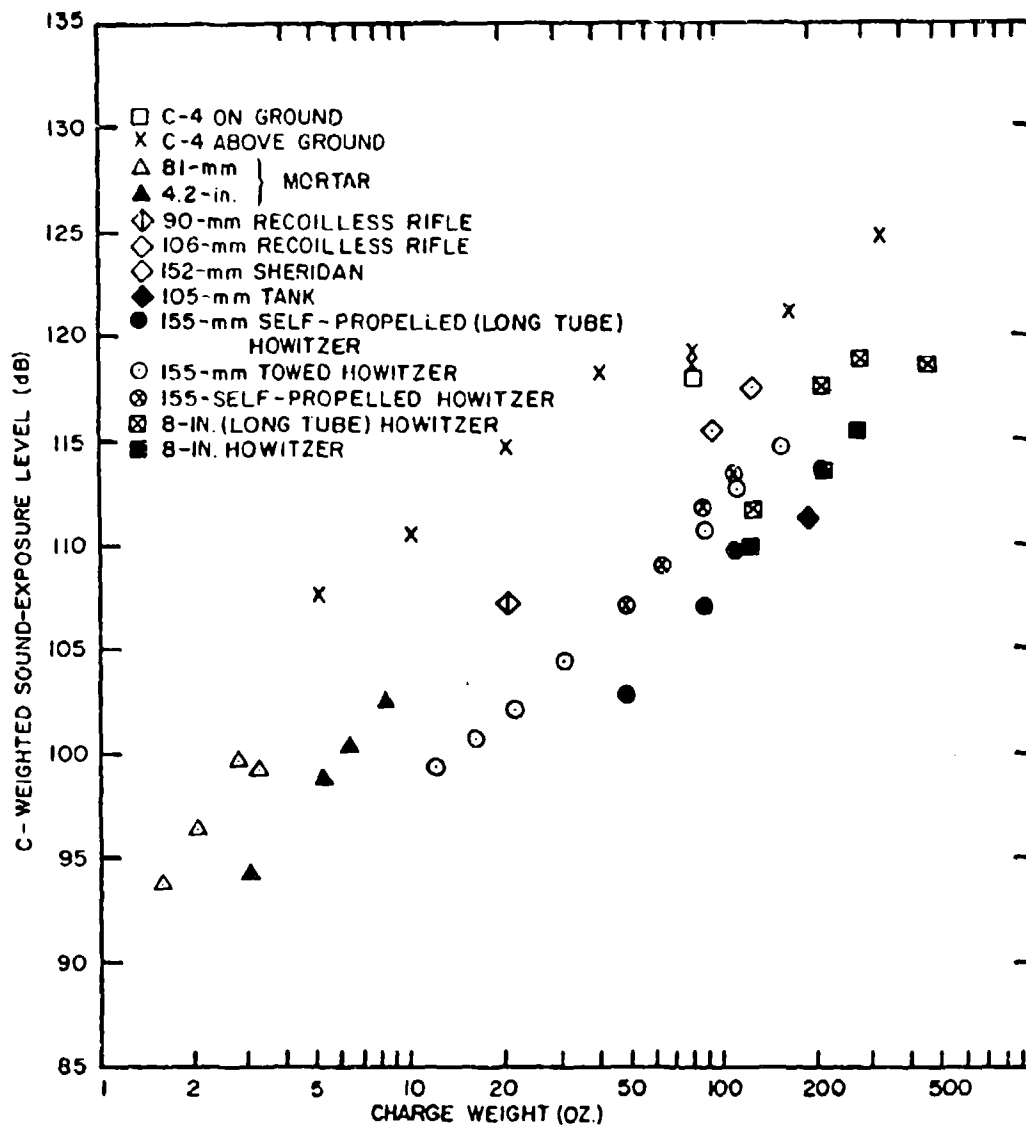


Figure 6. C-weighted SEL vs C-4 charge weight. Groupings are by tube length; the shift in the C-4 and 8 in. gun line at levels in excess of about 118 dB occurs because the C-weighting excludes the very low frequencies.

Table 2  
Barrel Lengths of Weapons Tested at Fort Sill

| <u>Very short (very light)</u> | <u>Model</u> |
|--------------------------------|--------------|
| 81-mm mortar                   |              |
| <u>Short tube</u>              |              |
| 4.2-in. mortar                 | M30          |
| 106-mm recoilless rifles       | M40A1        |
| 90-mm recoilless rifles        | M67          |
| 152-mm Sheridan tank gun       | M551         |
| <u>Regular tube</u>            |              |
| 105-mm howitzer                | M102         |
| 155-mm howitzer                | M109         |
| 8-in. howitzer                 | M110         |
| 155-mm howitzer                | M114         |
| <u>Long tube</u>               |              |
| 155-mm howitzer                | M109A1       |
| 8-in. self-propelled           | M110A1       |
| 105-mm tank                    | M60          |

Table 3  
Equation Parameters and Correlation Factors ( $r^2$ )  
for Weapons Tested at Fort Sill (F-weighted SEL)

| <u>Weapon</u>            | <u>Model</u> | <u>Equation Parameters</u> |          |                         |
|--------------------------|--------------|----------------------------|----------|-------------------------|
|                          |              | <u>A</u>                   | <u>B</u> | <u><math>r^2</math></u> |
| 81-mm mortar             |              | 91.65                      | 20.13    | 0.94                    |
| 4.2-in. mortar           | M30          | 87.05                      | 18.38    | 0.99                    |
| 106-mm recoilless rifles | M40A1        | N/A                        | N/A      | N/A                     |
| 90-mm recoilless rifles  | M57          | N/A                        | N/A      | N/A                     |
| 152-mm Sheridan tank gun | M551         | N/A                        | N/A      | N/A                     |
| 105-mm howitzer          | M102         | 83.97                      | 15.72    | 0.99                    |
| 155-mm howitzer          | M109         | 74.85                      | 20.48    | 1.00                    |
| 8 in. howitzer           | 10           | 88.30                      | 13.62    | 0.95                    |
| 105-mm howitzer          | M114         | 84.93                      | 15.59    | 0.97                    |
| 155-mm howitzer          | M109A1       | 75.16                      | 18.23    | 0.98                    |
| 8-in. self-propelled     | M110A1       | 80.04                      | 16.26    | 1.00                    |
| 105-mm tank              | M60          | N/A                        | N/A      | N/A                     |
| Short tube               |              | 89.14                      | 15.63    | 1.00                    |
| Regular tube             |              | 84.40                      | 15.48    | 0.99                    |
| Long tube                |              | 75.07                      | 18.35    | 0.99                    |
| C4                       |              | 101.59                     | 11.85    | 0.99                    |

$$\text{Level} = A + B * \log_{10} (\text{weight of propellant})$$

Table 4

Equation Parameters and Correlation Factors ( $r^2$ )  
for Weapons Tested at Fort Sill (C-weighted SEL)

| <u>Weapon</u>            | <u>Model</u> | <u>Equation Parameters</u> |          |                         |
|--------------------------|--------------|----------------------------|----------|-------------------------|
|                          |              | <u>A</u>                   | <u>B</u> | <u><math>r^2</math></u> |
| 81-mm mortar             |              | 90.27                      | 19.57    | 0.94                    |
| 4.2-in. mortar           | M30          | 85.17                      | 18.85    | 1.00                    |
| 106-mm recoilless rifles | M40A1        | N/A                        | N/A      | N/A                     |
| 90-mm recoilless rifles  | M67          | N/A                        | N/A      | N/A                     |
| 152-mm Sheridan tank gun | M551         | N/A                        | N/A      | N/A                     |
| 105-mm howitzer          | M102         | 83.78                      | 13.91    | 0.98                    |
| 155-mm howitzer          | M109         | 75.74                      | 18.51    | 1.00                    |
| 8-in. howitzer           | M110         | 60.91                      | 24.49    | 1.00                    |
| 155-mm howitzer          | M114         | 80.81                      | 15.59    | 0.98                    |
| 155-mm howitzer          | M109A1       | 72.08                      | 18.11    | 0.99                    |
| 8-in. self-propelled     | M110A1       | 76.99                      | 15.87    | 1.00                    |
| 105-mm tank              | M60          | N/A                        | N/A      | N/A                     |
| Short tube               |              | 88.75                      | 13.85    | 0.99                    |
| Regular tube             |              | 82.22                      | 14.99    | 0.99                    |
| Long tube                |              | 74.26                      | 16.94    | 0.97                    |

$$\text{Level} = A + B * \log_{10} (\text{weight of propellant})$$

## 5 RESULTS

### Prediction Method

CERL's previous noise propagation study at Fort Leonard Wood<sup>7</sup> established the noise-level standard for a 5-lb charge of C-4. The Fort Sill tests described in this report use the variance in gun-noise levels from this C-4 standard to develop correction factors which allow the prediction of the effects of gun type, charge size, and charge type on gun-noise levels.

The weight equivalency tables developed as a result of the study described in this report can also be used to predict gun-noise impacts. To do so requires that the weight equivalency plot in Figure 6 be used to determine the charge weight/weapon correction factor.

First, select the appropriate C-4 value from the weight relationship plotted in Figure 6. Second, select the appropriate inner-ring energy average for the weapon for which noise impact is to be predicted by the equations in Table 4. Finally, select the appropriate average difference from the rear-of-gun reference point for the weapon under consideration from Appendix D. (See Figure 7 for an example of this procedure.)

When the value for the C-4 plus the value of average difference from the rear-of-gun reference point is subtracted from the inner-ring energy average, the result is the charge weight/weapon correction factor (see Figure 7).

To determine the directivity correction factor, select the appropriate value from the tables in Appendix D and interpolate, if necessary (see Figure 7).

### Additional Results

Figure 6 exhibits a number of interesting relationships:

1. The amplitude vs weight of the C-4 charge curve is not a straight line, but more S-shaped. This results from the gradual shift to lower frequencies as the weight of charge is increased. And, as the

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<sup>7</sup> Schomer, P. D., R. J. Goff, and L. M. Little, The Statistics of Amplitude and Spectrum of Blasts Propagated in the Atmosphere, Volumes I and II, Technical Report N13/ADA0333475 and ADA033361 (CERL, November 1976).

Find correction factors, for the side (90°) of a 155-mm towed howitzer (M114) for three green bags:

1. Three green bags = 49.4 oz of propellant

2. 49.4 oz of C-4 (C-weighted SEL from Figure 6) = 118.8 dB ← ①

From Table 4

|              | A     | B     | r <sup>2</sup> |
|--------------|-------|-------|----------------|
| Short tube   | 88.75 | 13.85 | 0.99           |
| Regular tube | 82.22 | 14.99 | 0.99           |
| Long tube    | 74.26 | 16.94 | 0.97           |

② → 107.61 = 82.22 + 14.99 \* Log<sup>10</sup> (49.4)

From Appendix D

NAME 155 MM HOWITZER M114  
ELEVATION ALL  
CHARGE SIZE ALL

| CHANNEL | ENERGY | DIFFERENCE FROM REAR | ANGLE   | DIFFERENCE FROM REAR |
|---------|--------|----------------------|---------|----------------------|
| 1       | 112.57 | 9.80                 | 0°      | 14.93                |
| 2       | 105.84 | 3.41                 | 30°     | 12.55                |
| 3       | 103.24 | 0.00                 | 60°     | 10.18                |
| 4       | 105.72 | 2.86                 | 90°     | 6.87 ← ④             |
| 5       | 113.15 | 10.71                | 120°    | 3.20                 |
| 6       | 106.10 | 10.28                | 150°    | 1.56                 |
| 7       | 99.41  | 3.09                 | 180°    | 0.00                 |
| 8       | 101.99 | 6.24                 | 210°    | 1.56                 |
| 9       | 115.59 | 14.93                | 240°    | 3.20                 |
| 10      | 106.87 | 9.83                 | 270°    | 6.87                 |
| 11      | 103.64 | 7.42                 | 300°    | 10.18                |
| 12      | 99.20  | 3.52                 | 330°    | 12.55                |
| 13      | 97.15  | 1.51                 |         |                      |
| 14      | 97.45  | 0.00                 |         |                      |
| 15      | 97.43  | 1.61                 |         |                      |
| 16      | 102.14 | 6.32                 | AVERAGE | 9.45 ← ③             |

Weight/Weapon Correction = ② - ① - ③

-20.6 dB = 107.6 - 118.8 - 9.45

Directivity Correction ④ = 6.87

Figure 7. Weight/weapon and directivity correction factor prediction method.

shift is made to lower frequencies, the C-weighting gradually attenuates more and more of the signal. Thus, at higher charge sizes for the larger weapons, the weapon curves move very close to the C-4 curve. This is because of the spectral shift operating on the C-4, but not yet on the weapons.

2. Figure 5, which uses flat weighting, shows a straight line for the C-4 weight relationship, and a 3.6-dB increase when C-4 weight is doubled. Three sizes of weapons -- short, medium, and long tube -- are on this same curve. (The longer the tube, the more contained the charge, and, therefore, the smaller the noise.)

3. The weapon curves grow at a faster rate than those of the unconstrained C-4 curves, indicating that the bigger the charge in a given tube length, the more unconstrained it appears, and thus the more it approaches the C-4 curve.

4. The last major finding of this study was the effect of a muzzle brake on directivity patterns. Figures 8 and 9 show directivity patterns for a self-propelled and a towed 155-mm howitzer, respectively. The self-propelled howitzer uses a muzzle brake, the towed howitzer does not; the directivity pattern for the self-propelled howitzer is practically circular whereas the directivity pattern for the towed howitzer is strongly towards the front of the gun. This indicates that the muzzle brake causes some of the gases and noise which would go towards the front to be redirected toward the sides and rear: the result is an almost circular pattern. The same general relationship is true for the other weapons; i.e., with a muzzle brake, the directivity pattern is virtually circular. Without a muzzle brake, the directivity pattern is much stronger towards the front of the gun. The exceptions, of course, are the recoilless rifles which have a strong component both towards the front and the rear of the weapon.

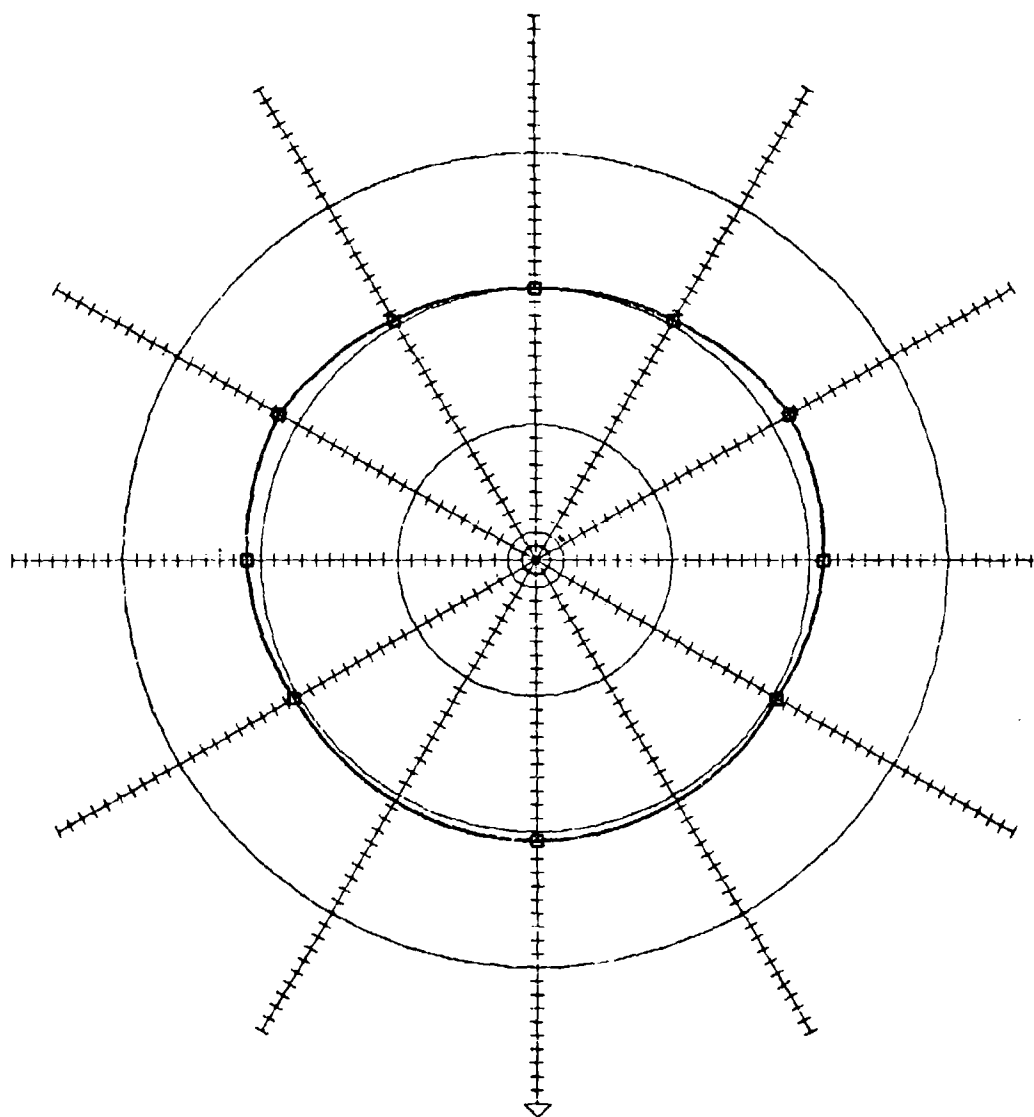


Figure 8. Directivity pattern of a self-propelled 155-mm howitzer. Each hatch mark is 1 dB. The absolute level at the rear of the gun is 100 dB.

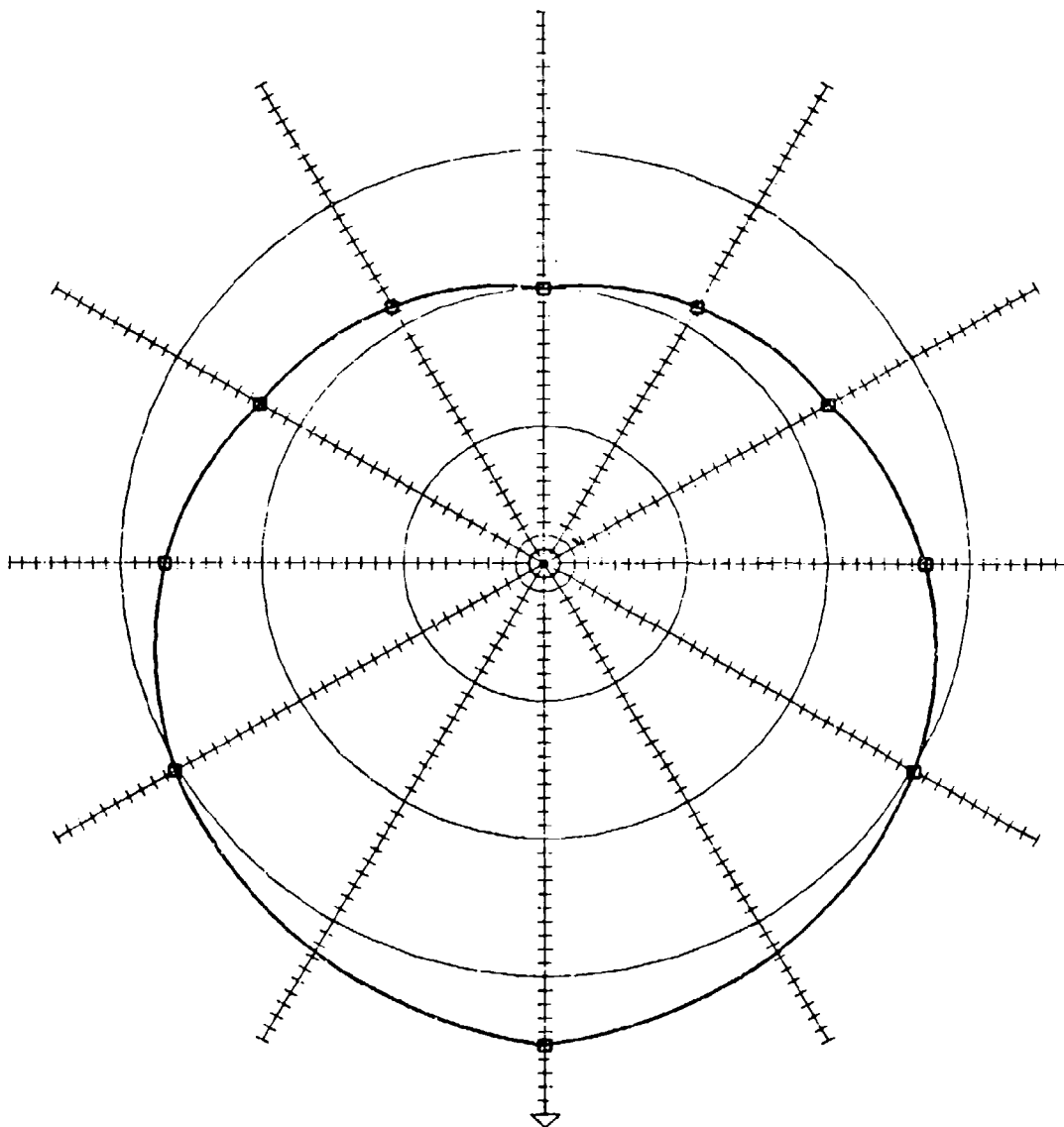


Figure 9. Directivity pattern of a towed 155-mm howitzer. Each hatch mark is 1 dB. The absolute level at the rear of the gun is 100 db.

## 6 CONCLUSIONS

Precise sound-pressure level contours (directivity patterns) and weight equivalence patterns which relate weight of charge to equivalent C-4 weight were developed for Army weapons in current use. Data and information developed as a result of this study are presented in a form suitable for use in manual or automated blast noise-impact prediction methods.

The following general technical conclusions can also be made from this study:

1. Elevation has little influence on directivity patterns; therefore, directivity patterns can be considered as independent of elevation. Muzzle brakes (except for recoilless rifles) are the biggest factor affecting weapon contour shapes. Muzzle brakes cause directivity patterns to become almost circular.

2. The weight equivalency tables developed are a function of tube size, with the longest tubes being the quietest because the charge is most contained.

APPENDIX A:

EVENT LOG

| #   | DAY | TIME     | WEAPON          | MODEL | CHARGE SIZE   | ELEVA | RANGE |
|-----|-----|----------|-----------------|-------|---------------|-------|-------|
| 51  | 13  | 12:51:16 | 105 MM TANK     | M60   |               |       |       |
| 52  | 13  | 12:58:46 | CALIBRATION     |       | 5.00 LBS.     |       |       |
| 53  | 13  | 14:01:26 | CALIBRATION     |       | 5.00 LBS.     |       |       |
| 54  | 13  | 14:04:41 | 105 MM TANK     | M60   |               |       |       |
| 55  | 13  | 14:05:20 | 105 MM TANK     | M60   |               |       |       |
| 56  | 13  | 14:06:05 | 105 MM TANK     | M60   |               |       |       |
| 57  | 13  | 14:12:07 | CALIBRATION     |       | 5.00 LBS.     |       |       |
| 58  | 13  | 14:15:17 | 105 MM TANK     | M60   |               |       |       |
| 59  | 13  | 14:15:57 | 105 MM TANK     | M60   |               |       |       |
| 60  | 13  | 14:16:36 | 105 MM TANK     | M60   |               |       |       |
| 61  | 13  | 14:22:37 | CALIBRATION     |       | 5.00 LBS.     |       |       |
| 62  | 13  | 14:25:41 | 105 MM TANK     | M60   |               |       |       |
| 63  | 13  | 14:26:21 | 105 MM TANK     | M60   |               |       |       |
| 64  | 13  | 14:27:01 | 105 MM TANK     | M60   |               |       |       |
| 65  | 13  | 14:38:25 | CALIBRATION     |       | 5.00 LBS.     |       |       |
| 66  | 13  | 16:12:29 | CALIBRATION     |       | 5.00 LBS.     |       |       |
| 67  | 13  | 16:20:58 | C4 ON GROUND    |       | 5.00 LBS.     |       |       |
| 68  | 13  | 16:27:12 | CALIBRATION     |       | 5.00 LBS.     |       |       |
| 69  | 13  | 16:35:40 | C4 ON GROUND    |       | 5.00 LBS.     |       |       |
| 70  | 13  | 16:43:14 | CALIBRATION     |       | 5.00 LBS.     |       |       |
| 71  | 13  | 16:55:40 | C4 ON GROUND    |       | 5.00 LBS.     |       |       |
| 72  | 13  | 17:02:02 | CALIBRATION     |       | 5.00 LBS.     |       |       |
| 73  | 13  | 17:09:00 | C4 ON GROUND    |       | 5.00 LBS.     |       |       |
| 74  | 13  | 17:16:34 | CALIBRATION     |       | 5.00 LBS.     |       |       |
| 75  | 13  | 17:24:03 | C4 ON GROUND    |       | 5.00 LBS.     |       |       |
| 76  | 14  | 10:45:50 | CALIBRATION     |       | 5.00 LBS.     |       |       |
| 77  | 14  | 10:54:29 | CALIBRATION     |       | 5.00 LBS.     |       |       |
| 78  | 14  | 10:58:59 | 4.2 INCH MORTAR | M30   | 11 GREEN BAGS | 900   |       |
| 79  | 14  | 11:04:31 | 4.2 INCH MORTAR | M30   | 11 GREEN BAGS | 900   |       |
| 80  | 14  | 11:08:21 | 4.2 INCH MORTAR | M30   | 11 GREEN BAGS | 900   |       |
| 81  | 14  | 11:09:04 | 4.2 INCH MORTAR | M30   | 11 GREEN BAGS | 900   |       |
| 82  | 14  | 11:09:44 | 4.2 INCH MORTAR | M30   | 11 GREEN BAGS | 900   |       |
| 83  | 14  | 11:17:39 | CALIBRATION     |       | 5.00 LBS.     |       |       |
| 84  | 14  | 11:28:04 | CALIBRATION     |       | 5.00 LBS.     |       |       |
| 85  | 14  | 11:31:24 | 4.2 INCH MORTAR | M30   | 24 GREEN BAGS | 900   |       |
| 86  | 14  | 11:34:23 | 4.2 INCH MORTAR | M30   | 24 GREEN BAGS | 900   |       |
| 87  | 14  | 11:37:56 | 4.2 INCH MORTAR | M30   | 24 GREEN BAGS | 900   |       |
| 88  | 14  | 11:38:38 | 4.2 INCH MORTAR | M30   | 24 GREEN BAGS | 900   |       |
| 89  | 14  | 11:39:19 | 4.2 INCH MORTAR | M30   | 24 GREEN BAGS | 900   |       |
| 90  | 14  | 11:46:56 | CALIBRATION     |       | 5.00 LBS.     |       |       |
| 91  | 14  | 11:56:07 | CALIBRATION     |       | 5.00 LBS.     |       |       |
| 92  | 14  | 12:00:10 | 4.2 INCH MORTAR | M30   | 20 GREEN BAGS | 1065  |       |
| 93  | 14  | 12:06:03 | 4.2 INCH MORTAR | M30   | 20 GREEN BAGS | 1065  |       |
| 94  | 14  | 12:06:45 | 4.2 INCH MORTAR | M30   | 20 GREEN BAGS | 1065  |       |
| 95  | 14  | 12:07:07 | 4.2 INCH MORTAR | M30   | 20 GREEN BAGS | 1065  |       |
| 96  | 14  | 12:08:07 | 4.2 INCH MORTAR | M30   | 20 GREEN BAGS | 1065  |       |
| 97  | 14  | 12:13:30 | CALIBRATION     |       | 5.00 LBS.     |       |       |
| 98  | 14  | 12:26:05 | CALIBRATION     |       | 5.00 LBS.     |       |       |
| 99  | 14  | 12:30:11 | 4.2 INCH MORTAR | M30   | 31 GREEN BAGS | 1065  |       |
| 100 | 14  | 12:33:30 | 4.2 INCH MORTAR | M30   | 31 GREEN BAGS | 1065  |       |

| #   | DAY | TIME     | WEAPON          | MODEL | CHARGE SIZE   | ELEVA | RANGE |
|-----|-----|----------|-----------------|-------|---------------|-------|-------|
| 101 | 14  | 12:34:11 | 4.2 INCH MORTAR | M30   | 31 GREEN BAGS | 1065  |       |
| 102 | 14  | 12:34:53 | 4.2 INCH MORTAR | M30   | 31 GREEN BAGS | 1065  |       |
| 103 | 14  | 12:35:36 | 4.2 INCH MORTAR | M30   | 31 GREEN BAGS | 1065  |       |
| 104 | 14  | 12:42:55 | CALIBRATION     |       | 5.00 LBS.     |       |       |
| 105 | 14  | 14:23:10 | CALIBRATION     |       | 5.00 LBS.     |       |       |
| 106 | 14  | 14:27:12 | 81 MM MORTAR    |       | 4 GREEN BAGS  | 900   | 2400  |
| 107 | 14  | 14:32:32 | 81 MM MORTAR    |       | 4 GREEN BAGS  | 900   | 2400  |
| 108 | 14  | 14:33:16 | 81 MM MORTAR    |       | 4 GREEN BAGS  | 900   | 2400  |
| 109 | 14  | 14:33:56 | 81 MM MORTAR    |       | 4 GREEN BAGS  | 900   | 2400  |
| 110 | 14  | 14:34:38 | 81 MM MORTAR    |       | 4 GREEN BAGS  | 900   | 2400  |
| 111 | 14  | 14:42:09 | CALIBRATION     |       | 5.00 LBS.     |       |       |
| 112 | 14  | 14:52:03 | CALIBRATION     |       | 5.00 LBS.     |       |       |
| 113 | 14  | 14:56:48 | 81 MM MORTAR    |       | 7 GREEN BAGS  | 900   | 3700  |
| 114 | 14  | 15:00:39 | 81 MM MORTAR    |       | 7 GREEN BAGS  | 900   | 3700  |
| 115 | 14  | 15:01:21 | 81 MM MORTAR    |       | 7 GREEN BAGS  | 900   | 3700  |
| 116 | 14  | 15:02:03 | 81 MM MORTAR    |       | 7 GREEN BAGS  | 900   | 3700  |
| 117 | 14  | 15:02:47 | 81 MM MORTAR    |       | 7 GREEN BAGS  | 900   | 3700  |
| 118 | 14  | 15:08:05 | CALIBRATION     |       | 5.00 LBS.     |       |       |
| 119 | 14  | 15:15:30 | CALIBRATION     |       | 5.00 LBS.     |       |       |
| 120 | 14  | 15:19:34 | 81 MM MORTAR    |       | 5 GREEN BAGS  | 1050  | 2525  |
| 121 | 14  | 15:23:27 | 81 MM MORTAR    |       | 5 GREEN BAGS  | 1050  | 2525  |
| 122 | 14  | 15:24:11 | 81 MM MORTAR    |       | 5 GREEN BAGS  | 1050  | 2525  |
| 123 | 14  | 15:24:52 | 81 MM MORTAR    |       | 5 GREEN BAGS  | 1050  | 2525  |
| 124 | 14  | 15:25:35 | 81 MM MORTAR    |       | 5 GREEN BAGS  | 1050  | 2525  |
| 125 | 14  | 15:30:37 | CALIBRATION     |       | 5.00 LBS.     |       |       |
| 126 | 14  | 15:38:56 | CALIBRATION     |       | 5.00 LBS.     |       |       |
| 127 | 14  | 15:42:15 | 81 MM MORTAR    |       | 8 GREEN BAGS  | 1050  | 3625  |
| 128 | 14  | 15:45:50 | 81 MM MORTAR    |       | 8 GREEN BAGS  | 1050  | 3625  |
| 129 | 14  | 15:46:31 | 81 MM MORTAR    |       | 8 GREEN BAGS  | 1050  | 3625  |
| 130 | 14  | 15:47:14 | 81 MM MORTAR    |       | 8 GREEN BAGS  | 1050  | 3625  |
| 131 | 14  | 15:47:55 | 81 MM MORTAR    |       | 8 GREEN BAGS  | 1050  | 3625  |
| 132 | 14  | 15:52:51 | CALIBRATION     |       | 5.00 LBS.     |       |       |
| 133 | 14  | 16:00:11 | CALIBRATION     |       | 5.00 LBS.     |       |       |
| 134 | 19  | 10:11:21 | CALIBRATION     |       | 5.00 LBS.     |       |       |
| 135 | 19  | 10:19:36 | CALIBRATION     |       | 5.00 LBS.     |       |       |
| 136 | 19  | 10:25:52 | 155 MM HOWITZER | M109  | 3 GREEN BAGS  | 150   |       |
| 137 | 19  | 10:29:27 | 155 MM HOWITZER | M109  | 3 GREEN BAGS  | 150   |       |
| 138 | 19  | 10:30:14 | 155 MM HOWITZER | M109  | 3 GREEN BAGS  | 150   |       |
| 139 | 19  | 10:30:57 | 155 MM HOWITZER | M109  | 3 GREEN BAGS  | 150   |       |
| 140 | 19  | 10:31:40 | 155 MM HOWITZER | M109  | 3 GREEN BAGS  | 150   |       |
| 141 | 19  | 10:42:21 | CALIBRATION     |       | 5.00 LBS.     |       |       |
| 142 | 19  | 10:48:47 | CALIBRATION     |       | 5.00 LBS.     |       |       |
| 143 | 19  | 10:53:07 | 155 MM HOWITZER | M109  | 4 GREEN BAGS  | 300   |       |
| 144 | 19  | 10:56:06 | 155 MM HOWITZER | M109  | 4 GREEN BAGS  | 300   |       |
| 145 | 19  | 10:56:50 | 155 MM HOWITZER | M109  | 4 GREEN BAGS  | 300   |       |
| 146 | 19  | 10:57:36 | 155 MM HOWITZER | M109  | 4 GREEN BAGS  | 300   |       |
| 147 | 19  | 10:58:18 | 155 MM HOWITZER | M109  | 4 GREEN BAGS  | 300   |       |
| 148 | 19  | 11:03:58 | CALIBRATION     |       | 5.00 LBS.     |       |       |
| 149 | 19  | 11:11:53 | CALIBRATION     |       | 5.00 LBS.     |       |       |
| 150 | 19  | 11:16:02 | 155 MM HOWITZER | M109  | 5 GREEN BAGS  | 350   |       |

| #   | DAY | TIME     | WEAPON          | MODEL | CHARGE SIZE  | ELEVA | RANGE |
|-----|-----|----------|-----------------|-------|--------------|-------|-------|
| 151 | 19  | 11:19:05 | 155 MM HOWITZER | M109  | 5 GREEN BAGS | 350   |       |
| 152 | 19  | 11:19:47 | 155 MM HOWITZER | M109  | 5 GREEN BAGS | 350   |       |
| 153 | 19  | 11:20:29 | 155 MM HOWITZER | M109  | 5 GREEN BAGS | 350   |       |
| 154 | 19  | 11:21:11 | 155 MM HOWITZER | M109  | 5 GREEN BAGS | 350   |       |
| 155 | 19  | 11:35:57 | CALIBRATION     |       | 5.00 LBS.    |       |       |
| 156 | 19  | 11:40:57 | CALIBRATION     |       | 5.00 LBS.    |       |       |
| 157 | 19  | 11:44:00 | 155 MM HOWITZER | M109  | 5 WHITE BAGS | 60    |       |
| 158 | 19  | 12:58:46 | CALIBRATION     |       | 5.00 LBS.    |       |       |
| 159 | 19  | 13:02:09 | 155 MM HOWITZER | M109  | 5 WHITE BAGS | 60    |       |
| 160 | 19  | 13:02:55 | 155 MM HOWITZER | M109  | 5 WHITE BAGS | 60    |       |
| 161 | 19  | 13:03:39 | 155 MM HOWITZER | M109  | 5 WHITE BAGS | 60    |       |
| 162 | 19  | 13:04:23 | 155 MM HOWITZER | M109  | 5 WHITE BAGS | 60    |       |
| 163 | 19  | 13:14:00 | CALIBRATION     |       | 5.00 LBS.    |       |       |
| 164 | 19  | 13:21:14 | C4 ON GROUND    |       | 5.00 LBS.    |       |       |
| 165 | 19  | 13:25:11 | 155 MM HOWITZER | M109  | 5 WHITE BAGS | 350   |       |
| 166 | 19  | 13:28:13 | 155 MM HOWITZER | M109  | 5 WHITE BAGS | 350   |       |
| 167 | 19  | 13:28:59 | 155 MM HOWITZER | M109  | 5 WHITE BAGS | 350   |       |
| 168 | 19  | 13:29:41 | 155 MM HOWITZER | M109  | 5 WHITE BAGS | 350   |       |
| 169 | 19  | 13:30:23 | 155 MM HOWITZER | M109  | 5 WHITE BAGS | 350   |       |
| 170 | 19  | 13:35:51 | CALIBRATION     |       | 5.00 LBS.    |       |       |
| 171 | 19  | 13:44:23 | CALIBRATION     |       | 5.00 LBS.    |       |       |
| 172 | 19  | 13:48:17 | 155 MM HOWITZER | M109  | 5 WHITE BAGS | 1275  |       |
| 173 | 19  | 13:53:01 | 155 MM HOWITZER | M109  | 5 WHITE BAGS | 1275  |       |
| 174 | 19  | 13:53:52 | 155 MM HOWITZER | M109  | 5 WHITE BAGS | 1275  |       |
| 175 | 19  | 13:54:34 | 155 MM HOWITZER | M109  | 5 WHITE BAGS | 1275  |       |
| 176 | 19  | 13:55:17 | 155 MM HOWITZER | M109  | 5 WHITE BAGS | 1275  |       |
| 177 | 19  | 14:00:55 | CALIBRATION     |       | 5.00 LBS.    |       |       |
| 178 | 19  | 15:13:32 | C4              |       | 5.00 LBS.    |       |       |
| 179 | 19  | 15:19:14 | C4              |       | 0.31 LBS.    |       |       |
| 180 | 19  | 15:26:17 | C4              |       | 20.00 LBS.   |       |       |
| 181 | 19  | 15:35:06 | C4              |       | 1.25 LBS.    |       |       |
| 182 | 19  | 15:42:46 | C4              |       | 2.50 LBS.    |       |       |
| 183 | 19  | 15:50:23 | C4              |       | 10.00 LBS.   |       |       |
| 184 | 19  | 15:56:29 | C4              |       | 0.62 LBS.    |       |       |
| 185 | 19  | 16:02:47 | C4              |       | 5.00 LBS.    |       |       |
| 186 | 19  | 16:09:40 | C4              |       | 0.31 LBS.    |       |       |
| 187 | 19  | 16:19:52 | C4              |       | 20.00 LBS.   |       |       |
| 188 | 19  | 16:26:35 | C4              |       | 1.25 LBS.    |       |       |
| 189 | 19  | 16:32:32 | C4              |       | 2.50 LBS.    |       |       |
| 190 | 19  | 16:39:59 | C4              |       | 10.00 LBS.   |       |       |
| 191 | 19  | 16:47:12 | C4              |       | 0.62 LBS.    |       |       |
| 192 | 19  | 16:52:34 | C4              |       | 5.00 LBS.    |       |       |
| 193 | 19  | 16:58:31 | C4              |       | 0.31 LBS.    |       |       |
| 194 | 19  | 17:05:39 | C4              |       | 20.00 LBS.   |       |       |
| 195 | 19  | 17:11:19 | C4              |       | 1.25 LBS.    |       |       |
| 196 | 19  | 17:16:50 | C4              |       | 2.50 LBS.    |       |       |
| 197 | 19  | 17:24:05 | C4              |       | 10.00 LBS.   |       |       |
| 198 | 19  | 17:30:06 | C4              |       | 0.62 LBS.    |       |       |
| 199 | 19  | 17:35:47 | C4              |       | 5.00 LBS.    |       |       |
| 200 | 20  | 9:47:53  | CALIBRATION     |       | 5.00 LBS.    |       |       |

| #   | DAY | TIME     | WEAPON               | MODEL | CHARGE SIZE  | ELEVA | RANGE |
|-----|-----|----------|----------------------|-------|--------------|-------|-------|
| 201 | 20  | 10:08:33 | CALIBRATION          |       | 5.00 LBS.    |       |       |
| 202 | 20  | 10:22:05 | 8 INCH HOWITZER      | M110  | 5 WHITE BAGS | 100   |       |
| 203 | 20  | 10:42:00 | 8 INCH HOWITZER      | M110  | 5 WHITE BAGS | 100   |       |
| 204 | 20  | 10:57:09 | 8 INCH HOWITZER      | M110  | 5 WHITE BAGS | 100   |       |
| 205 | 20  | 11:03:39 | CALIBRATION          |       | 5.00 LBS.    |       |       |
| 206 | 20  | 11:12:43 | 8 INCH HOWITZER      | M110  | 5 WHITE BAGS | 100   |       |
| 207 | 20  | 11:17:36 | 8 INCH HOWITZER      | M110  | 5 WHITE BAGS | 100   |       |
| 208 | 20  | 11:21:30 | 8 INCH HOWITZER      | M110  | 5 WHITE BAGS | 200   |       |
| 209 | 20  | 11:28:23 | CALIBRATION          |       | 5.00 LBS.    |       |       |
| 210 | 20  | 11:40:01 | 8 INCH HOWITZER      | M110  | 5 WHITE BAGS | 200   |       |
| 211 | 20  | 11:42:45 | 8 INCH HOWITZER      | M110  | 5 WHITE BAGS | 200   |       |
| 212 | 20  | 11:44:51 | 8 INCH HOWITZER      | M110  | 5 WHITE BAGS | 200   |       |
| 213 | 20  | 11:50:48 | CALIBRATION          |       | 5.00 LBS.    |       |       |
| 214 | 20  | 13:41:01 | CALIBRATION          |       | 5.00 LBS.    |       |       |
| 215 | 20  | 13:49:13 | 8 INCH HOWITZER      | M110  | 5 WHITE BAGS | 200   |       |
| 216 | 20  | 13:53:53 | 8 INCH HOWITZER      | M110  | 7 WHITE BAGS | 100   |       |
| 217 | 20  | 14:38:48 | 8 INCH HOWITZER      | M110  | 7 WHITE BAGS | 100   |       |
| 218 | 20  | 14:45:16 | CALIBRATION          |       | 5.00 LBS.    |       |       |
| 219 | 20  | 15:50:43 | CALIBRATION          |       | 5.00 LBS.    |       |       |
| 220 | 20  | 15:59:22 | 8 INCH HOWITZER      | M110  | 7 WHITE BAGS | 100   |       |
| 221 | 20  | 16:01:16 | 8 INCH HOWITZER      | M110  | 7 WHITE BAGS | 100   |       |
| 222 | 20  | 16:03:09 | 8 INCH HOWITZER      | M110  | 7 WHITE BAGS | 100   |       |
| 223 | 20  | 16:09:50 | CALIBRATION          |       | 5.00 LBS.    |       |       |
| 224 | 20  | 16:18:57 | 8 INCH HOWITZER      | M110  | 3 GREEN BAGS | 200   |       |
| 225 | 20  | 16:21:08 | 8 INCH HOWITZER      | M110  | 3 GREEN BAGS | 200   |       |
| 226 | 20  | 16:23:09 | 8 INCH HOWITZER      | M110  | 3 GREEN BAGS | 200   |       |
| 227 | 20  | 16:29:51 | CALIBRATION          |       | 5.00 LBS.    |       |       |
| 228 | 20  | 16:37:17 | 8 INCH HOWITZER      | M110  | 3 GREEN BAGS | 200   |       |
| 229 | 20  | 16:39:15 | 8 INCH HOWITZER      | M110  | 3 GREEN BAGS | 200   |       |
| 230 | 20  | 16:43:44 | 8 INCH HOWITZER      | M110  | 3 GREEN BAGS | 400   |       |
| 231 | 20  | 16:50:48 | CALIBRATION          |       | 5.00 LBS.    |       |       |
| 232 | 20  | 18:30:58 | C4 ON GROUND         |       | 5.00 LBS.    |       |       |
| 233 | 20  | 18:37:05 | 8 INCH HOWITZER      | M110  | 3 GREEN BAGS | 400   |       |
| 234 | 20  | 18:39:04 | 8 INCH HOWITZER      | M110  | 3 GREEN BAGS | 400   |       |
| 235 | 20  | 18:41:05 | 8 INCH HOWITZER      | M110  | 3 GREEN BAGS | 400   |       |
| 236 | 20  | 18:46:43 | CALIBRATION          |       | 5.00 LBS.    |       |       |
| 237 | 20  | 18:52:24 | 8 INCH HOWITZER      | M110  | 3 GREEN BAGS | 400   |       |
| 238 | 20  | 18:54:23 | 8 INCH HOWITZER      | M110  | 5 GREEN BAGS | 200   |       |
| 239 | 20  | 18:56:24 | 8 INCH HOWITZER      | M110  | 5 GREEN BAGS | 200   |       |
| 240 | 20  | 19:01:38 | CALIBRATION          |       | 5.00 LBS.    |       |       |
| 241 | 20  | 19:07:43 | 8 INCH HOWITZER      | M110  | 5 GREEN BAGS | 200   |       |
| 242 | 20  | 19:09:44 | 8 INCH HOWITZER      | M110  | 5 GREEN BAGS | 200   |       |
| 243 | 20  | 19:11:45 | 8 INCH HOWITZER      | M110  | 5 GREEN BAGS | 200   |       |
| 244 | 20  | 19:18:23 | CALIBRATION          |       | 5.00 LBS.    |       |       |
| 245 | 20  | 19:25:10 | CALIBRATION          |       | 5.00 LBS.    |       |       |
| 246 | 21  | 9:44:31  | CALIBRATION          |       | 5.00 LBS.    |       |       |
| 247 | 21  | 9:51:01  | CALIBRATION          |       | 5.00 LBS.    |       |       |
| 248 | 21  | 9:55:58  | 152 MM SHERIDAN TANK |       |              | 59    | 3095  |
| 249 | 21  | 10:00:21 | 152 MM SHERIDAN TANK |       |              | 59    | 3095  |
| 250 | 21  | 10:01:17 | 152 MM SHERIDAN TANK |       |              | 59    | 3095  |

| #   | DAY | TIME     | WEAPON               | MODEL. | CHARGE SIZE | ELEVA | RANGE |
|-----|-----|----------|----------------------|--------|-------------|-------|-------|
| 251 | 21  | 10:02:21 | 152 MM SHERIDAN TANK |        |             | 59    | 3095  |
| 252 | 21  | 10:09:10 | CALIBRATION          |        | 5.00 LBS.   |       |       |
| 253 | 21  | 10:13:35 | 152 MM SHERIDAN TANK |        |             | 59    | 3095  |
| 254 | 21  | 10:17:21 | 152 MM SHERIDAN TANK |        |             | 59    | 3095  |
| 255 | 21  | 10:18:13 | 152 MM SHERIDAN TANK |        |             | 59    | 3095  |
| 256 | 21  | 10:26:34 | 152 MM SHERIDAN TANK |        |             | 59    | 3095  |
| 257 | 21  | 10:35:09 | CALIBRATION          |        | 5.00 LBS.   |       |       |
| 258 | 21  | 10:41:07 | 152 MM SHERIDAN TANK |        |             | 59    | 3095  |
| 259 | 21  | 10:41:49 | 152 MM SHERIDAN TANK |        |             | 59    | 3095  |
| 260 | 21  | 10:42:30 | 152 MM SHERIDAN TANK |        |             | 50    | 2900  |
| 261 | 21  | 10:46:21 | 152 MM SHERIDAN TANK |        |             | 50    | 2900  |
| 262 | 21  | 10:51:36 | CALIBRATION          |        | 5.00 LBS.   |       |       |
| 263 | 21  | 10:54:35 | 152 MM SHERIDAN TANK |        |             | 50    | 2900  |
| 264 | 21  | 10:55:15 | 152 MM SHERIDAN TANK |        |             | 50    | 2900  |
| 265 | 21  | 10:55:55 | 152 MM SHERIDAN TANK |        |             | 50    | 2900  |
| 266 | 21  | 10:56:36 | 152 MM SHERIDAN TANK |        |             | 50    | 2900  |
| 267 | 21  | 11:02:29 | CALIBRATION          |        | 5.00 LBS.   |       |       |
| 268 | 21  | 11:05:36 | 152 MM SHERIDAN TANK |        |             | 50    | 2900  |
| 269 | 21  | 11:06:17 | 152 MM SHERIDAN TANK |        |             | 50    | 2900  |
| 270 | 21  | 11:06:57 | 152 MM SHERIDAN TANK |        |             | 50    | 2900  |
| 271 | 21  | 11:07:36 | 152 MM SHERIDAN TANK |        |             | 50    | 2900  |
| 272 | 21  | 11:13:59 | CALIBRATION          |        | 5.00 LBS.   |       |       |
| 273 | 21  | 11:46:55 | CALIBRATION          |        | 5.00 LBS.   |       |       |
| 274 | 21  | 11:53:36 | 152 MM SHERIDAN TANK |        |             | 45    | 2750  |
| 275 | 21  | 11:54:17 | 152 MM SHERIDAN TANK |        |             | 45    | 2750  |
| 276 | 21  | 11:54:59 | 152 MM SHERIDAN TANK |        |             | 45    | 2750  |
| 277 | 21  | 11:55:43 | 152 MM SHERIDAN TANK |        |             | 45    | 2750  |
| 278 | 21  | 12:01:09 | CALIBRATION          |        | 5.00 LBS.   |       |       |
| 279 | 21  | 12:04:03 | 152 MM SHERIDAN TANK |        |             | 45    | 2750  |
| 280 | 21  | 12:04:45 | 152 MM SHERIDAN TANK |        |             | 45    | 2750  |
| 281 | 21  | 12:05:28 | 152 MM SHERIDAN TANK |        |             | 45    | 2750  |
| 282 | 21  | 12:06:13 | 152 MM SHERIDAN TANK |        |             | 45    | 2750  |
| 283 | 21  | 12:13:54 | CALIBRATION          |        | 5.00 LBS.   |       |       |
| 284 | 21  | 12:15:55 | 152 MM SHERIDAN TANK |        |             | 45    | 2750  |
| 285 | 21  | 12:16:40 | 152 MM SHERIDAN TANK |        |             | 45    | 2750  |
| 286 | 21  | 12:17:19 | 152 MM SHERIDAN TANK |        |             | 40    | 2600  |
| 287 | 21  | 12:18:03 | 152 MM SHERIDAN TANK |        |             | 40    | 2600  |
| 288 | 21  | 12:23:25 | CALIBRATION          |        | 5.00 LBS.   |       |       |
| 289 | 21  | 12:26:28 | 152 MM SHERIDAN TANK |        |             | 40    | 2600  |
| 290 | 21  | 12:27:13 | 152 MM SHERIDAN TANK |        |             | 40    | 2600  |
| 291 | 21  | 12:27:56 | 152 MM SHERIDAN TANK |        |             | 40    | 2600  |
| 292 | 21  | 12:28:38 | 152 MM SHERIDAN TANK |        |             | 40    | 2600  |
| 293 | 21  | 12:34:10 | CALIBRATION          |        | 5.00 LBS.   |       |       |
| 294 | 21  | 12:37:21 | 152 MM SHERIDAN TANK |        |             | 40    | 2600  |
| 295 | 21  | 12:38:01 | 152 MM SHERIDAN TANK |        |             | 40    | 2600  |
| 296 | 21  | 12:38:44 | 152 MM SHERIDAN TANK |        |             | 40    | 2600  |
| 297 | 21  | 12:39:28 | 152 MM SHERIDAN TANK |        |             | 40    | 2600  |
| 298 | 21  | 12:45:17 | CALIBRATION          |        | 5.00 LBS.   |       |       |
| 299 | 21  | 13:58:40 | C4                   |        | 5.00 LBS.   |       |       |
| 300 | 21  | 14:07:15 | C4                   |        | 0.62 LBS.   |       |       |

| #   | DAY | TIME     | WEAPON      | MODEL | CHARGE SIZE | ELEVA | RANGE |
|-----|-----|----------|-------------|-------|-------------|-------|-------|
| 301 | 21  | 14:14:25 | C-1         |       | 20.00 LBS.  |       |       |
| 302 | 21  | 14:19:53 | C-1         |       | 1.25 LBS.   |       |       |
| 303 | 21  | 14:26:14 | C-1         |       | 2.50 LBS.   |       |       |
| 304 | 21  | 14:34:19 | C-1         |       | 10.00 LBS.  |       |       |
| 305 | 21  | 14:40:29 | C-1         |       | 0.31 LBS.   |       |       |
| 306 | 21  | 14:46:03 | C-1         |       | 5.00 LBS.   |       |       |
| 307 | 21  | 14:51:06 | C-1         |       | 0.62 LBS.   |       |       |
| 308 | 21  | 14:57:09 | C-1         |       | 20.00 LBS.  |       |       |
| 309 | 21  | 15:02:35 | C-1         |       | 1.25 LBS.   |       |       |
| 310 | 21  | 15:07:49 | C-1         |       | 2.50 LBS.   |       |       |
| 311 | 21  | 15:14:24 | C-1         |       | 10.00 LBS.  |       |       |
| 312 | 21  | 15:20:07 | C-1         |       | 0.31 LBS.   |       |       |
| 313 | 21  | 15:26:19 | C-1         |       | 5.00 LBS.   |       |       |
| 314 | 22  | 9:34:09  | C-1         |       | 5.00 LBS.   |       |       |
| 315 | 22  | 9:42:21  | C-1         |       | 0.31 LBS.   |       |       |
| 316 | 22  | 9:49:47  | C-1         |       | 20.00 LBS.  |       |       |
| 317 | 22  | 9:56:03  | C-1         |       | 1.25 LBS.   |       |       |
| 318 | 22  | 10:01:51 | C-1         |       | 2.50 LBS.   |       |       |
| 319 | 22  | 10:07:45 | C-1         |       | 10.00 LBS.  |       |       |
| 320 | 22  | 10:19:03 | C-1         |       | 0.62 LBS.   |       |       |
| 321 | 22  | 10:24:55 | C-1         |       | 5.00 LBS.   |       |       |
| 322 | 22  | 10:30:47 | C-1         |       | 0.31 LBS.   |       |       |
| 323 | 22  | 10:38:20 | C-1         |       | 20.00 LBS.  |       |       |
| 324 | 22  | 10:44:34 | C-1         |       | 1.25 LBS.   |       |       |
| 325 | 22  | 10:50:07 | C-1         |       | 2.50 LBS.   |       |       |
| 326 | 22  | 10:56:23 | C-1         |       | 10.00 LBS.  |       |       |
| 327 | 22  | 11:04:20 | C-1         |       | 0.62 LBS.   |       |       |
| 328 | 22  | 12:31:24 | C-1         |       | 5.00 LBS.   |       |       |
| 329 | 22  | 12:35:43 | C-1         |       | 0.31 LBS.   |       |       |
| 330 | 22  | 12:41:50 | C-1         |       | 20.00 LBS.  |       |       |
| 331 | 22  | 12:46:10 | C-1         |       | 1.25 LBS.   |       |       |
| 332 | 22  | 12:49:53 | C-1         |       | 2.50 LBS.   |       |       |
| 333 | 22  | 12:54:49 | C-1         |       | 10.00 LBS.  |       |       |
| 334 | 22  | 13:03:11 | C-1         |       | 0.62 LBS.   |       |       |
| 335 | 22  | 13:08:30 | C-1         |       | 5.00 LBS.   |       |       |
| 336 | 22  | 13:12:28 | C-1         |       | 0.31 LBS.   |       |       |
| 337 | 22  | 13:17:39 | C-1         |       | 20.00 LBS.  |       |       |
| 338 | 22  | 13:21:57 | C-1         |       | 1.25 LBS.   |       |       |
| 339 | 22  | 13:26:37 | C-1         |       | 2.50 LBS.   |       |       |
| 340 | 22  | 13:31:25 | C-1         |       | 10.00 LBS.  |       |       |
| 341 | 22  | 13:39:24 | C-1         |       | 0.62 LBS.   |       |       |
| 342 | 22  | 13:43:48 | C-1         |       | 5.00 LBS.   |       |       |
| 343 | 22  | 13:48:14 | C-1         |       | 0.31 LBS.   |       |       |
| 344 | 22  | 13:53:42 | C-1         |       | 20.00 LBS.  |       |       |
| 345 | 22  | 13:58:08 | C-1         |       | 1.25 LBS.   |       |       |
| 346 | 22  | 14:02:18 | C-1         |       | 2.50 LBS.   |       |       |
| 347 | 22  | 14:07:14 | C-1         |       | 10.00 LBS.  |       |       |
| 348 | 22  | 14:11:35 | C-1         |       | 0.62 LBS.   |       |       |
| 349 | 22  | 14:21:55 | C-1         |       | 5.00 LBS.   |       |       |
| 350 | 23  | 10:13:26 | CALIBRATION |       | 5.00 LBS.   |       |       |

| #   | DAY | TIME     | WEAPON          | MODEL  | CHARGE SIZE  | ELEVA | RANGE |
|-----|-----|----------|-----------------|--------|--------------|-------|-------|
| 351 | 23  | 10:18:46 | CALIBRATION     |        | 5.00 LBS.    |       |       |
| 352 | 23  | 10:24:15 | 155 MM HOWITZER | M114A1 | 3 GREEN BAGS | 200   | 2800  |
| 353 | 23  | 10:29:15 | 155 MM HOWITZER | M114A1 | 3 GREEN BAGS | 200   | 2800  |
| 354 | 23  | 10:29:58 | 155 MM HOWITZER | M114A1 | 3 GREEN BAGS | 200   | 2800  |
| 355 | 23  | 10:34:30 | CALIBRATION     |        | 5.00 LBS.    |       |       |
| 356 | 23  | 10:37:55 | 155 MM HOWITZER | M114A1 | 3 GREEN BAGS | 200   | 2800  |
| 357 | 23  | 10:40:45 | 155 MM HOWITZER | M114A1 | 3 GREEN BAGS | 200   | 2800  |
| 358 | 23  | 10:41:30 | 155 MM HOWITZER | M114A1 | 3 GREEN BAGS | 500   | 5600  |
| 359 | 23  | 10:46:39 | CALIBRATION     |        | 5.00 LBS.    |       |       |
| 360 | 23  | 10:49:57 | 155 MM HOWITZER | M114A1 | 3 GREEN BAGS | 500   | 5600  |
| 361 | 23  | 10:50:40 | 155 MM HOWITZER | M114A1 | 3 GREEN BAGS | 500   | 5600  |
| 362 | 23  | 10:51:26 | 155 MM HOWITZER | M114A1 | 3 GREEN BAGS | 500   | 5600  |
| 363 | 23  | 10:56:42 | CALIBRATION     |        | 5.00 LBS.    |       |       |
| 364 | 23  | 11:00:03 | 155 MM HOWITZER | M114A1 | 3 GREEN BAGS | 500   | 5600  |
| 365 | 23  | 11:00:43 | 155 MM HOWITZER | M114A1 | 5 GREEN BAGS | 200   | 4300  |
| 366 | 23  | 11:03:13 | 155 MM HOWITZER | M114A1 | 5 GREEN BAGS | 200   | 4300  |
| 367 | 23  | 11:07:41 | CALIBRATION     |        | 5.00 LBS.    |       |       |
| 368 | 23  | 11:17:34 | 155 MM HOWITZER | M114A1 | 5 GREEN BAGS | 200   | 4300  |
| 369 | 23  | 11:18:19 | 155 MM HOWITZER | M114A1 | 5 GREEN BAGS | 200   | 4300  |
| 370 | 23  | 11:19:03 | 155 MM HOWITZER | M114A1 | 5 WHITE BAGS | 200   |       |
| 371 | 23  | 11:25:56 | CALIBRATION     |        | 5.00 LBS.    |       |       |
| 372 | 23  | 12:09:44 | CALIBRATION     |        | 5.00 LBS.    |       |       |
| 373 | 23  | 12:12:51 | 155 MM HOWITZER | M114A1 | 5 GREEN BAGS | 185   | 7000  |
| 374 | 23  | 12:13:33 | 155 MM HOWITZER | M114A1 | 5 WHITE BAGS | 185   | 7000  |
| 375 | 23  | 12:14:16 | 155 MM HOWITZER | M114A1 | 5 WHITE BAGS | 185   | 7000  |
| 376 | 23  | 12:19:08 | CALIBRATION     |        | 5.00 LBS.    |       |       |
| 377 | 23  | 12:23:10 | 155 MM HOWITZER | M114A1 | 5 WHITE BAGS | 185   | 4200  |
| 378 | 23  | 12:23:51 | 155 MM HOWITZER | M114A1 | 5 WHITE BAGS | 185   | 4200  |
| 379 | 23  | 12:24:34 | 155 MM HOWITZER | M114A1 | 5 WHITE BAGS | 348   | 7000  |
| 380 | 23  | 12:28:59 | CALIBRATION     |        | 5.00 LBS.    |       |       |
| 381 | 23  | 12:31:52 | 155 MM HOWITZER | M114A1 | 5 WHITE BAGS | 348   | 7000  |
| 382 | 23  | 12:32:34 | 155 MM HOWITZER | M114A1 | 5 WHITE BAGS | 348   | 7000  |
| 383 | 23  | 12:33:17 | 155 MM HOWITZER | M114A1 | 5 WHITE BAGS | 348   | 7000  |
| 384 | 23  | 12:39:27 | CALIBRATION     |        | 5.00 LBS.    |       |       |
| 385 | 23  | 12:42:55 | 155 MM HOWITZER | M114A1 | 5 WHITE BAGS | 348   | 7000  |
| 386 | 23  | 12:43:39 | 155 MM HOWITZER | M114A1 | 7 WHITE BAGS | 185   | 7000  |
| 387 | 23  | 12:44:22 | 155 MM HOWITZER | M114A1 | 7 WHITE BAGS | 185   | 7000  |
| 388 | 23  | 12:48:29 | CALIBRATION     |        | 5.00 LBS.    |       |       |
| 389 | 23  | 12:51:32 | 155 MM HOWITZER | M114A1 | 7 WHITE BAGS | 185   | 7000  |
| 390 | 23  | 12:52:16 | 155 MM HOWITZER | M114A1 | 7 WHITE BAGS | 185   | 7000  |
| 391 | 23  | 12:52:58 | 155 MM HOWITZER | M114A1 | 7 WHITE BAGS | 185   | 7000  |
| 392 | 23  | 12:58:09 | CALIBRATION     |        | 5.00 LBS.    |       |       |
| 393 | 23  | 13:02:45 | CALIBRATION     |        | 5.00 LBS.    |       |       |
| 394 | 26  | 9:31:12  | CALIBRATION     |        | 5.00 LBS.    |       |       |
| 395 | 26  | 9:35:51  | CALIBRATION     |        | 5.00 LBS.    |       |       |
| 396 | 26  | 9:42:06  | 105 MM HOWITZER | M102   | 3 WHITE BAGS | 250   | 2700  |
| 397 | 26  | 9:46:48  | 105 MM HOWITZER | M102   | 3 WHITE BAGS | 250   | 2700  |
| 398 | 26  | 9:47:30  | 105 MM HOWITZER | M102   | 3 WHITE BAGS | 250   | 2700  |
| 399 | 26  | 9:52:20  | CALIBRATION     |        | 5.00 LBS.    |       |       |
| 400 | 26  | 9:55:54  | 105 MM HOWITZER | M102   | 3 WHITE BAGS | 250   | 2700  |

| #   | DAY | TIME     | WEAPON                 | MODEL | CHARGE SIZE  | ELEVA | RANGE |
|-----|-----|----------|------------------------|-------|--------------|-------|-------|
| 401 | 26  | 9:56:52  | 105 MM HOWITZER        | M102  | 3 WHITE BAGS | 250   | 2700  |
| 402 | 26  | 9:57:34  | 105 MM HOWITZER        | M102  | 4 WHITE BAGS | 250   | 3400  |
| 403 | 26  | 10:02:38 | CALIBRATION            |       | 5.00 LBS.    |       |       |
| 404 | 26  | 10:06:40 | 105 MM HOWITZER        | M102  | 4 WHITE BAGS | 250   | 3400  |
| 405 | 26  | 10:07:22 | 105 MM HOWITZER        | M102  | 4 WHITE BAGS | 250   | 3400  |
| 406 | 26  | 10:08:03 | 105 MM HOWITZER        | M102  | 4 WHITE BAGS | 250   | 3400  |
| 407 | 26  | 10:12:23 | CALIBRATION            |       | 5.00 LBS.    |       |       |
| 408 | 26  | 10:15:53 | 105 MM HOWITZER        | M102  | 4 WHITE BAGS | 250   | 3400  |
| 409 | 26  | 10:16:37 | 105 MM HOWITZER        | M102  | 4 WHITE BAGS | 450   | 5200  |
| 410 | 26  | 10:17:19 | 105 MM HOWITZER        | M102  | 4 WHITE BAGS | 450   | 5200  |
| 411 | 26  | 10:21:46 | CALIBRATION            |       | 5.00 LBS.    |       |       |
| 412 | 26  | 10:24:42 | 105 MM HOWITZER        | M102  | 4 WHITE BAGS | 450   | 5200  |
| 413 | 26  | 10:25:24 | 105 MM HOWITZER        | M102  | 4 WHITE BAGS | 450   | 5200  |
| 414 | 26  | 10:26:06 | 105 MM HOWITZER        | M102  | 4 WHITE BAGS | 450   | 5200  |
| 415 | 26  | 10:30:21 | CALIBRATION            |       | 5.00 LBS.    |       |       |
| 416 | 26  | 10:34:27 | 105 MM HOWITZER        | M102  | 5 WHITE BAGS | 250   | 4000  |
| 417 | 26  | 10:35:06 | 105 MM HOWITZER        | M102  | 5 WHITE BAGS | 250   | 4000  |
| 418 | 26  | 10:35:48 | 105 MM HOWITZER        | M102  | 5 WHITE BAGS | 250   | 4000  |
| 419 | 26  | 10:41:50 | CALIBRATION            |       | 5.00 LBS.    |       |       |
| 420 | 26  | 11:08:22 | CALIBRATION            |       | 5.00 LBS.    |       |       |
| 421 | 26  | 11:12:14 | 105 MM HOWITZER        | M102  | 5 WHITE BAGS | 250   | 4000  |
| 422 | 26  | 11:12:53 | 105 MM HOWITZER        | M102  | 5 WHITE BAGS | 250   | 4000  |
| 423 | 26  | 11:13:35 | 105 MM HOWITZER        | M102  | 5 WHITE BAGS | 450   | 6700  |
| 424 | 26  | 11:17:39 | CALIBRATION            |       | 5.00 LBS.    |       |       |
| 425 | 26  | 11:20:57 | 105 MM HOWITZER        | M102  | 5 WHITE BAGS | 450   | 6700  |
| 426 | 26  | 11:21:41 | 105 MM HOWITZER        | M102  | 5 WHITE BAGS | 450   | 6700  |
| 427 | 26  | 11:22:23 | 105 MM HOWITZER        | M102  | 5 WHITE BAGS | 450   | 6700  |
| 428 | 26  | 11:27:01 | CALIBRATION            |       | 5.00 LBS.    |       |       |
| 429 | 26  | 11:30:02 | 105 MM HOWITZER        | M102  | 5 WHITE BAGS | 450   | 6700  |
| 430 | 26  | 11:30:45 | 105 MM HOWITZER        | M102  | 6 WHITE BAGS | 250   | 5200  |
| 431 | 26  | 11:31:27 | 105 MM HOWITZER        | M102  | 6 WHITE BAGS | 250   | 5200  |
| 432 | 26  | 11:34:47 | CALIBRATION            |       | 5.00 LBS.    |       |       |
| 433 | 26  | 11:38:00 | 105 MM HOWITZER        | M102  | 6 WHITE BAGS | 250   | 5200  |
| 434 | 26  | 11:38:41 | 105 MM HOWITZER        | M102  | 6 WHITE BAGS | 250   | 5200  |
| 435 | 26  | 11:39:25 | 105 MM HOWITZER        | M102  | 6 WHITE BAGS | 250   | 5200  |
| 436 | 26  | 11:43:55 | CALIBRATION            |       | 5.00 LBS.    |       |       |
| 437 | 26  | 11:48:01 | CALIBRATION            |       | 5.00 LBS.    |       |       |
| 438 | 26  | 13:52:34 | CALIBRATION            |       | 5.00 LBS.    |       |       |
| 439 | 26  | 13:58:00 | 90 MM RECOILLESS RIFLE | M67   |              |       |       |
| 440 | 26  | 14:02:32 | 90 MM RECOILLESS RIFLE | M67   |              |       |       |
| 441 | 26  | 14:03:23 | 90 MM RECOILLESS RIFLE | M67   |              |       |       |
| 442 | 26  | 14:10:18 | CALIBRATION            |       | 5.00 LBS.    |       |       |
| 443 | 26  | 14:14:10 | 90 MM RECOILLESS RIFLE | M67   |              |       |       |
| 444 | 26  | 14:16:58 | 90 MM RECOILLESS RIFLE | M67   |              |       |       |
| 445 | 26  | 14:17:41 | 90 MM RECOILLESS RIFLE | M67   |              |       |       |
| 446 | 26  | 14:21:59 | CALIBRATION            |       | 5.00 LBS.    |       |       |
| 447 | 26  | 14:26:06 | 90 MM RECOILLESS RIFLE | M67   |              |       |       |
| 448 | 26  | 14:26:49 | 90 MM RECOILLESS RIFLE | M67   |              |       |       |
| 449 | 26  | 14:27:40 | 90 MM RECOILLESS RIFLE | M67   |              |       |       |
| 450 | 26  | 14:31:54 | CALIBRATION            |       | 5.00 LBS.    |       |       |

| #   | DAY | TIME     | WEAPON                  | MODEL | CHARGE SIZE | ELEVA | RANGE |
|-----|-----|----------|-------------------------|-------|-------------|-------|-------|
| 451 | 26  | 15:26:51 | CALIBRATION             |       | 5.00 LBS.   |       |       |
| 452 | 26  | 15:30:24 | 90 MM RECOILLESS RIFLE  | M67   |             |       |       |
| 453 | 26  | 15:31:08 | 90 MM RECOILLESS RIFLE  | M67   |             |       |       |
| 454 | 26  | 15:31:53 | 90 MM RECOILLESS RIFLE  | M67   |             |       |       |
| 455 | 26  | 15:35:46 | CALIBRATION             |       | 5.00 LBS.   |       |       |
| 456 | 26  | 15:39:05 | 90 MM RECOILLESS RIFLE  | M67   |             |       |       |
| 457 | 26  | 15:39:47 | 90 MM RECOILLESS RIFLE  | M67   |             |       |       |
| 458 | 26  | 15:40:29 | 90 MM RECOILLESS RIFLE  | M67   |             |       |       |
| 459 | 26  | 15:44:11 | CALIBRATION             |       | 5.00 LBS.   |       |       |
| 460 | 26  | 15:47:33 | 90 MM RECOILLESS RIFLE  | M67   |             |       |       |
| 461 | 26  | 15:48:14 | 90 MM RECOILLESS RIFLE  | M67   |             |       |       |
| 462 | 26  | 15:48:56 | 90 MM RECOILLESS RIFLE  | M67   |             |       |       |
| 463 | 26  | 15:53:08 | CALIBRATION             |       | 5.00 LBS.   |       |       |
| 464 | 26  | 15:56:56 | 90 MM RECOILLESS RIFLE  | M67   |             |       |       |
| 465 | 26  | 15:57:41 | 90 MM RECOILLESS RIFLE  | M67   |             |       |       |
| 466 | 26  | 15:58:28 | 90 MM RECOILLESS RIFLE  | M67   |             |       |       |
| 467 | 26  | 16:02:16 | CALIBRATION             |       | 5.00 LBS.   |       |       |
| 468 | 26  | 16:10:31 | 90 MM RECOILLESS RIFLE  | M67   |             |       |       |
| 469 | 26  | 16:11:14 | 90 MM RECOILLESS RIFLE  | M67   |             |       |       |
| 470 | 26  | 16:11:55 | 90 MM RECOILLESS RIFLE  | M67   |             |       |       |
| 471 | 26  | 16:16:54 | CALIBRATION             |       | 5.00 LBS.   |       |       |
| 472 | 26  | 16:19:54 | 90 MM RECOILLESS RIFLE  | M67   |             |       |       |
| 473 | 26  | 16:20:35 | 90 MM RECOILLESS RIFLE  | M67   |             |       |       |
| 474 | 26  | 16:21:18 | 90 MM RECOILLESS RIFLE  | M67   |             |       |       |
| 475 | 26  | 16:27:05 | CALIBRATION             |       | 5.00 LBS.   |       |       |
| 476 | 26  | 16:29:59 | 90 MM RECOILLESS RIFLE  | M67   |             |       |       |
| 477 | 26  | 16:30:44 | 90 MM RECOILLESS RIFLE  | M67   |             |       |       |
| 478 | 26  | 16:31:28 | 90 MM RECOILLESS RIFLE  | M67   |             |       |       |
| 479 | 26  | 16:35:34 | CALIBRATION             |       | 5.00 LBS.   |       |       |
| 480 | 26  | 16:39:36 | CALIBRATION             |       | 5.00 LBS.   |       |       |
| 481 | 27  | 9:15:23  | CALIBRATION             |       | 5.00 LBS.   |       |       |
| 482 | 27  | 9:19:56  | CALIBRATION             |       | 5.00 LBS.   |       |       |
| 483 | 27  | 9:23:43  | 106 MM RECOILLESS RIFLE | M40A1 |             |       | 1200  |
| 484 | 27  | 9:34:52  | 106 MM RECOILLESS RIFLE | M40A1 |             |       | 1200  |
| 485 | 27  | 9:38:05  | 106 MM RECOILLESS RIFLE | M40A1 |             |       | 1200  |
| 486 | 27  | 9:44:25  | CALIBRATION             |       | 5.00 LBS.   |       |       |
| 487 | 27  | 9:47:26  | 106 MM RECOILLESS RIFLE | M40A1 |             |       | 1200  |
| 488 | 27  | 9:48:13  | 106 MM RECOILLESS RIFLE | M40A1 |             |       | 1200  |
| 489 | 27  | 9:48:58  | 106 MM RECOILLESS RIFLE | M40A1 |             |       | 1200  |
| 490 | 27  | 9:59:40  | CALIBRATION             |       | 5.00 LBS.   |       |       |
| 491 | 27  | 10:03:40 | 106 MM RECOILLESS RIFLE | M40A1 |             |       | 1500  |
| 492 | 27  | 10:04:21 | 106 MM RECOILLESS RIFLE | M40A1 |             |       | 1500  |
| 493 | 27  | 10:05:03 | 106 MM RECOILLESS RIFLE | M40A1 |             |       | 1500  |
| 494 | 27  | 10:37:47 | CALIBRATION             |       | 5.00 LBS.   |       |       |
| 495 | 27  | 10:41:14 | 106 MM RECOILLESS RIFLE | M40A1 |             |       | 1500  |
| 496 | 27  | 10:41:55 | 106 MM RECOILLESS RIFLE | M40A1 |             |       | 1500  |
| 497 | 27  | 10:42:38 | 106 MM RECOILLESS RIFLE | M40A1 |             |       | 1500  |
| 498 | 27  | 10:48:31 | CALIBRATION             |       | 5.00 LBS.   |       |       |
| 499 | 27  | 10:51:21 | 106 MM RECOILLESS RIFLE | M40A1 |             |       | 2000  |
| 500 | 27  | 10:52:01 | 106 MM RECOILLESS RIFLE | M40A1 |             |       | 2000  |

| #   | DAY | TIME     | WEAPON                 | MODEL | CHARGE SIZE  | ELEVA | RANGE |
|-----|-----|----------|------------------------|-------|--------------|-------|-------|
| S01 | 27  | 10:52:43 | 106 MM RECOILESS RIFLE | M40A1 |              |       | 2000  |
| S02 | 27  | 10:56:42 | CALIBRATION            |       | 5.00 LBS.    |       |       |
| S03 | 27  | 10:59:35 | 106 MM RECOILESS RIFLE | M40A1 |              |       | 2000  |
| S04 | 27  | 11:00:18 | 106 MM RECOILESS RIFLE | M40A1 |              |       | 2000  |
| S05 | 27  | 11:01:00 | 106 MM RECOILESS RIFLE | M40A1 |              |       | 2000  |
| S06 | 27  | 11:05:33 | CALIBRATION            |       | 5.00 LBS.    |       |       |
| S07 | 27  | 11:08:27 | 106 MM RECOILESS RIFLE | M40A1 |              |       | 2500  |
| S08 | 27  | 11:09:14 | 106 MM RECOILESS RIFLE | M40A1 |              |       | 2500  |
| S09 | 27  | 11:10:01 | 106 MM RECOILESS RIFLE | M40A1 |              |       | 2500  |
| S10 | 27  | 11:15:09 | CALIBRATION            |       | 5.00 LBS.    |       |       |
| S11 | 27  | 11:19:12 | 106 MM RECOILESS RIFLE | M40A1 |              |       | 2500  |
| S12 | 27  | 11:19:54 | 106 MM RECOILESS RIFLE | M40A1 |              |       | 2500  |
| S13 | 27  | 11:20:34 | 106 MM RECOILESS RIFLE | M40A1 |              |       | 2500  |
| S14 | 27  | 11:25:35 | CALIBRATION            |       | 5.00 LBS.    |       |       |
| S15 | 27  | 11:53:48 | CALIBRATION            |       | 5.00 LBS.    |       |       |
| S16 | 27  | 11:56:41 | 106 MM RECOILESS RIFLE | M40A1 |              |       | 3000  |
| S17 | 27  | 11:57:22 | 106 MM RECOILESS RIFLE | M40A1 |              |       | 3000  |
| S18 | 27  | 11:58:03 | 106 MM RECOILESS RIFLE | M40A1 |              |       | 3000  |
| S19 | 27  | 12:02:04 | CALIBRATION            |       | 5.00 LBS.    |       |       |
| S20 | 27  | 12:04:52 | 106 MM RECOILESS RIFLE | M40A1 |              |       | 3000  |
| S21 | 27  | 12:05:34 | 106 MM RECOILESS RIFLE | M40A1 |              |       | 3000  |
| S22 | 27  | 12:06:15 | 106 MM RECOILESS RIFLE | M40A1 |              |       | 3000  |
| S23 | 27  | 12:10:23 | CALIBRATION            |       | 5.00 LBS.    |       |       |
| S24 | 27  | 12:14:27 | CALIBRATION            |       | 5.00 LBS.    |       |       |
| S25 | 27  | 12:35:19 | CALIBRATION            |       | 5.00 LBS.    |       |       |
| S26 | 27  | 12:39:37 | CALIBRATION            |       | 5.00 LBS.    |       |       |
| S27 | 27  | 13:45:54 | 155 MM HOWITZER        | M114  | 4 GREEN BAGS | 200   | 3450  |
| S28 | 27  | 13:50:39 | 155 MM HOWITZER        | M114  | 4 GREEN BAGS | 200   | 3450  |
| S29 | 27  | 13:53:50 | 155 MM HOWITZER        | M114  | 4 GREEN BAGS | 200   | 3450  |
| S30 | 27  | 13:58:25 | CALIBRATION            |       | 5.00 LBS.    |       |       |
| S31 | 27  | 14:04:19 | 155 MM HOWITZER        | M114  | 4 GREEN BAGS | 200   | 3450  |
| S32 | 27  | 14:05:00 | 155 MM HOWITZER        | M114  | 4 GREEN BAGS | 200   | 3450  |
| S33 | 27  | 14:05:43 | 155 MM HOWITZER        | M114  | 4 GREEN BAGS | 400   | 5900  |
| S34 | 27  | 14:10:14 | CALIBRATION            |       | 5.00 LBS.    |       |       |
| S35 | 27  | 14:14:08 | 155 MM HOWITZER        | M114  | 4 GREEN BAGS | 400   | 5900  |
| S36 | 27  | 14:14:50 | 155 MM HOWITZER        | M114  | 4 GREEN BAGS | 400   | 5900  |
| S37 | 27  | 14:15:32 | 155 MM HOWITZER        | M114  | 4 GREEN BAGS | 400   | 5900  |
| S38 | 27  | 14:19:34 | CALIBRATION            |       | 5.00 LBS.    |       |       |
| S39 | 27  | 14:23:14 | 155 MM HOWITZER        | M114  | 4 GREEN BAGS | 400   | 5900  |
| S40 | 27  | 14:23:58 | 155 MM HOWITZER        | M114  | 5 GREEN BAGS | 200   | 4300  |
| S41 | 27  | 14:24:41 | 155 MM HOWITZER        | M114  | 5 GREEN BAGS | 200   | 4300  |
| S42 | 27  | 14:30:05 | CALIBRATION            |       | 5.00 LBS.    |       |       |
| S43 | 27  | 15:25:09 | CALIBRATION            |       | 5.00 LBS.    |       |       |
| S44 | 27  | 15:28:30 | 155 MM HOWITZER        | M114  | 5 GREEN BAGS | 200   | 4300  |
| S45 | 27  | 15:29:12 | 155 MM HOWITZER        | M114  | 5 GREEN BAGS | 200   | 4300  |
| S46 | 27  | 15:29:54 | 155 MM HOWITZER        | M114  | 5 GREEN BAGS | 200   | 4300  |
| S47 | 27  | 15:34:25 | CALIBRATION            |       | 5.00 LBS.    |       |       |
| S48 | 27  | 15:37:44 | 155 MM HOWITZER        | M114  | 5 WHITE BAGS | 200   | 4300  |
| S49 | 27  | 15:38:27 | 155 MM HOWITZER        | M114  | 5 WHITE BAGS | 200   | 4300  |
| S50 | 27  | 15:39:19 | 155 MM HOWITZER        | M114  | 5 WHITE BAGS | 200   | 4300  |

| #   | DAY | TIME     | WEAPON                | MODEL  | CHARGE SIZE  | ELEVA | RANGE |
|-----|-----|----------|-----------------------|--------|--------------|-------|-------|
| 551 | 27  | 15:43:48 | CALIBRATION           |        | 5.00 LBS.    |       |       |
| 552 | 27  | 15:47:11 | 155 MM HOWITZER       | M114   | 5 WHITE BAGS | 200   | 4300  |
| 553 | 27  | 15:47:52 | 155 MM HOWITZER       | M114   | 5 WHITE BAGS | 200   | 4300  |
| 554 | 27  | 15:48:35 | 155 MM HOWITZER       | M114   | 5 WHITE BAGS | 350   | 6700  |
| 555 | 27  | 15:52:31 | CALIBRATION           |        | 5.00 LBS.    |       |       |
| 556 | 27  | 15:55:37 | 155 MM HOWITZER       | M114   | 5 WHITE BAGS | 350   | 6700  |
| 557 | 27  | 15:56:20 | 155 MM HOWITZER       | M114   | 5 WHITE BAGS | 350   | 6700  |
| 558 | 27  | 15:57:02 | 155 MM HOWITZER       | M114   | 5 WHITE BAGS | 350   | 6700  |
| 559 | 27  | 16:01:07 | CALIBRATION           |        | 5.00 LBS.    |       |       |
| 560 | 27  | 16:04:11 | 155 MM HOWITZER       | M114   | 5 WHITE BAGS | 350   | 6700  |
| 561 | 27  | 16:04:54 | 155 MM HOWITZER       | M114   | 6 WHITE BAGS | 200   | 5700  |
| 562 | 27  | 16:05:34 | 155 MM HOWITZER       | M114   | 6 WHITE BAGS | 200   | 5700  |
| 563 | 27  | 16:09:56 | CALIBRATION           |        | 5.00 LBS.    |       |       |
| 564 | 27  | 16:12:58 | 155 MM HOWITZER       | M114   | 6 WHITE BAGS | 200   | 5700  |
| 565 | 27  | 16:13:47 | 155 MM HOWITZER       | M114   | 6 WHITE BAGS | 200   | 5700  |
| 566 | 27  | 16:14:30 | 155 MM HOWITZER       | M114   | 6 WHITE BAGS | 200   | 5700  |
| 567 | 27  | 16:19:33 | CALIBRATION           |        | 5.00 LBS.    |       |       |
| 568 | 27  | 16:22:42 | CALIBRATION           |        | 5.00 LBS.    |       |       |
| 569 | 28  | 13:30:34 | CALIBRATION           |        | 5.00 LBS.    |       |       |
| 570 | 28  | 13:35:53 | 8 INCH SELF PROPELLED | M110A1 | 3 GREEN BAGS | 200   |       |
| 571 | 28  | 13:43:19 | 8 INCH SELF PROPELLED | M110A1 | 3 GREEN BAGS | 200   |       |
| 572 | 28  | 13:44:50 | 8 INCH SELF PROPELLED | M110A1 | 3 GREEN BAGS | 200   |       |
| 573 | 28  | 13:46:23 | 8 INCH SELF PROPELLED | M110A1 | 3 GREEN BAGS | 200   |       |
| 574 | 28  | 13:51:06 | CALIBRATION           |        | 5.00 LBS.    |       |       |
| 575 | 28  | 13:54:08 | 8 INCH SELF PROPELLED | M110A1 | 3 GREEN BAGS | 200   |       |
| 576 | 28  | 13:55:11 | 8 INCH SELF PROPELLED | M110A1 | 3 GREEN BAGS | 350   |       |
| 577 | 28  | 13:56:15 | 8 INCH SELF PROPELLED | M110A1 | 3 GREEN BAGS | 350   |       |
| 578 | 28  | 13:57:17 | 8 INCH SELF PROPELLED | M110A1 | 3 GREEN BAGS | 350   |       |
| 579 | 28  | 14:04:01 | CALIBRATION           |        | 5.00 LBS.    |       |       |
| 580 | 28  | 14:07:04 | 8 INCH SELF PROPELLED | M110A1 | 3 GREEN BAGS | 350   |       |
| 581 | 28  | 14:08:04 | 8 INCH SELF PROPELLED | M110A1 | 5 GREEN BAGS | 200   |       |
| 582 | 28  | 14:09:06 | 8 INCH SELF PROPELLED | M110A1 | 5 GREEN BAGS | 200   |       |
| 583 | 28  | 14:10:08 | 8 INCH SELF PROPELLED | M110A1 | 5 GREEN BAGS | 200   |       |
| 584 | 28  | 14:15:03 | CALIBRATION           |        | 5.00 LBS.    |       |       |
| 585 | 28  | 14:18:30 | 8 INCH SELF PROPELLED | M110A1 | 5 GREEN BAGS | 200   |       |
| 586 | 28  | 14:19:50 | 8 INCH SELF PROPELLED | M110A1 | 5 GREEN BAGS | 200   |       |
| 587 | 28  | 14:31:51 | 8 INCH SELF PROPELLED | M110A1 | 5 WHITE BAGS | 200   |       |
| 588 | 28  | 14:32:52 | 8 INCH SELF PROPELLED | M110A1 | 5 WHITE BAGS | 200   |       |
| 589 | 28  | 14:37:19 | CALIBRATION           |        | 5.00 LBS.    |       |       |
| 590 | 28  | 15:34:08 | 8 INCH SELF PROPELLED | M110A1 | 5 WHITE BAGS | 200   |       |
| 591 | 28  | 15:35:10 | 8 INCH SELF PROPELLED | M110A1 | 5 WHITE BAGS | 200   |       |
| 592 | 28  | 15:36:10 | 8 INCH SELF PROPELLED | M110A1 | 5 WHITE BAGS | 200   |       |
| 593 | 28  | 15:37:10 | 8 INCH SELF PROPELLED | M110A1 | 5 WHITE BAGS | 300   |       |
| 594 | 28  | 15:41:43 | CALIBRATION           |        | 5.00 LBS.    |       |       |
| 595 | 28  | 15:44:28 | 8 INCH SELF PROPELLED | M110A1 | 5 WHITE BAGS | 300   |       |
| 596 | 28  | 15:45:31 | 8 INCH SELF PROPELLED | M110A1 | 5 WHITE BAGS | 300   |       |
| 597 | 28  | 15:46:32 | 8 INCH SELF PROPELLED | M110A1 | 5 WHITE BAGS | 300   |       |
| 598 | 28  | 15:47:37 | 8 INCH SELF PROPELLED | M110A1 | 5 WHITE BAGS | 300   |       |
| 599 | 28  | 15:52:12 | CALIBRATION           |        | 5.00 LBS.    |       |       |

APPENDIX B:

WEATHER CONDITIONS FOR JUNE 12 TO 28, 1976,  
FORT SILL, OK

| DAY | HOURL | TEMP (F) | DEW POINT | RELATIVE HUMIDITY | DIRECT | W I N D SPEED | GUST |
|-----|-------|----------|-----------|-------------------|--------|---------------|------|
| 28  | 09    | 82       | 69        | 65                | 190    | 13            |      |
| 28  | 10    | 84       | 70        | 63                | 200    | 16            |      |
| 28  | 11    | 84       | 69        | 60                | 200    | 18            |      |
| 28  | 12    | 87       | 70        | 57                | 200    | 08            |      |
| 28  | 13    | 91       | 70        | 51                | 190    | 13            |      |
| 28  | 14    | 97       | 69        | 40                | 190    | 10            |      |
| 28  | 15    | 96       | 70        | 43                | 220    | 09            |      |
| 28  | 16    | 95       | 68        | 41                | 160    | 08            |      |
| 28  | 17    | 96       | 61        | 31                | 180    | 06            |      |
| 28  | 18    | 93       | 66        | 41                | 130    | 06            |      |
| 28  | 19    | MISS     | MISS      | NA                | 090    | 10            |      |
| 28  | 20    | 74       | 73        | 97                | 030    | 14            |      |
| 28  | 21    | 70       | 70        | 100               | 130    | 12            |      |
| 27  | 09    | 80       | 65        | 60                | 220    | 06            |      |
| 27  | 10    | 87       | 67        | 51                | 230    | 10            |      |
| 27  | 11    | 88       | 66        | 48                | 240    | 06            |      |
| 27  | 12    | 87       | 67        | 51                | 250    | 12            |      |
| 27  | 13    | 92       | 66        | 42                | 220    | 11            |      |
| 27  | 14    | 95       | 65        | 37                | 180    | 16            |      |
| 27  | 15    | 96       | 64        | 35                | 190    | 14            |      |
| 27  | 16    | 95       | 64        | 36                | 190    | 10            |      |
| 27  | 17    | 95       | 64        | 36                | 160    | 10            |      |
| 27  | 18    | 94       | 62        | 35                | 170    | 10            |      |
| 27  | 19    | 94       | 66        | 40                | 150    | 14            |      |
| 27  | 20    | 91       | 63        | 39                | 160    | 12            |      |
| 27  | 21    | 88       | 63        | 43                | 160    | 10            |      |
| 26  | 09    | 79       | 64        | 60                | 220    | 06            |      |
| 26  | 10    | 83       | 65        | 54                | 220    | 06            |      |
| 26  | 11    | 85       | 66        | 53                | 220    | 04            |      |
| 26  | 12    | 89       | 64        | 43                | 220    | 10            |      |
| 26  | 13    | 93       | 67        | 42                | 220    | 10            |      |
| 26  | 14    | 94       | 65        | 39                | 180    | 07            |      |
| 26  | 15    | 94       | 63        | 36                | 150    | 05            | 18   |
| 26  | 16    | 96       | 62        | 33                | 190    | 10            |      |
| 26  | 17    | 95       | 64        | 36                | 120    | 10            | 17   |
| 26  | 18    | 94       | 61        | 33                | 160    | 11            |      |
| 26  | 19    | 93       | 61        | 34                | 180    | 10            |      |
| 26  | 20    | 90       | 62        | 39                | 180    | 09            |      |
| 26  | 21    | 87       | 63        | 44                | 170    | 09            |      |

| DAY | HOUR | TEMP (F) | DEW<br>POINT | RELATIVE<br>HUMIDITY | W I N D<br>DIREC SPEED | GUST |
|-----|------|----------|--------------|----------------------|------------------------|------|
| 25  | 09   | 87       | 65           | 48                   | 240                    | 06   |
| 25  | 10   | 89       | 63           | 42                   | CALM                   |      |
| 25  | 11   | 92       | 61           | 35                   | 220                    | 02   |
| 25  | 12   | 95       | 61           | 33                   | 330                    | 04   |
| 25  | 13   | 97       | 60           | 29                   | 160                    | 10   |
| 25  | 14   | 97       | 64           | 34                   | 220                    | 10   |
| 25  | 15   | 95       | 61           | 32                   | 130                    | 08   |
| 25  | 16   | 91       | 65           | 42                   | 160                    | 08   |
| 25  | 17   | 88       | 66           | 48                   | 170                    | 16   |
| 25  | 18   | 87       | 67           | 51                   | 200                    | 12   |
| 25  | 19   | 83       | 67           | 58                   | 230                    | 10   |
| 25  | 20   | 82       | 67           | 60                   | 200                    | 06   |
| 25  | 21   | 82       | 66           | 58                   | 250                    | 02   |
| 24  | 09   | 82       | 66           | 58                   | 190                    | 06   |
| 24  | 10   | 85       | 66           | 53                   | 160                    | 08   |
| 24  | 11   | 88       | 66           | 48                   | CALM                   |      |
| 24  | 12   | 90       | 62           | 39                   | 190                    | 04   |
| 24  | 13   | 93       | 58           | 31                   | 130                    | 04   |
| 24  | 14   | 95       | 61           | 33                   | 120                    | 10   |
| 24  | 15   | 97       | 58           | 27                   | 070                    | 10   |
| 24  | 16   | 96       | 60           | 30                   | 090                    | 06   |
| 24  | 17   | 95       | 61           | 32                   | 080                    | 07   |
| 24  | 18   | 94       | 62           | 35                   | 090                    | 08   |
| 24  | 19   | 93       | 68           | 44                   | 100                    | 05   |
| 24  | 20   | 89       | 66           | 46                   | 090                    | 06   |
| 24  | 21   | 86       | 67           | 53                   | CALM                   |      |
| 23  | 09   | 80       | 68           | 66                   | 220                    | 08   |
| 23  | 10   | 84       | 65           | 53                   | 230                    | 06   |
| 23  | 11   | 86       | 62           | 45                   | 190                    | 08   |
| 23  | 12   | 91       | 64           | 41                   | 220                    | 13   |
| 23  | 13   | 90       | 63           | 41                   | 200                    | 07   |
| 23  | 14   | 93       | 62           | 36                   | 150                    | 11   |
| 23  | 15   | 93       | 61           | 34                   | 210                    | 07   |
| 23  | 16   | 93       | 62           | 36                   | 130                    | 07   |
| 23  | 17   | 92       | 62           | 37                   | 140                    | 12   |
| 23  | 18   | 91       | 63           | 39                   | 140                    | 13   |
| 23  | 19   | 90       | 63           | 40                   | 150                    | 13   |
| 23  | 20   | 87       | 61           | 42                   | 140                    | 08   |
| 23  | 21   | 84       | 61           | 46                   | 150                    | 05   |

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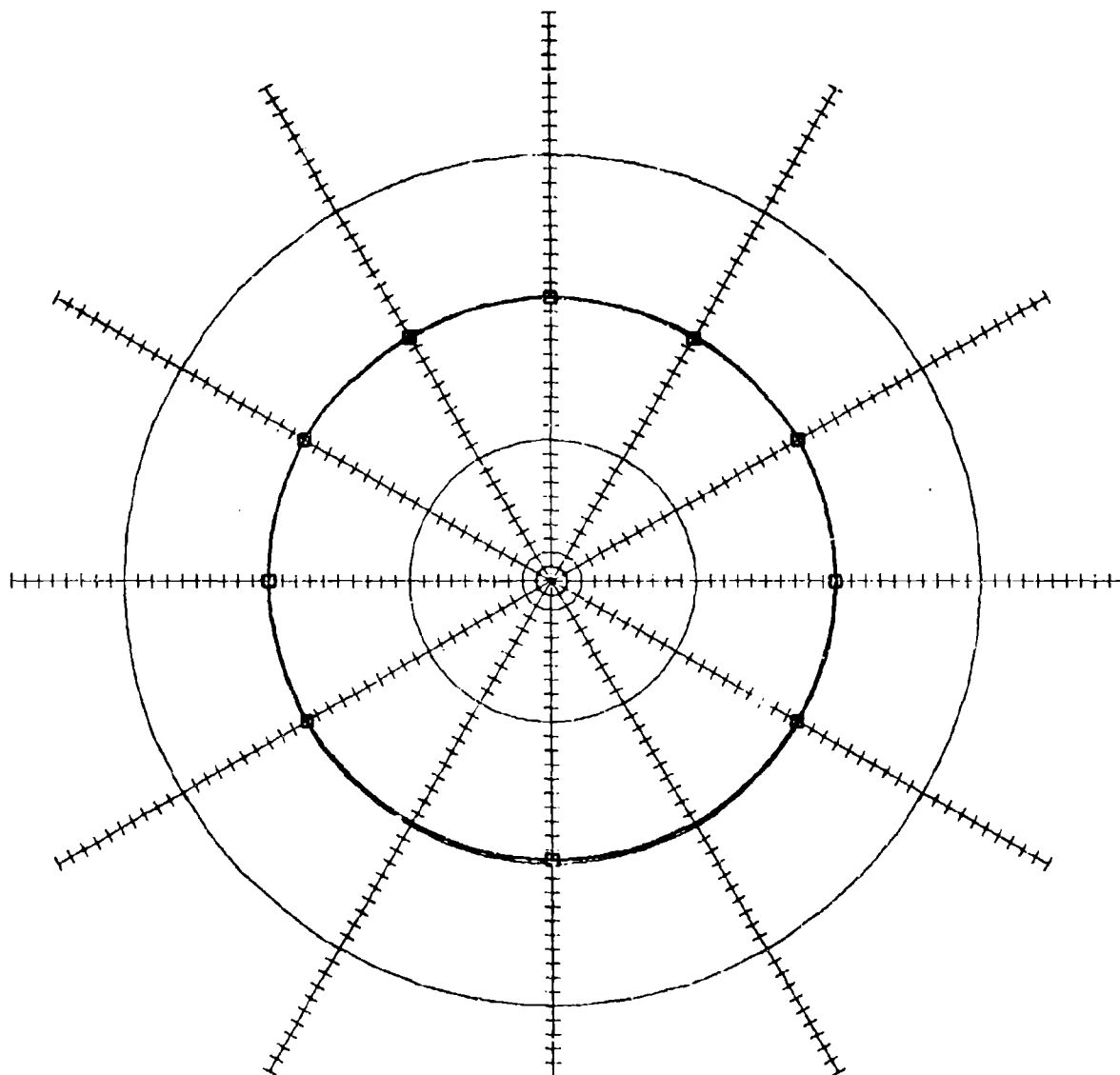
| DAY | HOUR | TEMP (P) | DEW<br>POINT | RELATIVE<br>HUMIDITY | W I N D<br>DIREC | SPEED | D<br>GUST |
|-----|------|----------|--------------|----------------------|------------------|-------|-----------|
| 22  | 09   | 81       | 64           | 56                   | 210              | 15    |           |
| 22  | 10   | 83       | 64           | 53                   | 210              | 08    | 18        |
| 22  | 11   | 85       | 62           | 46                   | 220              | 11    | 18        |
| 22  | 12   | 88       | 63           | 43                   | 210              | 13    | 19        |
| 22  | 13   | 90       | 63           | 41                   | 210              | 08    | 23        |
| 22  | 14   | 90       | 60           | 37                   | 190              | 10    |           |
| 22  | 15   | 90       | 62           | 39                   | 220              | 07    |           |
| 22  | 16   | 90       | 61           | 38                   | 170              | 11    |           |
| 22  | 17   | 90       | 62           | 39                   | 150              | 12    |           |
| 22  | 18   | 87       | 60           | 40                   | 160              | 18    |           |
| 22  | 19   | 87       | 60           | 49                   | 190              | 16    |           |
| 22  | 20   | 84       | 60           | 44                   | 170              | 06    |           |
| 22  | 21   | 83       | 62           | 49                   | 160              | 12    |           |
| 21  | 09   | 82       | 63           | 52                   | 210              | 12    | 16        |
| 21  | 10   | 84       | 63           | 49                   | 210              | 10    |           |
| 21  | 11   | 86       | 61           | 43                   | 200              | 11    |           |
| 21  | 12   | 89       | 61           | 39                   | 210              | 08    | 18        |
| 21  | 13   | 91       | 61           | 37                   | 210              | 08    | 24        |
| 21  | 14   | 92       | 63           | 38                   | 180              | 14    | 21        |
| 21  | 15   | 92       | 61           | 35                   | 180              | 11    | 18        |
| 21  | 16   | 92       | 59           | 33                   | 190              | 12    | 20        |
| 21  | 17   | 92       | 60           | 34                   | 140              | 11    |           |
| 21  | 18   | 91       | 66           | 43                   | 190              | 15    | 20        |
| 21  | 19   | 89       | 66           | 41                   | 160              | 10    |           |
| 21  | 20   | 84       | 62           | 47                   | 140              | 14    |           |
| 21  | 21   | 83       | 64           | 52                   | 150              | 12    |           |
| 20  | 09   | 82       | 68           | 62                   | 200              | 14    |           |
| 20  | 10   | 86       | 68           | 55                   | 200              | 15    | 20        |
| 20  | 11   | 88       | 65           | 46                   | 200              | 15    | 18        |
| 20  | 12   | 90       | 64           | 42                   | 210              | 16    | 24        |
| 20  | 13   | 93       | 63           | 37                   | 190              | 13    | 24        |
| 20  | 14   | 95       | 64           | 36                   | 180              | 17    | 24        |
| 20  | 15   | 96       | 61           | 31                   | 210              | 15    | 28        |
| 20  | 16   | 98       | 61           | 30                   | 200              | 13    | 23        |
| 20  | 17   | 95       | 61           | 32                   | 190              | 20    | 32        |
| 20  | 18   | 93       | 60           | 33                   | 180              | 16    | 25        |
| 20  | 19   | 90       | 60           | 36                   | 170              | 15    |           |
| 20  | 20   | 87       | 61           | 41                   | 170              | 14    | 23        |
| 20  | 21   | 85       | 64           | 49                   | 170              | 13    |           |

| DAY | HOURL | TEMP(F) | DEW<br>POINT | RELATIVE<br>HUMIDITY | W I N D<br>DIREC | SPEED | D<br>GUST |
|-----|-------|---------|--------------|----------------------|------------------|-------|-----------|
| 19  | 09    | 78      | 71           | 79                   | 160              | 13    |           |
| 19  | 10    | 81      | 71           | 71                   | 160              | 12    |           |
| 19  | 11    | 85      | 71           | 63                   | 150              | 11    | 16        |
| 19  | 12    | 87      | 70           | 57                   | 160              | 12    | 18        |
| 19  | 13    | 87      | 70           | 57                   | 130              | 16    | 20        |
| 19  | 14    | 89      | 70           | 54                   | 140              | 15    | 22        |
| 19  | 15    | 91      | 65           | 42                   | 180              | 16    | 20        |
| 19  | 16    | 94      | 57           | 41                   | 180              | 12    | 20        |
| 19  | 17    | 92      | 62           | 37                   | 170              | 13    | 22        |
| 19  | 18    | 91      | 61           | 36                   | 160              | 15    | 26        |
| 19  | 19    | 88      | 63           | 43                   | 160              | 13    | 22        |
| 19  | 20    | 85      | 65           | 50                   | 150              | 13    | 20        |
| 19  | 21    | 82      | 66           | 58                   | 150              | 14    |           |
| 18  | 09    | 79      | 72           | 79                   | 180              | 05    |           |
| 18  | 10    | 83      | 73           | 72                   | 130              | 04    |           |
| 18  | 11    | 86      | 72           | 63                   | 180              | 05    |           |
| 18  | 12    | 86      | 69           | 57                   | 130              | 06    |           |
| 18  | 13    | 88      | 69           | 53                   | 130              | 08    | 14        |
| 18  | 14    | 90      | 69           | 50                   | 150              | 12    |           |
| 18  | 15    | 90      | 68           | 48                   | 150              | 18    |           |
| 18  | 16    | 90      | 66           | 45                   | 160              | 16    | 25        |
| 18  | 17    | 86      | 67           | 52                   | 180              | 14    |           |
| 18  | 18    | 87      | 66           | 49                   | 160              | 14    |           |
| 18  | 19    | 84      | 68           | 58                   | 160              | 18    |           |
| 18  | 20    | 81      | 69           | 67                   | 160              | 08    |           |
| 18  | 21    | 80      | 69           | 69                   | 170              | 02    |           |
| 17  | 09    | 79      | 69           | 71                   | 120              | 06    |           |
| 17  | 10    | 80      | 68           | 66                   | 160              | 10    |           |
| 17  | 11    | 83      | 68           | 60                   | 130              | 08    | 13        |
| 17  | 12    | 84      | 68           | 59                   | 150              | 06    |           |
| 17  | 13    | 86      | 68           | 55                   | 120              | 05    |           |
| 17  | 14    | 86      | 66           | 51                   | 130              | 09    | 15        |
| 17  | 15    | 88      | 66           | 48                   | 110              | 09    | 18        |
| 17  | 16    | 88      | 64           | 45                   | 120              | 06    |           |
| 17  | 17    | 88      | 64           | 45                   | 110              | 08    |           |
| 17  | 18    | 87      | 63           | 45                   | 170              | 08    |           |
| 17  | 19    | 86      | 63           | 46                   | 130              | 07    |           |
| 17  | 20    | 81      | 64           | 55                   | 100              | 04    |           |
| 17  | 21    | 78      | 64           | 62                   | 120              | 04    |           |

| DAY | HOOR | TEMP(F) | DEW<br>POINT | RELATIVE<br>HUMIDITY | DIREC | W I N D<br>SPEED | GUST |
|-----|------|---------|--------------|----------------------|-------|------------------|------|
| 16  | 09   | 75      | 69           | 81                   | CALM  |                  |      |
| 16  | 10   | 76      | 69           | 79                   | 010   | 02               |      |
| 16  | 11   | 79      | 70           | 82                   | 040   | 05               |      |
| 16  | 12   | 81      | 71           | 71                   | 050   | 03               |      |
| 16  | 13   | 84      | 69           | 60                   | 070   | 05               |      |
| 16  | 14   | 86      | 69           | 57                   | 070   | 11               |      |
| 16  | 15   | 87      | 69           | 55                   | 030   | 06               |      |
| 16  | 16   | 88      | 66           | 48                   | 050   | 10               |      |
| 16  | 17   | 87      | 66           | 49                   | 050   | 08               |      |
| 16  | 18   | 87      | 66           | 50                   | 070   | 08               |      |
| 16  | 19   | 85      | 66           | 53                   | 070   | 05               |      |
| 16  | 20   | 80      | 67           | 64                   | 080   | 04               |      |
| 16  | 21   | 78      | 67           | 68                   | 090   | 04               |      |
| 15  | 09   | 71      | 69           | 93                   | 200   | 08               |      |
| 15  | 10   | 72      | 70           | 93                   | 190   | 10               |      |
| 15  | 11   | 73      | 70           | 90                   | 220   | 12               | 20   |
| 15  | 12   | 77      | 72           | 84                   | 200   | 08               |      |
| 15  | 13   | 77      | 72           | 84                   | 210   | 05               |      |
| 15  | 14   | 81      | 70           | 69                   | 200   | 12               |      |
| 15  | 15   | 82      | 70           | 67                   | 180   | 04               |      |
| 15  | 16   | 85      | 70           | 60                   | 170   | 06               |      |
| 15  | 17   | 87      | 69           | 55                   | 160   | 08               |      |
| 15  | 18   | 86      | 67           | 53                   | 190   | 04               |      |
| 15  | 19   | 85      | 68           | 56                   | CALM  |                  |      |
| 15  | 20   | 82      | 70           | 67                   | CALM  |                  |      |
| 15  | 21   | 81      | 69           | 67                   | 150   | 06               |      |
| 14  | 09   | 78      | 67           | 68                   | 210   | 10               |      |
| 14  | 10   | 80      | 67           | 64                   | 170   | 04               |      |
| 14  | 11   | 81      | 66           | 60                   | 150   | 10               |      |
| 14  | 12   | 83      | 65           | 54                   | 190   | 10               |      |
| 14  | 13   | 85      | 64           | 49                   | 170   | 14               | 22   |
| 14  | 14   | 85      | 65           | 51                   | 160   | 14               | 23   |
| 14  | 15   | 87      | 67           | 51                   | 170   | 10               |      |
| 14  | 16   | 87      | 64           | 46                   | 180   | 10               |      |
| 14  | 17   | 86      | 65           | 49                   | 200   | 08               | 15   |
| 14  | 18   | 78      | 65           | 64                   | 130   | 10               | 15   |
| 14  | 19   | 82      | 67           | 60                   | 150   | 08               |      |
| 14  | 20   | 80      | 68           | 66                   | 140   | 04               |      |
| 14  | 21   | 78      | 69           | 73                   | 140   | 07               |      |

| DAY | HOUR | TEMP (F) | DEW<br>POINT | RELATIVE<br>HUMIDITY | W I N D<br>DIREC SPEED | GUST |
|-----|------|----------|--------------|----------------------|------------------------|------|
| 13  | 09   | 82       | 69           | 64                   | 190 08                 |      |
| 13  | 10   | 84       | 68           | 59                   | 180 12                 |      |
| 13  | 11   | 86       | 65           | 49                   | 170 12                 |      |
| 13  | 12   | 87       | 64           | 46                   | 180 08                 |      |
| 13  | 13   | 88       | 65           | 46                   | 140 10                 | 17   |
| 13  | 14   | 87       | 65           | 48                   | 180 08                 |      |
| 13  | 15   | 88       | 64           | 45                   | 190 10                 |      |
| 13  | 16   | 87       | 64           | 46                   | 170 12                 | 19   |
| 13  | 17   | 83       | 68           | 60                   | 120 12                 | 19   |
| 13  | 18   | 78       | 67           | 68                   | 160 18                 | 25   |
| 13  | 19   | 76       | 66           | 71                   | 160 06                 |      |
| 13  | 20   | 75       | 66           | 73                   | 160 03                 |      |
| 13  | 21   | 74       | 67           | 78                   | 140 05                 |      |
| 12  | 09   | 78       | 69           | 73                   | 180 12                 |      |
| 12  | 10   | 82       | 67           | 60                   | 180 12                 |      |
| 12  | 11   | 83       | 67           | 58                   | 180 16                 |      |
| 12  | 12   | 86       | 64           | 48                   | 200 16                 |      |
| 12  | 13   | 88       | 65           | 46                   | 190 10                 | 23   |
| 12  | 14   | 90       | 63           | 41                   | 210 10                 |      |
| 12  | 15   | 92       | 62           | 37                   | 200 10                 | 18   |
| 12  | 16   | 89       | 63           | 47                   | 190 07                 | 19   |
| 12  | 17   | 90       | 65           | 43                   | 220 10                 |      |
| 12  | 18   | 89       | 64           | 43                   | 160 14                 | 18   |
| 12  | 19   | 81       | 67           | 62                   | 200 09                 | 17   |
| 12  | 20   | 78       | 65           | 64                   | 160 04                 |      |
| 12  | 21   | 76       | 65           | 68                   | 150 04                 |      |

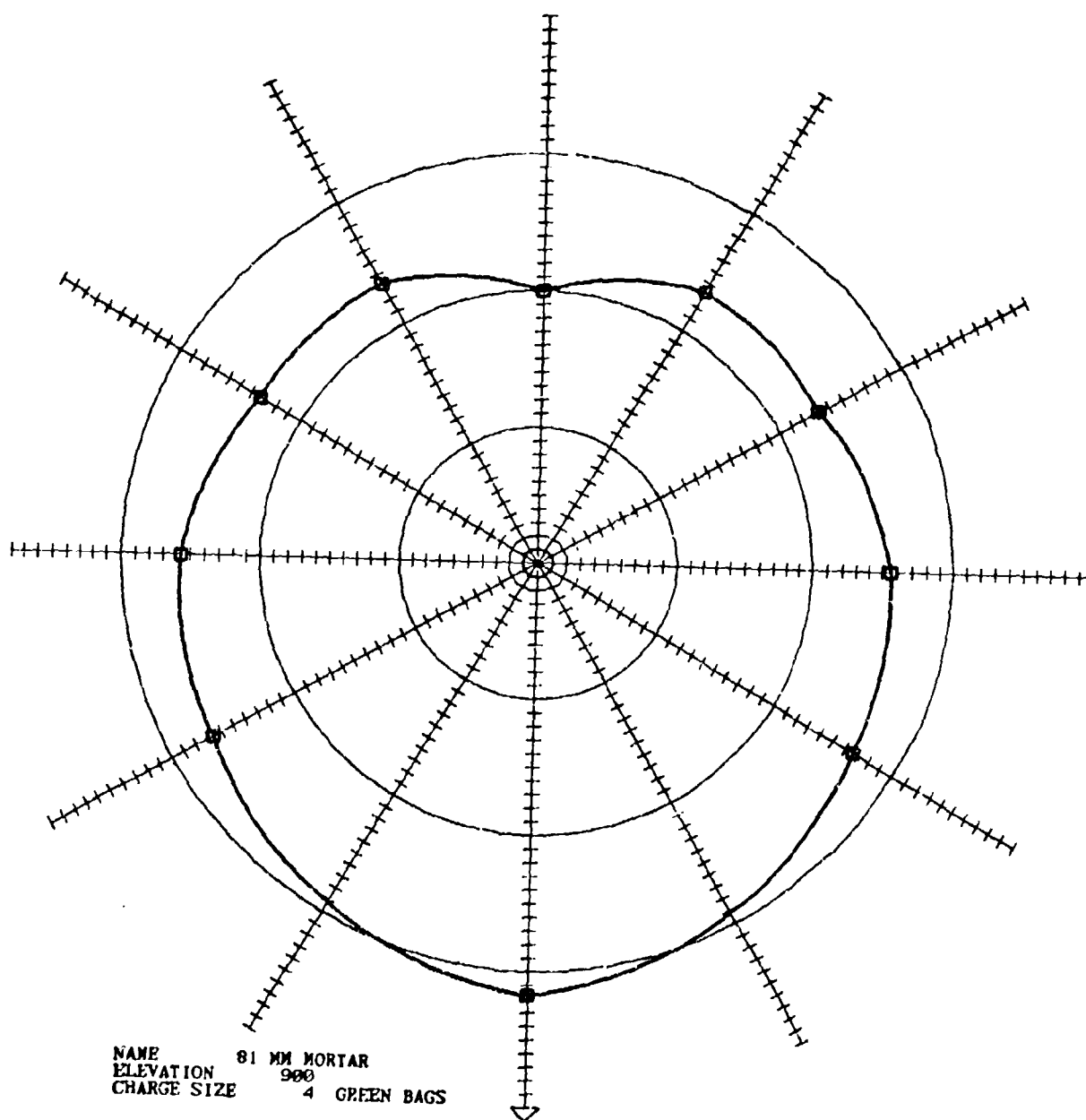
APPENDIX C:  
DIRECTIVITY PATTERNS



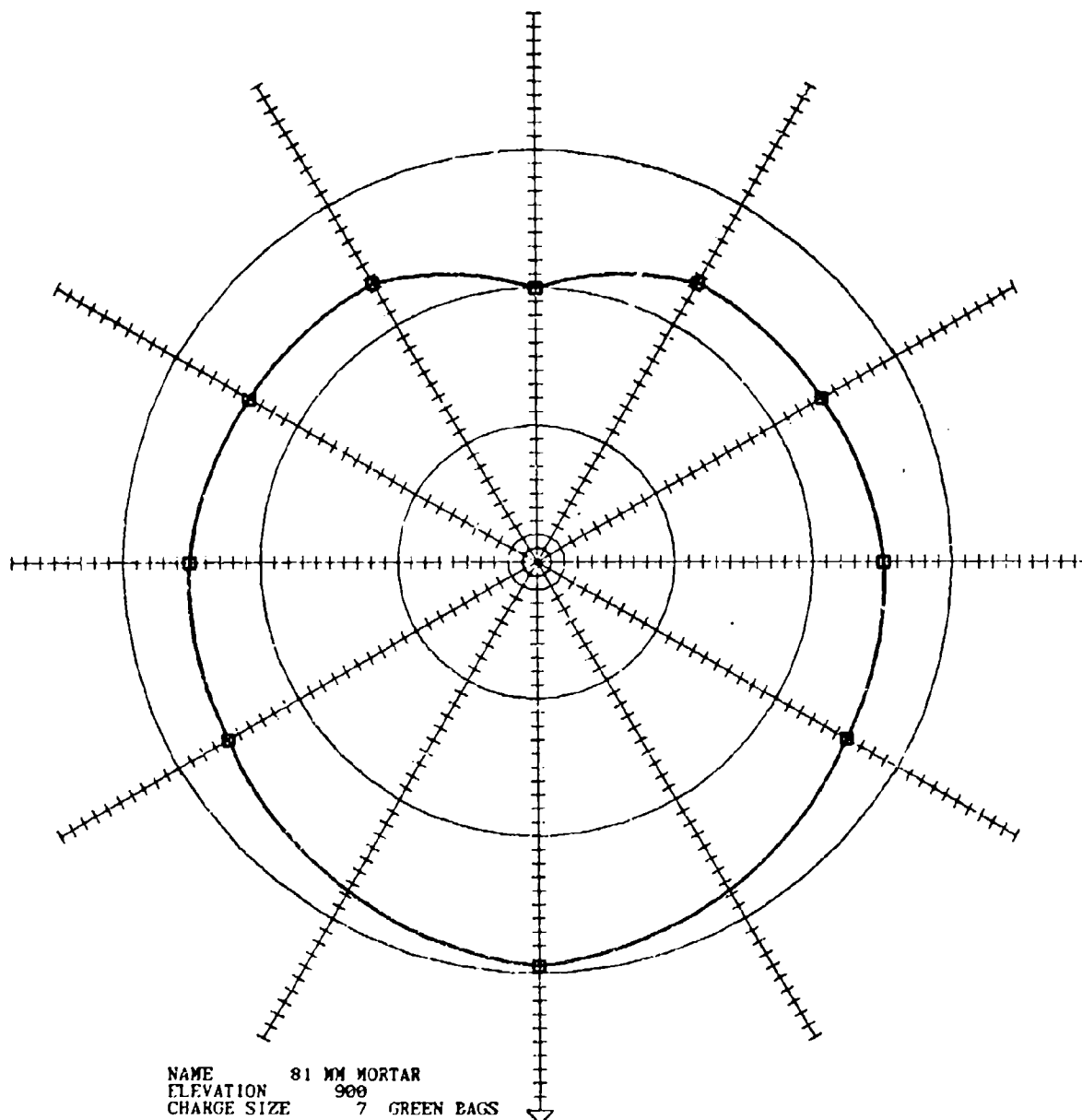
NAME  
ELEVATION  
CHARGE SIZE

CALIBRATION  
0  
5.00 LBS.

| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE   | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|---------|-------------------------|-----------------------|
| 1       | 118.62 | -0.17                   | 0°      | -0.33                   | -0.24                 |
| 2       | 118.75 | -0.08                   | 30°     | -0.27                   | -0.17                 |
| 3       | 118.78 | 0.00                    | 60°     | -0.20                   | -0.10                 |
| 4       | 118.93 | 0.08                    | 90°     | -0.09                   | -0.00                 |
| 5       | 119.22 | -0.11                   | 120°    | -0.00                   | 0.09                  |
| 6       | 112.85 | -0.29                   | 150°    | -0.16                   | -0.05                 |
| 7       | 113.16 | 0.10                    | 180°    | 0.00                    | 0.09                  |
| 8       | 113.14 | -0.25                   | 210°    | -0.16                   | -0.06                 |
| 9       | 118.56 | -0.33                   | 240°    | -0.00                   | 0.09                  |
| 10      | 112.65 | -0.25                   | 270°    | -0.09                   | -0.00                 |
| 11      | 112.95 | 0.19                    | 300°    | -0.20                   | -0.10                 |
| 12      | 112.58 | -0.13                   | 330°    | -0.27                   | -0.17                 |
| 13      | 112.81 | 0.02                    |         |                         |                       |
| 14      | 113.00 | 0.00                    |         |                         |                       |
| 15      | 112.60 | -0.35                   |         |                         |                       |
| 16      | 112.77 | -0.44                   |         |                         |                       |
|         |        |                         | AVERAGE | -0.15                   | -0.05                 |

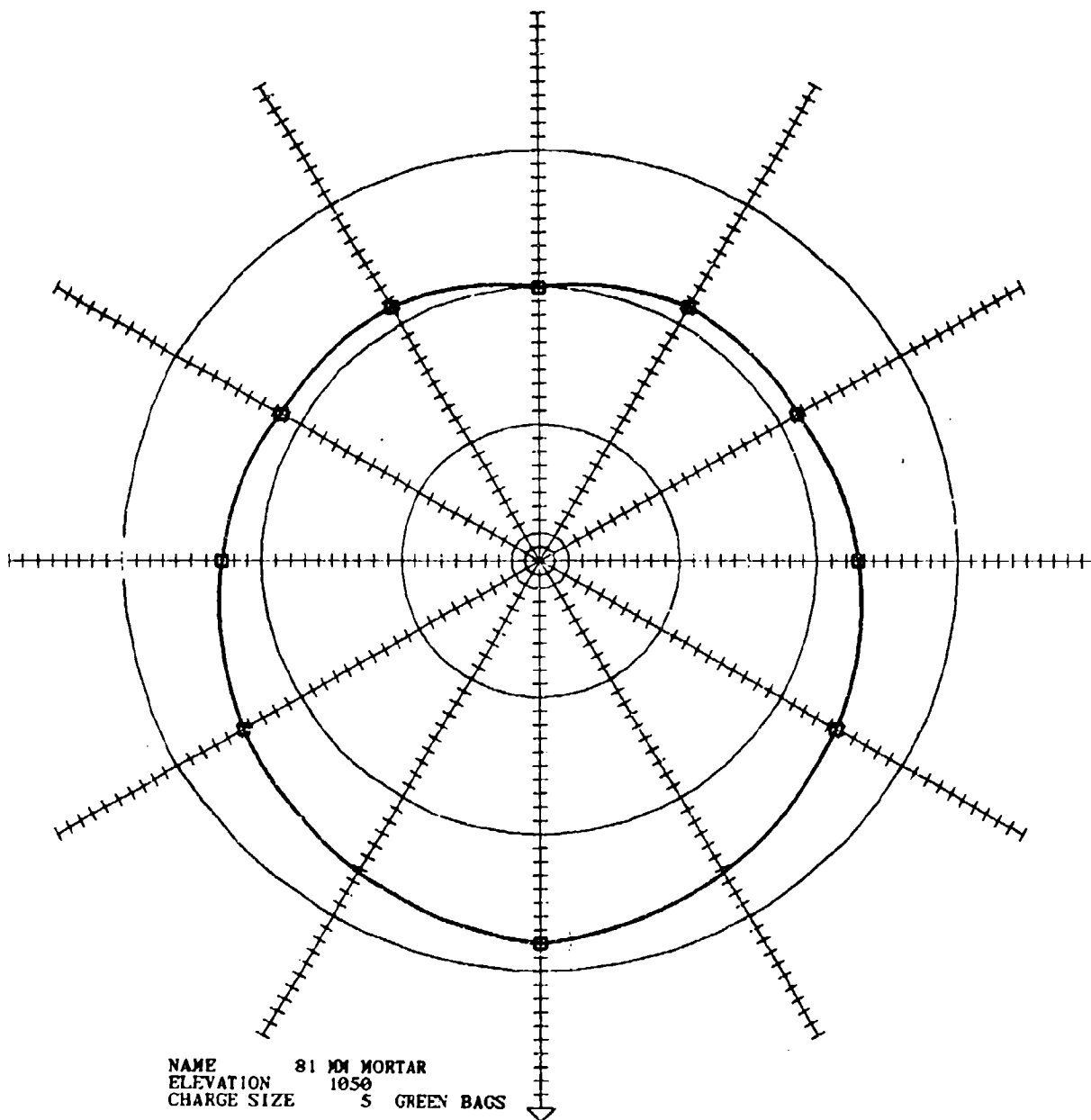


| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE   | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|---------|-------------------------|-----------------------|
| 1       | 95.25  | 9.83                    | 0°      | 11.71                   | -21.42                |
| 2       | 91.56  | 5.20                    | 30°     | 9.17                    | -23.96                |
| 3       | 86.40  | 0.00                    | 60°     | 6.63                    | -26.50                |
| 4       | 87.12  | 1.06                    | 90°     | 5.65                    | -27.49                |
| 5       | 91.35  | 5.10                    | 120°    | 3.27                    | -29.86                |
| 6       | 82.81  | 3.40                    | 150°    | 3.34                    | -29.79                |
| 7       | 77.86  | -1.00                   | 180°    | 0.00                    | -33.14                |
| 8       | 81.69  | 3.40                    | 210°    | 3.34                    | -29.79                |
| 9       | 98.45  | 11.71                   | 240°    | 3.27                    | -29.86                |
| 10      | 86.85  | 7.69                    | 270°    | 5.65                    | -27.49                |
| 11      | 87.11  | 7.90                    | 300°    | 6.63                    | -26.50                |
| 12      | 85.16  | 6.15                    | 330°    | 9.17                    | -23.96                |
| 13      | 83.76  | 3.74                    |         |                         |                       |
| 14      | 80.29  | 0.00                    |         |                         |                       |
| 15      | 83.63  | 3.34                    |         |                         |                       |
| 16      | 83.69  | 3.40                    |         |                         |                       |
|         |        |                         | AVERAGE | 6.88                    | -26.33                |

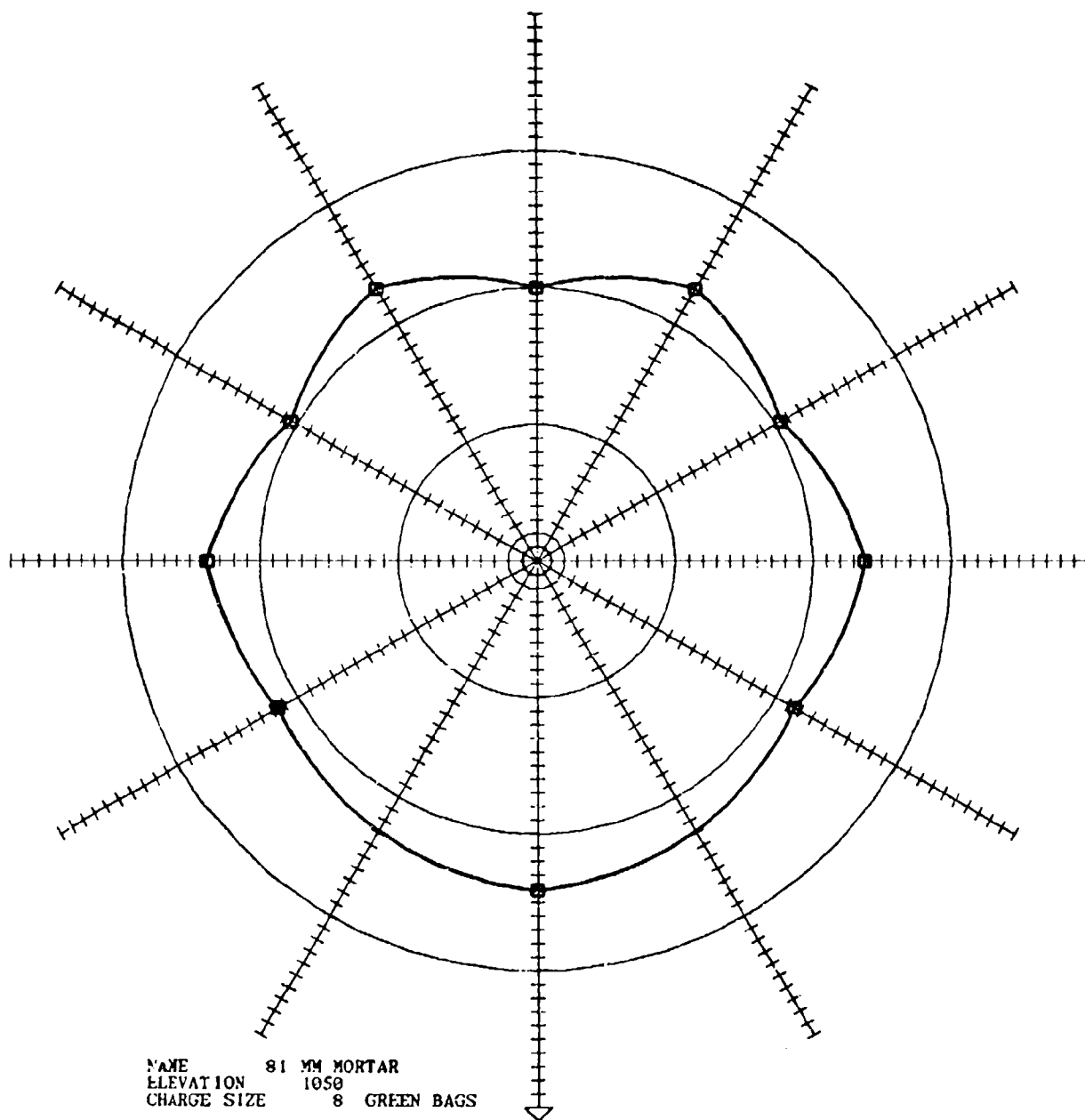


NAME 81 MM MORTAR  
ELEVATION 900  
CHARGE SIZE 7 GREEN BAGS

| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE   | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|---------|-------------------------|-----------------------|
| 1       | 100.42 | 6.41                    | 0°      | 9.44                    | -16.91                |
| 2       | 98.73  | 4.72                    | 30°     | 7.64                    | -18.71                |
| 3       | 94.04  | 0.00                    | 60°     | 5.85                    | -20.50                |
| 4       | 96.73  | 2.58                    | 90°     | 5.11                    | -21.25                |
| 5       | 97.67  | 3.67                    | 120°    | 3.88                    | -22.47                |
| 6       | 90.82  | 5.34                    | 150°    | 3.47                    | -22.88                |
| 7       | 87.61  | 2.08                    | 180°    | 0.00                    | -26.36                |
| 8       | 88.93  | 3.30                    | 210°    | 3.47                    | -22.88                |
| 9       | 103.51 | 9.44                    | 240°    | 3.88                    | -22.47                |
| 10      | 93.43  | 7.96                    | 270°    | 5.11                    | -21.25                |
| 11      | 92.34  | 6.92                    | 300°    | 5.85                    | -20.50                |
| 12      | 91.61  | 6.16                    | 330°    | 7.64                    | -18.71                |
| 13      | 88.95  | 3.48                    |         |                         |                       |
| 14      | 85.61  | 0.00                    |         |                         |                       |
| 15      | 89.09  | 3.47                    |         |                         |                       |
| 16      | 88.93  | 3.30                    |         |                         |                       |
|         |        |                         | AVERAGE | 5.73                    | -20.61                |

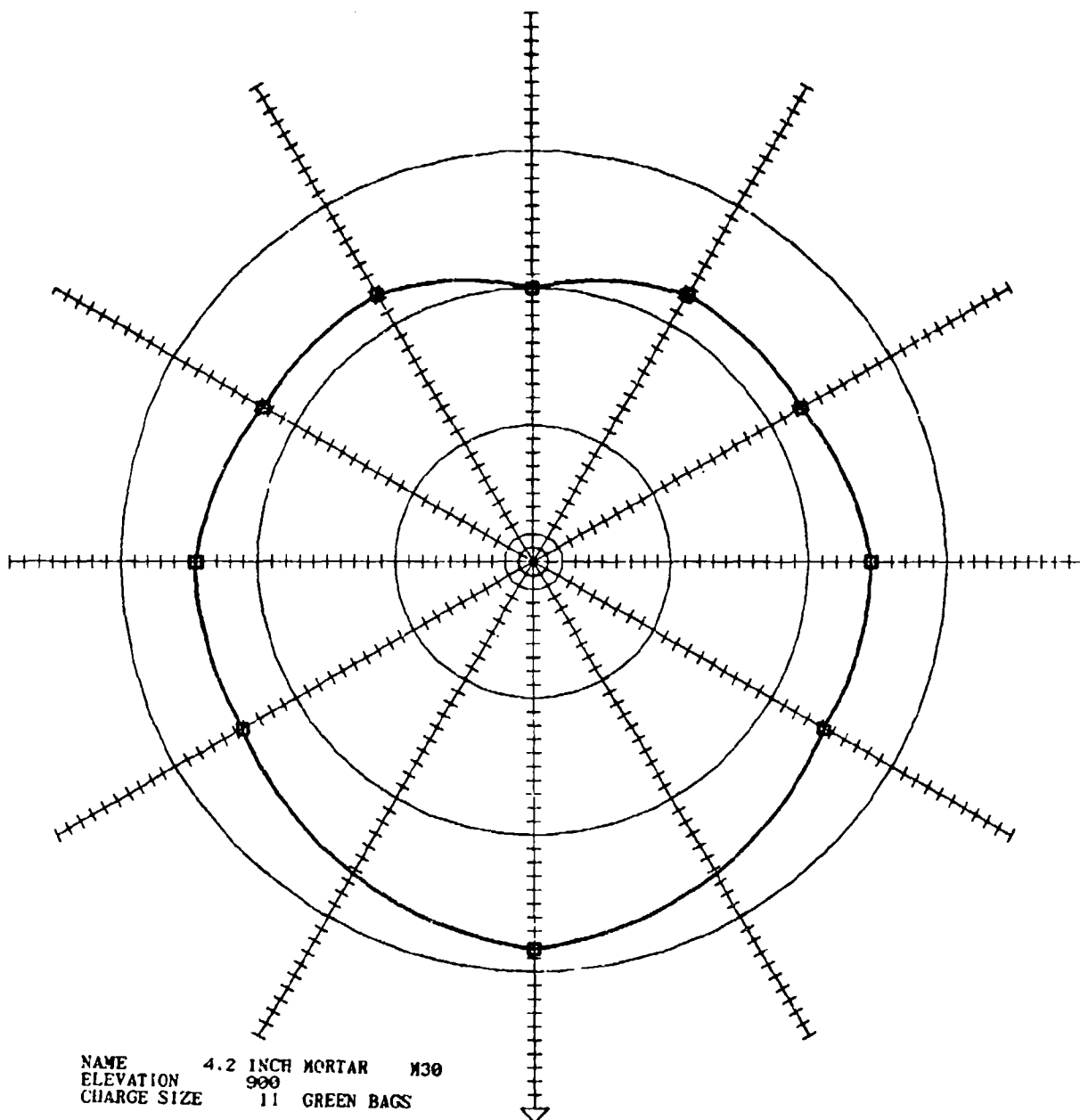


| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE   | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|---------|-------------------------|-----------------------|
| 1       | 98.59  | 7.01                    | 0°      | 7.93                    | -20.75                |
| 2       | 95.95  | 4.55                    | 30°     | 6.25                    | -22.43                |
| 3       | 91.54  | 0.00                    | 60°     | 4.57                    | -24.12                |
| 4       | 90.86  | -0.90                   | 90°     | 2.89                    | -25.01                |
| 5       | 94.29  | 2.55                    | 120°    | 1.50                    | -27.18                |
| 6       | 86.53  | 2.77                    | 150°    | 1.43                    | -27.25                |
| 7       | 81.47  | -2.64                   | 180°    | 0.00                    | -28.69                |
| 8       | 84.33  | 0.12                    | 210°    | 1.43                    | -27.25                |
| 9       | 99.38  | 7.93                    | 240°    | 1.50                    | -27.18                |
| 10      | 89.98  | 5.82                    | 270°    | 2.89                    | -25.01                |
| 11      | 89.57  | 5.65                    | 300°    | 4.57                    | -24.12                |
| 12      | 88.71  | 4.85                    | 330°    | 6.25                    | -22.43                |
| 13      | 86.75  | 2.80                    |         |                         |                       |
| 14      | 84.64  | 0.00                    |         |                         |                       |
| 15      | 84.18  | -4.00                   |         |                         |                       |
| 16      | 84.33  | 0.12                    |         |                         |                       |
|         |        |                         | AVERAGE | 4.10                    | -24.58                |



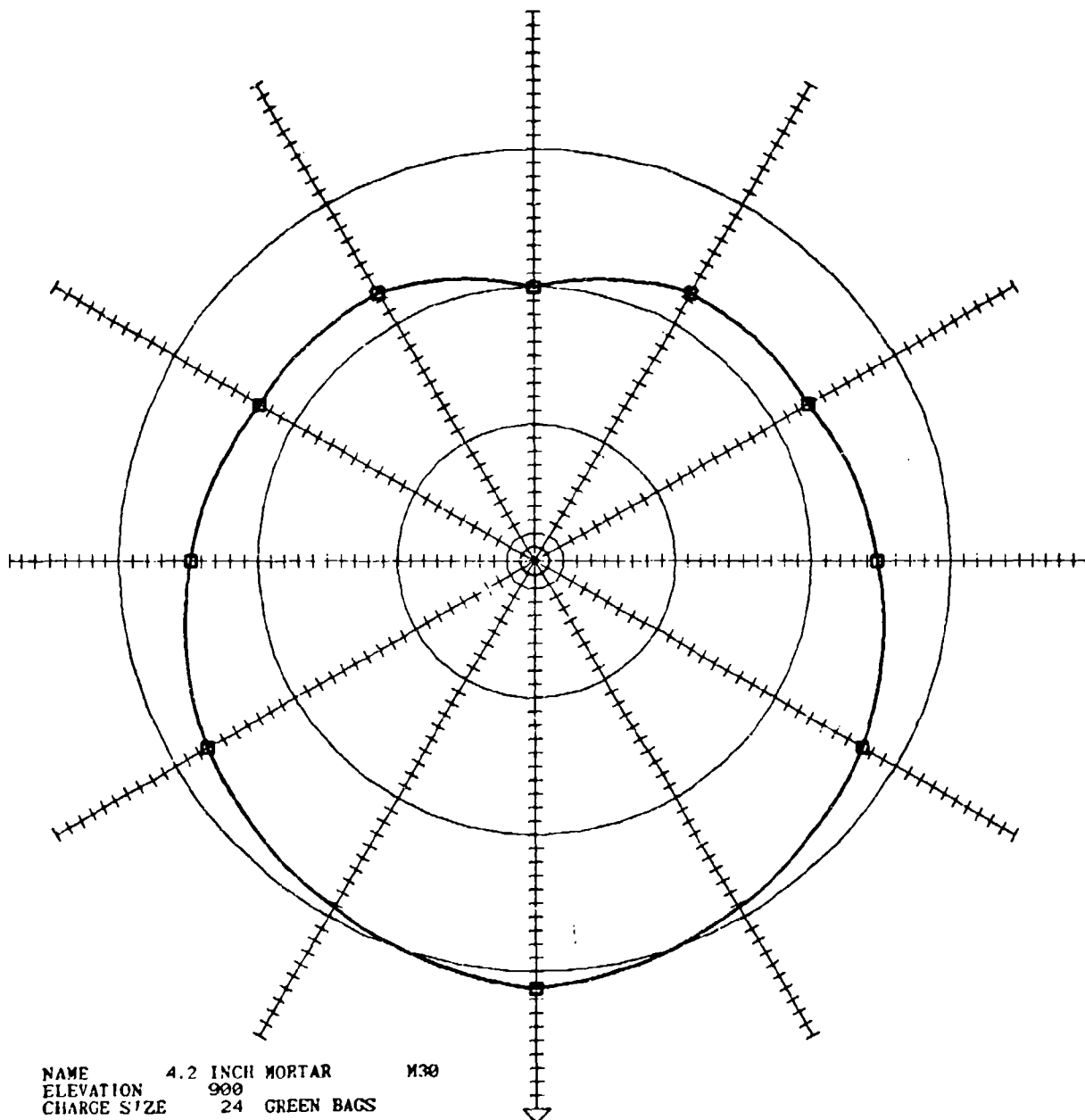
NAME 81 MM MORTAR  
ELEVATION 1050  
CHARGE SIZE 8 GREEN BAGS

| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE   | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|---------|-------------------------|-----------------------|
| 1       | 101.18 | 3.96                    | 0°      | 4.10                    | -18.08                |
| 2       | 98.99  | 1.74                    | 30°     | 2.81                    | -19.36                |
| 3       | 97.31  | 0.00                    | 60°     | 1.53                    | -20.64                |
| 4       | 96.33  | -1.05                   | 90°     | 3.82                    | -18.36                |
| 5       | 97.02  | -0.46                   | 120°    | 0.44                    | -21.73                |
| 6       | 88.42  | -1.71                   | 150°    | 3.00                    | -19.18                |
| 7       | 91.04  | -0.09                   | 180°    | 0.00                    | -22.18                |
| 8       | 94.09  | 4.28                    | 210°    | 3.00                    | -19.18                |
| 9       | 101.36 | 4.10                    | 240°    | 0.44                    | -21.73                |
| 10      | 93.90  | 4.34                    | 270°    | 3.82                    | -18.36                |
| 11      | 93.36  | 3.82                    | 300°    | 1.53                    | -20.64                |
| 12      | 90.71  | 1.20                    | 330°    | 2.81                    | -19.36                |
| 13      | 91.63  | 1.98                    |         |                         |                       |
| 14      | 90.26  | 0.00                    |         |                         |                       |
| 15      | 94.30  | 4.27                    |         |                         |                       |
| 16      | 0.00   | -1.79                   |         |                         |                       |
|         |        |                         | AVERAGE | 2.48                    | -19.69                |



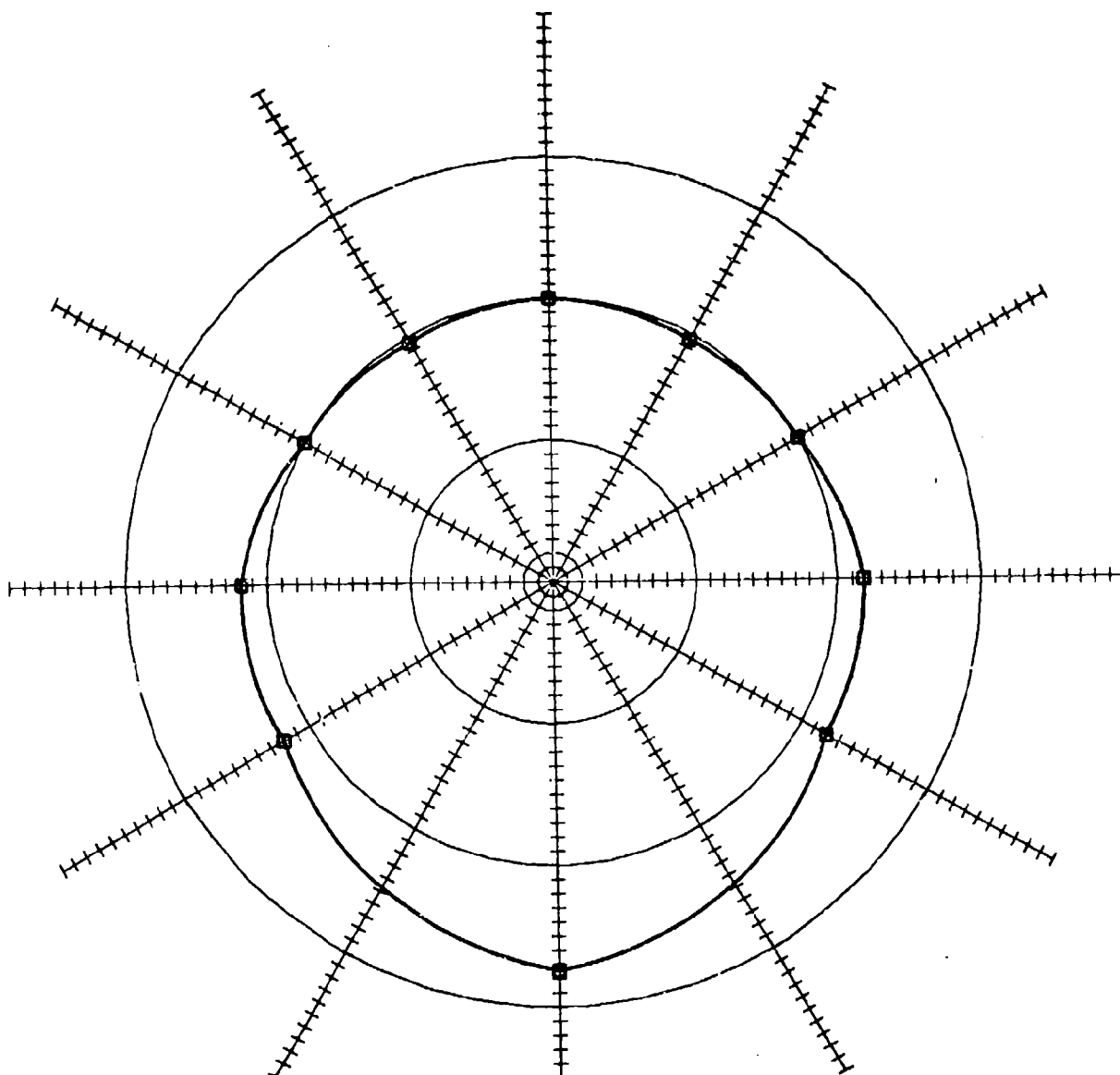
NAME 4.2 INCH MORTAR M30  
ELEVATION 900  
CHARGE SIZE 11 GREEN BAGS

| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|-------|-------------------------|-----------------------|
| 1       | 96.20  | 7.38                    | 0°    | 8.30                    | -22.79                |
| 2       | 92.70  | 3.88                    | 30°   | 6.33                    | -24.76                |
| 3       | 88.82  | 0.00                    | 60°   | 4.36                    | -26.72                |
| 4       | 90.06  | 1.17                    | 90°   | 4.50                    | -26.59                |
| 5       | 91.36  | 2.05                    | 120°  | 2.55                    | -28.54                |
| 6       | 83.60  | -0.10                   | 150°  | 2.50                    | -28.59                |
| 7       | 83.50  | 1.32                    | 180°  | 0.00                    | -31.09                |
| 8       | 84.46  | 2.93                    | 210°  | 2.50                    | -28.59                |
| 9       | 97.84  | 8.30                    | 240°  | 2.55                    | -28.54                |
| 10      | 88.90  | 7.66                    | 270°  | 4.50                    | -26.59                |
| 11      | 87.43  | 6.07                    | 300°  | 4.36                    | -26.72                |
| 12      | 85.30  | 3.82                    | 330°  | 6.33                    | -24.76                |
| 13      | 83.44  | 2.45                    |       |                         |                       |
| 14      | 81.34  | 0.00                    |       |                         |                       |
| 15      | 84.09  | 2.56                    |       |                         |                       |
| 16      | 84.46  | 2.93                    |       |                         |                       |
| AVERAGE |        |                         |       | 4.60                    | -26.49                |



NAME 4.2 INCH MORTAR M30  
ELEVATION 900  
CHARGE SIZE 24 GREEN BAGS

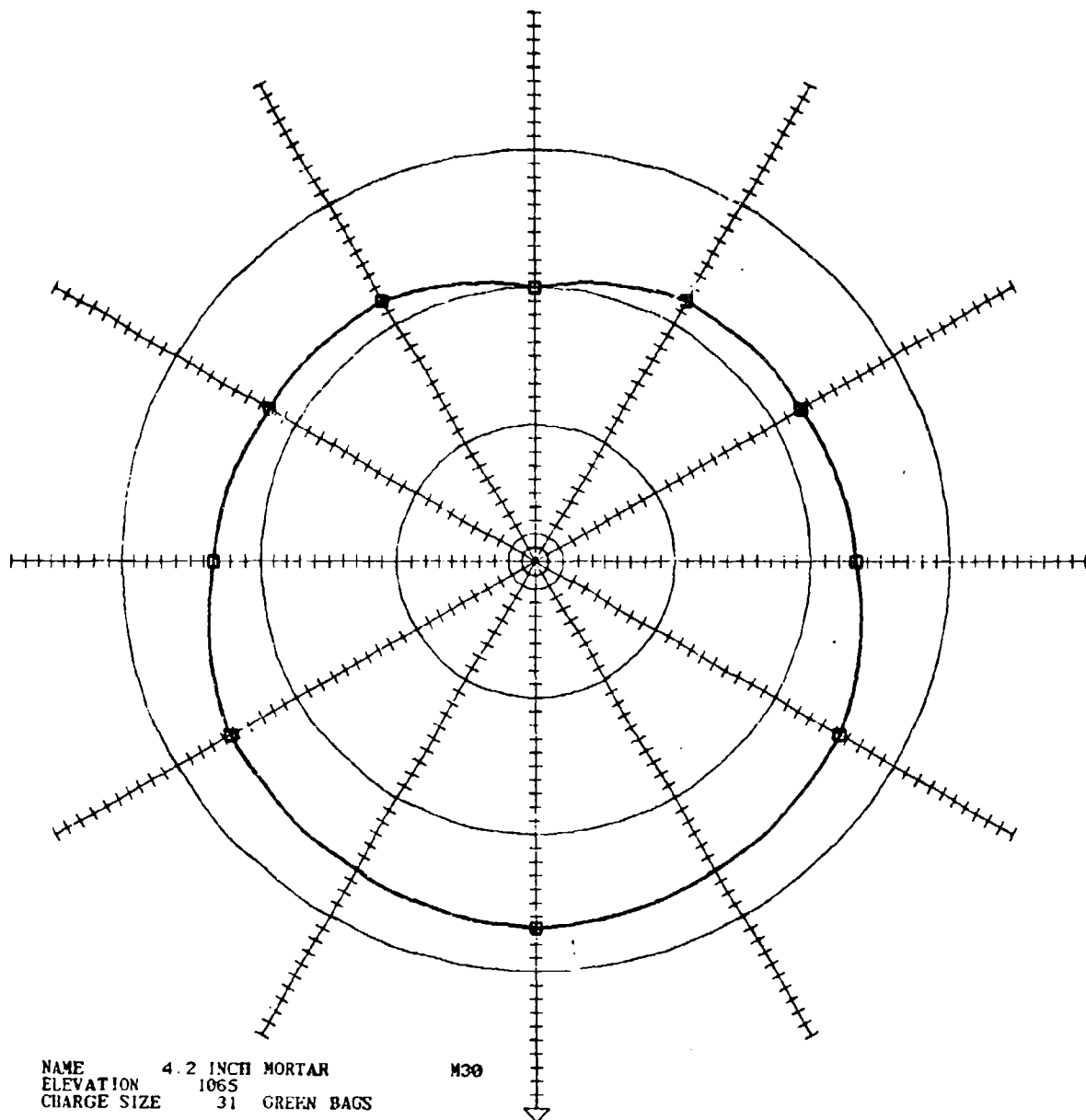
| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|-------|-------------------------|-----------------------|
| 1       | 100.48 | 7.02                    | 0°    | 11.21                   | -14.94                |
| 2       | 98.65  | 5.24                    | 30°   | 9.22                    | -16.93                |
| 3       | 93.36  | 0.00                    | 60°   | 7.23                    | -18.91                |
| 4       | 95.18  | 1.70                    | 90°   | 4.76                    | -21.95                |
| 5       | 99.94  | 6.58                    | 120°  | 2.85                    | -23.30                |
| 6       | 92.58  | 7.01                    | 150°  | 2.59                    | -23.56                |
| 7       | 85.76  | -0.12                   | 180°  | 0.00                    | -26.16                |
| 8       | 88.52  | 2.85                    | 210°  | 2.59                    | -23.56                |
| 9       | 104.61 | 11.21                   | 240°  | 2.85                    | -23.30                |
| 10      | 93.92  | 8.34                    | 270°  | 4.76                    | -21.95                |
| 11      | 92.42  | 6.66                    | 300°  | 7.23                    | -18.91                |
| 12      | 90.04  | 4.60                    | 330°  | 9.22                    | -16.93                |
| 13      | 87.68  | 2.18                    |       |                         |                       |
| 14      | 85.61  | 0.00                    |       |                         |                       |
| 15      | 88.69  | 2.99                    |       |                         |                       |
| 16      | 88.52  | 2.85                    |       |                         |                       |
| AVERAGE |        |                         |       | 6.61                    | -19.60                |



NAME 4.2 INCH MORTAR  
ELEVATION 1065  
CHARGE SIZE 20 GREEN BAGS

M30

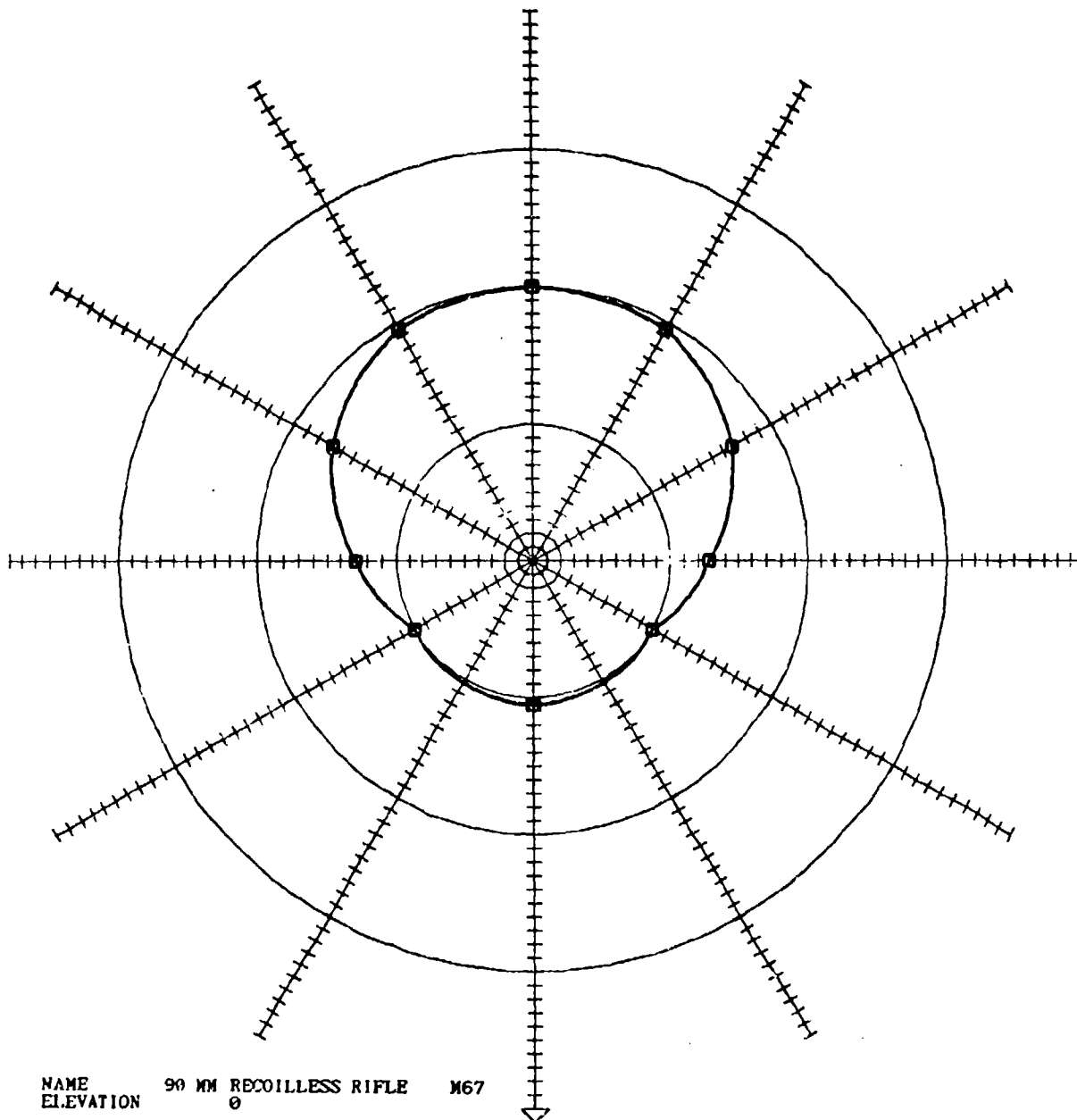
| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|-------|-------------------------|-----------------------|
| 1       | 100.51 | 5.94                    | 0°    | 7.39                    | -17.08                |
| 2       | 98.13  | 3.47                    | 30°   | 4.69                    | -19.77                |
| 3       | 94.72  | 0.00                    | 60°   | 2.00                    | -22.47                |
| 4       | 94.86  | -0.23                   | 90°   | 1.80                    | -22.46                |
| 5       | 95.69  | 0.92                    | 120°  | -0.02                   | -24.49                |
| 6       | 85.93  | -2.89                   | 150°  | -0.41                   | -24.88                |
| 7       | 83.12  | -5.40                   | 180°  | 0.00                    | -24.48                |
| 8       | 88.30  | -0.21                   | 210°  | -0.41                   | -24.68                |
| 9       | 102.12 | 7.39                    | 240°  | -0.02                   | -24.49                |
| 10      | 92.42  | 4.03                    | 270°  | 1.80                    | -22.46                |
| 11      | 92.43  | 3.80                    | 300°  | 2.00                    | -22.47                |
| 12      | 90.67  | 2.07                    | 330°  | 4.69                    | -19.77                |
| 13      | 89.83  | 1.39                    |       |                         |                       |
| 14      | 88.97  | 0.00                    |       |                         |                       |
| 15      | 87.20  | -2.21                   |       |                         |                       |
| 16      | 88.30  | -0.21                   |       |                         |                       |
| AVERAGE |        |                         |       | 2.71                    | -21.73                |



NAME 4.2 INCH MORTAR  
ELEVATION 1065  
CHARGE SIZE 31 GREEN BAGS

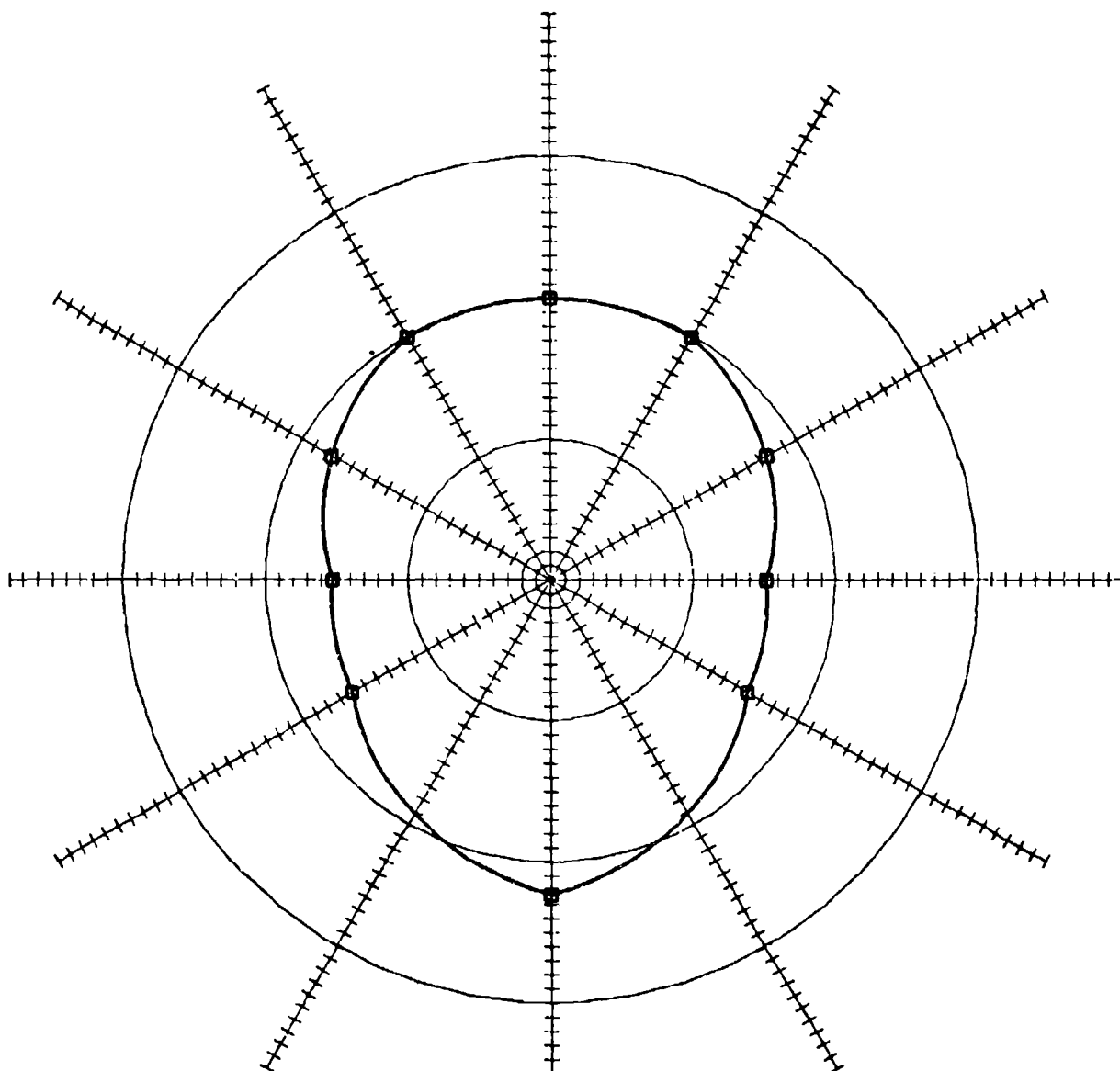
M30

| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|-------|-------------------------|-----------------------|
| 1       | 104.76 | 6.28                    | 0°    | 6.77                    | -14.70                |
| 2       | 101.53 | 3.08                    | 30°   | 6.10                    | -15.38                |
| 3       | 98.59  | 0.00                    | 60°   | 5.42                    | -16.05                |
| 4       | 98.83  | 0.28                    | 90°   | 3.18                    | -18.31                |
| 5       | 102.37 | 3.73                    | 120°  | 2.27                    | -19.21                |
| 6       | 95.83  | 5.21                    | 150°  | 1.92                    | -19.56                |
| 7       | 91.77  | 1.09                    | 180°  | 0.00                    | -21.49                |
| 8       | 92.49  | 2.01                    | 210°  | 1.92                    | -19.56                |
| 9       | 105.24 | 6.77                    | 240°  | 2.27                    | -19.21                |
| 10      | 96.75  | 6.47                    | 270°  | 3.18                    | -18.31                |
| 11      | 94.79  | 4.35                    | 300°  | 5.42                    | -16.05                |
| 12      | 94.94  | 4.63                    | 330°  | 6.10                    | -15.38                |
| 13      | 92.45  | 1.97                    |       |                         |                       |
| 14      | 91.19  | 0.00                    |       |                         |                       |
| 15      | 92.35  | 1.87                    |       |                         |                       |
| 16      | 92.49  | 2.01                    |       |                         |                       |
| AVERAGE |        |                         |       | 4.19                    | -17.28                |



NAME 90 MM RECOILLESS RIFLE M67  
ELEVATION 0

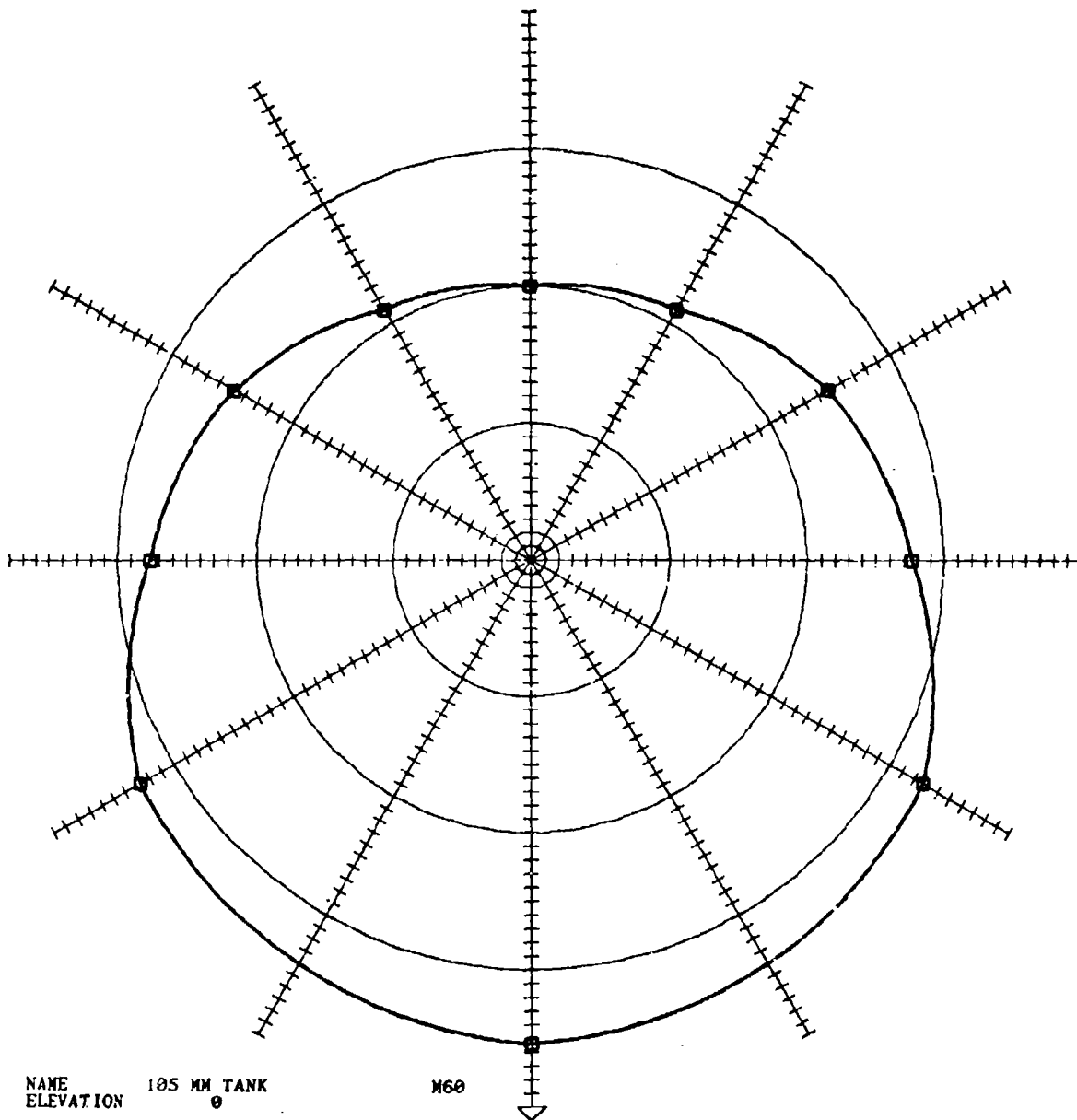
| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE   | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|---------|-------------------------|-----------------------|
| 1       | 102.66 | -8.84                   | 0°      | -9.51                   | -16.51                |
| 2       | 107.71 | -3.71                   | 30°     | -9.75                   | -16.75                |
| 3       | 111.26 | 0.00                    | 60°     | -9.98                   | -16.99                |
| 4       | 108.44 | -2.81                   | 90°     | -7.18                   | -14.19                |
| 5       | 100.66 | -10.59                  | 120°    | -3.17                   | -10.18                |
| 6       | 94.20  | -11.68                  | 150°    | -0.49                   | -7.50                 |
| 7       | 102.80 | -3.37                   | 180°    | 0.00                    | -7.00                 |
| 8       | 97.30  | -8.45                   | 210°    | -0.49                   | -7.50                 |
| 9       | 102.01 | -9.51                   | 240°    | -3.17                   | -10.18                |
| 10      | 98.65  | -8.80                   | 270°    | -7.18                   | -14.19                |
| 11      | 98.97  | -6.68                   | 300°    | -9.98                   | -16.99                |
| 12      | 102.80 | -3.00                   | 330°    | -9.75                   | -16.75                |
| 13      | 105.64 | 0.04                    |         |                         |                       |
| 14      | 105.56 | 0.00                    |         |                         |                       |
| 15      | 104.57 | -1.01                   |         |                         |                       |
| 16      | 99.33  | -7.65                   |         |                         |                       |
|         |        |                         | AVERAGE | -4.11                   | -11.11                |



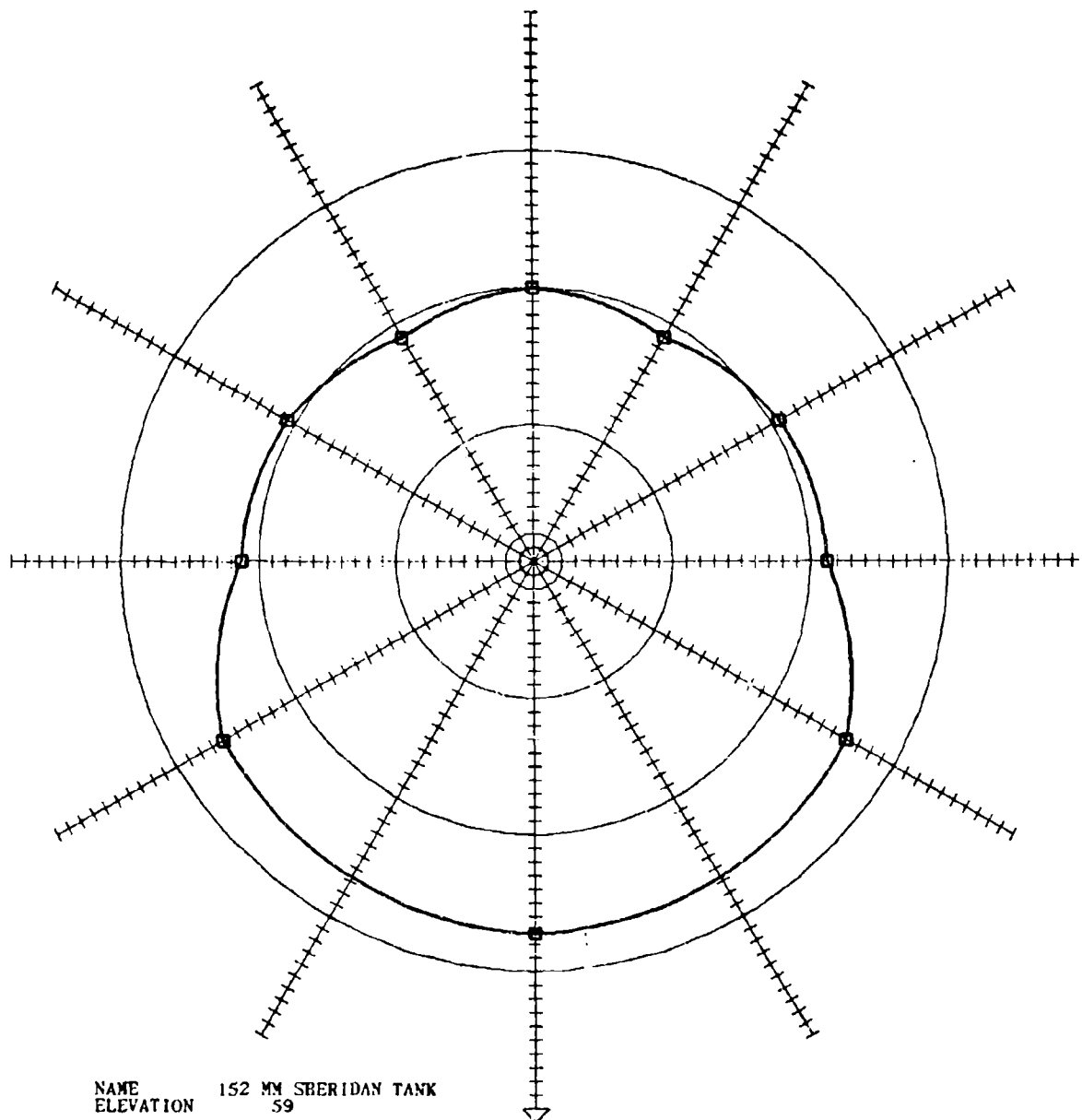
NAME 106 MM RECOILLESS RIFLE  
ELEVATION ALL

M40A1

| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE   | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|---------|-------------------------|-----------------------|
| 1       | 115.09 | -4.06                   | 0°      | 2.28                    | 3.40                  |
| 2       | 116.01 | -3.41                   | 30°     | -0.87                   | 0.24                  |
| 3       | 119.17 | 0.00                    | 60°     | -4.02                   | -2.91                 |
| 4       | 117.23 | -1.93                   | 90°     | -4.77                   | -3.66                 |
| 5       | 115.44 | -3.79                   | 120°    | -2.40                   | -1.28                 |
| 6       | 108.98 | -4.02                   | 150°    | -0.07                   | 1.03                  |
| 7       | 111.31 | -2.40                   | 180°    | 0.00                    | 1.11                  |
| 8       | 108.75 | -4.77                   | 210°    | -0.07                   | 1.03                  |
| 9       | 120.73 | 2.80                    | 240°    | -2.40                   | -1.28                 |
| 10      | 108.51 | -4.02                   | 270°    | -4.77                   | -3.66                 |
| 11      | 107.40 | -4.77                   | 300°    | -4.02                   | -2.91                 |
| 12      | 109.81 | -2.40                   | 330°    | -0.87                   | 0.24                  |
| 13      | 112.64 | -0.07                   |         |                         |                       |
| 14      | 113.09 | 0.00                    |         |                         |                       |
| 15      | 113.09 | -0.07                   |         |                         |                       |
| 16      | 108.81 | -4.08                   |         |                         |                       |
|         |        |                         | AVERAGE | -1.29                   | -0.18                 |

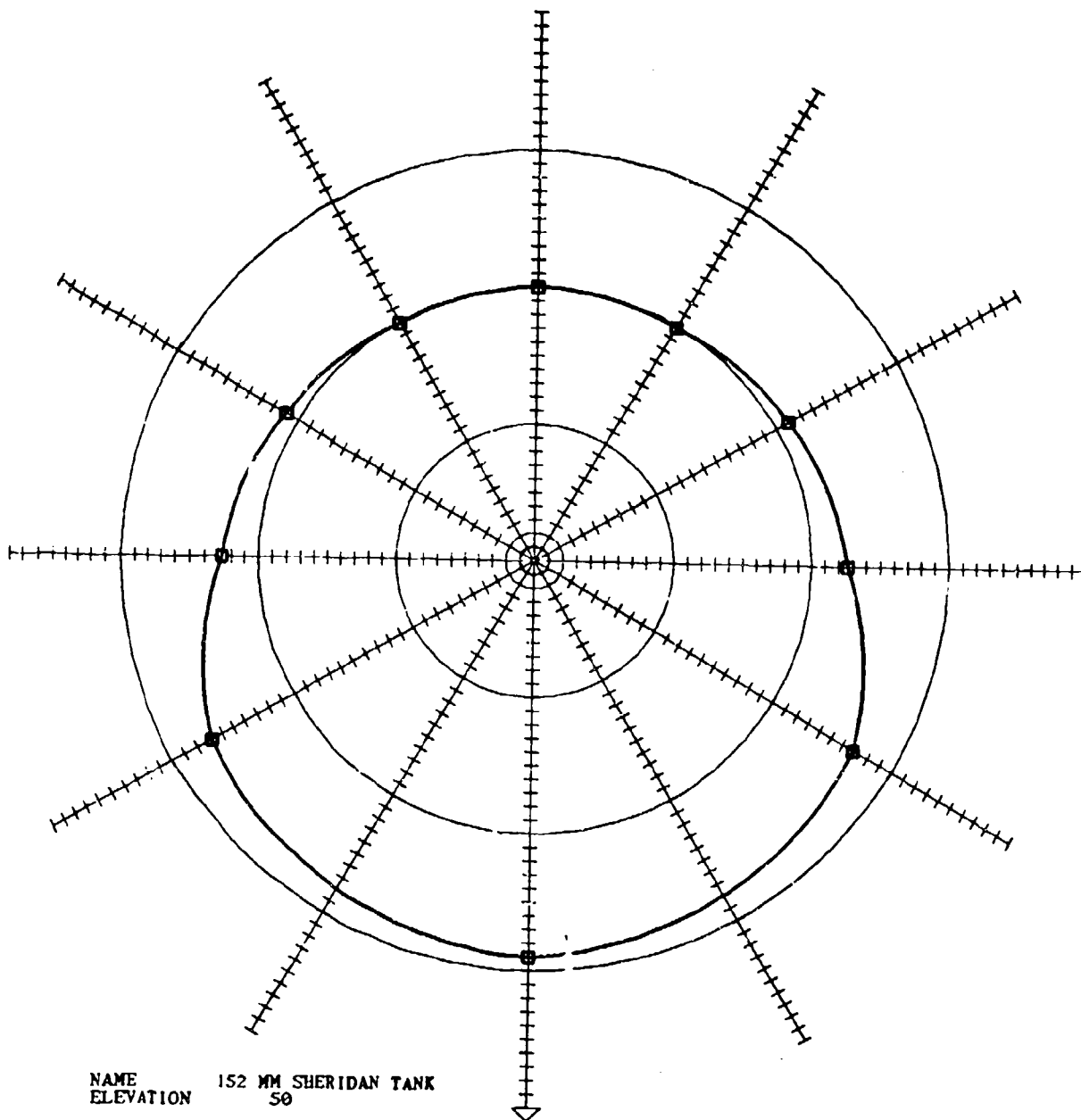


| NAME 105 MM TANK |        | M60                  |                    |
|------------------|--------|----------------------|--------------------|
| ELEVATION        | 0      |                      |                    |
| CHANNEL          | ENERGY | DIFFERENCE FROM REAR | DIFFERENCE FROM C4 |
| 1                | 113.04 | 13.09                | 15.35              |
| 2                | 105.87 | 5.98                 | 14.04              |
| 3                | 100.07 | 0.00                 | 12.73              |
| 4                | 104.39 | 4.24                 | 7.61               |
| 5                | 113.07 | 12.68                | 4.81               |
| 6                | 106.63 | 12.81                | 1.09               |
| 7                | 97.69  | 3.36                 | 0.00               |
| 8                | 99.98  | 5.55                 | 1.09               |
| 9                | 115.47 | 15.35                | 4.81               |
| 10               | 106.29 | 12.28                | 7.61               |
| 11               | 103.08 | 9.06                 | 12.73              |
| 12               | 99.70  | 5.66                 | 14.04              |
| 13               | 96.08  | 1.97                 |                    |
| 14               | 94.70  | 0.00                 |                    |
| 15               | 94.43  | 0.33                 |                    |
| 16               | 100.19 | 5.92                 |                    |
| AVERAGE          |        | 10.78                | -8.53              |



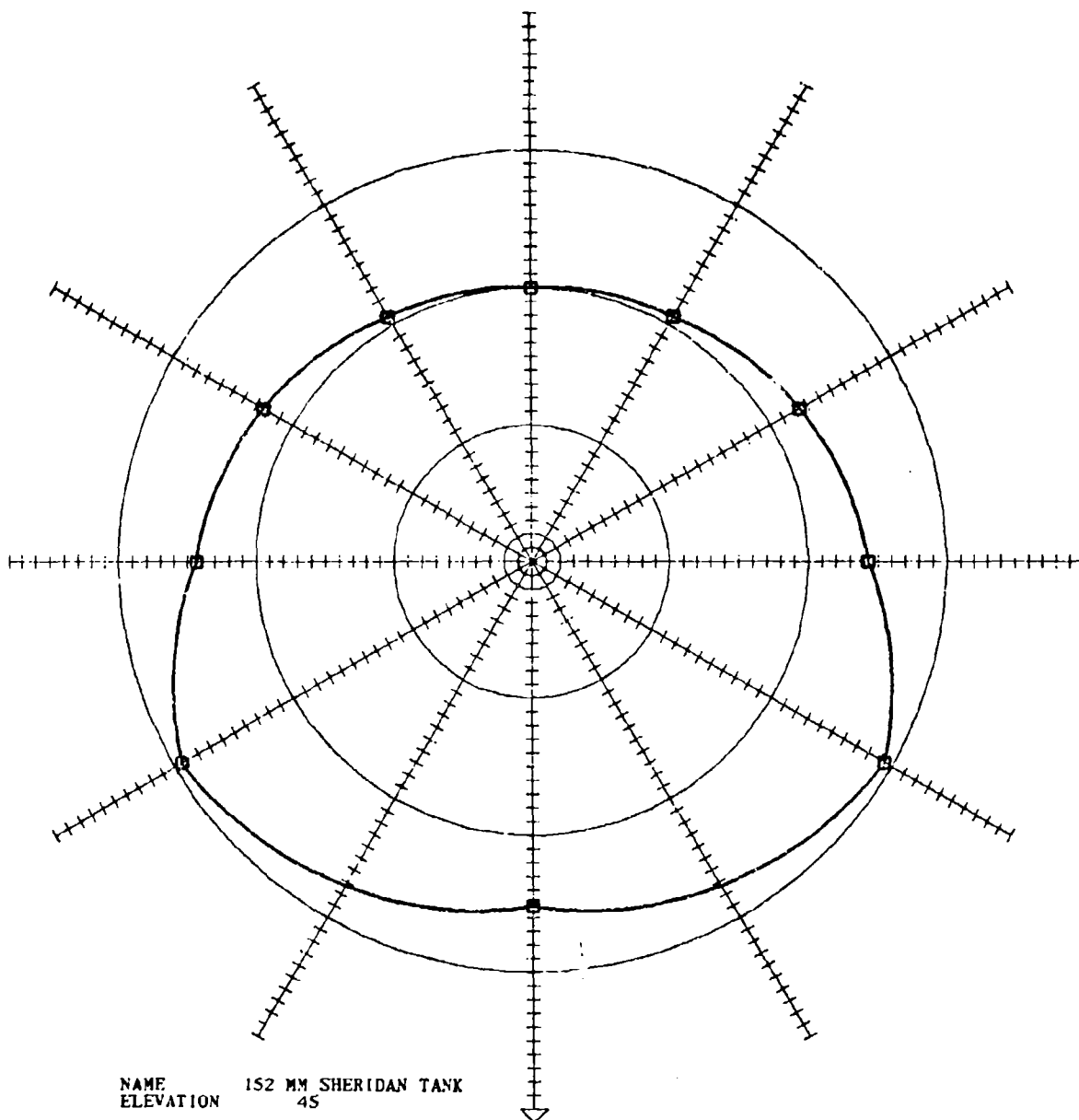
NAME 152 MM SBERIDAN TANK  
ELEVATION 59

| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|-------|-------------------------|-----------------------|
| 1       | 0.00   | 12.18                   | 0°    | 7.22                    | -1.14                 |
| 2       | 111.89 | 1.86                    | 30°   | 6.66                    | -1.70                 |
| 3       | 110.07 | 0.00                    | 60°   | 6.10                    | -2.26                 |
| 4       | 109.94 | -0.08                   | 90°   | 1.27                    | -7.09                 |
| 5       | 115.21 | 5.26                    | 120°  | 0.57                    | -7.79                 |
| 6       | 112.39 | 7.37                    | 150°  | -1.11                   | -9.48                 |
| 7       | 104.05 | -0.85                   | 180°  | 0.00                    | -8.36                 |
| 8       | 105.97 | 1.08                    | 210°  | -1.11                   | -9.48                 |
| 9       | 117.38 | 7.22                    | 240°  | 0.57                    | -7.79                 |
| 10      | 110.58 | 5.66                    | 270°  | 1.27                    | -7.09                 |
| 11      | 106.40 | 1.47                    | 300°  | 6.10                    | -2.26                 |
| 12      | 106.47 | 1.37                    | 330°  | 6.66                    | -1.70                 |
| 13      | 104.53 | -0.41                   |       |                         |                       |
| 14      | 104.91 | 0.00                    |       |                         |                       |
| 15      | 103.13 | -1.81                   |       |                         |                       |
| 16      | 105.98 | 1.07                    |       |                         |                       |
| AVERAGE |        |                         |       | 4.00                    | -4.35                 |



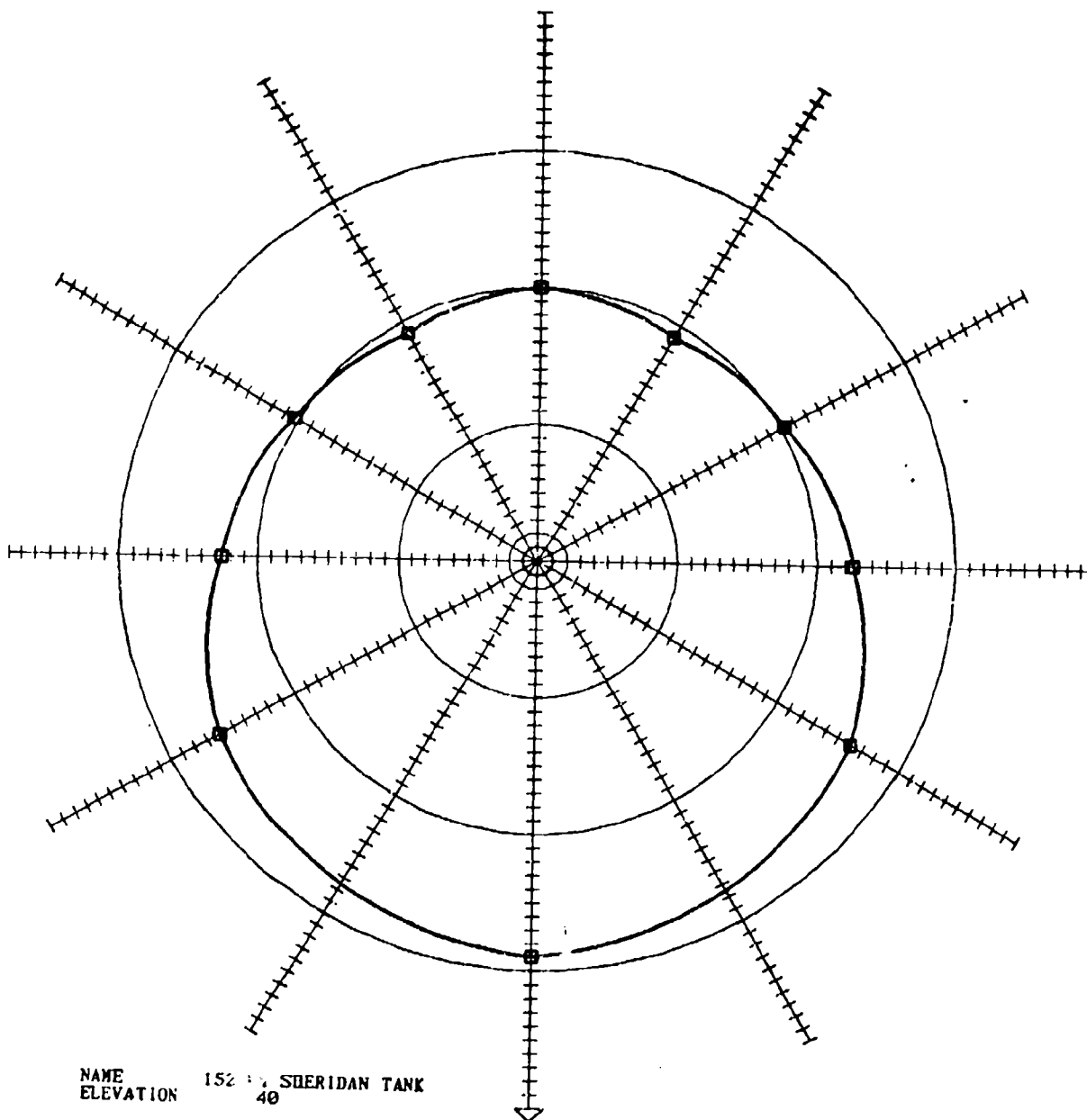
NAME 152 MM SHERIDAN TANK  
ELEVATION 50

| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE   | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|---------|-------------------------|-----------------------|
| 1       | 0.00   | 12.18                   | 0°      | 9.00                    | -0.46                 |
| 2       | 110.46 | 0.62                    | 30°     | 7.93                    | -1.53                 |
| 3       | 109.96 | 0.00                    | 60°     | 6.86                    | -2.60                 |
| 4       | 111.08 | 1.17                    | 90°     | 2.69                    | -6.77                 |
| 5       | 115.10 | 5.11                    | 120°    | 0.96                    | -8.50                 |
| 6       | 112.05 | 8.07                    | 150°    | -0.13                   | -9.60                 |
| 7       | 105.04 | 1.29                    | 180°    | 0.00                    | -9.46                 |
| 8       | 106.18 | 2.18                    | 210°    | -0.13                   | -9.60                 |
| 9       | 118.86 | 9.00                    | 240°    | 0.96                    | -8.50                 |
| 10      | 111.14 | 7.40                    | 270°    | 2.69                    | -6.77                 |
| 11      | 106.82 | 3.06                    | 300°    | 6.86                    | -2.60                 |
| 12      | 104.56 | 0.77                    | 330°    | 7.93                    | -1.53                 |
| 13      | 104.41 | 0.56                    |         |                         |                       |
| 14      | 103.84 | 0.00                    |         |                         |                       |
| 15      | 102.82 | -0.83                   |         |                         |                       |
| 16      | 106.32 | 2.31                    |         |                         |                       |
|         |        |                         | AVERAGE | 5.14                    | -4.32                 |



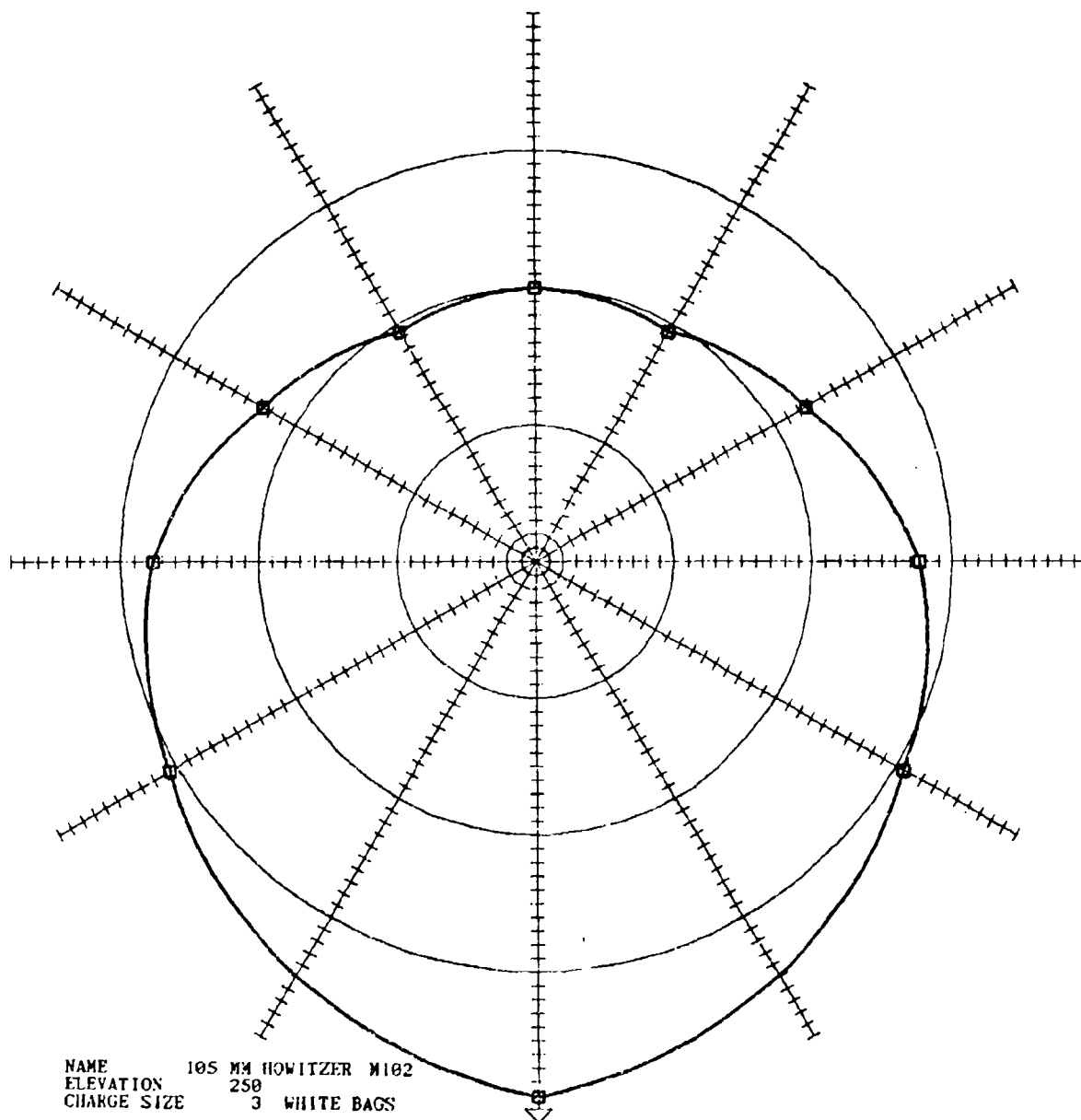
NAME 152 MM SHERIDAN TANK  
ELEVATION 45

| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE   | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|---------|-------------------------|-----------------------|
| 1       | 120.91 | 9.92                    | 0°      | 5.17                    | -5.46                 |
| 2       | 114.59 | 3.62                    | 30°     | 7.28                    | -3.35                 |
| 3       | 110.79 | 0.00                    | 60°     | 9.39                    | -1.24                 |
| 4       | 109.62 | -0.28                   | 90°     | 4.32                    | -6.31                 |
| 5       | 119.68 | 8.07                    | 120°    | 2.39                    | -8.24                 |
| 6       | 110.51 | 9.09                    | 150°    | 0.65                    | -9.98                 |
| 7       | 103.38 | 2.31                    | 180°    | 0.00                    | -10.63                |
| 8       | 102.08 | -1.37                   | 210°    | 0.65                    | -9.98                 |
| 9       | 115.19 | 5.17                    | 240°    | 2.39                    | -8.24                 |
| 10      | 111.74 | 10.48                   | 270°    | 4.32                    | -6.31                 |
| 11      | 106.93 | 5.82                    | 300°    | 9.39                    | -1.24                 |
| 12      | 104.98 | 3.92                    | 330°    | 7.28                    | -3.35                 |
| 13      | 102.56 | 1.45                    |         |                         |                       |
| 14      | 101.23 | 0.00                    |         |                         |                       |
| 15      | 101.21 | -0.13                   |         |                         |                       |
| 16      | 104.53 | 2.83                    |         |                         |                       |
|         |        |                         | AVERAGE | 5.60                    | -5.03                 |



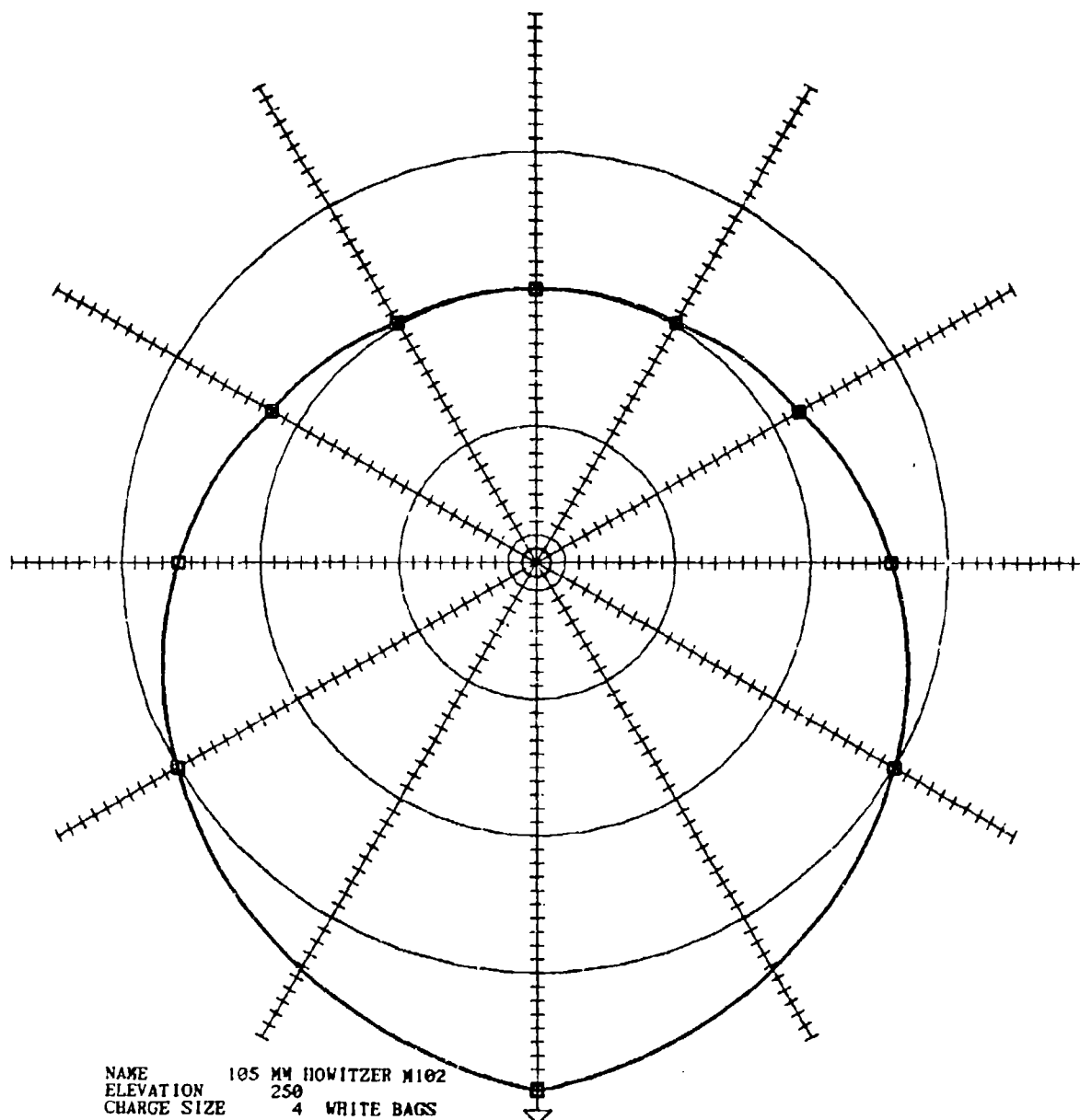
NAME 152 SHERIDAN TANK  
ELEVATION 40

| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|-------|-------------------------|-----------------------|
| 1       | 116.31 | 6.94                    | 0°    | 8.89                    | -0.50                 |
| 2       | 111.16 | 1.68                    | 30°   | 7.48                    | -1.91                 |
| 3       | 109.43 | 0.00                    | 60°   | 6.07                    | -3.31                 |
| 4       | 109.09 | -0.27                   | 90°   | 2.65                    | -6.73                 |
| 5       | 114.79 | 5.36                    | 120°  | 0.27                    | -9.11                 |
| 6       | 109.63 | 5.17                    | 150°  | -0.96                   | -10.35                |
| 7       | 101.85 | -1.97                   | 180°  | 0.00                    | -9.39                 |
| 8       | 104.32 | 0.32                    | 210°  | -0.96                   | -10.35                |
| 9       | 118.37 | 8.89                    | 240°  | 0.27                    | -9.11                 |
| 10      | 110.46 | 6.83                    | 270°  | 2.65                    | -6.73                 |
| 11      | 107.82 | 4.04                    | 300°  | 6.07                    | -3.31                 |
| 12      | 105.61 | 1.67                    | 330°  | 7.48                    | -1.91                 |
| 13      | 103.57 | -0.07                   |       |                         |                       |
| 14      | 103.70 | 0.00                    |       |                         |                       |
| 15      | 101.95 | -1.85                   |       |                         |                       |
| 16      | 105.24 | 1.27                    |       |                         |                       |
| AVERAGE |        |                         |       | 4.70                    | -4.68                 |



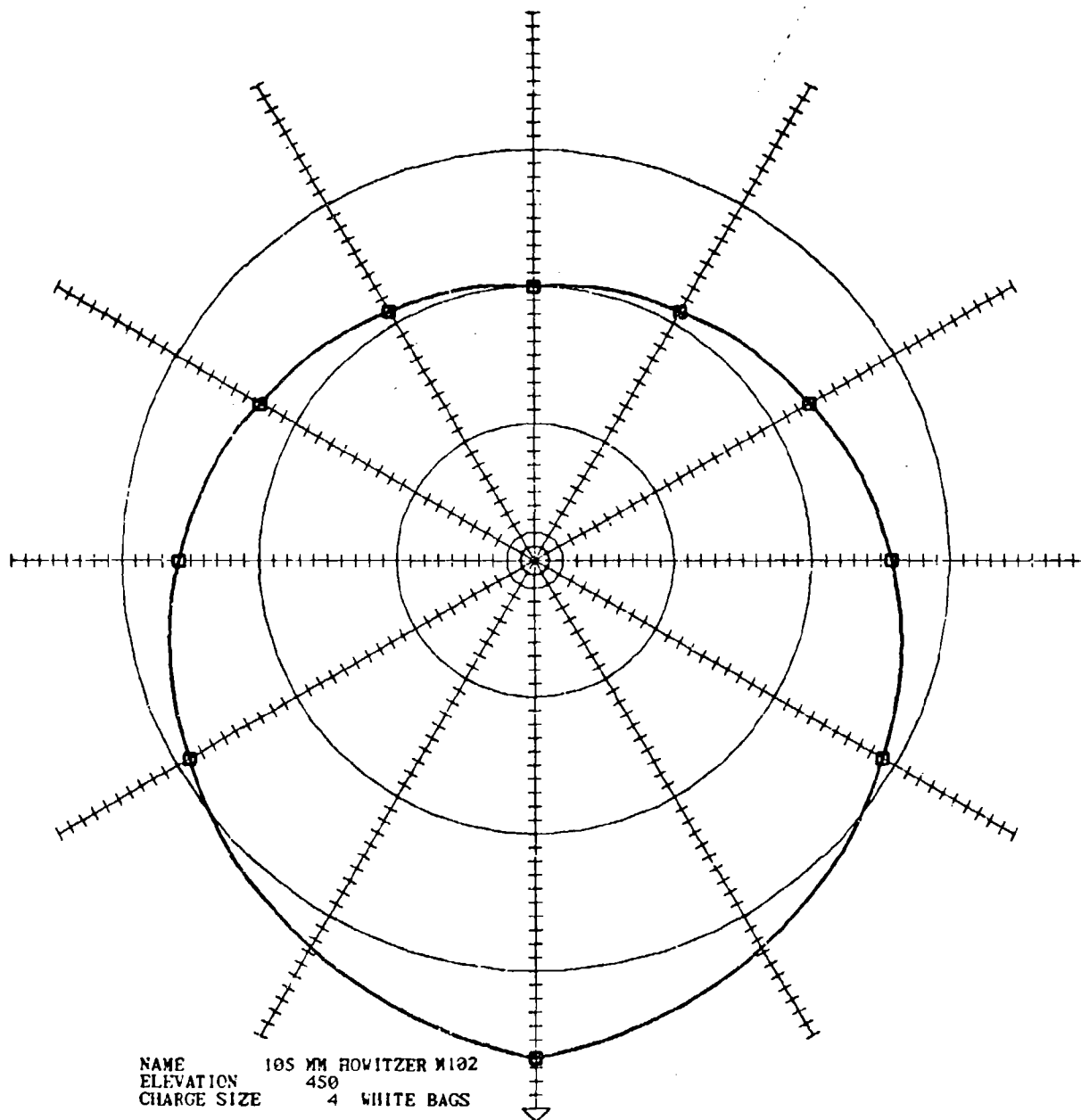
NAME 105 MM HOWITZER M102  
ELEVATION 250  
CHARGE SIZE 3 WHITE BAGS

| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|-------|-------------------------|-----------------------|
| 1       | 97.53  | 10.77                   | 0°    | 19.12                   | -13.19                |
| 2       | 90.53  | 3.76                    | 30°   | 14.86                   | -17.45                |
| 3       | 86.80  | 0.00                    | 60°   | 10.61                   | -21.70                |
| 4       | 88.31  | 1.52                    | 90°   | 7.65                    | -24.66                |
| 5       | 95.40  | 8.56                    | 120°  | 2.60                    | -29.71                |
| 6       | 88.81  | 10.65                   | 150°  | -0.58                   | -32.90                |
| 7       | 80.19  | 2.05                    | 180°  | 0.00                    | -32.32                |
| 8       | 84.32  | 6.19                    | 210°  | -0.58                   | -32.90                |
| 9       | 105.90 | 19.12                   | 240°  | 2.60                    | -29.71                |
| 10      | 90.52  | 12.45                   | 270°  | 7.65                    | -24.66                |
| 11      | 87.22  | 9.13                    | 300°  | 10.61                   | -21.70                |
| 12      | 81.16  | 3.07                    | 330°  | 14.86                   | -17.45                |
| 13      | 77.74  | -0.34                   |       |                         |                       |
| 14      | 78.11  | 0.00                    |       |                         |                       |
| 15      | 77.00  | -0.90                   |       |                         |                       |
| 16      | 84.27  | 5.79                    |       |                         |                       |
| AVERAGE |        |                         |       | 11.85                   | -20.46                |

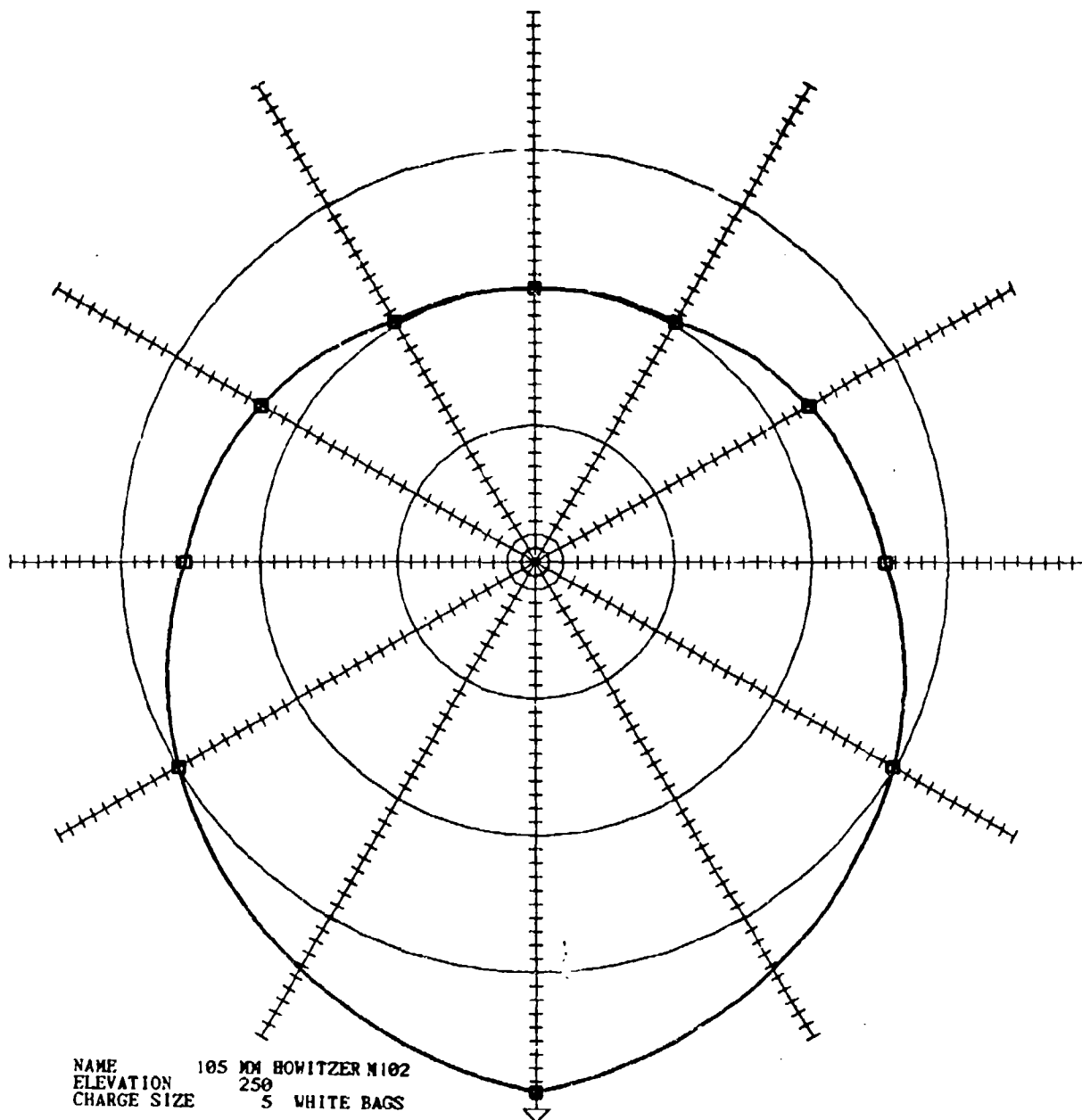


NAME 105 MM HOWITZER M102  
 ELEVATION 250  
 CHARGE SIZE 4 WHITE BAGS

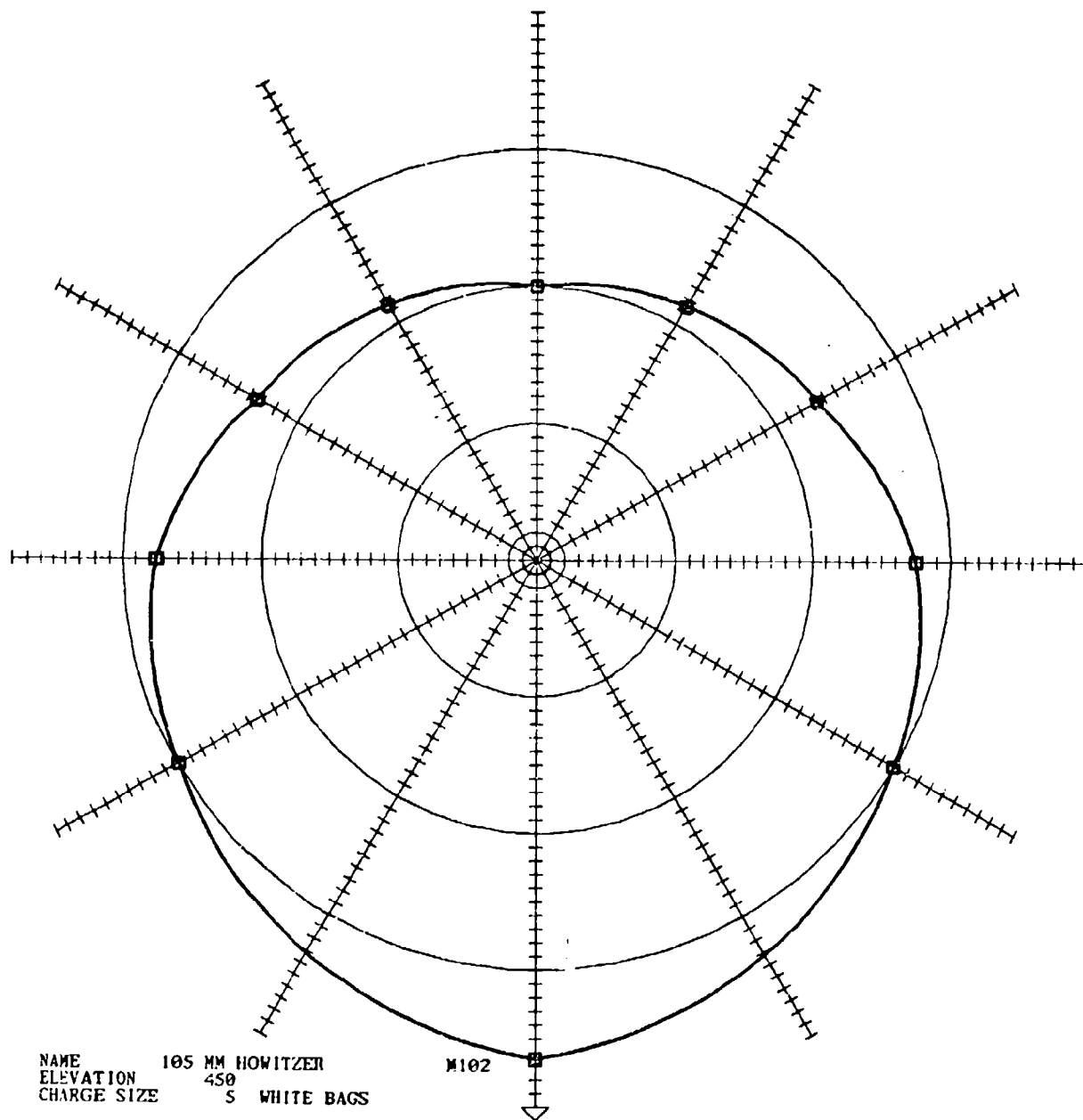
| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE   | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|---------|-------------------------|-----------------------|
| 1       | 100.08 | 10.44                   | 0°      | 18.54                   | -11.20                |
| 2       | 93.28  | 3.67                    | 30°     | 14.29                   | -15.46                |
| 3       | 89.52  | 0.00                    | 60°     | 10.04                   | -19.71                |
| 4       | 90.35  | 0.79                    | 90°     | 5.86                    | -23.88                |
| 5       | 97.67  | 8.12                    | 120°    | 2.08                    | -27.66                |
| 6       | 89.97  | 8.67                    | 150°    | 0.21                    | -29.53                |
| 7       | 81.14  | -0.12                   | 180°    | 0.00                    | -29.75                |
| 8       | 86.34  | 4.82                    | 210°    | 0.21                    | -29.53                |
| 9       | 108.11 | 18.54                   | 240°    | 2.08                    | -27.66                |
| 10      | 93.35  | 12.33                   | 270°    | 5.86                    | -23.88                |
| 11      | 88.58  | 7.49                    | 300°    | 10.04                   | -19.71                |
| 12      | 84.62  | 3.61                    | 330°    | 14.29                   | -15.46                |
| 13      | 81.95  | 0.97                    |         |                         |                       |
| 14      | 81.09  | 0.00                    |         |                         |                       |
| 15      | 80.48  | -0.54                   |         |                         |                       |
| 16      | 85.31  | 4.23                    |         |                         |                       |
|         |        |                         | AVERAGE | 11.23                   | -18.51                |



| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE   | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|---------|-------------------------|-----------------------|
| 1       | 98.69  | 9.11                    | 0°      | 16.30                   | -13.15                |
| 2       | 93.35  | 3.75                    | 30°     | 12.64                   | -16.81                |
| 3       | 89.59  | 0.00                    | 60°     | 8.99                    | -20.47                |
| 4       | 90.93  | 1.35                    | 90°     | 5.80                    | -23.65                |
| 5       | 97.03  | 7.45                    | 120°    | 2.91                    | -26.54                |
| 6       | 90.62  | 9.56                    | 150°    | 0.95                    | -28.49                |
| 7       | 83.43  | 2.37                    | 180°    | 0.00                    | -29.45                |
| 8       | 86.43  | 5.02                    | 210°    | 0.95                    | -28.49                |
| 9       | 105.96 | 16.30                   | 240°    | 2.91                    | -26.54                |
| 10      | 92.07  | 10.99                   | 270°    | 5.80                    | -23.65                |
| 11      | 87.77  | 6.70                    | 300°    | 8.98                    | -20.47                |
| 12      | 85.15  | 4.16                    | 330°    | 12.64                   | -16.81                |
| 13      | 82.62  | 1.57                    |         |                         |                       |
| 14      | 81.06  | 0.00                    |         |                         |                       |
| 15      | 81.36  | 0.33                    |         |                         |                       |
| 16      | 85.99  | 4.90                    |         |                         |                       |
|         |        |                         | AVERAGE | 9.63                    | -19.82                |

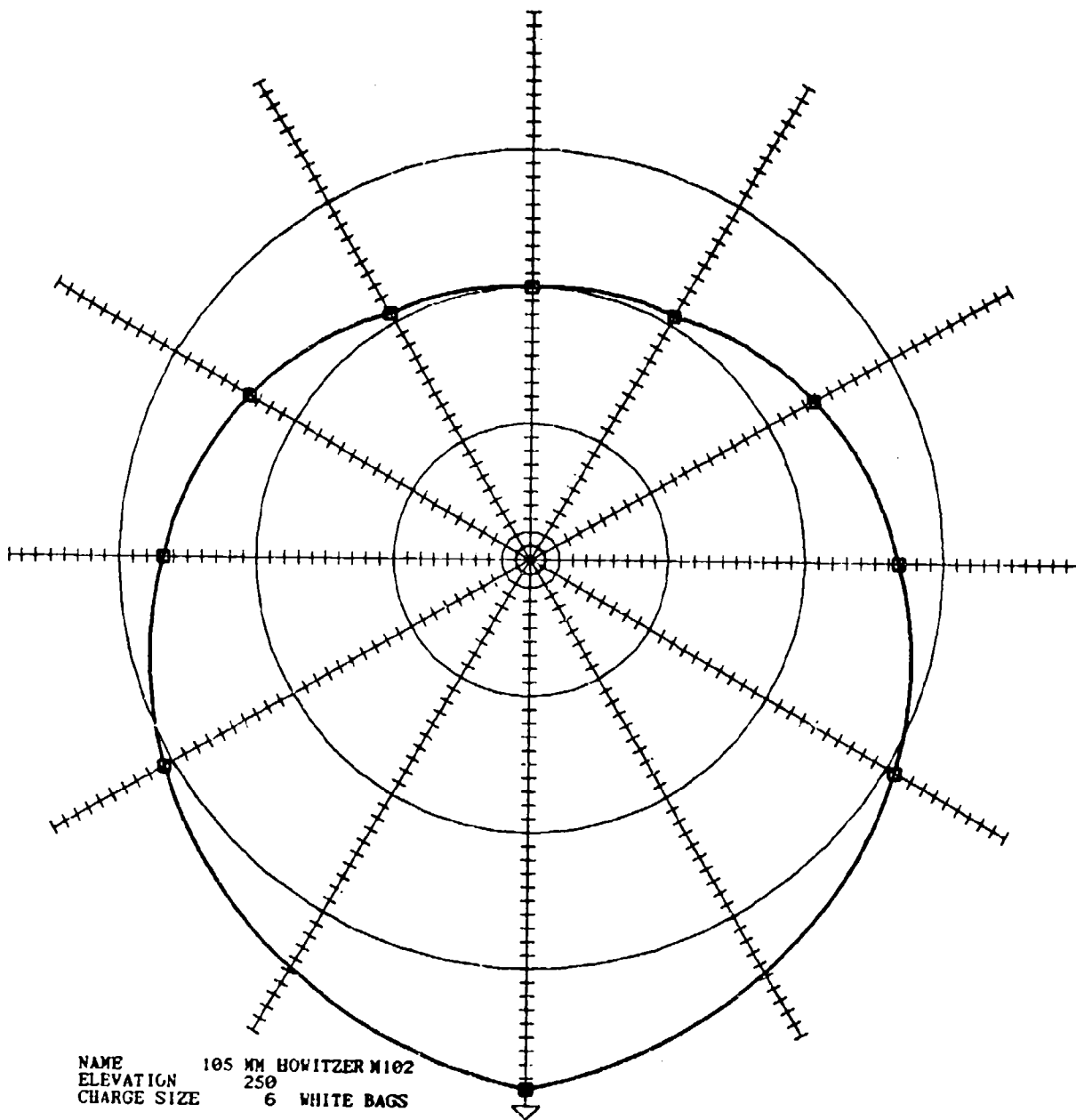


| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE   | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|---------|-------------------------|-----------------------|
| 1       | 101.66 | 11.17                   | 0°      | 18.74                   | -16.59                |
| 2       | 95.03  | 4.47                    | 30°     | 14.30                   | -13.59                |
| 3       | 90.53  | 0.00                    | 60°     | 9.86                    | -18.03                |
| 4       | 91.36  | 0.77                    | 90°     | 5.36                    | -22.52                |
| 5       | 99.92  | 9.22                    | 120°    | 2.93                    | -24.96                |
| 6       | 91.12  | 7.65                    | 150°    | 0.27                    | -27.62                |
| 7       | 85.05  | 1.94                    | 180°    | 0.00                    | -27.90                |
| 8       | 87.13  | 3.91                    | 210°    | 0.27                    | -27.62                |
| 9       | 109.17 | 18.74                   | 240°    | 2.93                    | -24.96                |
| 10      | 94.43  | 11.25                   | 270°    | 5.36                    | -22.52                |
| 11      | 90.24  | 7.07                    | 300°    | 9.86                    | -18.03                |
| 12      | 87.66  | 4.33                    | 330°    | 14.30                   | -13.59                |
| 13      | 85.13  | 1.99                    |         |                         |                       |
| 14      | 83.18  | 0.00                    |         |                         |                       |
| 15      | 81.78  | -1.44                   |         |                         |                       |
| 16      | 86.85  | 3.66                    |         |                         |                       |
|         |        |                         | AVERAGE | 11.30                   | -16.59                |



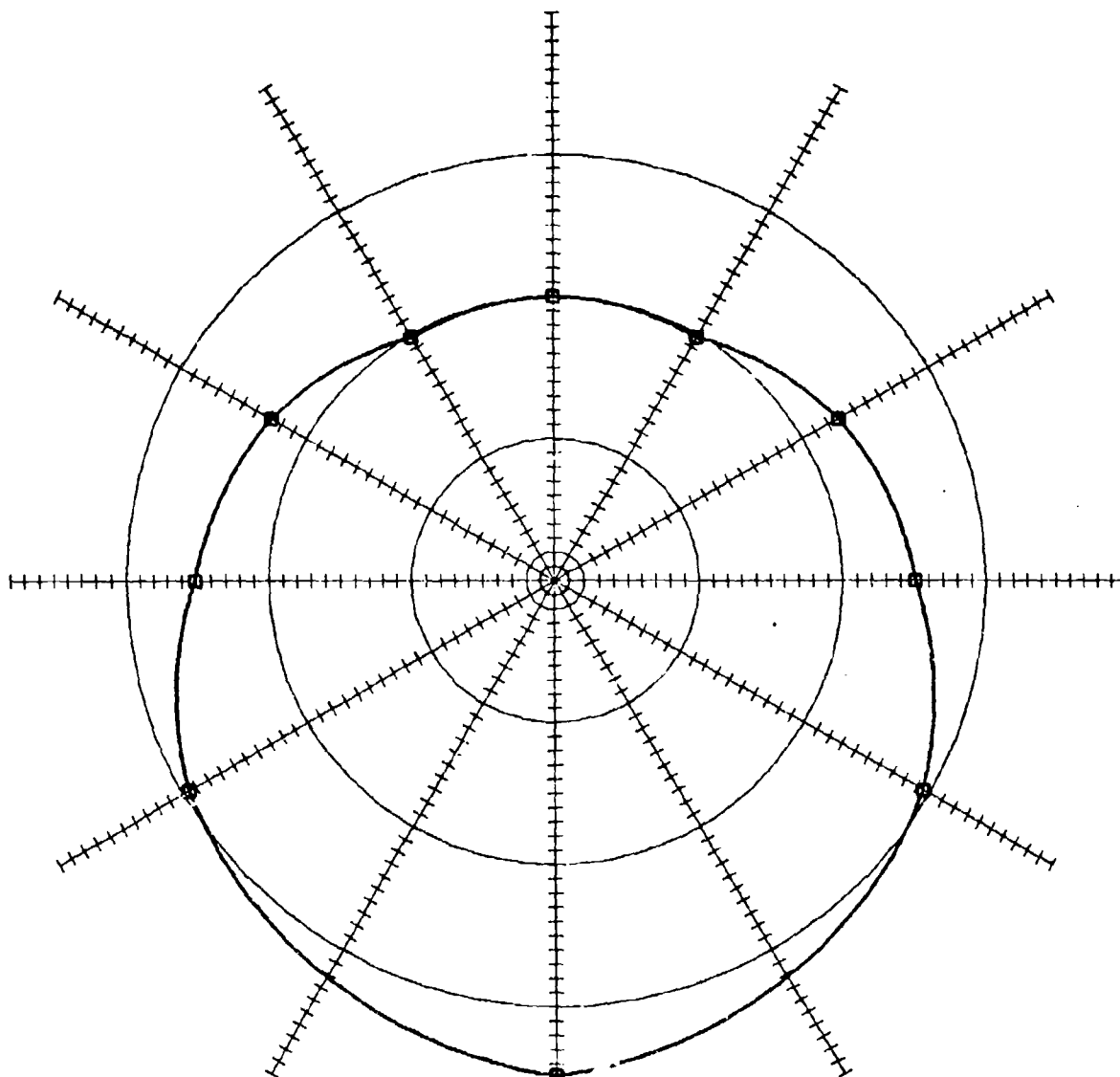
NAME 105 MM HOWITZER  
ELEVATION 450  
CHARGE SIZE S WHITE BAGS

| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|-------|-------------------------|-----------------------|
| 1       | 100.85 | 10.43                   | 0°    | 16.45                   | -11.31                |
| 2       | 94.97  | 4.49                    | 30°   | 13.19                   | -14.57                |
| 3       | 90.41  | 0.00                    | 60°   | 9.93                    | -17.83                |
| 4       | 93.06  | 2.57                    | 90°   | 7.48                    | -20.28                |
| 5       | 100.41 | 10.01                   | 120°  | 3.41                    | -24.35                |
| 6       | 92.71  | 9.49                    | 150°  | 1.48                    | -26.27                |
| 7       | 85.88  | 2.66                    | 180°  | 0.00                    | -27.77                |
| 8       | 92.10  | 8.44                    | 210°  | 1.48                    | -26.27                |
| 9       | 106.87 | 16.45                   | 240°  | 3.41                    | -24.35                |
| 10      | 92.64  | 9.72                    | 270°  | 7.48                    | -20.28                |
| 11      | 90.23  | 7.16                    | 300°  | 9.93                    | -17.83                |
| 12      | 87.01  | 3.91                    | 330°  | 13.19                   | -14.57                |
| 13      | 85.68  | 2.61                    |       |                         |                       |
| 14      | 83.07  | 0.00                    |       |                         |                       |
| 15      | 83.47  | 0.35                    |       |                         |                       |
| 16      | 91.53  | 7.89                    |       |                         |                       |
| AVERAGE |        |                         |       | 10.18                   | -17.58                |



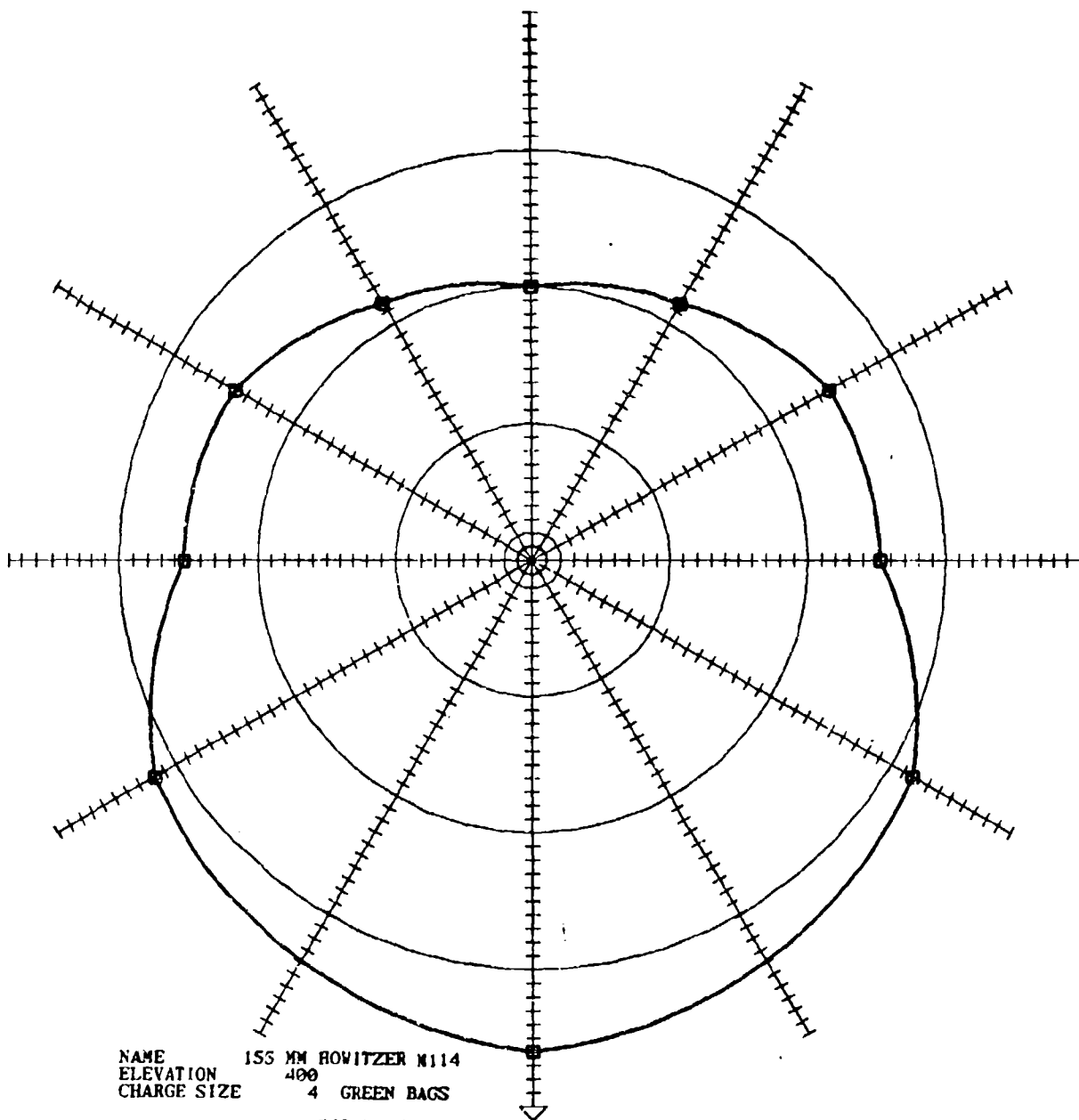
NAME 105 MM HOWITZER M102  
ELEVATION 250  
CHARGE SIZE 6 WHITE BAGS

| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|-------|-------------------------|-----------------------|
| 1       | 104.60 | 12.36                   | 0°    | 0.00                    | -25.43                |
| 2       | 97.78  | 5.56                    | 30°   | 5.32                    | -20.10                |
| 3       | 92.20  | 0.00                    | 60°   | 10.65                   | -14.77                |
| 4       | 95.29  | 3.03                    | 90°   | 6.73                    | -18.69                |
| 5       | 102.22 | 9.77                    | 120°  | 3.75                    | -21.67                |
| 6       | 94.56  | 8.47                    | 150°  | 0.73                    | -24.69                |
| 7       | 87.87  | 1.88                    | 180°  | 0.00                    | -25.43                |
| 8       | 90.71  | 4.70                    | 210°  | 0.73                    | -24.69                |
| 9       | 0.00   | 16.45                   | 240°  | 3.75                    | -21.67                |
| 10      | 98.75  | 12.60                   | 270°  | 6.73                    | -18.69                |
| 11      | 94.87  | 8.77                    | 300°  | 10.65                   | -14.77                |
| 12      | 90.49  | 4.52                    | 330°  | 5.32                    | -20.10                |
| 13      | 88.01  | 2.02                    |       |                         |                       |
| 14      | 85.93  | 0.00                    |       |                         |                       |
| 15      | 85.46  | -0.56                   |       |                         |                       |
| 16      | 90.71  | 4.68                    |       |                         |                       |
| AVERAGE |        |                         |       | 11.63                   | -13.80                |



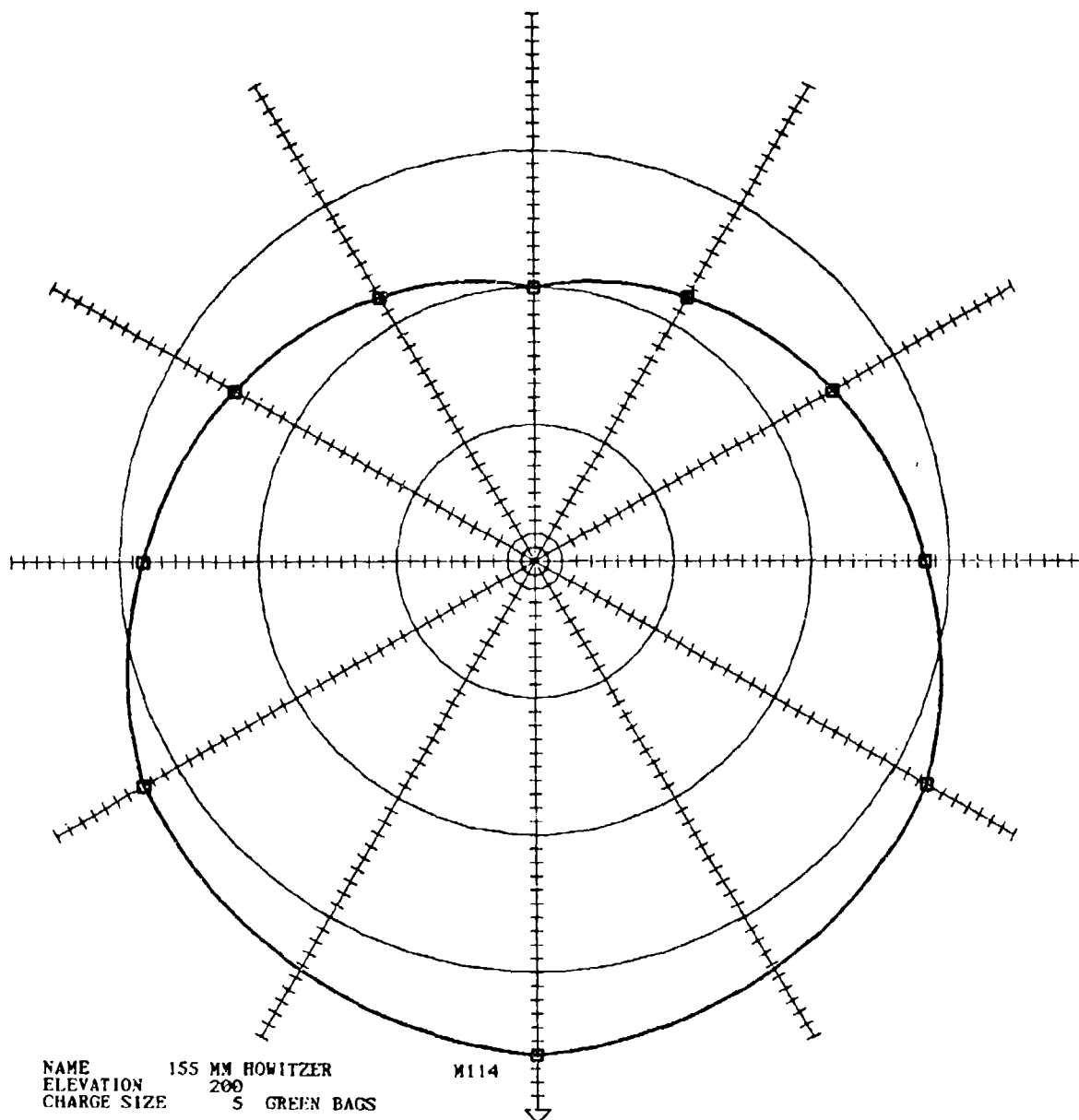
NAME 155 MM HOWITZER M114  
ELEVATION 200  
CHARGE SIZE 4 GREEN BAGS

| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE   | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|---------|-------------------------|-----------------------|
| 1       | 108.09 | 8.49                    | 0°      | 14.81                   | -4.07                 |
| 2       | 103.66 | 3.95                    | 30°     | 12.15                   | -6.72                 |
| 3       | 99.70  | 0.00                    | 60°     | 9.50                    | -9.38                 |
| 4       | 102.44 | 2.56                    | 90°     | 5.06                    | -13.82                |
| 5       | 110.63 | 10.95                   | 120°    | 2.80                    | -16.08                |
| 6       | 102.08 | 9.50                    | 150°    | -0.22                   | -19.11                |
| 7       | 94.76  | 2.80                    | 180°    | 0.00                    | -18.89                |
| 8       | 96.29  | 5.06                    | 210°    | -0.22                   | -19.11                |
| 9       | 114.50 | 12.42                   | 240°    | 2.80                    | -16.08                |
| 10      | 0.00   | 9.50                    | 270°    | 5.06                    | -13.82                |
| 11      | 99.27  | 5.06                    | 300°    | 9.50                    | -9.38                 |
| 12      | 96.19  | 2.80                    | 330°    | 12.15                   | -6.72                 |
| 13      | 92.90  | -0.22                   |         |                         |                       |
| 14      | 0.00   | 0.00                    |         |                         |                       |
| 15      | 93.63  | -0.22                   |         |                         |                       |
| 16      | 97.64  | 5.06                    |         |                         |                       |
|         |        |                         | AVERAGE | 8.94                    | -9.94                 |

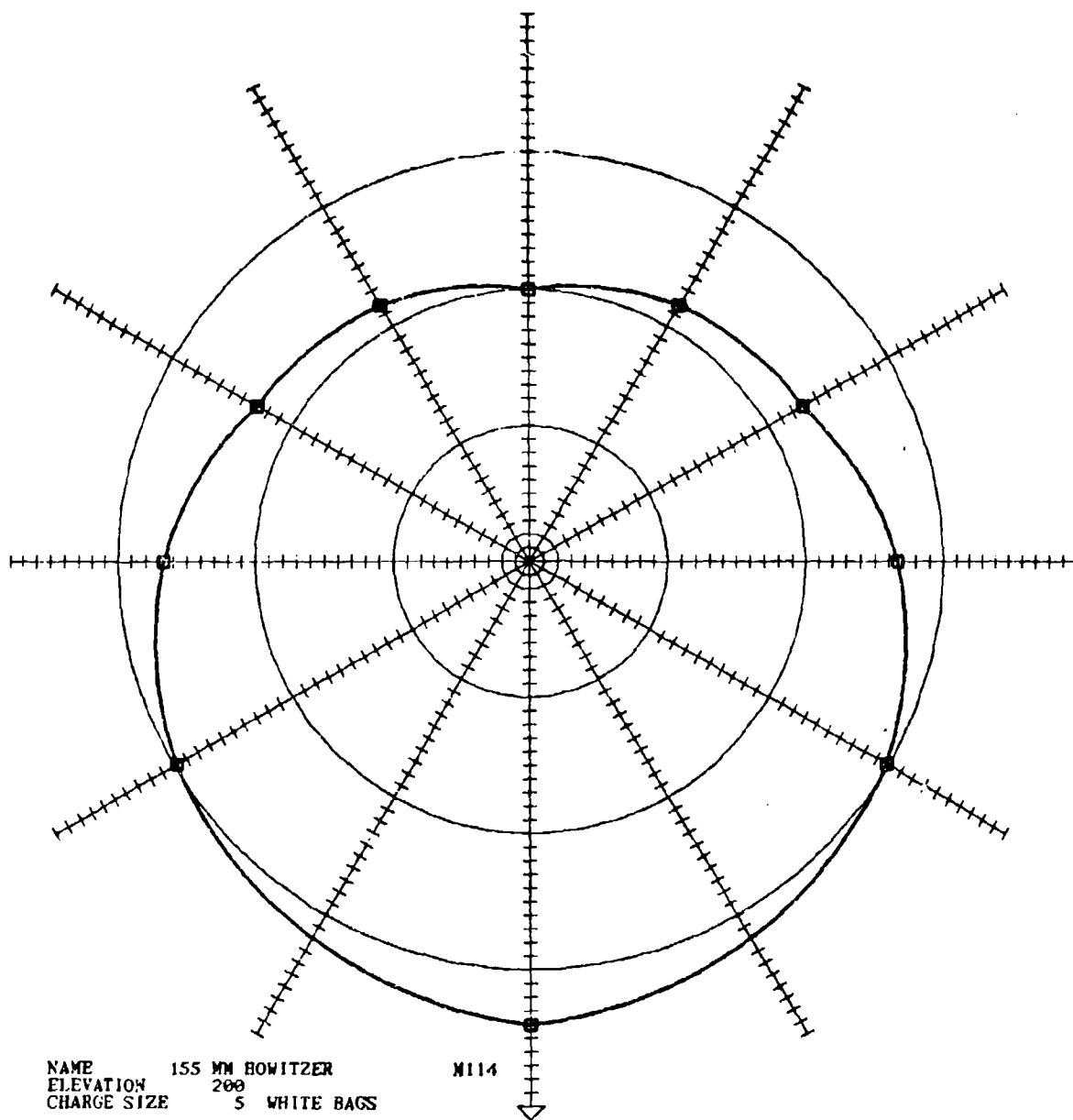


NAME 155 MM HOWITZER M114  
ELEVATION 400  
CHARGE SIZE 4 GREEN BAGS

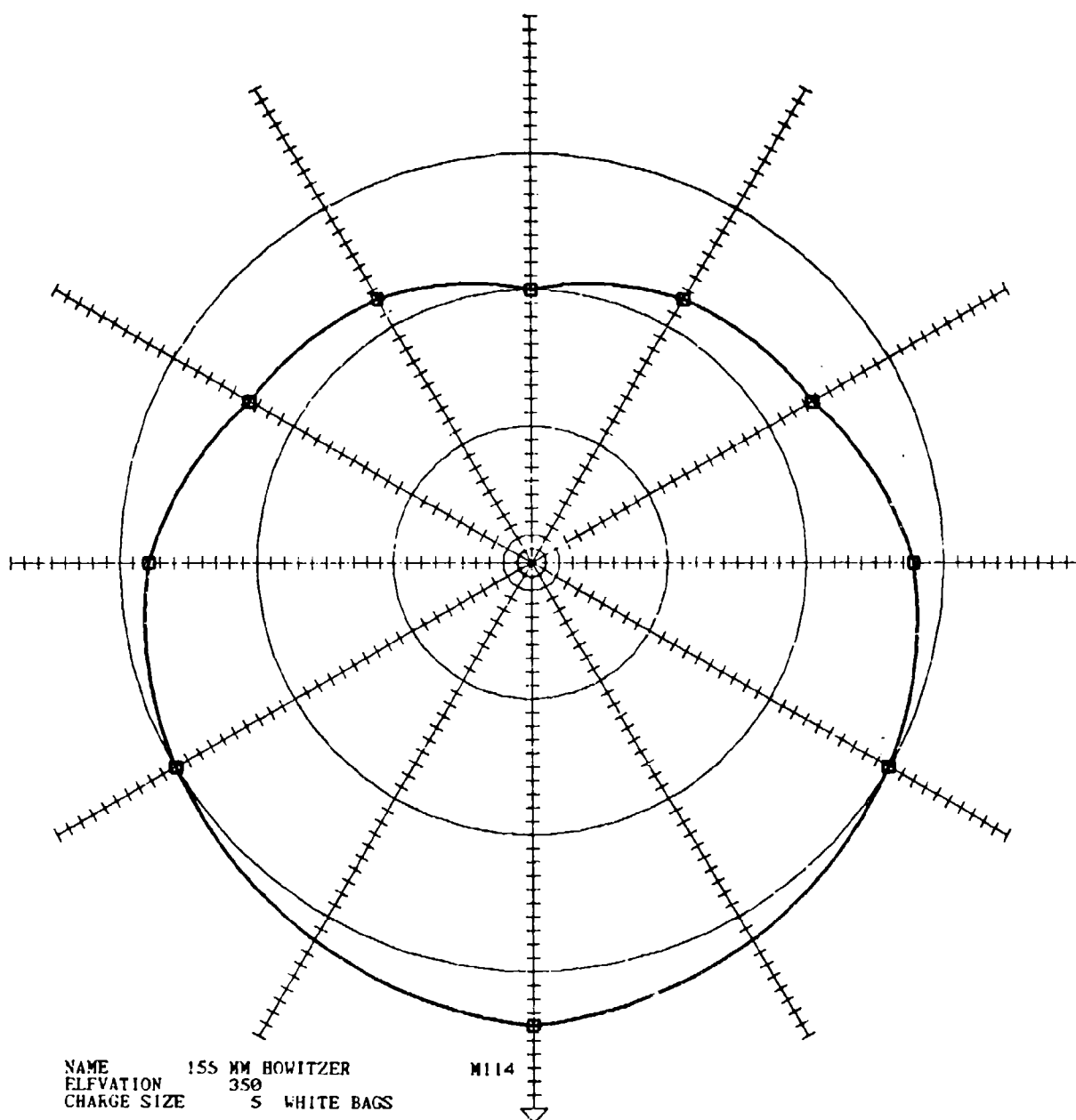
| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE   | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|---------|-------------------------|-----------------------|
| 1       | 108.58 | 10.98                   | 0°      | 15.96                   | -4.11                 |
| 2       | 102.49 | 4.94                    | 30°     | 13.85                   | -6.21                 |
| 3       | 97.54  | 0.00                    | 60°     | 11.75                   | -8.31                 |
| 4       | 101.24 | 3.65                    | 90°     | 5.24                    | -14.82                |
| 5       | 110.49 | 12.75                   | 120°    | 4.91                    | -15.16                |
| 6       | 102.12 | 11.75                   | 150°    | 1.66                    | -18.40                |
| 7       | 97.24  | 4.91                    | 180°    | 0.00                    | -20.07                |
| 8       | 96.70  | 5.24                    | 210°    | 1.66                    | -18.40                |
| 9       | 113.55 | 12.07                   | 240°    | 4.91                    | -15.16                |
| 10      | 102.12 | 11.75                   | 270°    | 5.24                    | -14.82                |
| 11      | 96.45  | 5.24                    | 300°    | 11.75                   | -8.31                 |
| 12      | 95.22  | 4.91                    | 330°    | 13.85                   | -6.21                 |
| 13      | 93.89  | 1.65                    |         |                         |                       |
| 14      | 91.15  | 0.00                    |         |                         |                       |
| 15      | 91.15  | 1.66                    |         |                         |                       |
| 16      | 96.26  | 5.24                    |         |                         |                       |
|         |        |                         | AVERAGE | 10.50                   | -9.56                 |



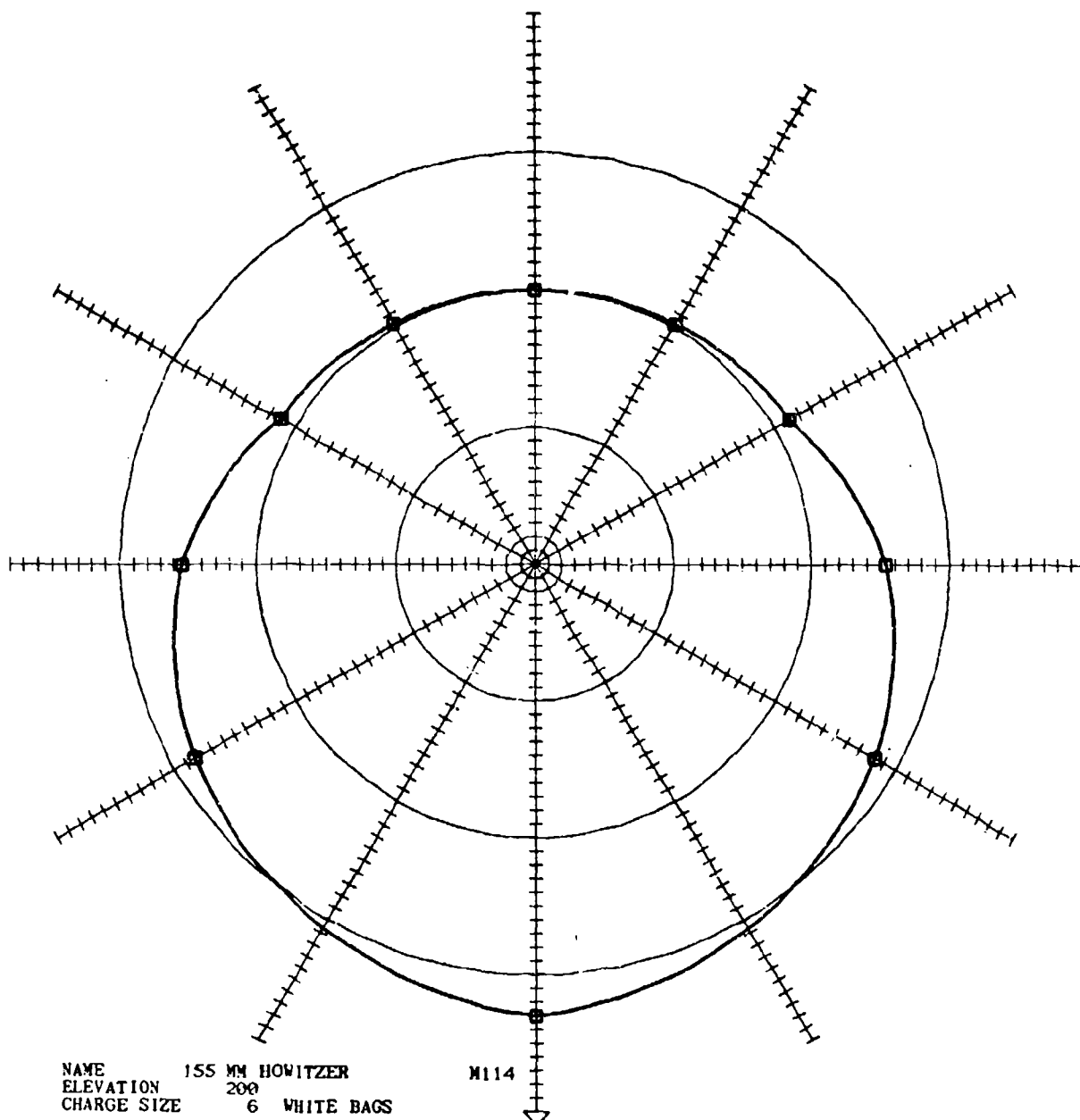
| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|-------|-------------------------|-----------------------|
| 1       | 112.23 | 13.22                   | 0°    | 0.00                    | -19.61                |
| 2       | 104.66 | 5.68                    | 30°   | 6.32                    | -13.28                |
| 3       | 99.30  | 0.00                    | 60°   | 12.65                   | -6.96                 |
| 4       | 103.03 | 4.08                    | 90°   | 8.23                    | -11.37                |
| 5       | 111.74 | 12.74                   | 120°  | 4.91                    | -14.70                |
| 6       | 104.07 | 11.23                   | 150°  | 2.23                    | -17.38                |
| 7       | 96.54  | 4.19                    | 180°  | 0.00                    | -19.61                |
| 8       | 92.23  | 6.59                    | 210°  | 2.23                    | -17.38                |
| 9       | 0.00   | 16.07                   | 240°  | 4.91                    | -14.70                |
| 10      | 105.88 | 12.96                   | 270°  | 8.23                    | -11.37                |
| 11      | 101.89 | 9.56                    | 300°  | 12.65                   | -6.96                 |
| 12      | 98.17  | 5.73                    | 330°  | 6.32                    | -13.28                |
| 13      | 96.72  | 4.66                    |       |                         |                       |
| 14      | 93.06  | 0.00                    |       |                         |                       |
| 15      | 92.95  | -0.20                   |       |                         |                       |
| 16      | 99.06  | 6.89                    |       |                         |                       |
| AVERAGE |        |                         |       | 11.15                   | -8.51                 |



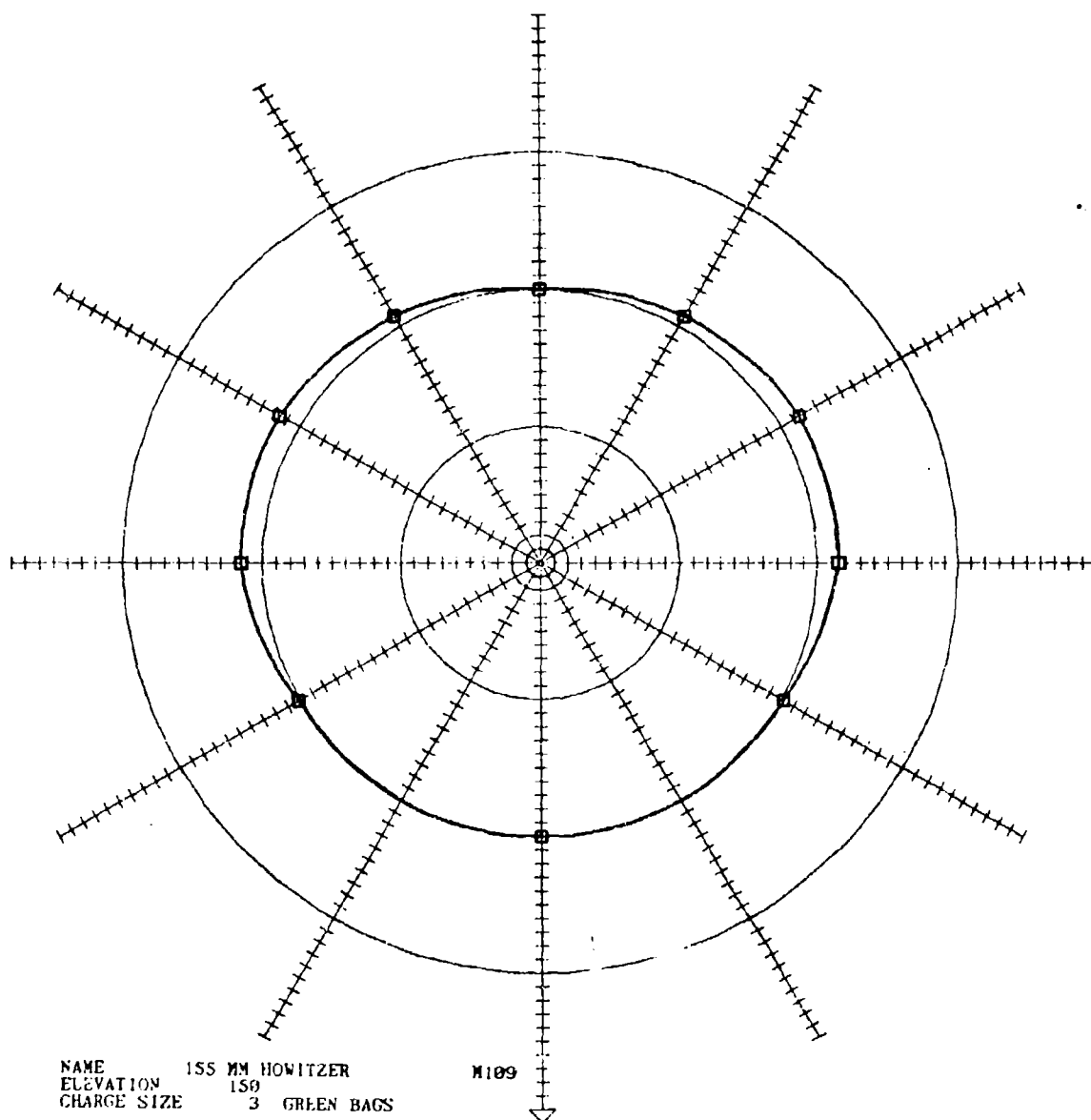
| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|-------|-------------------------|-----------------------|
| 1       | 113.34 | 8.40                    | 0°    | 0.00                    | -14.50                |
| 2       | 106.27 | 1.38                    | 30°   | 4.89                    | -9.61                 |
| 3       | 104.88 | 0.00                    | 60°   | 9.78                    | -4.71                 |
| 4       | 107.92 | 2.87                    | 90°   | 6.67                    | -7.82                 |
| 5       | 115.45 | 10.52                   | 120°  | 2.85                    | -11.65                |
| 6       | 109.05 | 11.83                   | 150°  | 1.73                    | -12.77                |
| 7       | 102.34 | 3.74                    | 180°  | 0.00                    | -14.50                |
| 8       | 103.95 | 6.65                    | 210°  | 1.73                    | -12.77                |
| 9       | 0.00   | 16.07                   | 240°  | 2.85                    | -11.65                |
| 10      | 105.49 | 8.39                    | 270°  | 6.67                    | -7.82                 |
| 11      | 103.65 | 6.52                    | 300°  | 9.78                    | -4.71                 |
| 12      | 100.58 | 3.39                    | 330°  | 4.89                    | -9.61                 |
| 13      | 97.90  | 0.79                    |       |                         |                       |
| 14      | 97.26  | 0.00                    |       |                         |                       |
| 15      | 99.87  | 2.67                    |       |                         |                       |
| 16      | 104.08 | 6.83                    |       |                         |                       |
| AVERAGE |        |                         |       | 8.85                    | -5.89                 |



| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE   | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|---------|-------------------------|-----------------------|
| 1       | 112.76 | 8.79                    | 9°      | 13.89                   | -0.96                 |
| 2       | 106.62 | 2.66                    | 30°     | 11.90                   | -2.96                 |
| 3       | 103.98 | 0.00                    | 60°     | 9.91                    | -4.95                 |
| 4       | 107.18 | 3.13                    | 90°     | 7.90                    | -7.06                 |
| 5       | 113.08 | 9.11                    | 120°    | 3.61                    | -11.25                |
| 6       | 107.47 | 11.58                   | 150°    | 2.28                    | -12.58                |
| 7       | 100.85 | 4.74                    | 180°    | 0.00                    | -14.86                |
| 8       | 104.75 | 8.50                    | 210°    | 2.28                    | -12.58                |
| 9       | 117.77 | 13.89                   | 240°    | 3.61                    | -11.25                |
| 10      | 105.94 | 10.14                   | 270°    | 7.90                    | -7.06                 |
| 11      | 103.13 | 7.26                    | 300°    | 9.91                    | -4.95                 |
| 12      | 99.83  | 3.91                    | 330°    | 11.90                   | -2.96                 |
| 13      | 97.24  | 1.38                    |         |                         |                       |
| 14      | 95.81  | 0.00                    |         |                         |                       |
| 15      | 99.01  | 3.18                    |         |                         |                       |
| 16      | 104.56 | 8.34                    |         |                         |                       |
|         |        |                         | AVERAGE | 9.03                    | -5.83                 |

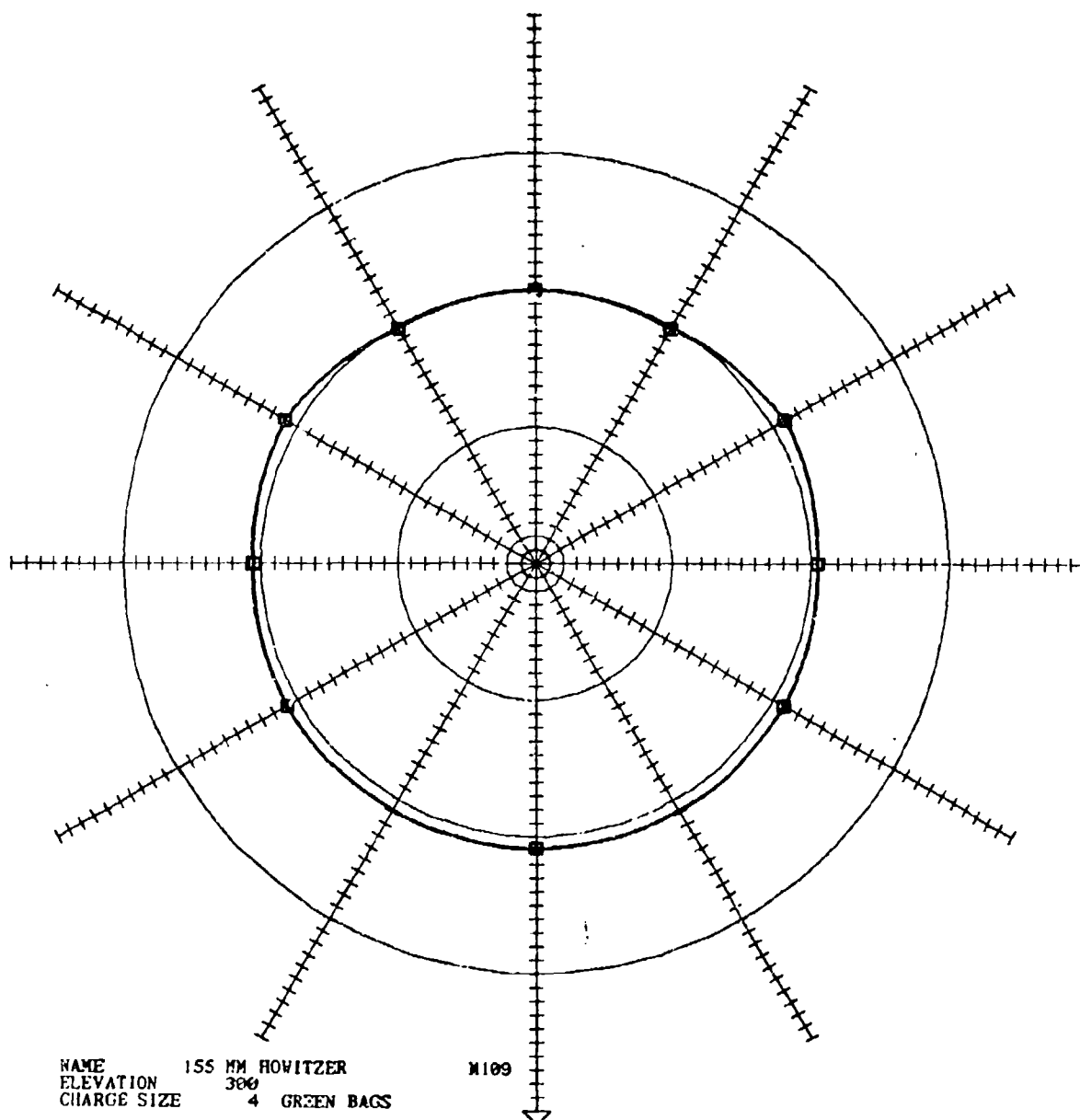


| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|-------|-------------------------|-----------------------|
| 1       | 115.76 | 8.93                    | 0°    | 0.00                    | -12.00                |
| 2       | 108.55 | 1.84                    | 30°   | 4.13                    | -7.87                 |
| 3       | 106.76 | 0.00                    | 60°   | 8.27                    | -3.73                 |
| 4       | 107.71 | 0.90                    | 90°   | 5.33                    | -6.66                 |
| 5       | 114.91 | 8.17                    | 120°  | 1.19                    | -10.80                |
| 6       | 107.03 | 6.87                    | 150°  | 0.25                    | -11.74                |
| 7       | 100.12 | 0.11                    | 180°  | 0.00                    | -12.00                |
| 8       | 103.29 | 3.42                    | 210°  | 0.25                    | -11.74                |
| 9       | 0.00   | 13.89                   | 240°  | 1.19                    | -10.80                |
| 10      | 108.88 | 9.10                    | 270°  | 5.33                    | -6.66                 |
| 11      | 107.44 | 7.22                    | 300°  | 8.27                    | -3.73                 |
| 12      | 101.70 | 1.93                    | 330°  | 4.13                    | -7.87                 |
| 13      | 100.24 | 0.45                    |       |                         |                       |
| 14      | 99.86  | 0.00                    |       |                         |                       |
| 15      | 99.97  | 0.06                    |       |                         |                       |
| 16      | 103.36 | 3.45                    |       |                         |                       |
| AVERAGE |        |                         |       | 7.60                    | -4.40                 |



NAME 155 MM HOWITZER  
ELEVATION 150  
CHARGE SIZE 3 GREEN BAGS

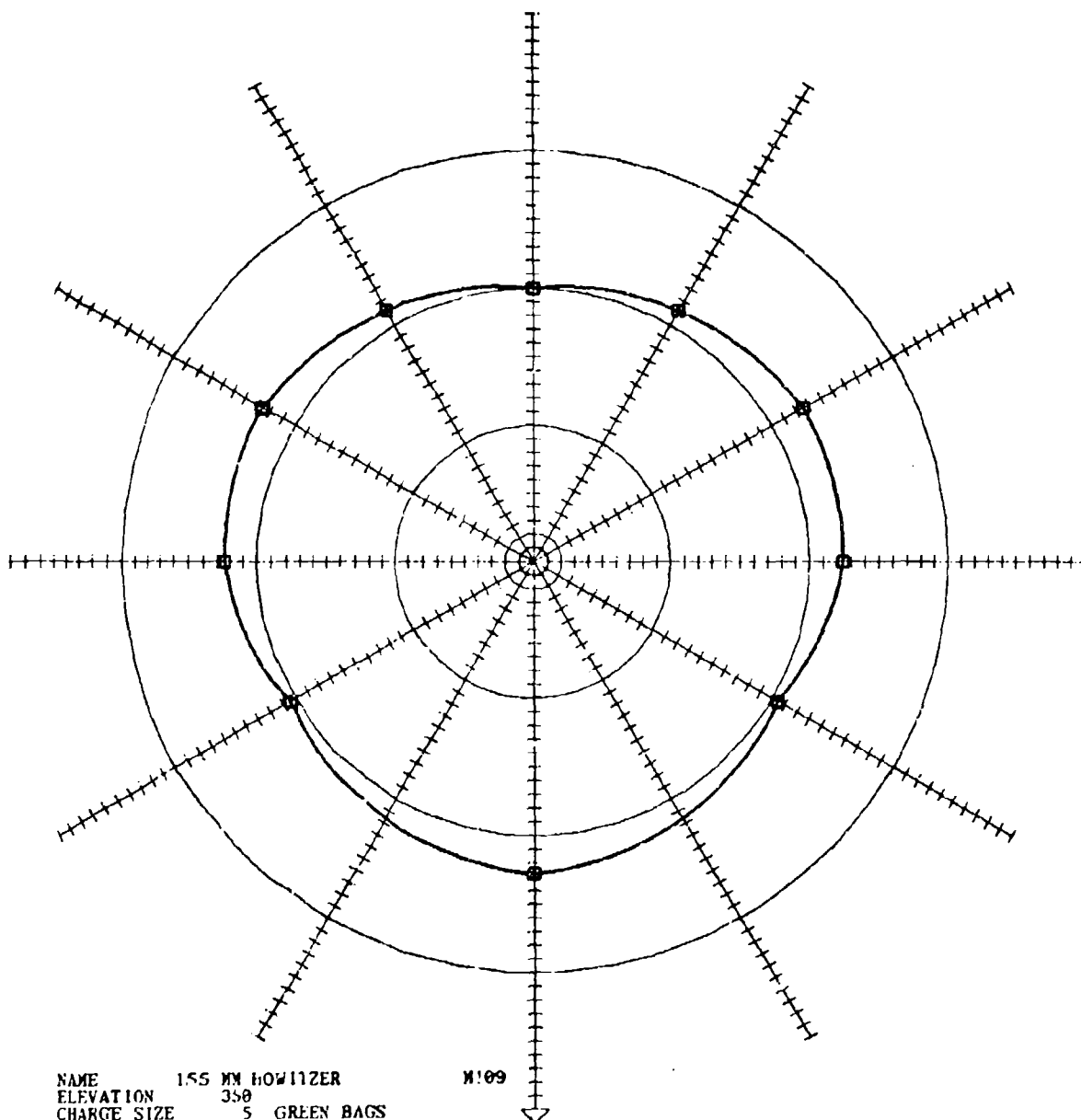
| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|-------|-------------------------|-----------------------|
| 1       | 108.15 | 1.95                    | 0°    | -0.01                   | -13.08                |
| 2       | 108.65 | 2.41                    | 30°   | 0.05                    | -13.01                |
| 3       | 106.20 | 0.00                    | 60°   | 0.12                    | -12.94                |
| 4       | 107.20 | 0.92                    | 90°   | 1.49                    | -11.57                |
| 5       | 105.37 | -1.04                   | 120°  | 1.56                    | -11.50                |
| 6       | 97.06  | -1.44                   | 150°  | 0.83                    | -12.23                |
| 7       | 98.75  | 0.27                    | 180°  | 0.00                    | -13.06                |
| 8       | 99.28  | 0.74                    | 210°  | 0.83                    | -12.23                |
| 9       | 106.19 | -0.01                   | 240°  | 1.56                    | -11.50                |
| 10      | 99.51  | 1.01                    | 270°  | 1.49                    | -11.57                |
| 11      | 100.79 | 2.26                    | 300°  | 0.12                    | -12.94                |
| 12      | 101.17 | 2.64                    | 330°  | 0.05                    | -13.01                |
| 13      | 99.39  | 0.88                    |       |                         |                       |
| 14      | 98.48  | 0.00                    |       |                         |                       |
| 15      | 99.35  | 0.78                    |       |                         |                       |
| 16      | 99.22  | 0.72                    |       |                         |                       |
| AVERAGE |        |                         |       | 0.72                    | -12.34                |



NAME 155 MM HOWITZER  
ELEVATION 3000  
CHARGE SIZE 4 GREEN BAGS

M109

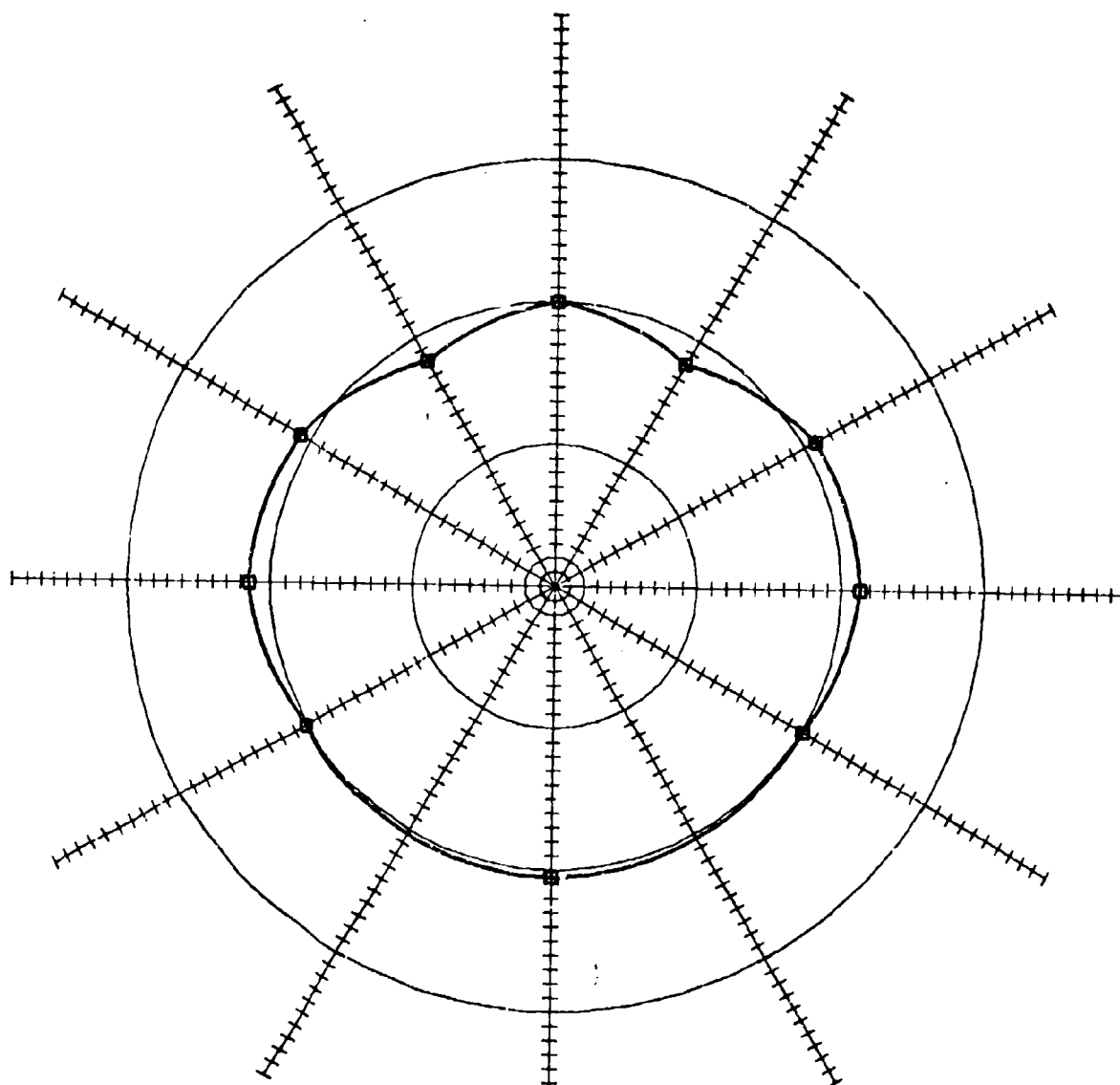
| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE   | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|---------|-------------------------|-----------------------|
| 1       | 110.24 | 2.29                    | 0°      | 0.80                    | -10.35                |
| 2       | 110.64 | 2.58                    | 30°     | 0.82                    | -10.33                |
| 3       | 108.01 | 0.00                    | 60°     | 0.85                    | -10.30                |
| 4       | 107.91 | -0.14                   | 90°     | 0.46                    | -10.69                |
| 5       | 108.15 | 0.06                    | 120°    | 0.95                    | -10.19                |
| 6       | 102.53 | 0.52                    | 150°    | -0.19                   | -11.35                |
| 7       | 99.56  | -1.74                   | 180°    | 0.00                    | -11.15                |
| 8       | 100.47 | -1.53                   | 210°    | -0.19                   | -11.35                |
| 9       | 108.87 | 0.80                    | 240°    | 0.95                    | -10.19                |
| 10      | 101.73 | 0.52                    | 270°    | 0.46                    | -10.69                |
| 11      | 103.35 | 2.21                    | 300°    | 0.85                    | -10.30                |
| 12      | 104.39 | 3.14                    | 330°    | 0.82                    | -10.33                |
| 13      | 102.17 | 0.79                    |         |                         |                       |
| 14      | 101.27 | 0.00                    |         |                         |                       |
| 15      | 100.08 | -1.18                   |         |                         |                       |
| 16      | 100.66 | -1.23                   |         |                         |                       |
|         |        |                         | AVERAGE | 0.57                    | -10.58                |



NAME 155 MM HOWITZER  
ELEVATION 350  
CHARGE SIZE 5 GREEN BAGS

M109

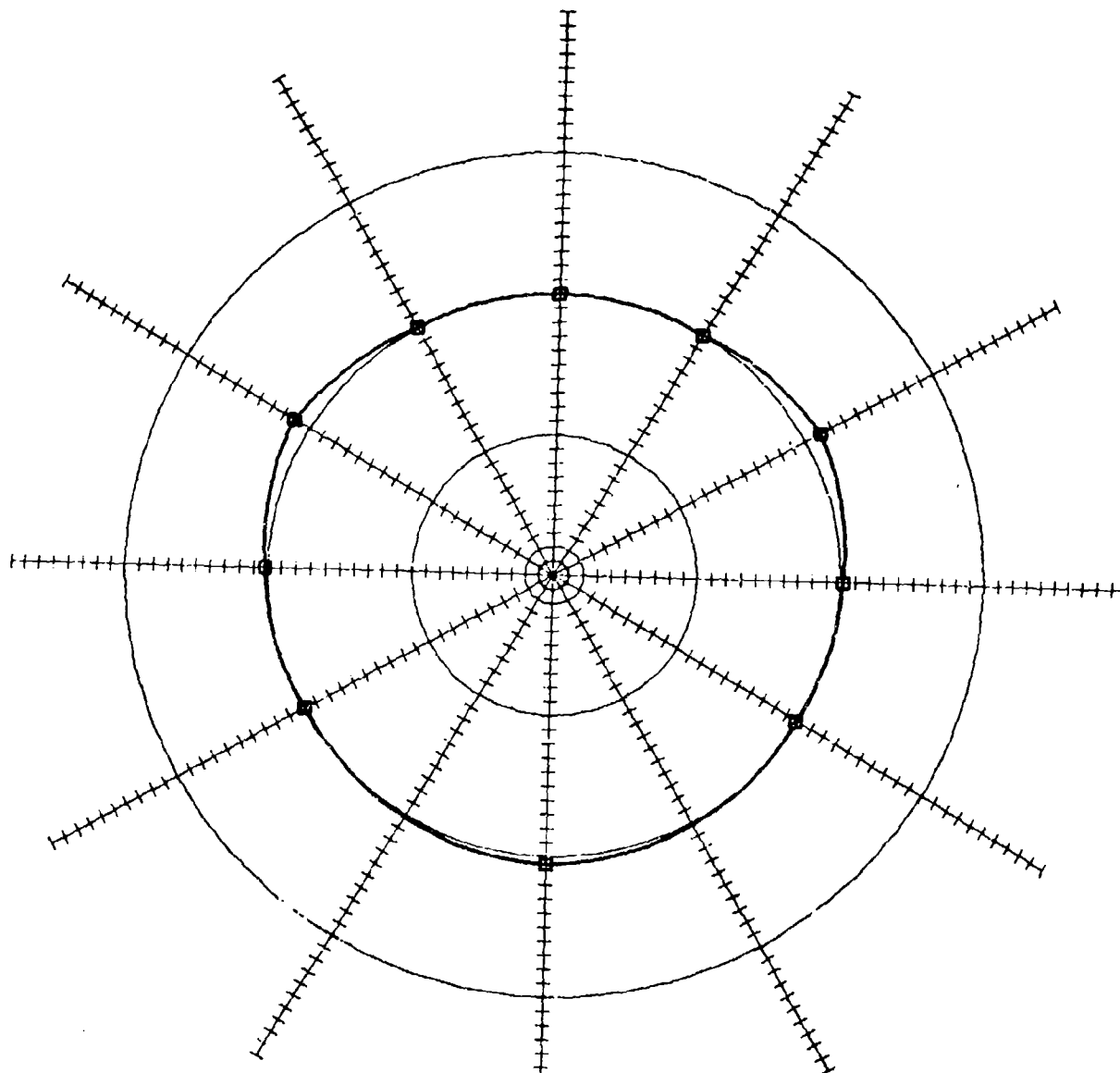
| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE   | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|---------|-------------------------|-----------------------|
| 1       | 111.72 | 1.52                    | 0°      | 2.74                    | -6.48                 |
| 2       | 112.77 | 2.52                    | 30°     | 1.59                    | -7.62                 |
| 3       | 110.22 | 0.00                    | 60°     | 0.45                    | -8.76                 |
| 4       | 112.33 | 2.02                    | 90°     | 2.40                    | -6.81                 |
| 5       | 110.15 | -0.11                   | 120°    | 2.57                    | -6.64                 |
| 6       | 101.72 | -1.09                   | 150°    | 1.22                    | -7.99                 |
| 7       | 105.34 | 2.36                    | 180°    | 0.00                    | -9.22                 |
| 8       | 106.06 | 3.20                    | 210°    | 1.22                    | -7.99                 |
| 9       | 112.94 | 2.74                    | 240°    | 2.57                    | -6.64                 |
| 10      | 104.24 | 1.52                    | 270°    | 2.40                    | -6.81                 |
| 11      | 104.52 | 1.81                    | 300°    | 0.45                    | -8.76                 |
| 12      | 106.05 | 3.40                    | 330°    | 1.59                    | -7.62                 |
| 13      | 104.53 | 1.88                    |         |                         |                       |
| 14      | 102.76 | 0.00                    |         |                         |                       |
| 15      | 103.22 | 0.56                    |         |                         |                       |
| 16      | 105.86 | 3.90                    |         |                         |                       |
|         |        |                         | AVERAGE | 1.69                    | -7.52                 |



NAME 155 MM HOWITZER  
ELEVATION 60  
CHARGE SIZE S WHITE BAGS

M109

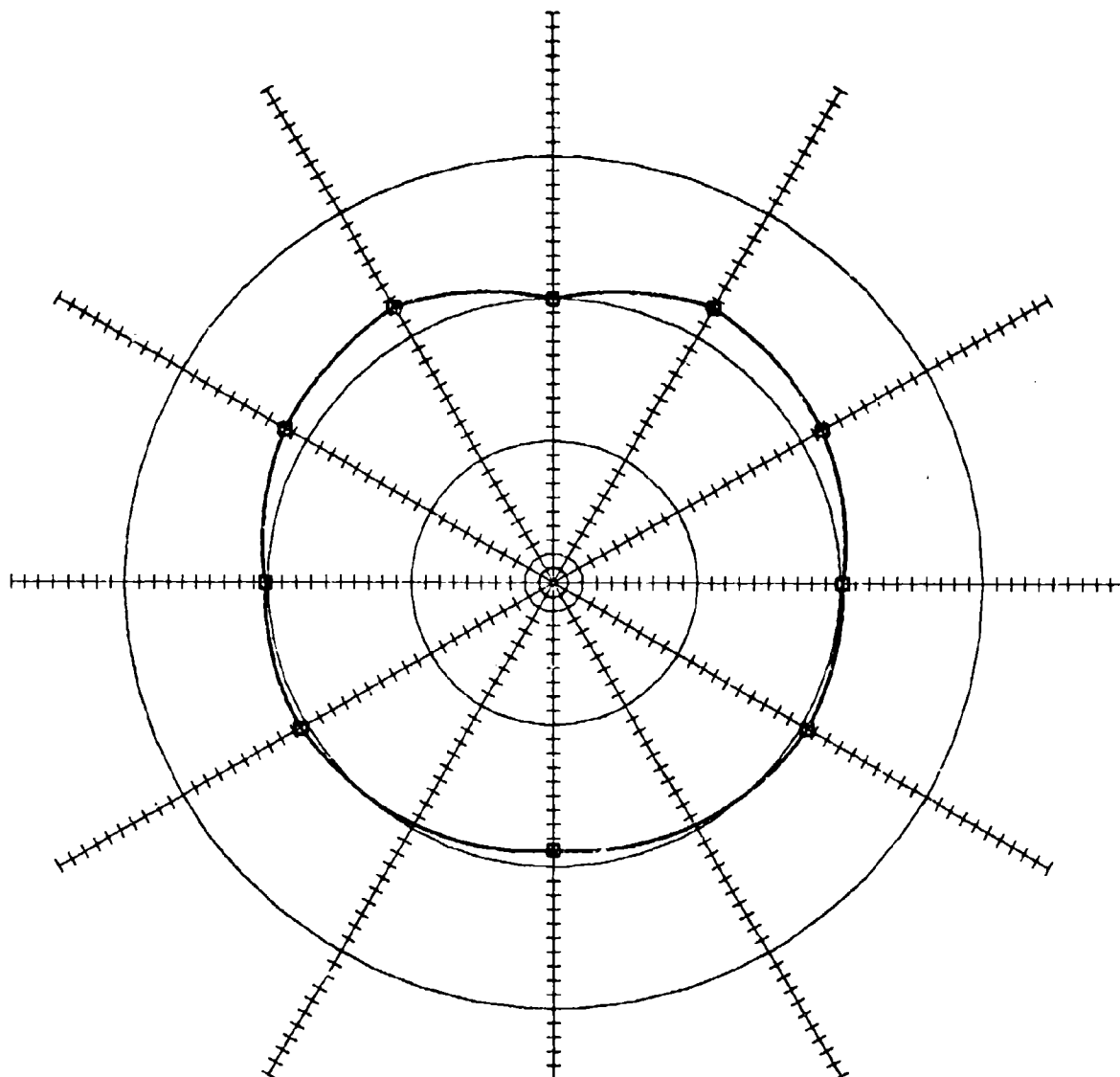
| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE   | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|---------|-------------------------|-----------------------|
| 1       | 113.53 | 1.31                    | 0°      | 0.48                    | -5.64                 |
| 2       | 114.12 | 1.91                    | 30°     | 0.29                    | -5.84                 |
| 3       | 112.15 | 0.00                    | 60°     | 0.09                    | -6.03                 |
| 4       | 113.59 | 1.20                    | 90°     | 1.34                    | -4.78                 |
| 5       | 112.57 | 0.30                    | 120°    | 0.81                    | -5.31                 |
| 6       | 104.83 | -1.72                   | 150°    | -1.86                   | -7.99                 |
| 7       | 105.78 | -1.02                   | 180°    | 0.00                    | -6.12                 |
| 8       | 113.33 | 6.10                    | 210°    | -1.86                   | -7.99                 |
| 9       | 112.63 | 0.48                    | 240°    | 0.81                    | -5.31                 |
| 10      | 106.98 | 0.49                    | 270°    | 1.34                    | -4.78                 |
| 11      | 107.03 | 0.67                    | 300°    | 0.09                    | -6.03                 |
| 12      | 107.93 | 1.16                    | 330°    | 0.29                    | -5.84                 |
| 13      | 105.78 | -0.67                   |         |                         |                       |
| 14      | 106.51 | 0.00                    |         |                         |                       |
| 15      | 103.52 | -3.05                   |         |                         |                       |
| 16      | 108.55 | 2.01                    |         |                         |                       |
|         |        |                         | AVERAGE | 0.26                    | -5.06                 |



NAME 155 MM HOWITZER  
ELEVATION 350  
CHARGE SIZE 5 WHITE BAGS

M109

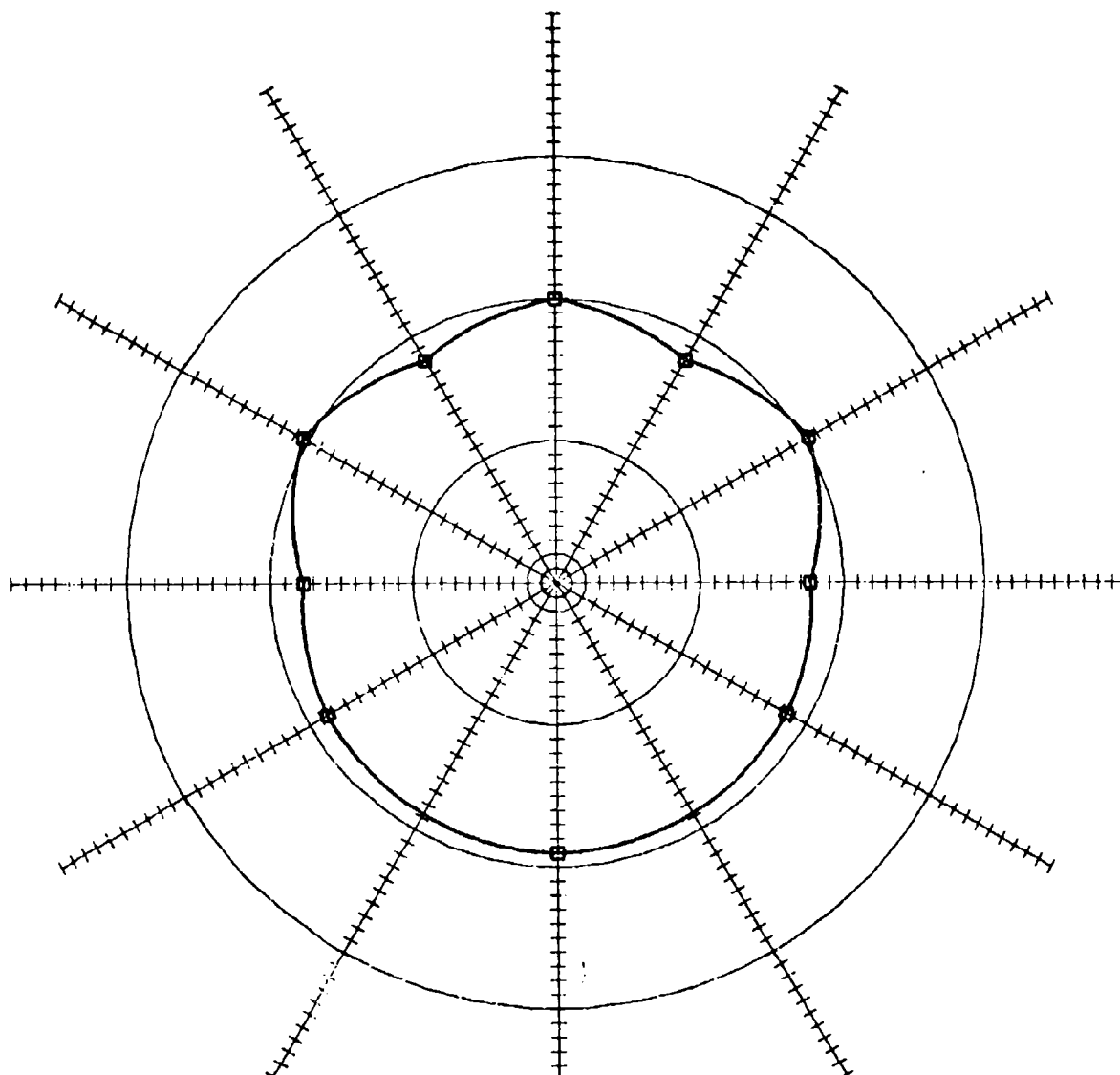
| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|-------|-------------------------|-----------------------|
| 1       | 113.52 | 1.48                    | 0°    | 0.48                    | -5.80                 |
| 2       | 114.38 | 2.34                    | 30°   | 0.14                    | -6.13                 |
| 3       | 112.07 | 0.00                    | 60°   | -0.18                   | -6.47                 |
| 4       | 114.09 | 2.02                    | 90°   | 0.15                    | -6.12                 |
| 5       | 113.22 | 1.09                    | 120°  | 1.17                    | -5.10                 |
| 6       | 104.68 | -2.36                   | 150°  | 0.01                    | -6.26                 |
| 7       | 105.51 | -1.51                   | 180°  | 0.00                    | -6.28                 |
| 8       | 107.56 | 0.18                    | 210°  | 0.01                    | -6.26                 |
| 9       | 112.63 | 0.48                    | 240°  | 1.17                    | -5.10                 |
| 10      | 105.82 | -0.97                   | 270°  | 0.15                    | -6.12                 |
| 11      | 107.18 | 0.46                    | 300°  | -0.18                   | -6.47                 |
| 12      | 108.57 | 1.86                    | 330°  | 0.14                    | -6.13                 |
| 13      | 107.98 | 1.28                    |       |                         |                       |
| 14      | 106.74 | 0.00                    |       |                         |                       |
| 15      | 105.55 | -1.25                   |       |                         |                       |
| 16      | 107.16 | -0.15                   |       |                         |                       |
| AVERAGE |        |                         |       | 0.27                    | -6.00                 |



NAME 155 MM HOWITZER  
ELEVATION 1275  
CHARGE SIZE 5 WHITE BAGS

M109

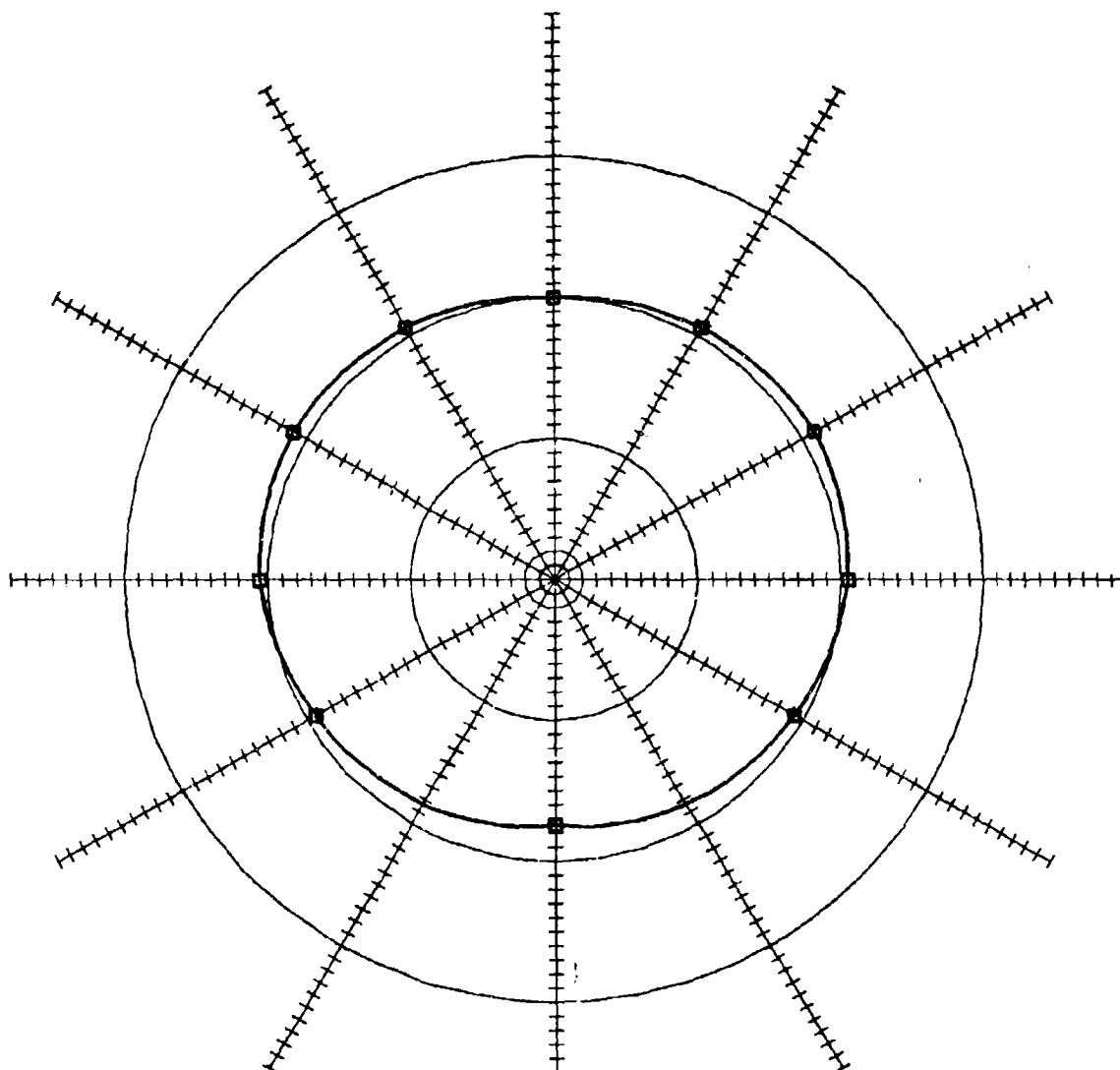
| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|-------|-------------------------|-----------------------|
| 1       | 114.68 | 1.70                    | 0°    | -1.20                   | -8.21                 |
| 2       | 116.42 | 3.40                    | 30°   | -0.36                   | -7.37                 |
| 3       | 113.05 | 0.00                    | 60°   | 0.46                    | -6.54                 |
| 4       | 112.27 | -1.92                   | 90°   | 0.16                    | -6.85                 |
| 5       | 113.10 | 0.04                    | 120°  | 1.63                    | -5.37                 |
| 6       | 105.48 | -0.53                   | 150°  | 2.39                    | -4.62                 |
| 7       | 106.91 | 1.14                    | 180°  | 0.00                    | -7.01                 |
| 8       | 103.10 | -2.65                   | 210°  | 2.39                    | -4.62                 |
| 9       | 111.77 | -1.20                   | 240°  | 1.63                    | -5.37                 |
| 10      | 106.36 | 0.82                    | 270°  | 0.16                    | -6.85                 |
| 11      | 108.65 | 3.04                    | 300°  | 0.46                    | -6.54                 |
| 12      | 109.14 | 3.58                    | 330°  | -0.36                   | -7.37                 |
| 13      | 108.85 | 3.36                    |       |                         |                       |
| 14      | 105.60 | 0.00                    |       |                         |                       |
| 15      | 107.07 | 1.41                    |       |                         |                       |
| 16      | 103.01 | -2.71                   |       |                         |                       |
| AVERAGE |        |                         |       | 0.75                    | -6.25                 |



NAME 155 MM HOWITZER  
ELEVATION 200  
CHARGE SIZE 3 GREEN BAGS

M109A1

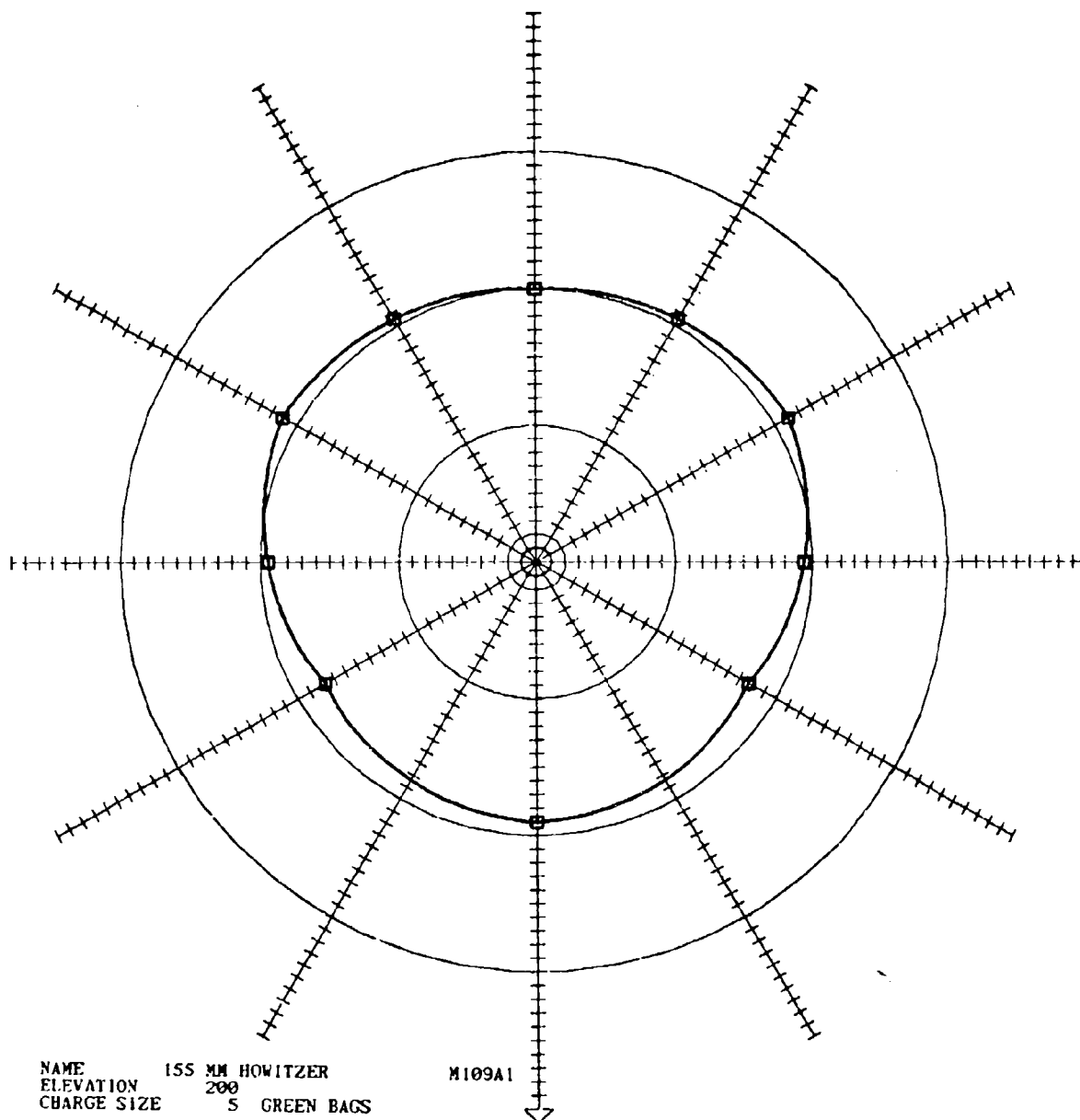
| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|-------|-------------------------|-----------------------|
| 1       | 103.82 | 0.55                    | 0°    | -1.00                   | -17.26                |
| 2       | 105.17 | 2.15                    | 30°   | -1.26                   | -17.52                |
| 3       | 101.51 | 0.00                    | 60°   | -1.53                   | -17.79                |
| 4       | 102.49 | -0.27                   | 90°   | -2.27                   | -18.53                |
| 5       | 101.63 | -2.57                   | 120°  | 0.40                    | -15.85                |
| 6       | 95.90  | -4.18                   | 150°  | -1.91                   | -18.17                |
| 7       | 96.00  | -0.92                   | 180°  | 0.00                    | -16.26                |
| 8       | 94.48  | -3.72                   | 210°  | -1.91                   | -18.17                |
| 9       | 101.16 | -1.00                   | 240°  | 0.40                    | -15.85                |
| 10      | 97.09  | 1.50                    | 270°  | -2.27                   | -18.53                |
| 11      | 97.24  | -0.90                   | 300°  | -1.53                   | -17.79                |
| 12      | 98.09  | 0.87                    | 330°  | -1.26                   | -17.52                |
| 13      | 96.45  | -1.52                   |       |                         |                       |
| 14      | 97.69  | 0.00                    |       |                         |                       |
| 15      | 95.56  | -2.30                   |       |                         |                       |
| 16      | 95.24  | -3.65                   |       |                         |                       |
| AVERAGE |        |                         |       | -1.07                   | -17.34                |



NAME 155 MM HOWITZER  
ELEVATION 500  
CHARGE SIZE 3 GREEN BAGS

M109A1

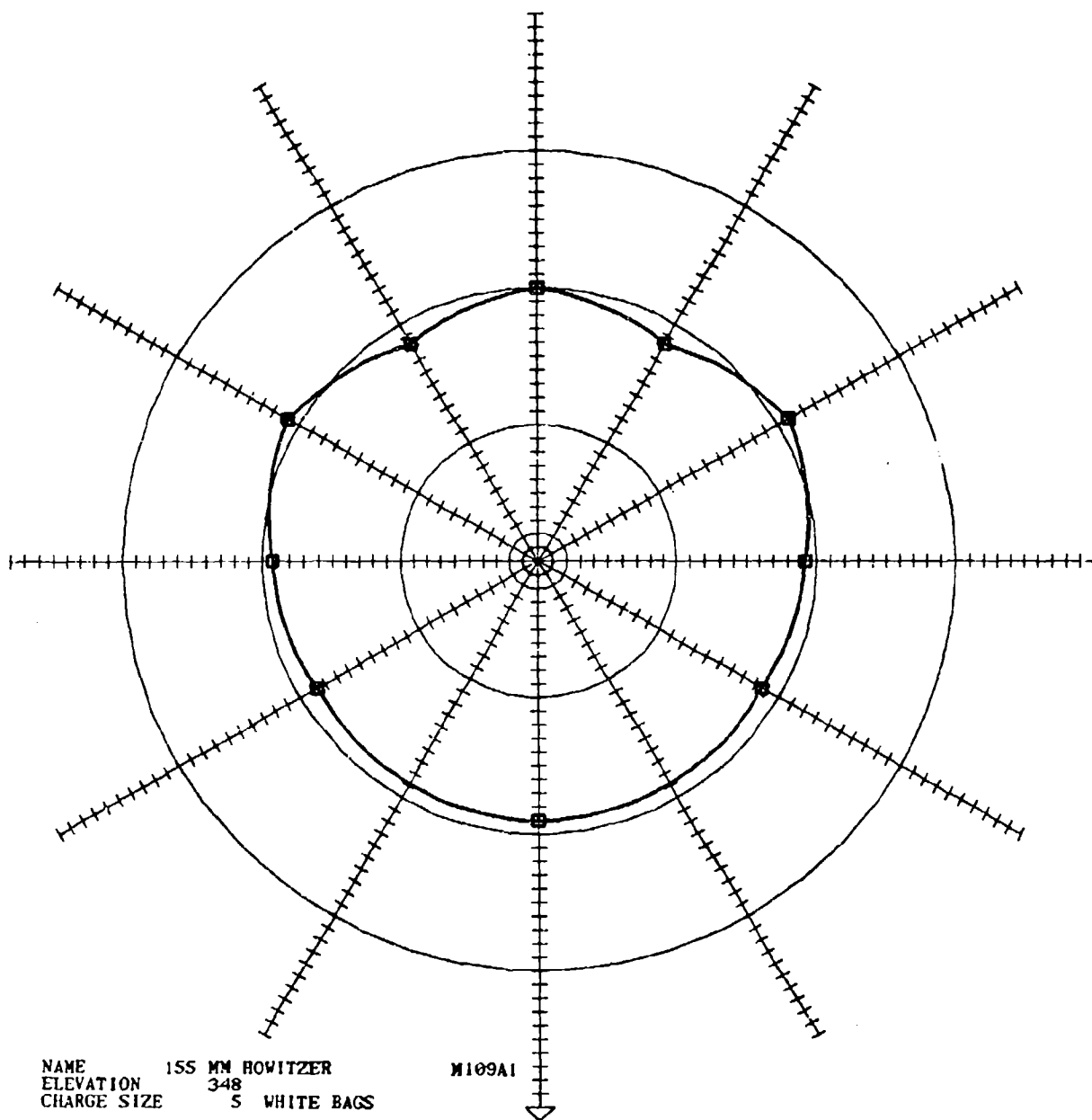
| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|-------|-------------------------|-----------------------|
| 1       | 102.10 | -0.04                   | 0°    | -2.59                   | -19.10                |
| 2       | 104.05 | 1.88                    | 30°   | -1.65                   | -18.16                |
| 3       | 102.35 | 0.00                    | 60°   | -0.70                   | -17.21                |
| 4       | 103.38 | 0.72                    | 90°   | 0.47                    | -16.02                |
| 5       | 101.84 | -1.11                   | 120°  | 1.00                    | -15.50                |
| 6       | 95.86  | -1.76                   | 150°  | 0.64                    | -15.86                |
| 7       | 97.16  | 1.08                    | 180°  | 0.00                    | -16.51                |
| 8       | 96.06  | 0.07                    | 210°  | 0.64                    | -15.86                |
| 9       | 93.44  | -2.59                   | 240°  | 1.00                    | -15.50                |
| 10      | 95.77  | 0.29                    | 270°  | 0.47                    | -16.02                |
| 11      | 95.28  | -0.27                   | 300°  | -0.70                   | -17.21                |
| 12      | 95.83  | 0.33                    | 330°  | -1.65                   | -18.16                |
| 13      | 96.87  | 1.24                    |       |                         |                       |
| 14      | 95.90  | 0.00                    |       |                         |                       |
| 15      | 96.34  | -0.10                   |       |                         |                       |
| 16      | 99.11  | 1.23                    |       |                         |                       |
| AVERAGE |        |                         |       | -0.11                   | -16.62                |



NAME 155 MM HOWITZER  
ELEVATION 200  
CHARGE SIZE 5 GREEN BAGS

M109A1

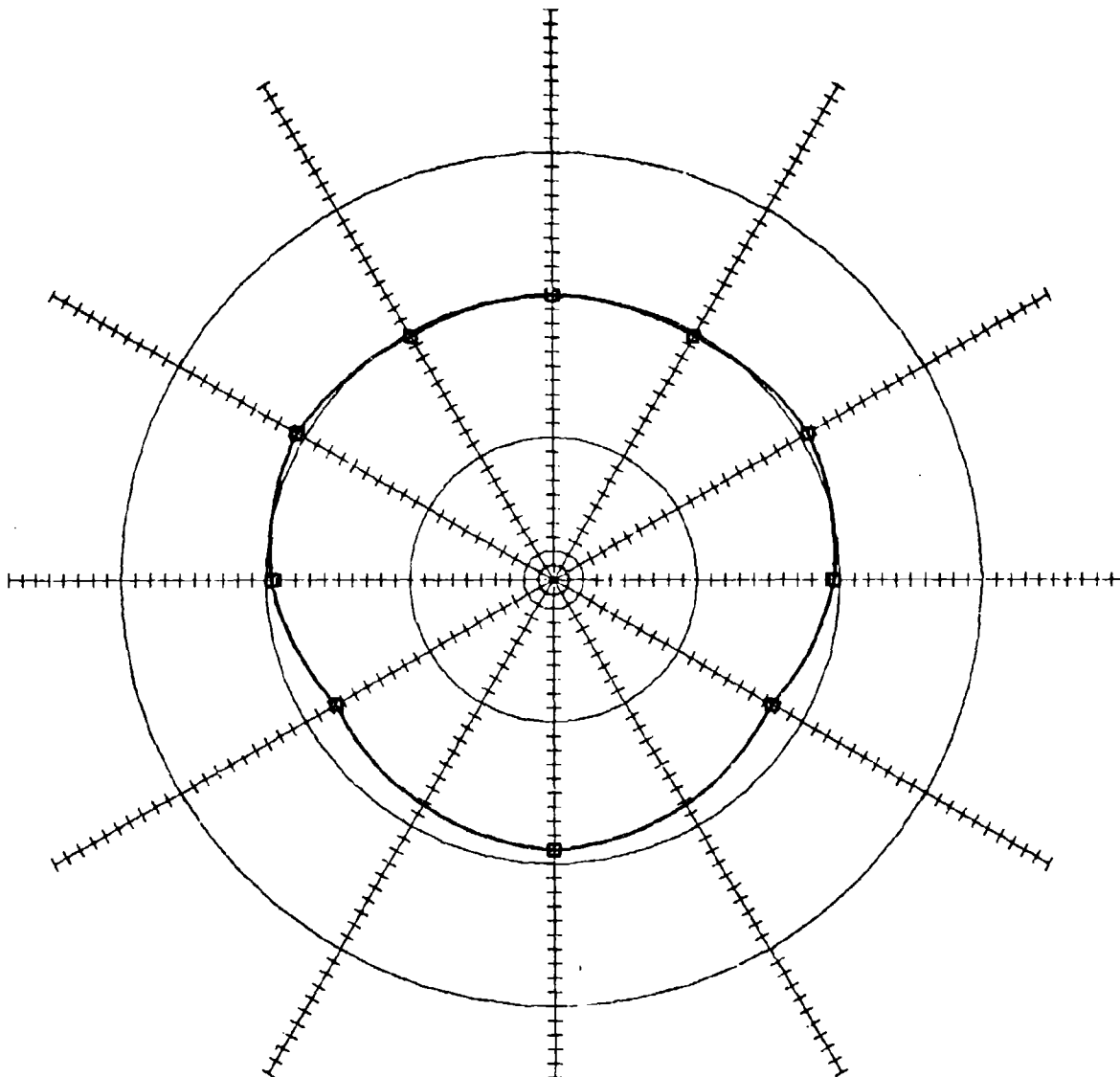
| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|-------|-------------------------|-----------------------|
| 1       | 106.89 | -0.44                   | 0°    | 0.00                    | -10.92                |
| 2       | 108.35 | 1.10                    | 30°   | -1.13                   | -12.06                |
| 3       | 107.13 | 0.00                    | 60°   | -2.27                   | -13.19                |
| 4       | 108.31 | 1.07                    | 90°   | -0.57                   | -11.50                |
| 5       | 103.82 | -3.44                   | 120°  | 1.13                    | -9.78                 |
| 6       | 96.72  | -4.37                   | 150°  | 0.52                    | -10.39                |
| 7       | 102.49 | -1.30                   | 180°  | 0.00                    | -10.92                |
| 8       | 99.52  | -1.72                   | 210°  | 0.52                    | -10.39                |
| 9       | 0.00   | -2.59                   | 240°  | 1.13                    | -9.78                 |
| 10      | 100.55 | -0.82                   | 270°  | -0.57                   | -11.50                |
| 11      | 102.28 | 0.87                    | 300°  | -2.27                   | -13.19                |
| 12      | 102.45 | 1.07                    | 330°  | -1.13                   | -12.06                |
| 13      | 102.19 | 0.84                    |       |                         |                       |
| 14      | 101.17 | 0.00                    |       |                         |                       |
| 15      | 100.65 | 0.10                    |       |                         |                       |
| 16      | 99.21  | -2.02                   |       |                         |                       |
| AVERAGE |        |                         |       | -0.40                   | -11.31                |



NAME 155 MM HOWITZER  
ELEVATION 348  
CHARGE SIZE 5 WHITE BAGS

M109A1

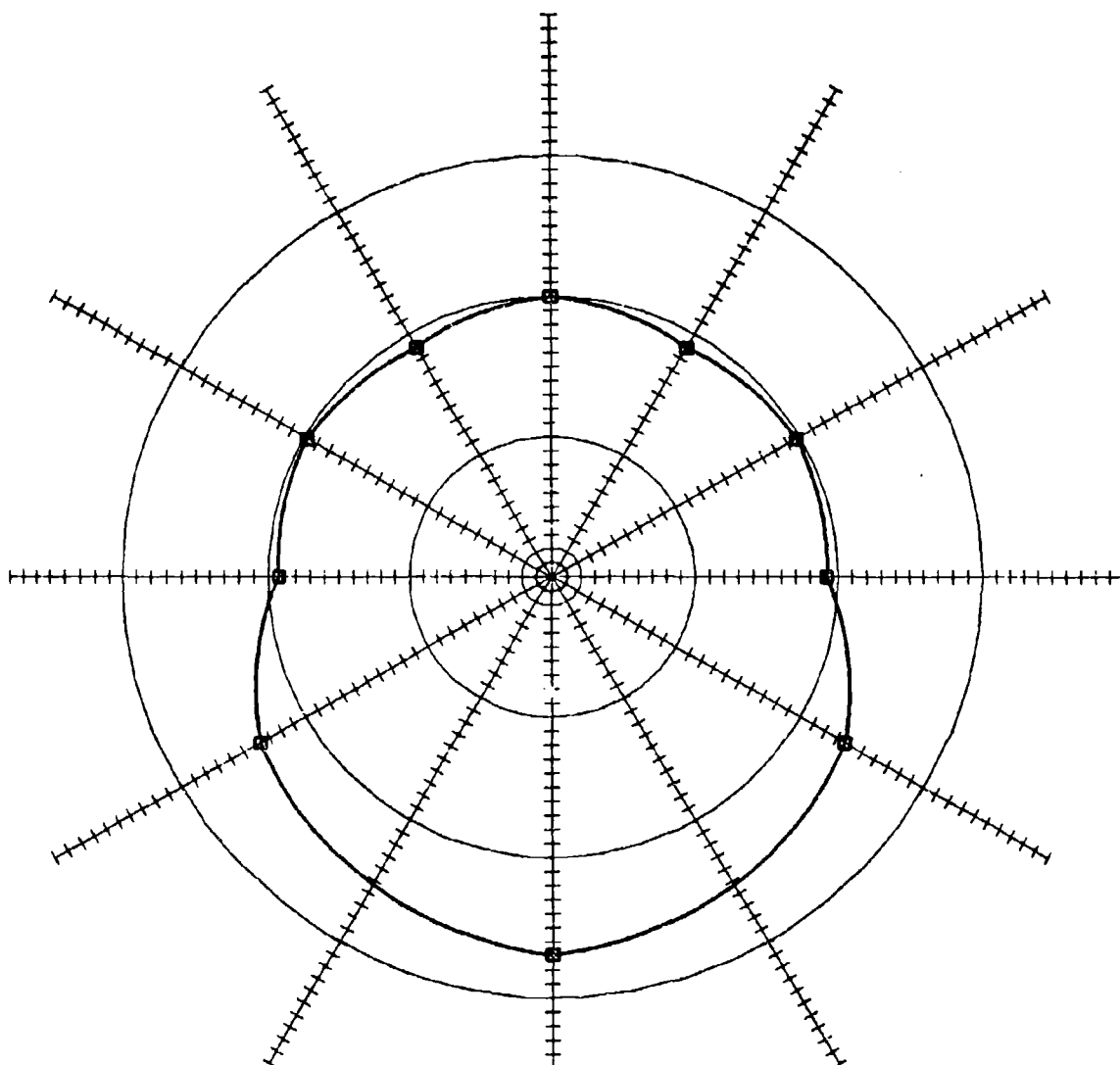
| CHANNEL | ENERGY | DIFFERENCE<br>FROM RFAR | ANGLE   | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|---------|-------------------------|-----------------------|
| 1       | 110.49 | 1.24                    | 0°      | 0.00                    | -8.51                 |
| 2       | 110.31 | 1.36                    | 30°     | -0.69                   | -9.21                 |
| 3       | 108.96 | 0.00                    | 60°     | -1.39                   | -9.91                 |
| 4       | 110.63 | 1.63                    | 90°     | -0.80                   | -9.32                 |
| 5       | 106.56 | -2.74                   | 120°    | 0.86                    | -7.65                 |
| 6       | 100.43 | -3.22                   | 150°    | -1.64                   | -10.16                |
| 7       | 103.77 | 0.14                    | 180°    | 0.00                    | -8.51                 |
| 8       | 103.18 | -1.09                   | 210°    | -1.64                   | -10.16                |
| 9       | 0.00   | -2.59                   | 240°    | 0.86                    | -7.65                 |
| 10      | 103.29 | -0.04                   | 270°    | -0.80                   | -9.32                 |
| 11      | 103.38 | -0.05                   | 300°    | -1.39                   | -9.91                 |
| 12      | 103.72 | 0.30                    | 330°    | -0.69                   | -9.21                 |
| 13      | 102.12 | -1.21                   |         |                         |                       |
| 14      | 103.34 | 0.00                    |         |                         |                       |
| 15      | 101.32 | -2.07                   |         |                         |                       |
| 16      | 102.82 | -1.55                   |         |                         |                       |
|         |        |                         | AVERAGE | -0.69                   | -9.20                 |



NAME 155 MM HOWITZER  
ELEVATION 185  
CHARGE SIZE 7 WHITE BAGS

M109A1

| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE   | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|---------|-------------------------|-----------------------|
| 1       | 112.02 | -2.62                   | 0°      | 0.00                    | -3.68                 |
| 2       | 114.39 | -0.28                   | 30°     | -1.23                   | -4.92                 |
| 3       | 114.57 | 0.00                    | 60°     | -2.46                   | -6.15                 |
| 4       | 115.39 | 0.00                    | 90°     | -0.40                   | -4.09                 |
| 5       | 112.73 | -1.92                   | 120°    | 0.56                    | -3.11                 |
| 6       | 106.53 | -1.55                   | 150°    | -0.25                   | -3.94                 |
| 7       | 110.72 | 2.39                    | 180°    | 0.00                    | -3.68                 |
| 8       | 107.29 | -1.28                   | 210°    | -0.25                   | -3.94                 |
| 9       | 0.00   | -2.59                   | 240°    | 0.56                    | -3.11                 |
| 10      | 104.53 | -3.76                   | 270°    | -0.40                   | -4.09                 |
| 11      | 108.76 | 0.55                    | 300°    | -2.46                   | -6.15                 |
| 12      | 107.43 | -0.63                   | 330°    | -1.23                   | -4.92                 |
| 13      | 107.14 | -1.22                   |         |                         |                       |
| 14      | 108.02 | 0.00                    |         |                         |                       |
| 15      | 109.00 | 0.71                    |         |                         |                       |
| 16      | 107.20 | -1.36                   |         |                         |                       |
|         |        |                         | AVERAGE | -0.68                   | -4.36                 |

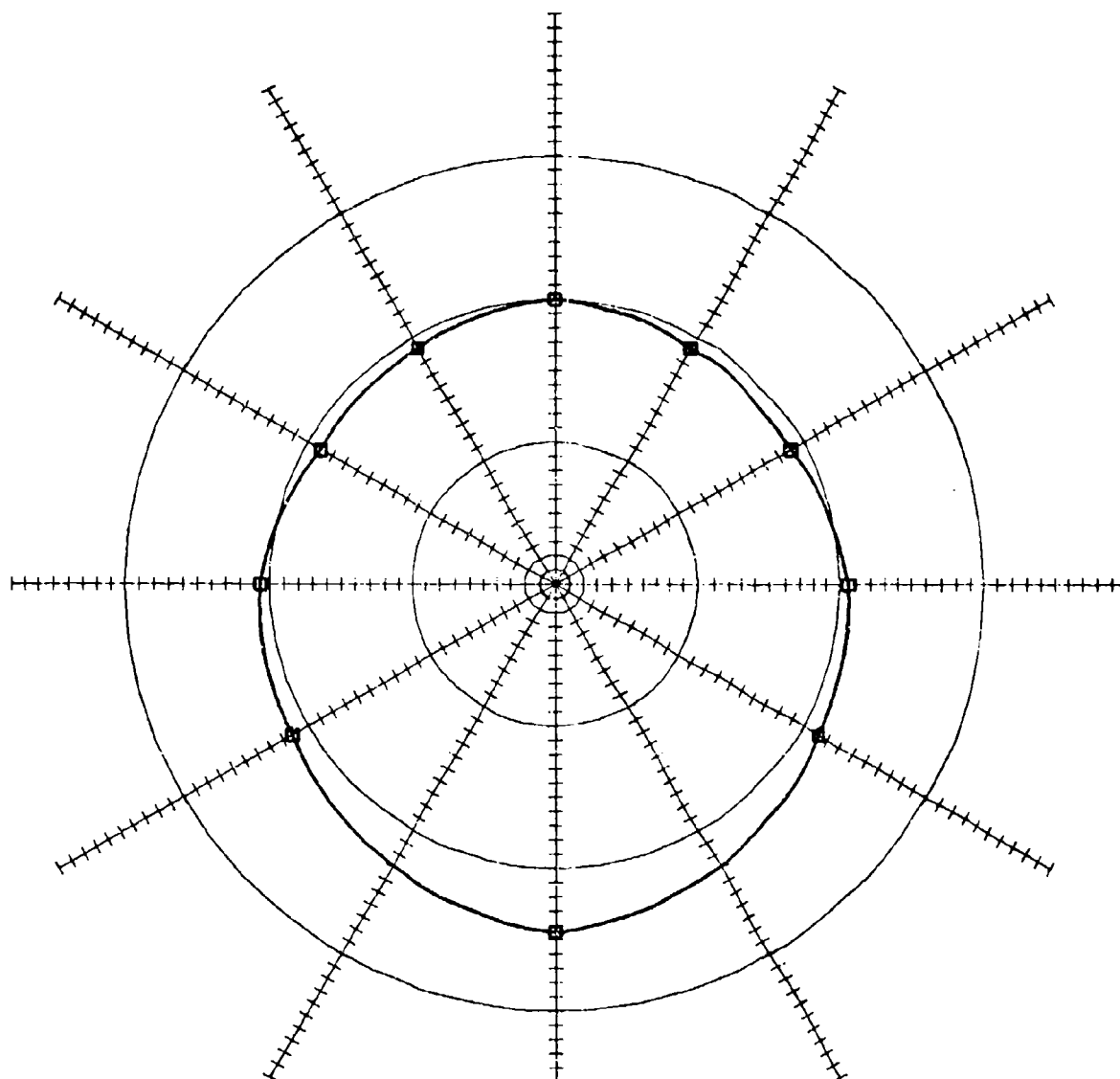


NAME 8 INCH HOWITZER  
ELEVATION 100  
CHARGE SIZE 5 WHITE BAGS

M110



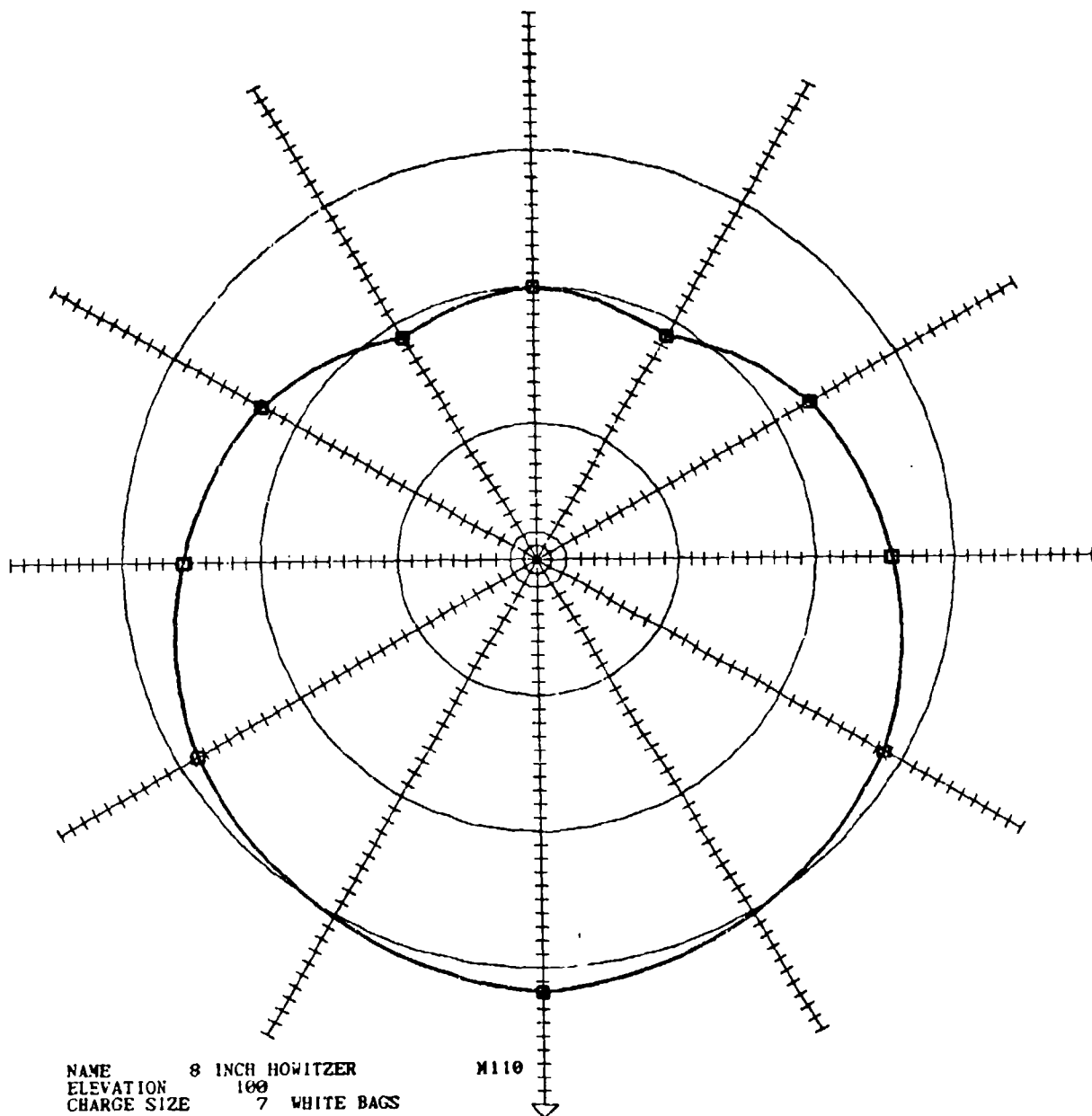
| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|-------|-------------------------|-----------------------|
| 1       | 121.36 | 2.79                    | 0°    | 6.88                    | 5.90                  |
| 2       | 118.60 | -0.02                   | 30°   | 5.28                    | 4.30                  |
| 3       | 118.59 | 0.00                    | 60°   | 3.68                    | 2.69                  |
| 4       | 118.03 | -0.56                   | 90°   | -0.78                   | -1.77                 |
| 5       | 123.44 | 4.53                    | 120°  | -0.28                   | -1.27                 |
| 6       | 117.78 | 4.48                    | 150°  | -1.11                   | -2.10                 |
| 7       | 111.93 | -1.10                   | 180°  | 0.00                    | -0.98                 |
| 8       | 112.82 | -0.09                   | 210°  | -1.11                   | -2.10                 |
| 9       | 125.47 | 6.88                    | 240°  | -0.28                   | -1.27                 |
| 10      | 115.80 | 2.93                    | 270°  | -0.78                   | -1.77                 |
| 11      | 111.72 | -1.25                   | 300°  | 3.68                    | 2.69                  |
| 12      | 113.88 | 0.56                    | 330°  | 5.28                    | 4.30                  |
| 13      | 111.19 | -1.84                   |       |                         |                       |
| 14      | 112.87 | 0.00                    |       |                         |                       |
| 15      | 112.65 | -0.37                   |       |                         |                       |
| 16      | 112.67 | -0.32                   |       |                         |                       |
| AVERAGE |        |                         |       | 2.71                    | 1.72                  |



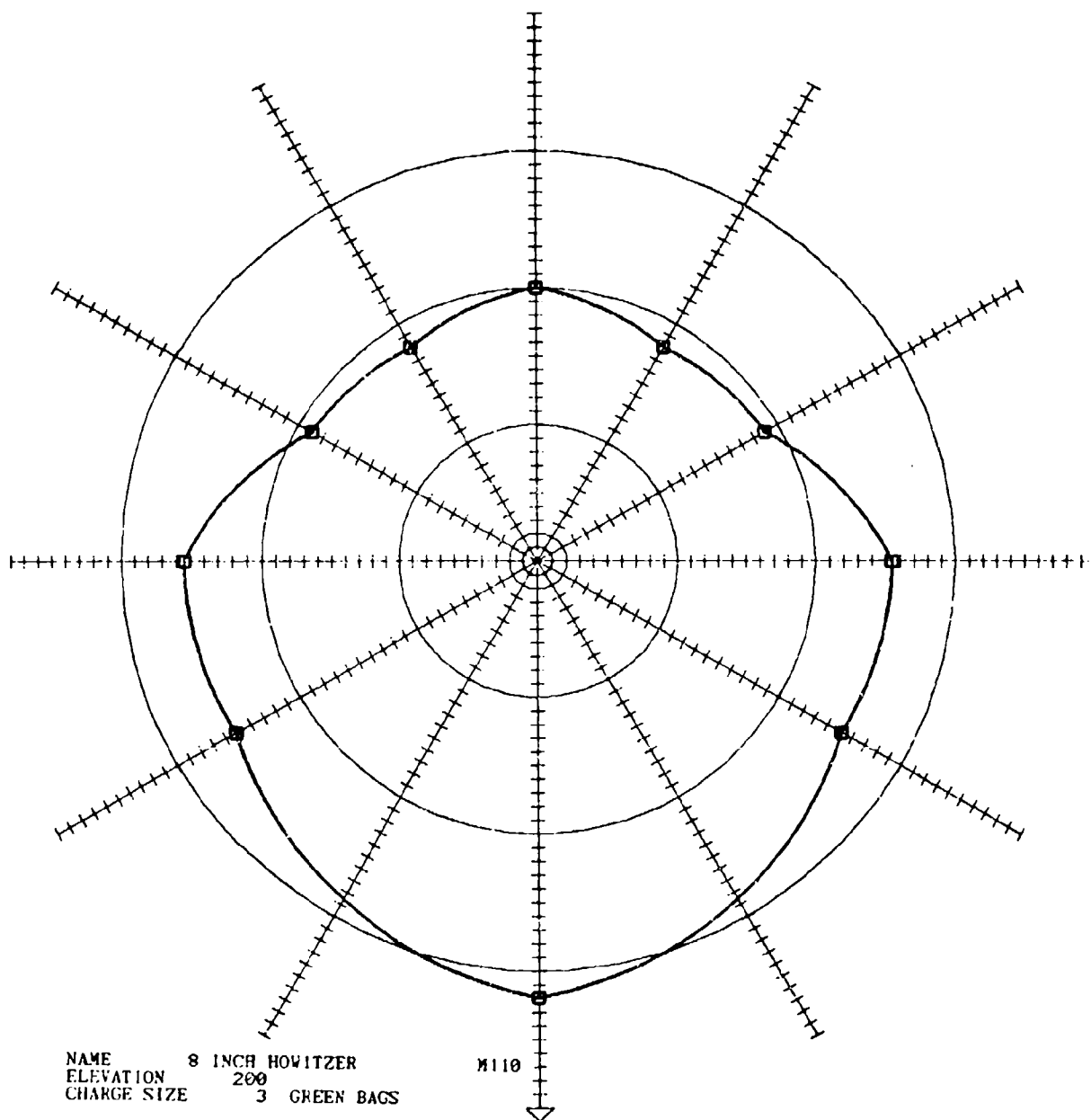
NAME 8 INCH HOWITZER  
ELEVATION 290  
CHARGE SIZE S WHITE BAGS

M110

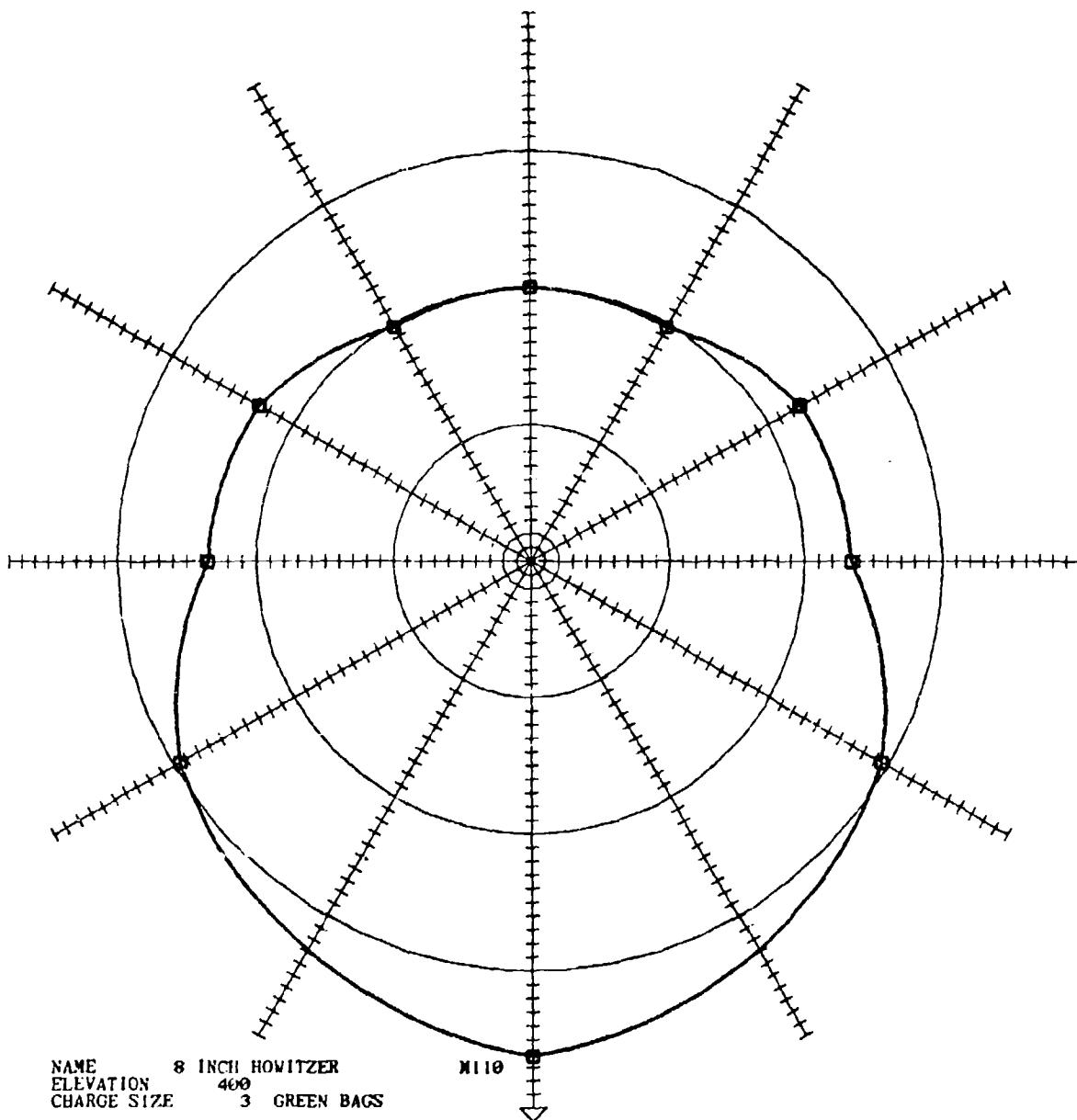
| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|-------|-------------------------|-----------------------|
| 1       | 119.90 | 0.97                    | 0°    | 4.45                    | 4.06                  |
| 2       | 118.00 | -1.07                   | 30°   | 2.85                    | 2.46                  |
| 3       | 119.02 | 0.00                    | 60°   | 1.25                    | 0.85                  |
| 4       | 118.58 | -0.65                   | 90°   | 0.59                    | 0.19                  |
| 5       | 120.14 | 1.22                    | 120°  | -1.07                   | -1.46                 |
| 6       | 113.76 | 0.25                    | 150°  | -0.85                   | -1.25                 |
| 7       | 113.50 | 0.32                    | 180°  | 0.00                    | -0.39                 |
| 8       | 115.44 | 2.32                    | 210°  | -0.85                   | -1.25                 |
| 9       | 123.47 | 4.45                    | 240°  | -1.07                   | -1.46                 |
| 10      | 115.21 | 2.31                    | 270°  | 0.59                    | 0.19                  |
| 11      | 111.66 | -1.21                   | 300°  | 1.25                    | 0.85                  |
| 12      | 110.32 | -2.51                   | 330°  | 2.85                    | 2.46                  |
| 13      | 111.55 | -1.21                   |       |                         |                       |
| 14      | 112.79 | 0.00                    |       |                         |                       |
| 15      | 112.72 | -0.49                   |       |                         |                       |
| 16      | 115.55 | 2.40                    |       |                         |                       |
| AVERAGE |        |                         |       | 1.20                    | 0.80                  |



| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|-------|-------------------------|-----------------------|
| 1       | 119.93 | 8.00                    | 0°    | 11.75                   | 3.56                  |
| 2       | 114.03 | 2.20                    | 30°   | 10.15                   | 1.96                  |
| 3       | 111.62 | 0.00                    | 60°   | 8.55                    | 0.36                  |
| 4       | 114.26 | 2.00                    | 90°   | 5.56                    | -2.62                 |
| 5       | 119.36 | 7.65                    | 120°  | 2.78                    | -5.40                 |
| 6       | 113.27 | 8.36                    | 150°  | -1.15                   | -9.34                 |
| 7       | 108.53 | 3.20                    | 180°  | 0.00                    | -8.18                 |
| 8       | 109.98 | 4.96                    | 210°  | -1.15                   | -9.34                 |
| 9       | 123.25 | 11.75                   | 240°  | 2.78                    | -5.40                 |
| 10      | 113.90 | 9.42                    | 270°  | 5.56                    | -2.62                 |
| 11      | 112.33 | 7.96                    | 300°  | 8.55                    | 0.36                  |
| 12      | 107.53 | 3.08                    | 330°  | 10.15                   | 1.96                  |
| 13      | 103.30 | -1.15                   |       |                         |                       |
| 14      | 104.55 | 0.00                    |       |                         |                       |
| 15      | 104.24 | -1.16                   |       |                         |                       |
| 16      | 108.80 | 3.16                    |       |                         |                       |
| AVERAGE |        |                         |       | 7.23                    | -0.95                 |



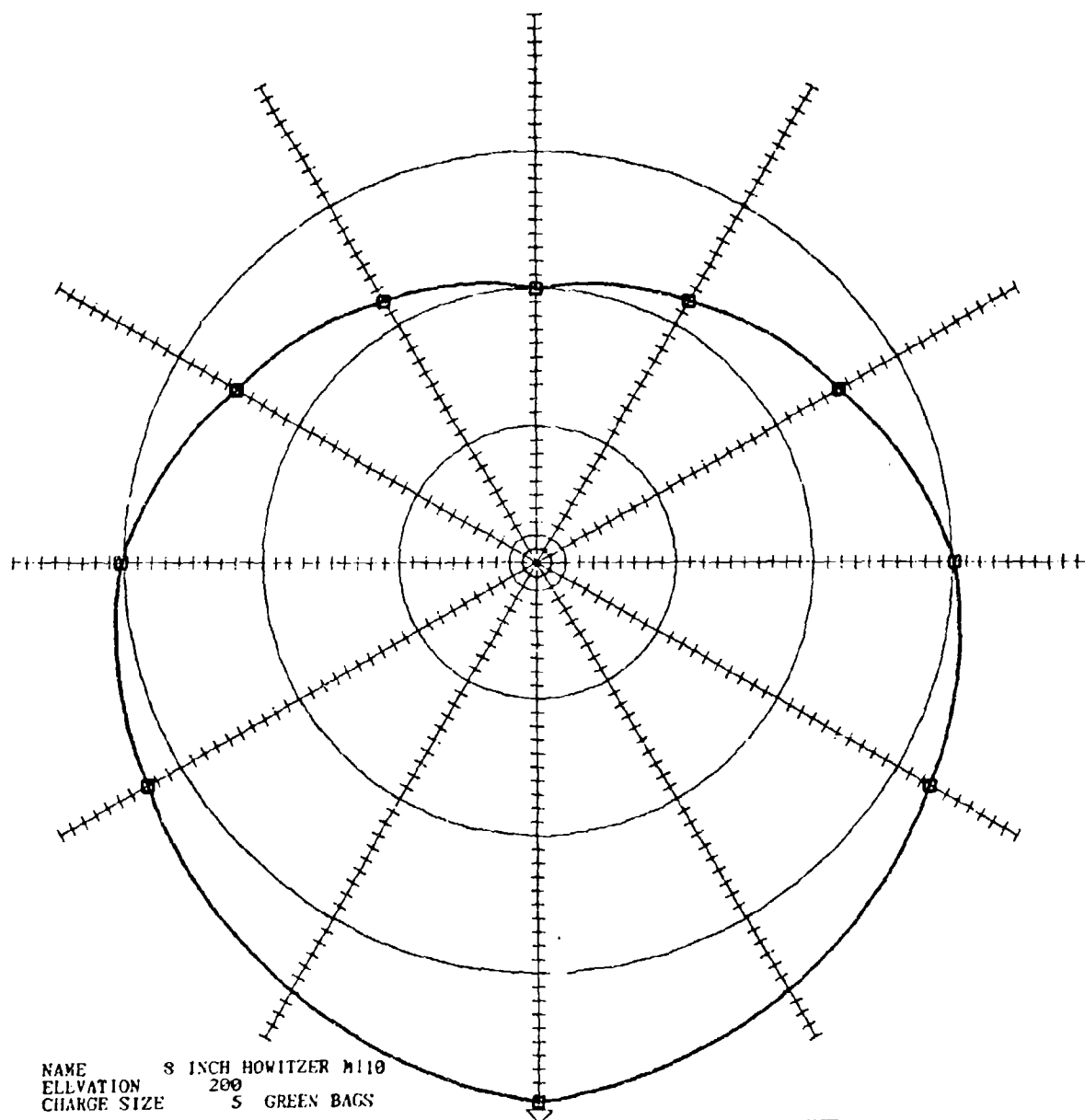
| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|-------|-------------------------|-----------------------|
| 1       | 111.56 | 6.40                    | 0°    | 11.89                   | -2.83                 |
| 2       | 107.02 | 2.33                    | 30°   | 8.54                    | -6.18                 |
| 3       | 104.74 | 0.00                    | 60°   | 5.19                    | -9.53                 |
| 4       | 101.78 | -3.43                   | 90°   | 5.42                    | -9.30                 |
| 5       | 108.21 | 4.03                    | 120°  | -1.09                   | -15.82                |
| 6       | 100.32 | 2.22                    | 150°  | -1.92                   | -16.66                |
| 7       | 92.73  | -5.07                   | 180°  | 0.00                    | -14.73                |
| 8       | 99.22  | 1.27                    | 210°  | -1.92                   | -16.66                |
| 9       | 116.81 | 11.89                   | 240°  | -1.09                   | -15.82                |
| 10      | 104.64 | 7.54                    | 270°  | 5.42                    | -9.30                 |
| 11      | 103.03 | 5.80                    | 300°  | 5.19                    | -9.53                 |
| 12      | 98.73  | 1.44                    | 330°  | 8.54                    | -6.18                 |
| 13      | 94.69  | -2.53                   |       |                         |                       |
| 14      | 97.76  | 0.00                    |       |                         |                       |
| 15      | 96.17  | -1.31                   |       |                         |                       |
| 16      | 105.35 | 4.80                    |       |                         |                       |
| AVERAGE |        |                         |       | 5.94                    | -8.78                 |



NAME 8 INCH HOWITZER  
ELEVATION 400  
CHARGE SIZE 3 GREEN BAGS

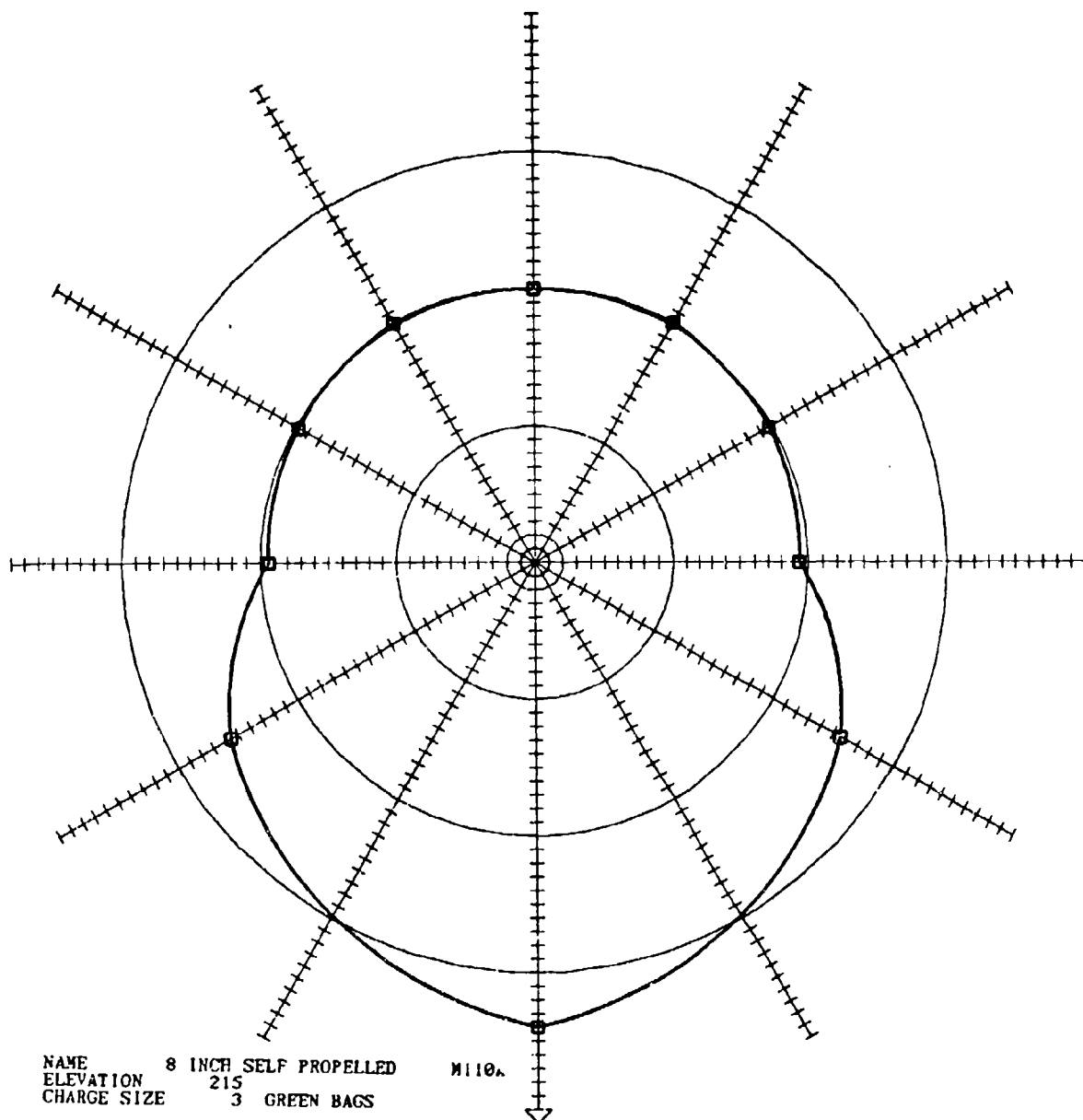
M110

| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE   | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|---------|-------------------------|-----------------------|
| 1       | 110.71 | 8.42                    | 0°      | 16.20                   | -1.78                 |
| 2       | 106.33 | 4.02                    | 30°     | 12.84                   | -5.14                 |
| 3       | 102.44 | 0.00                    | 60°     | 9.48                    | -8.50                 |
| 4       | 104.43 | 1.94                    | 96°     | 3.37                    | -14.60                |
| 5       | 111.05 | 7.95                    | 120°    | 2.76                    | -15.22                |
| 6       | 106.64 | 10.97                   | 150°    | -0.27                   | -18.26                |
| 7       | 97.25  | 1.66                    | 180°    | 0.00                    | -17.98                |
| 8       | 97.72  | 1.77                    | 210°    | -0.27                   | -18.26                |
| 9       | 118.57 | 16.20                   | 240°    | 2.76                    | -15.22                |
| 10      | 105.98 | 10.35                   | 270°    | 3.37                    | -14.60                |
| 11      | 101.56 | 5.87                    | 300°    | 9.48                    | -8.50                 |
| 12      | 98.73  | 3.06                    | 330°    | 12.84                   | -5.14                 |
| 13      | 96.99  | 1.30                    |         |                         |                       |
| 14      | 95.63  | 0.00                    |         |                         |                       |
| 15      | 93.92  | -1.85                   |         |                         |                       |
| 16      | 96.14  | 0.25                    |         |                         |                       |
|         |        |                         | AVERAGE | 9.57                    | -8.40                 |

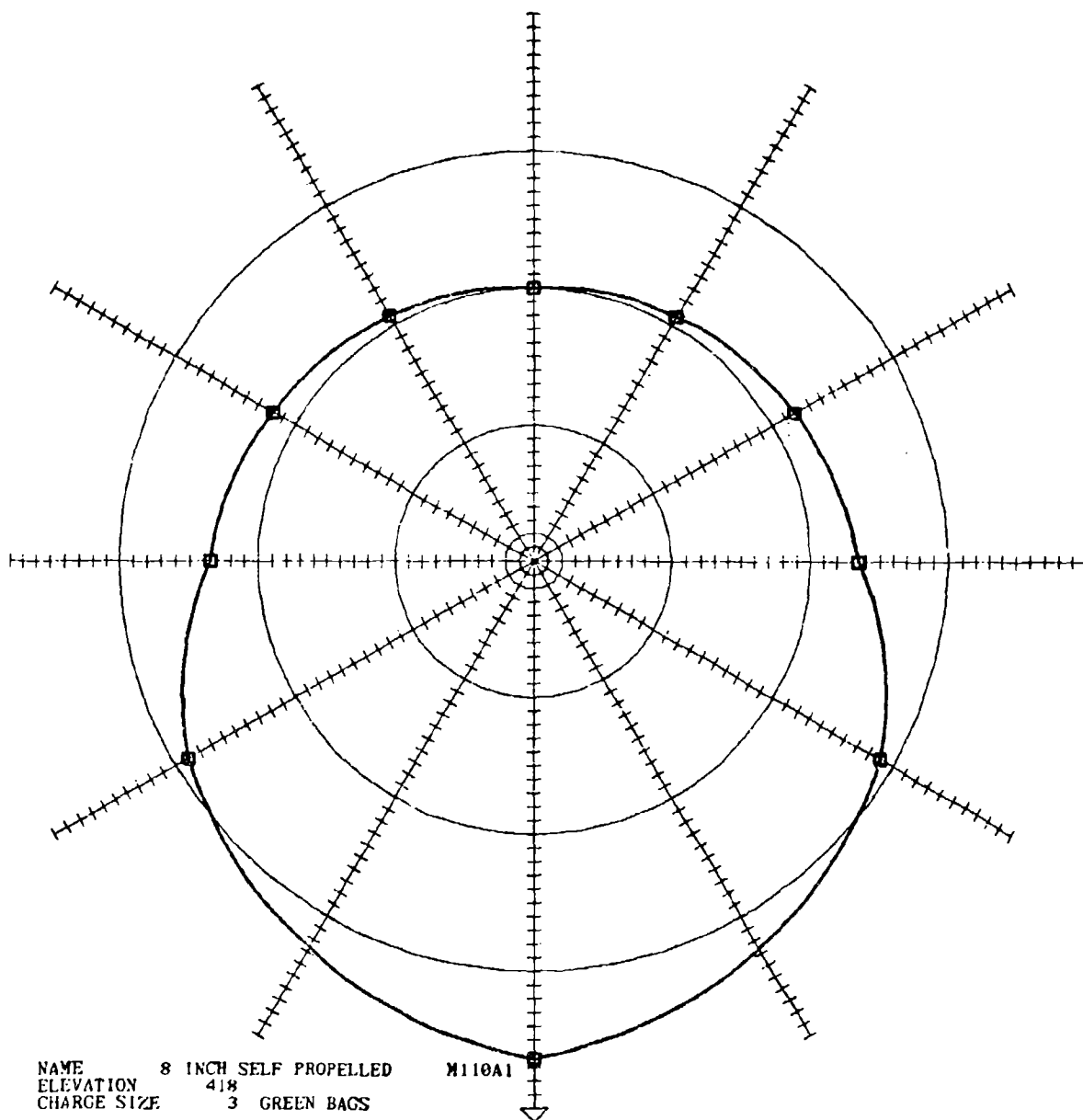


NAME 8 INCH HOWITZER M110  
 ELEVATION 200  
 CHARGE SIZE 5 GREEN BAGS

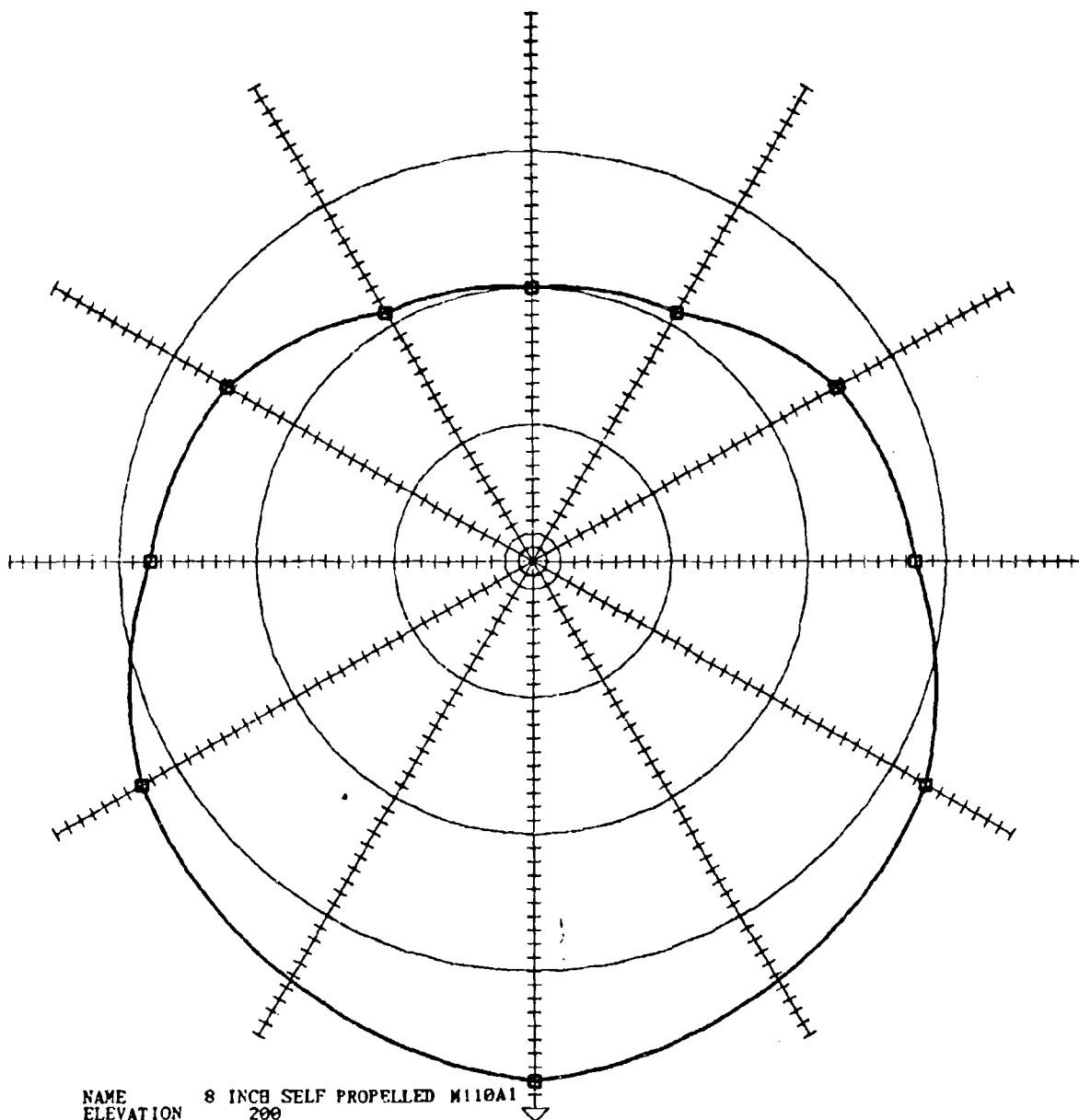
| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE   | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|---------|-------------------------|-----------------------|
| 1       | 116.87 | 12.18                   | 0°      | 19.41                   | 2.47                  |
| 2       | 108.85 | 4.18                    | 30°     | 16.05                   | -0.89                 |
| 3       | 104.73 | 0.00                    | 60°     | 12.69                   | -4.24                 |
| 4       | 103.08 | 4.44                    | 90°     | 10.13                   | -6.80                 |
| 5       | 115.42 | 10.72                   | 120°    | 5.24                    | -11.69                |
| 6       | 108.43 | 12.64                   | 150°    | 2.00                    | -14.93                |
| 7       | 101.47 | 5.44                    | 180°    | 0.00                    | -16.94                |
| 8       | 106.41 | 10.18                   | 210°    | 2.00                    | -14.93                |
| 9       | 124.14 | 19.41                   | 240°    | 5.24                    | -11.69                |
| 10      | 111.15 | 15.24                   | 270°    | 10.13                   | -6.80                 |
| 11      | 106.42 | 10.28                   | 300°    | 12.69                   | -4.24                 |
| 12      | 102.63 | 6.90                    | 330°    | 16.05                   | -0.89                 |
| 13      | 98.60  | 3.46                    |         |                         |                       |
| 14      | 95.80  | 0.00                    |         |                         |                       |
| 15      | 97.00  | 1.12                    |         |                         |                       |
| 16      | 106.34 | 9.98                    |         |                         |                       |
|         |        |                         | AVERAGE | 12.95                   | -3.99                 |



| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|-------|-------------------------|-----------------------|
| 1       | 109.58 | 7.03                    | 0°    | 13.93                   | -3.41                 |
| 2       | 104.35 | 1.69                    | 30°   | 9.77                    | -7.58                 |
| 3       | 102.56 | 0.00                    | 60°   | 5.60                    | -11.75                |
| 4       | 99.77  | -3.02                   | 90°   | -0.62                   | -17.98                |
| 5       | 106.15 | 3.31                    | 120°  | -0.26                   | -17.62                |
| 6       | 97.36  | 3.28                    | 150°  | 0.20                    | -17.16                |
| 7       | 92.48  | -2.30                   | 180°  | 0.00                    | -17.36                |
| 8       | 91.03  | -3.13                   | 210°  | 0.20                    | -17.16                |
| 9       | 116.72 | 13.93                   | 240°  | -0.26                   | -17.62                |
| 10      | 102.89 | 8.78                    | 270°  | -0.62                   | -17.98                |
| 11      | 97.77  | 4.30                    | 300°  | 5.60                    | -11.75                |
| 12      | 97.51  | 3.32                    | 330°  | 9.77                    | -7.58                 |
| 13      | 94.72  | 0.60                    |       |                         |                       |
| 14      | 94.23  | 0.00                    |       |                         |                       |
| 15      | 94.04  | -0.19                   |       |                         |                       |
| 16      | 92.01  | -2.26                   |       |                         |                       |
| AVERAGE |        |                         |       | 6.82                    | -10.53                |

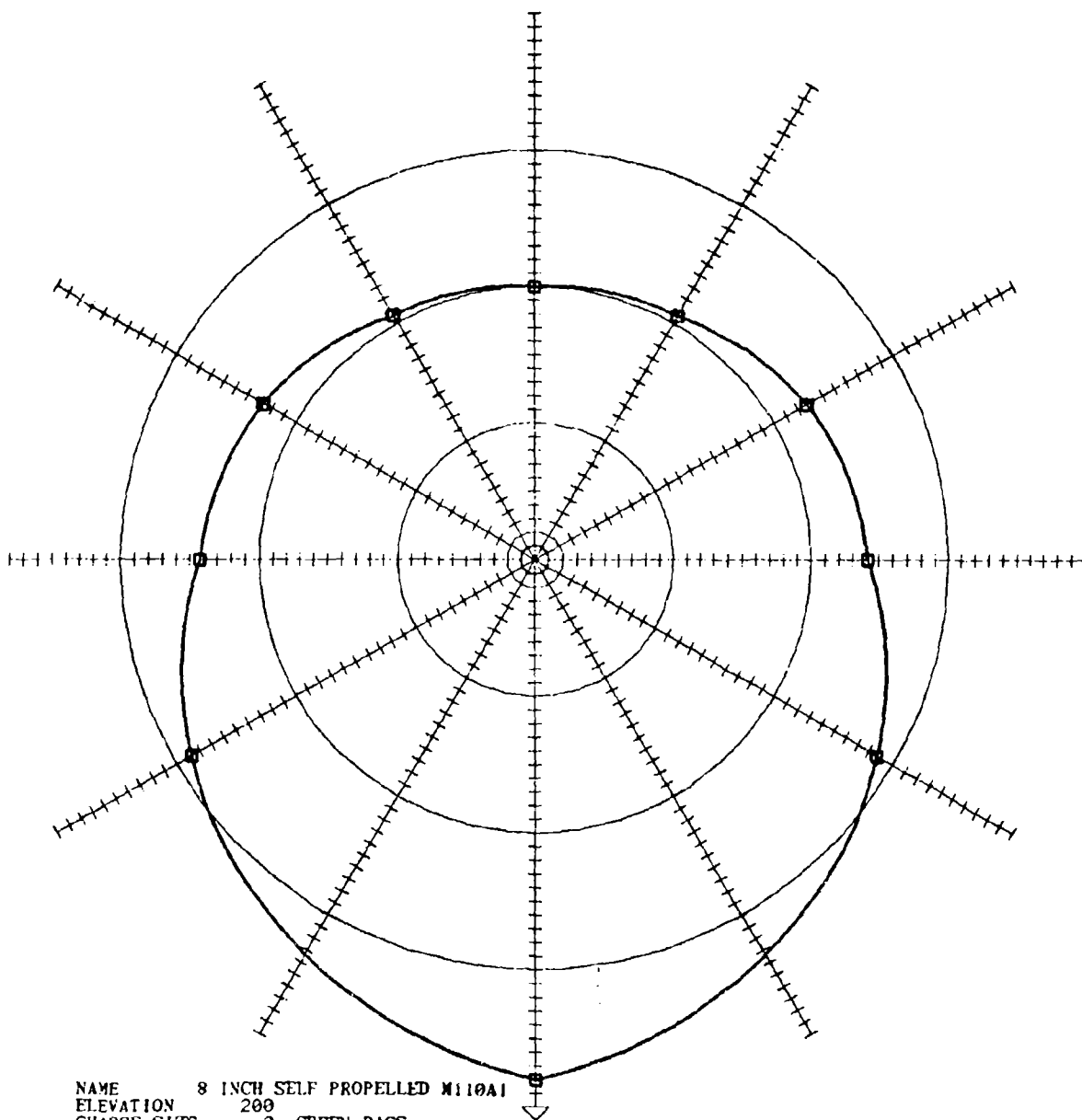


| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE   | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|---------|-------------------------|-----------------------|
| 1       | 109.39 | 9.40                    | 0°      | 16.36                   | -3.70                 |
| 2       | 102.61 | 2.56                    | 30°     | 12.64                   | -7.42                 |
| 3       | 100.18 | 0.00                    | 60°     | 8.92                    | -11.14                |
| 4       | 100.98 | 0.58                    | 90°     | 3.50                    | -16.57                |
| 5       | 108.12 | 7.30                    | 120°    | 1.78                    | -18.28                |
| 6       | 102.60 | 8.47                    | 150°    | 0.70                    | -19.36                |
| 7       | 97.80  | 2.46                    | 180°    | 0.00                    | -20.07                |
| 8       | 95.54  | 2.62                    | 210°    | 0.70                    | -19.36                |
| 9       | 116.44 | 16.36                   | 240°    | 1.78                    | -18.28                |
| 10      | 102.77 | 10.42                   | 270°    | 3.50                    | -16.57                |
| 11      | 96.77  | 4.30                    | 300°    | 8.92                    | -11.14                |
| 12      | 94.35  | 1.66                    | 330°    | 12.64                   | -7.42                 |
| 13      | 93.24  | 0.00                    |         |                         |                       |
| 14      | 92.47  | 0.00                    |         |                         |                       |
| 15      | 94.11  | -0.19                   |         |                         |                       |
| 16      | 95.51  | 2.70                    |         |                         |                       |
|         |        |                         | AVERAGE | 9.43                    | -10.58                |



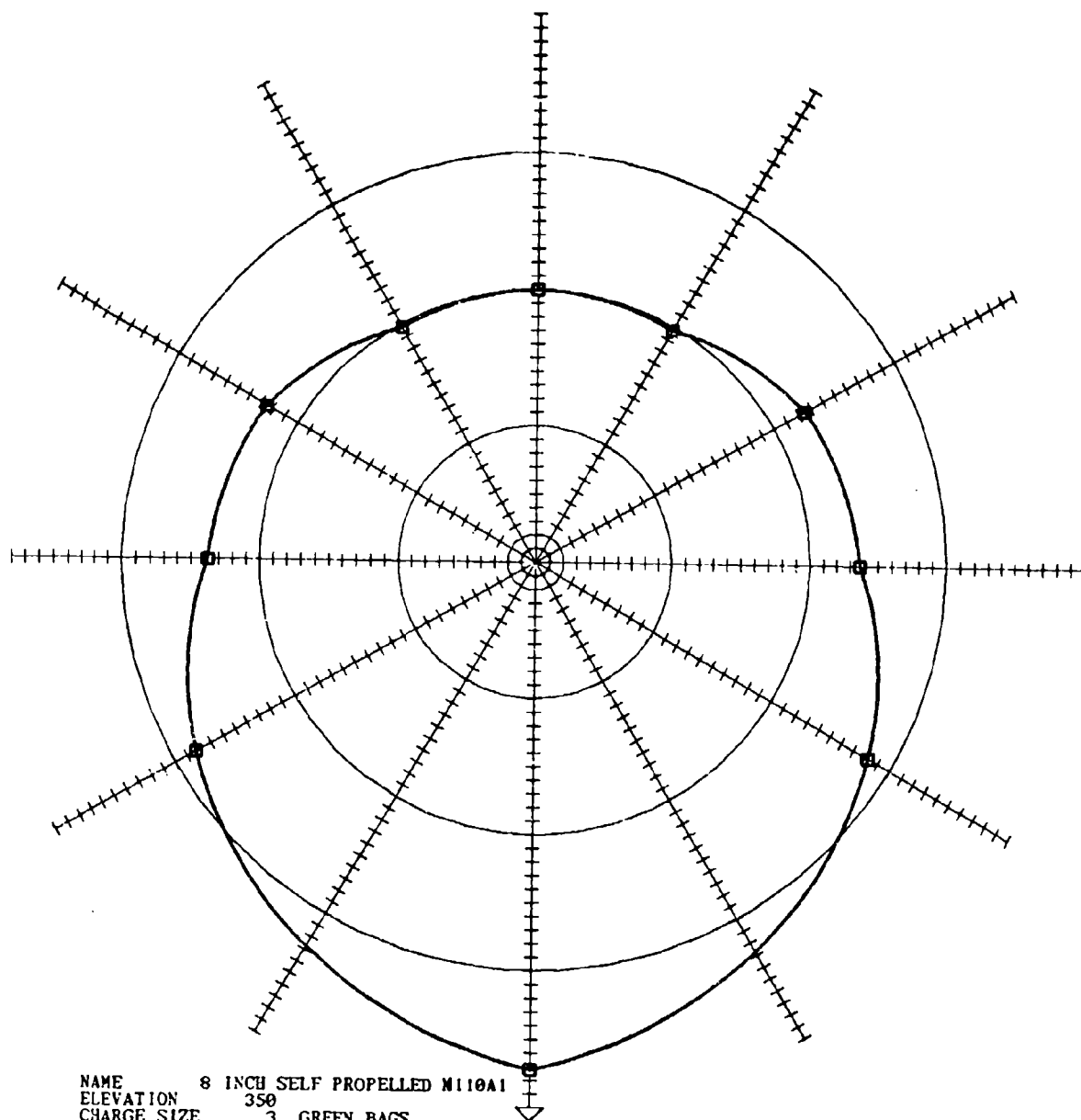
NAME 8 INCH SELF PROPELLED M110A1  
 ELEVATION 200  
 CHARGE SIZE 5 GREEN BAGS

| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE   | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|---------|-------------------------|-----------------------|
| 1       | 113.71 | 13.49                   | 0°      | 17.99                   | -0.57                 |
| 2       | 105.43 | 5.23                    | 30°     | 15.38                   | -3.31                 |
| 3       | 100.31 | 0.00                    | 60°     | 12.77                   | -6.06                 |
| 4       | 105.33 | 5.09                    | 90°     | 7.71                    | -11.12                |
| 5       | 112.68 | 12.45                   | 120°    | 5.50                    | -13.34                |
| 6       | 105.72 | 12.08                   | 150°    | 0.98                    | -17.86                |
| 7       | 100.76 | 6.66                    | 180°    | 0.00                    | -18.84                |
| 8       | 100.48 | 6.76                    | 210°    | 0.98                    | -17.86                |
| 9       | 118.30 | 17.99                   | 240°    | 5.50                    | -13.34                |
| 10      | 106.81 | 13.06                   | 270°    | 7.71                    | -11.12                |
| 11      | 104.12 | 11.40                   | 300°    | 12.77                   | -6.06                 |
| 12      | 98.71  | 5.01                    | 330°    | 15.38                   | -3.31                 |
| 13      | 95.56  | 1.69                    |         |                         |                       |
| 14      | 93.84  | 0.00                    |         |                         |                       |
| 15      | 94.66  | 0.17                    |         |                         |                       |
| 16      | 100.73 | 6.89                    |         |                         |                       |
|         |        |                         | AVERAGE | 12.05                   | -6.64                 |

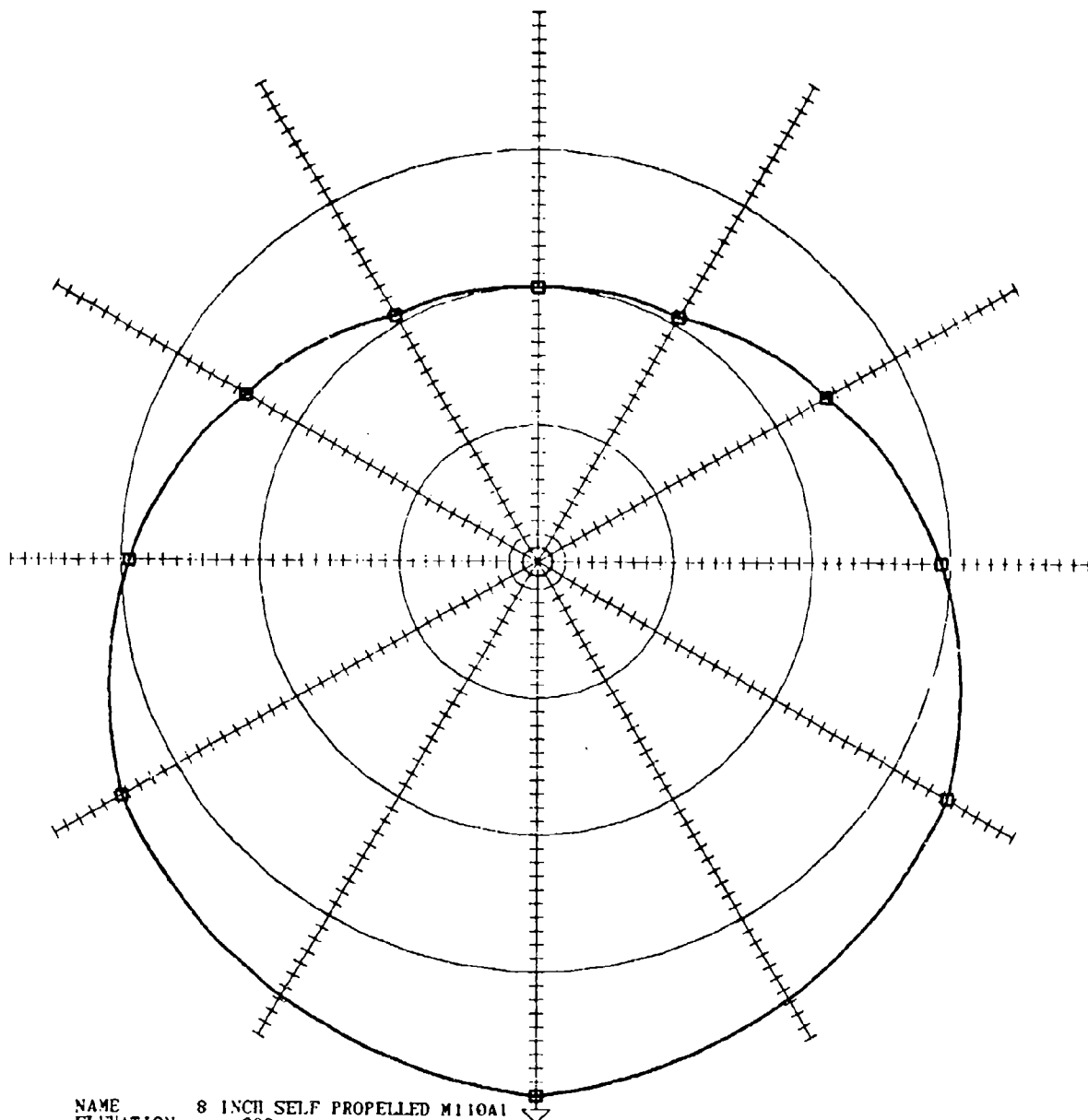


NAME 8 INCH SELF PROPELLED M110A1  
 ELEVATION 200  
 CHARGE SIZE 3 GREEN BAGS

| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE   | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|---------|-------------------------|-----------------------|
| 1       | 107.38 | 8.81                    | 0°      | 17.99                   | -2.57                 |
| 2       | 103.45 | 4.77                    | 30°     | 13.35                   | -7.21                 |
| 3       | 98.72  | 0.00                    | 60°     | 8.70                    | -11.85                |
| 4       | 99.90  | 0.99                    | 90°     | 4.20                    | -16.36                |
| 5       | 105.11 | 6.55                    | 120°    | 2.74                    | -17.82                |
| 6       | 97.93  | 7.39                    | 150°    | 0.62                    | -19.94                |
| 7       | 92.11  | 1.37                    | 180°    | 0.00                    | -20.57                |
| 8       | 91.65  | 1.44                    | 210°    | 0.62                    | -19.94                |
| 9       | 116.89 | 17.99                   | 240°    | 2.74                    | -17.82                |
| 10      | 102.62 | 12.05                   | 270°    | 4.20                    | -16.36                |
| 11      | 96.55  | 6.55                    | 300°    | 8.70                    | -11.85                |
| 12      | 94.01  | 3.83                    | 330°    | 13.35                   | -7.21                 |
| 13      | 92.38  | 2.16                    |         |                         |                       |
| 14      | 90.48  | 0.00                    |         |                         |                       |
| 15      | 89.37  | -0.92                   |         |                         |                       |
| 16      | 91.86  | 1.85                    |         |                         |                       |
|         |        |                         | AVERAGE | 10.46                   | -10.10                |

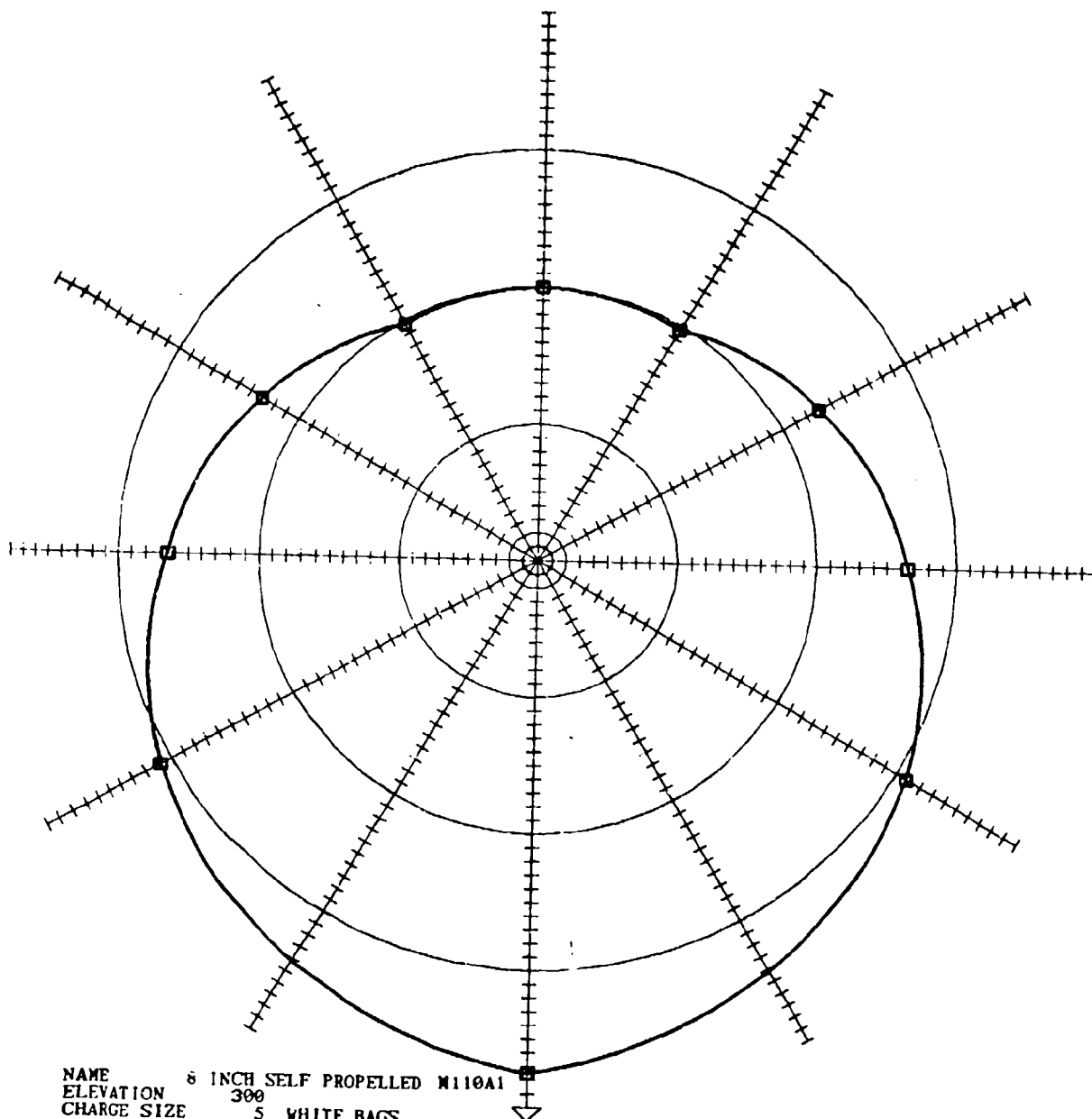


| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|-------|-------------------------|-----------------------|
| 1       | 107.52 | 9.39                    | 0°    | 17.22                   | -3.16                 |
| 2       | 103.29 | 5.19                    | 30°   | 12.71                   | -7.66                 |
| 3       | 98.21  | 0.00                    | 60°   | 8.21                    | -12.17                |
| 4       | 99.86  | 1.72                    | 90°   | 3.73                    | -16.65                |
| 5       | 105.22 | 6.64                    | 120°  | 2.53                    | -17.85                |
| 6       | 99.56  | 6.36                    | 150°  | -0.25                   | -20.63                |
| 7       | 91.03  | -0.66                   | 180°  | 0.00                    | -20.38                |
| 8       | 90.89  | -1.83                   | 210°  | -0.25                   | -20.63                |
| 9       | 115.41 | 17.22                   | 240°  | 2.53                    | -17.85                |
| 10      | 101.84 | 10.56                   | 270°  | 3.73                    | -16.65                |
| 11      | 95.44  | 3.73                    | 300°  | 8.21                    | -12.17                |
| 12      | 94.62  | 3.26                    | 330°  | 12.71                   | -7.66                 |
| 13      | 92.56  | 1.53                    |       |                         |                       |
| 14      | 91.50  | 0.00                    |       |                         |                       |
| 15      | 89.30  | -2.03                   |       |                         |                       |
| 16      | 93.50  | 1.85                    |       |                         |                       |
| AVERAGE |        |                         |       | 9.80                    | -10.58                |



NAME 8 INCH SELF PROPELLED M110A1  
 ELEVATION 200  
 CHARGE SIZE 5 WHITE BAGS

| CHANNEL | ENRGY  | DIFFERENCE<br>FROM REAR | ANGLE | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|-------|-------------------------|-----------------------|
| 1       | 115.80 | 15.20                   | 0°    | 0.00                    | -17.40                |
| 2       | 105.53 | 4.85                    | 30°   | 7.22                    | -10.17                |
| 3       | 100.62 | 0.00                    | 60°   | 14.45                   | -2.94                 |
| 4       | 103.79 | 3.20                    | 90°   | 9.34                    | -8.05                 |
| 5       | 113.70 | 13.10                   | 120°  | 4.23                    | -13.16                |
| 6       | 0.00   | 6.26                    | 150°  | 0.62                    | -16.77                |
| 7       | 97.32  | 2.99                    | 180°  | 0.00                    | -17.40                |
| 8       | 101.94 | 7.65                    | 210°  | 0.62                    | -16.77                |
| 9       | 0.00   | 17.22                   | 240°  | 4.23                    | -13.16                |
| 10      | 109.34 | 15.04                   | 270°  | 9.34                    | -8.05                 |
| 11      | 105.55 | 11.29                   | 300°  | 14.45                   | -2.94                 |
| 12      | 100.17 | 5.89                    | 330°  | 7.22                    | -10.17                |
| 13      | 94.85  | 0.59                    |       |                         |                       |
| 14      | 94.26  | 0.00                    |       |                         |                       |
| 15      | 94.90  | 0.64                    |       |                         |                       |
| 16      | 101.69 | 7.39                    |       |                         |                       |
| AVERAGE |        |                         |       | 13.28                   | -3.79                 |

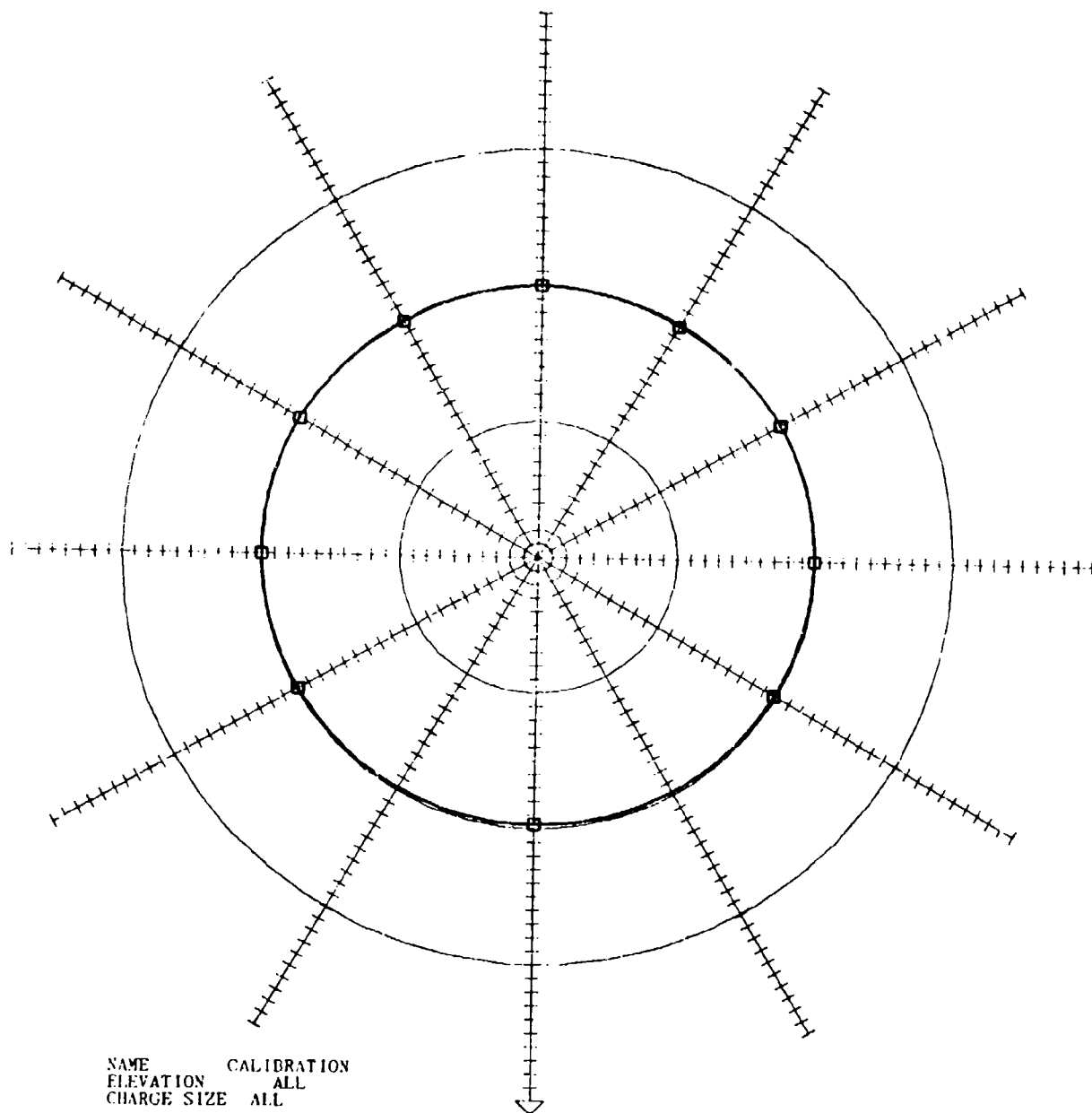


NAME 8 INCH SELF PROPELLED M110A1  
 ELEVATION 300  
 CHARGE SIZE 5 WHITE BAGS

| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE   | DIFFERENCE<br>FROM REAR | DIFFERENCE<br>FROM C4 |
|---------|--------|-------------------------|---------|-------------------------|-----------------------|
| 1       | 114.95 | 11.43                   | 0°      | 0.00                    | -14.68                |
| 2       | 107.12 | 3.70                    | 30°     | 5.40                    | -9.28                 |
| 3       | 103.54 | 0.00                    | 60°     | 10.80                   | -3.88                 |
| 4       | 106.26 | 2.88                    | 90°     | 6.56                    | -8.11                 |
| 5       | 113.56 | 10.16                   | 120°    | 3.04                    | -11.64                |
| 6       | 0.00   | 6.36                    | 150°    | -0.26                   | -14.95                |
| 7       | 98.73  | 1.85                    | 180°    | 0.00                    | -14.68                |
| 8       | 102.77 | 5.92                    | 210°    | -0.26                   | -14.95                |
| 9       | 0.00   | 17.22                   | 240°    | 3.04                    | -11.64                |
| 10      | 107.88 | 10.82                   | 270°    | 6.56                    | -8.11                 |
| 11      | 104.37 | 7.33                    | 300°    | 10.80                   | -3.88                 |
| 12      | 100.53 | 3.74                    | 330°    | 5.40                    | -9.28                 |
| 13      | 96.91  | 0.12                    |         |                         |                       |
| 14      | 96.83  | 0.00                    |         |                         |                       |
| 15      | 96.00  | -0.75                   |         |                         |                       |
| 16      | 102.61 | 5.79                    |         |                         |                       |
|         |        |                         | AVERAGE | 10.92                   | -3.76                 |

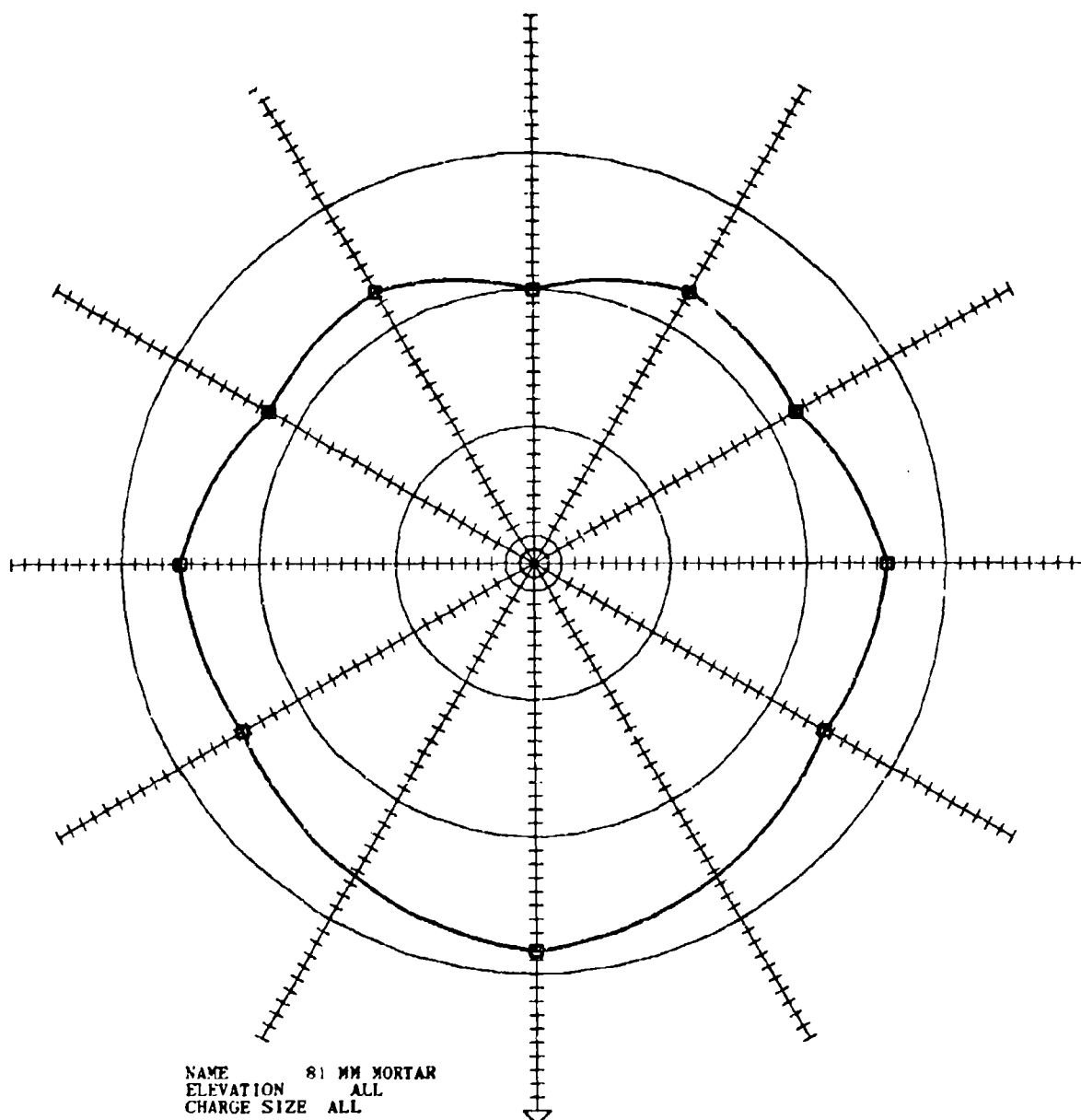
APPENDIX D:

COMPOSITE DIRECTIVITY PATTERNS



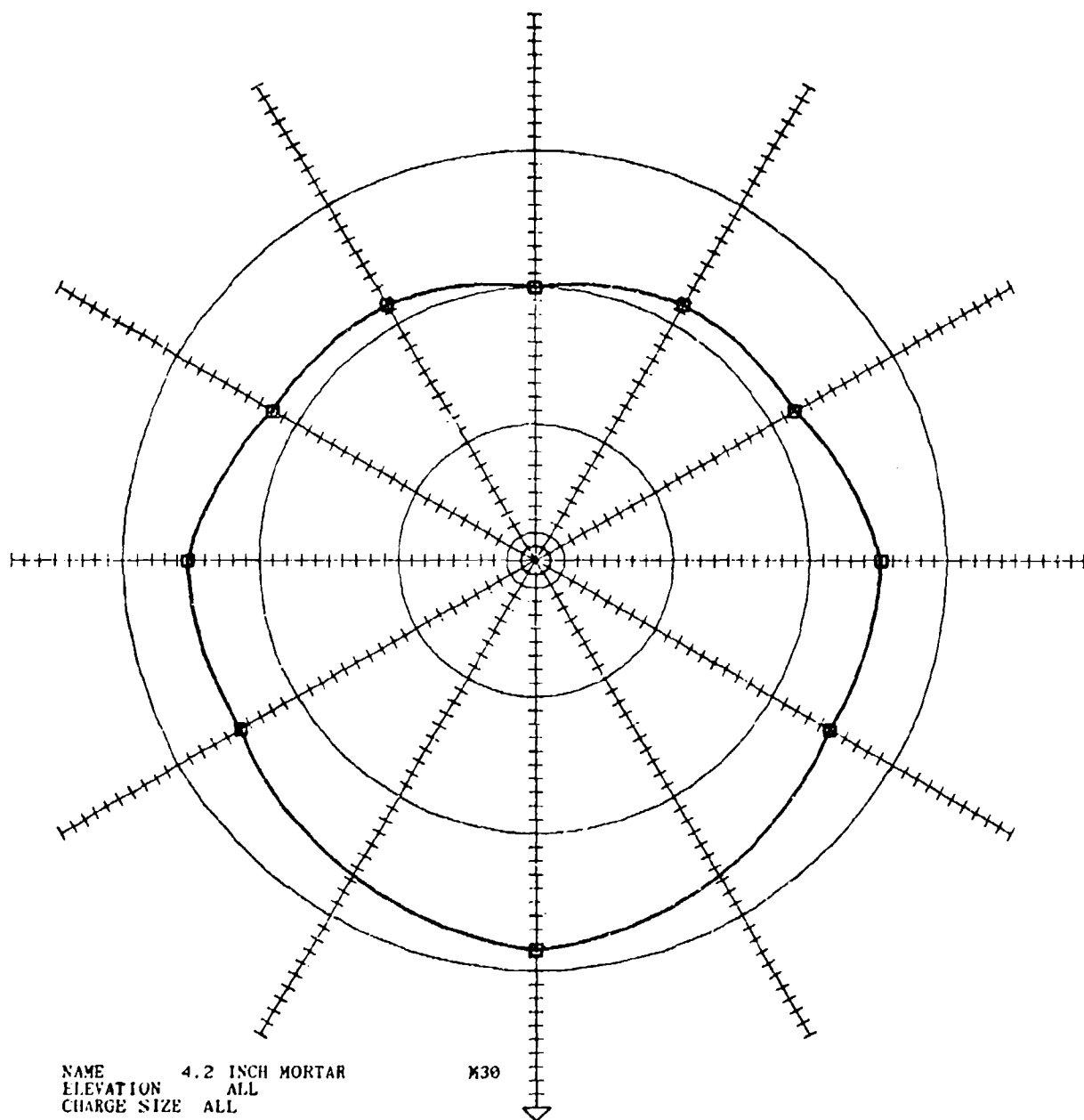
NAME CALIBRATION  
ELEVATION ALL  
CHARGE SIZE ALL

| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE   | DIFFERENCE<br>FROM REAR |
|---------|--------|-------------------------|---------|-------------------------|
| 1       | 118.62 | -0.17                   | 0°      | -0.33                   |
| 2       | 118.75 | -0.08                   | 30°     | -0.27                   |
| 3       | 118.78 | 0.00                    | 60°     | -0.20                   |
| 4       | 118.93 | 0.08                    | 90°     | -0.09                   |
| 5       | 119.22 | -0.11                   | 120°    | -0.00                   |
| 6       | 112.85 | -0.29                   | 150°    | -0.16                   |
| 7       | 113.16 | 0.10                    | 180°    | 0.00                    |
| 8       | 113.14 | -0.25                   | 210°    | -0.16                   |
| 9       | 118.56 | -0.33                   | 240°    | -0.09                   |
| 10      | 112.65 | -0.25                   | 270°    | -0.09                   |
| 11      | 112.95 | 0.19                    | 300°    | -0.20                   |
| 12      | 112.58 | -0.13                   | 330°    | -0.27                   |
| 13      | 112.81 | 0.02                    |         |                         |
| 14      | 113.00 | 0.00                    |         |                         |
| 15      | 112.69 | -0.35                   | AVERAGE | -0.15                   |
| 16      | 112.77 | -0.44                   |         |                         |



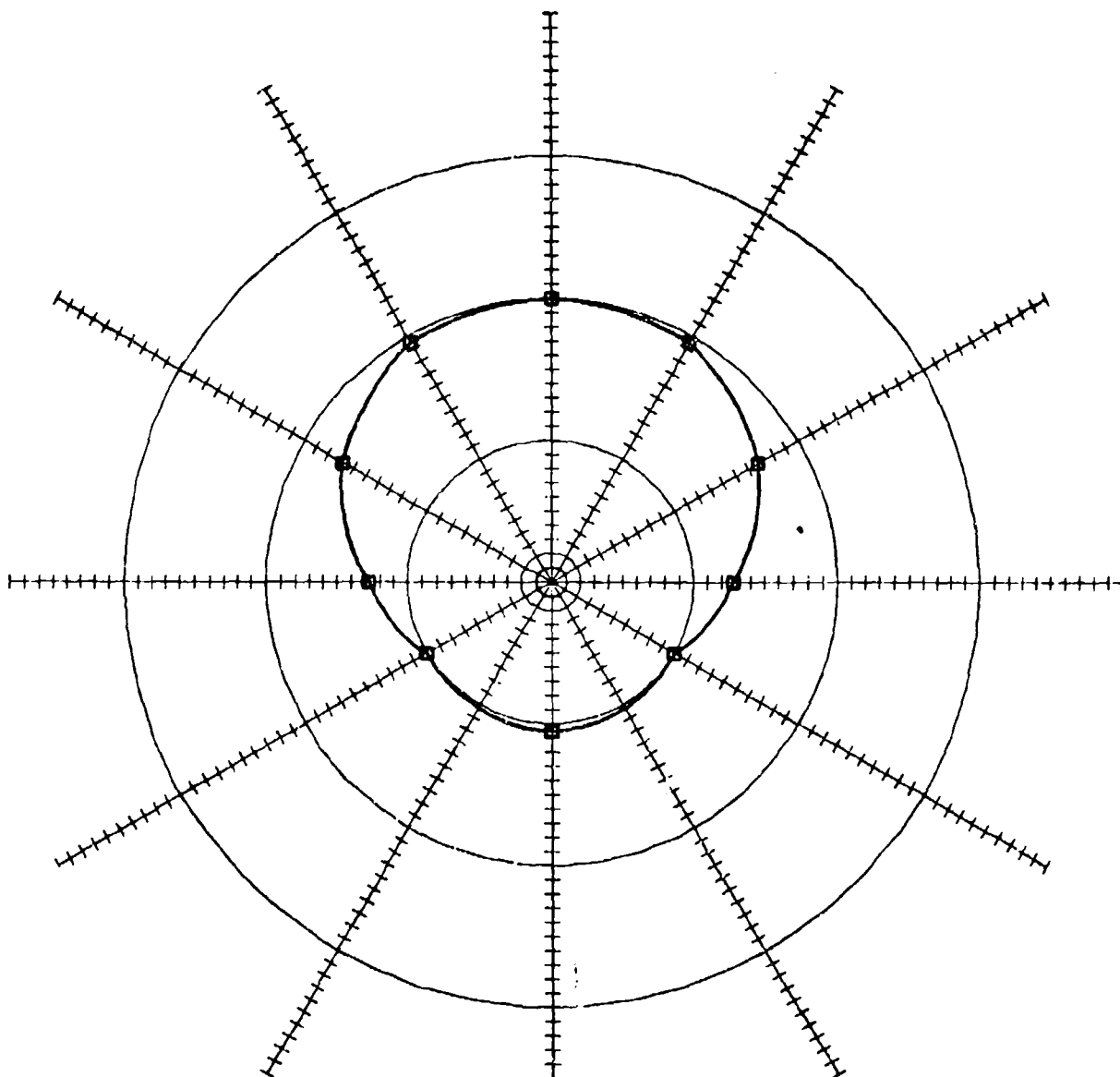
NAME 81 MM MORTAR  
ELEVATION ALL  
CHARGE SIZE ALL

| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE   | DIFFERENCE<br>FROM REAR |
|---------|--------|-------------------------|---------|-------------------------|
| 1       | 99.38  | 6.60                    | 0°      | 8.29                    |
| 2       | 97.15  | 4.05                    | 30°     | 6.39                    |
| 3       | 93.90  | 0.00                    | 60°     | 4.48                    |
| 4       | 94.29  | 0.42                    | 90°     | 5.75                    |
| 5       | 95.72  | 2.71                    | 120°    | 2.20                    |
| 6       | 88.19  | 2.25                    | 150°    | 2.88                    |
| 7       | 87.96  | -0.11                   | 180°    | 0.00                    |
| 8       | 90.81  | 2.74                    | 210°    | 2.98                    |
| 9       | 101.12 | 8.29                    | 240°    | 2.20                    |
| 10      | 91.86  | 6.26                    | 270°    | 5.75                    |
| 11      | 91.22  | 5.75                    | 300°    | 4.48                    |
| 12      | 89.66  | 4.28                    | 330°    | 6.39                    |
| 13      | 83.83  | 2.82                    |         |                         |
| 14      | 87.26  | 0.00                    |         |                         |
| 15      | 92.00  | 3.00                    |         |                         |
| 15      | 0.00   | 5.92                    |         |                         |
|         |        |                         | AVERAGE | 4.86                    |



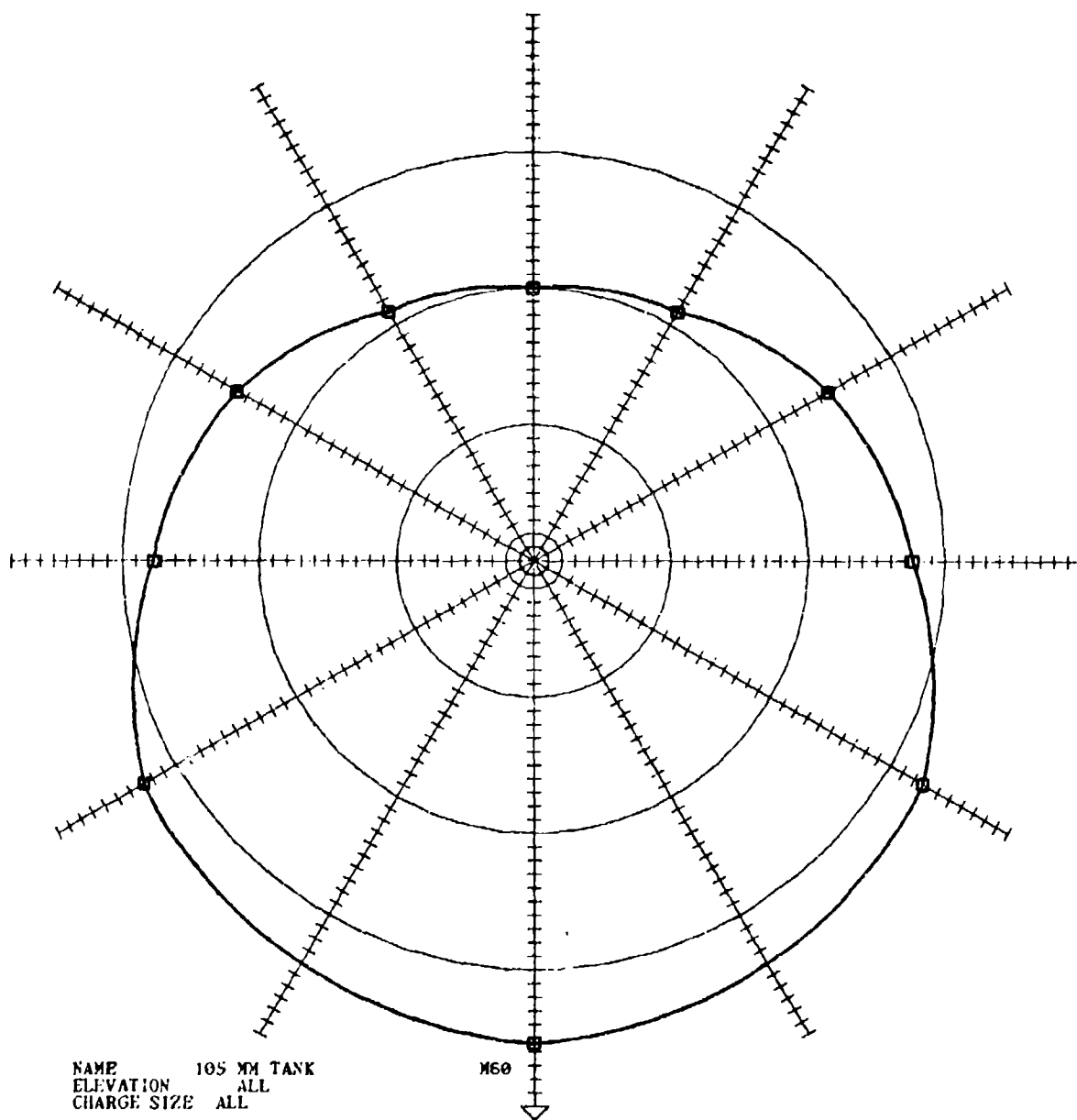
NAME 4.2 INCH MORTAR  
ELEVATION ALL  
CHARGE SIZE ALL

| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE   | DIFFERENCE<br>FROM REAR |
|---------|--------|-------------------------|---------|-------------------------|
| 1       | 101.50 | 6.65                    | 0°      | 8.45                    |
| 2       | 98.74  | 3.92                    | 30°     | 6.61                    |
| 3       | 95.16  | 0.00                    | 60°     | 4.78                    |
| 4       | 95.74  | 0.73                    | 90°     | 5.17                    |
| 5       | 99.06  | 3.32                    | 120°    | 1.89                    |
| 6       | 92.13  | 2.57                    | 150°    | 1.58                    |
| 7       | 87.61  | -0.88                   | 180°    | 0.00                    |
| 8       | 89.50  | 1.78                    | 210°    | 1.58                    |
| 9       | 103.97 | 8.45                    | 240°    | 1.89                    |
| 10      | 94.01  | 6.51                    | 270°    | 5.17                    |
| 11      | 92.47  | 5.17                    | 300°    | 4.78                    |
| 12      | 91.49  | 3.78                    | 330°    | 6.61                    |
| 13      | 89.45  | 1.98                    |         |                         |
| 14      | 88.31  | 0.00                    |         |                         |
| 15      | 89.24  | 1.16                    |         |                         |
| 16      | 0.00   | 5.92                    |         |                         |
|         |        |                         | AVERAGE | 4.74                    |

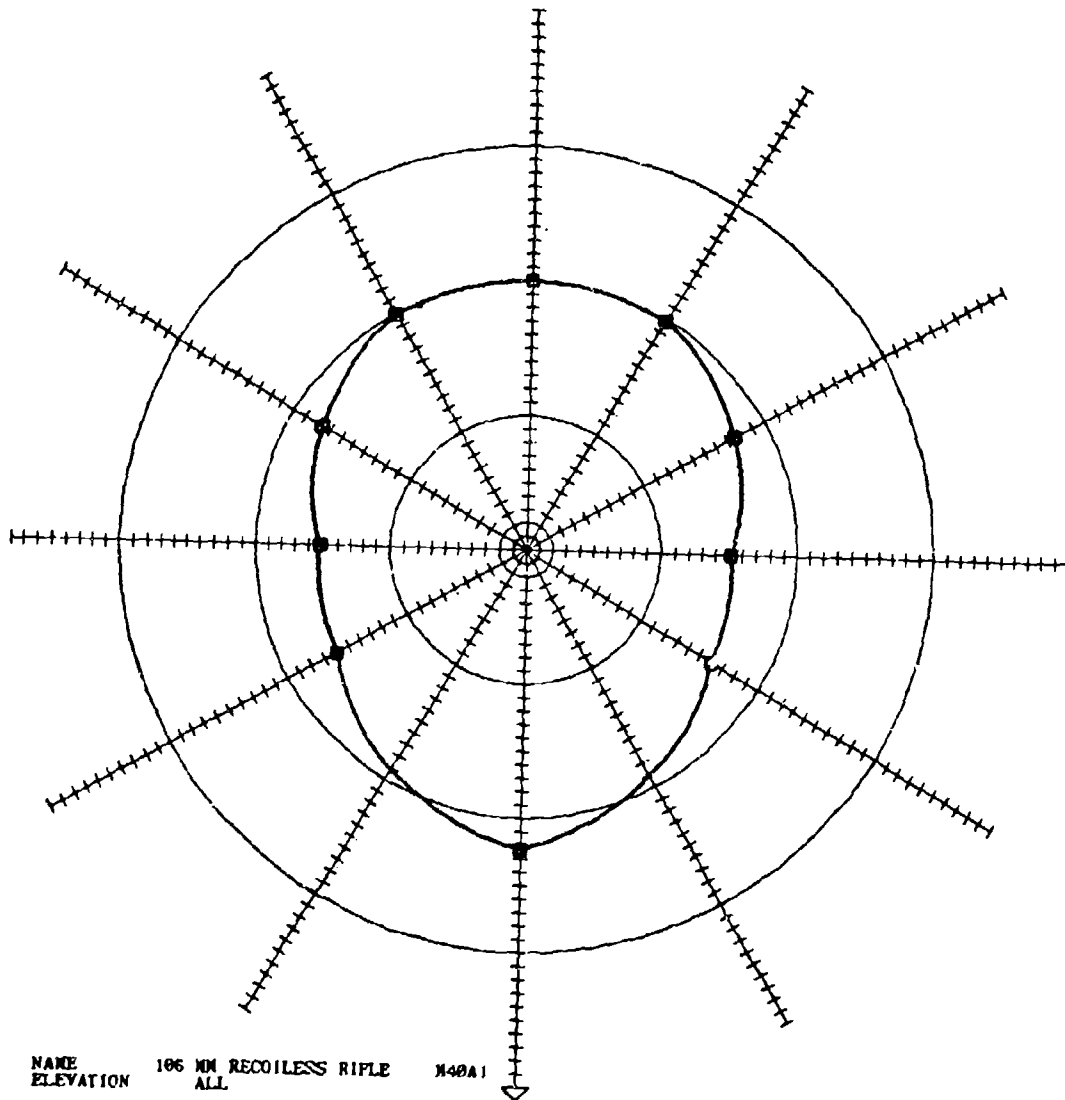


NAME 90 MM RECOILLESS RIFLE M67  
 ELEVATION ALL  
 CHARGE SIZE ALL

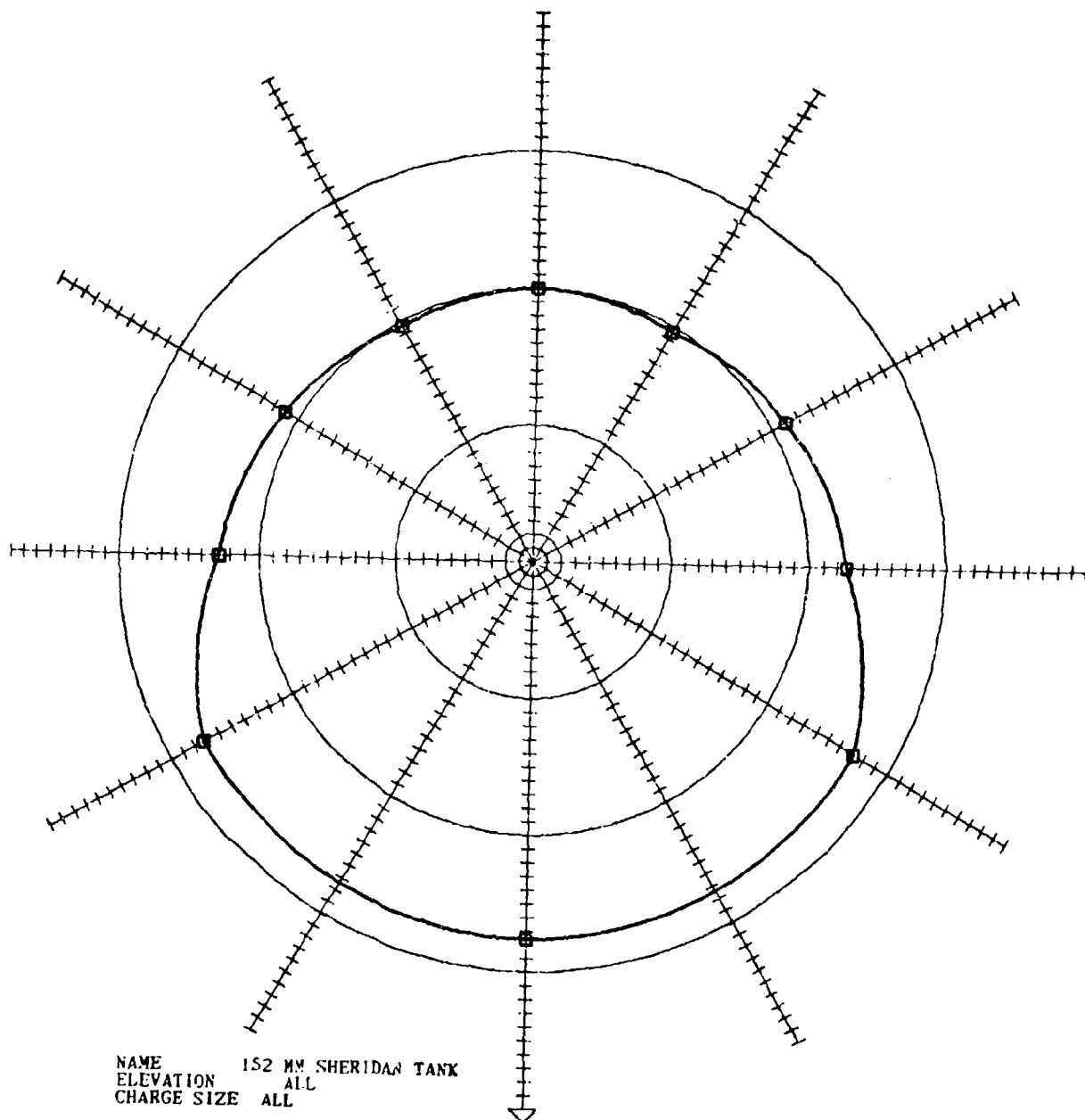
| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE   | DIFFERENCE<br>FROM REAR |
|---------|--------|-------------------------|---------|-------------------------|
| 1       | 102.66 | -8.84                   | 0°      | -9.51                   |
| 2       | 107.71 | -3.71                   | 30°     | -9.75                   |
| 3       | 111.26 | 0.00                    | 60°     | -9.98                   |
| 4       | 108.44 | -2.81                   | 90°     | -7.18                   |
| 5       | 100.66 | -10.59                  | 120°    | -3.17                   |
| 6       | 94.20  | -11.68                  | 150°    | -0.49                   |
| 7       | 102.80 | -3.37                   | 180°    | 0.00                    |
| 8       | 97.30  | -8.45                   | 210°    | -0.49                   |
| 9       | 102.01 | -9.51                   | 240°    | -3.17                   |
| 10      | 98.65  | -8.80                   | 270°    | -7.18                   |
| 11      | 98.97  | -6.68                   | 300°    | -9.98                   |
| 12      | 102.80 | -3.00                   | 330°    | -9.75                   |
| 13      | 105.64 | 0.04                    |         |                         |
| 14      | 105.56 | 0.00                    |         |                         |
| 15      | 104.57 | -1.01                   |         |                         |
| 16      | 99.33  | -7.65                   |         |                         |
|         |        |                         | AVERAGE | -4.11                   |



| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE   | DIFFERENCE<br>FROM REAR |
|---------|--------|-------------------------|---------|-------------------------|
| 1       | 113.04 | 13.09                   | 0°      | 15.35                   |
| 2       | 105.87 | 5.98                    | 30°     | 14.04                   |
| 3       | 100.07 | 0.00                    | 60°     | 12.73                   |
| 4       | 104.39 | 4.24                    | 90°     | 7.61                    |
| 5       | 113.07 | 12.68                   | 120°    | 4.81                    |
| 6       | 106.63 | 12.81                   | 150°    | 1.09                    |
| 7       | 97.68  | 3.36                    | 180°    | 0.00                    |
| 8       | 99.98  | 5.55                    | 210°    | 1.09                    |
| 9       | 115.47 | 15.35                   | 240°    | 4.81                    |
| 10      | 106.29 | 12.28                   | 270°    | 7.61                    |
| 11      | 103.08 | 9.06                    | 300°    | 12.73                   |
| 12      | 99.70  | 5.66                    | 330°    | 14.04                   |
| 13      | 96.08  | 1.97                    |         |                         |
| 14      | 94.70  | 0.00                    |         |                         |
| 15      | 94.43  | 0.33                    |         |                         |
| 16      | 100.19 | 5.32                    |         |                         |
|         |        |                         | AVERAGE | 10.78                   |

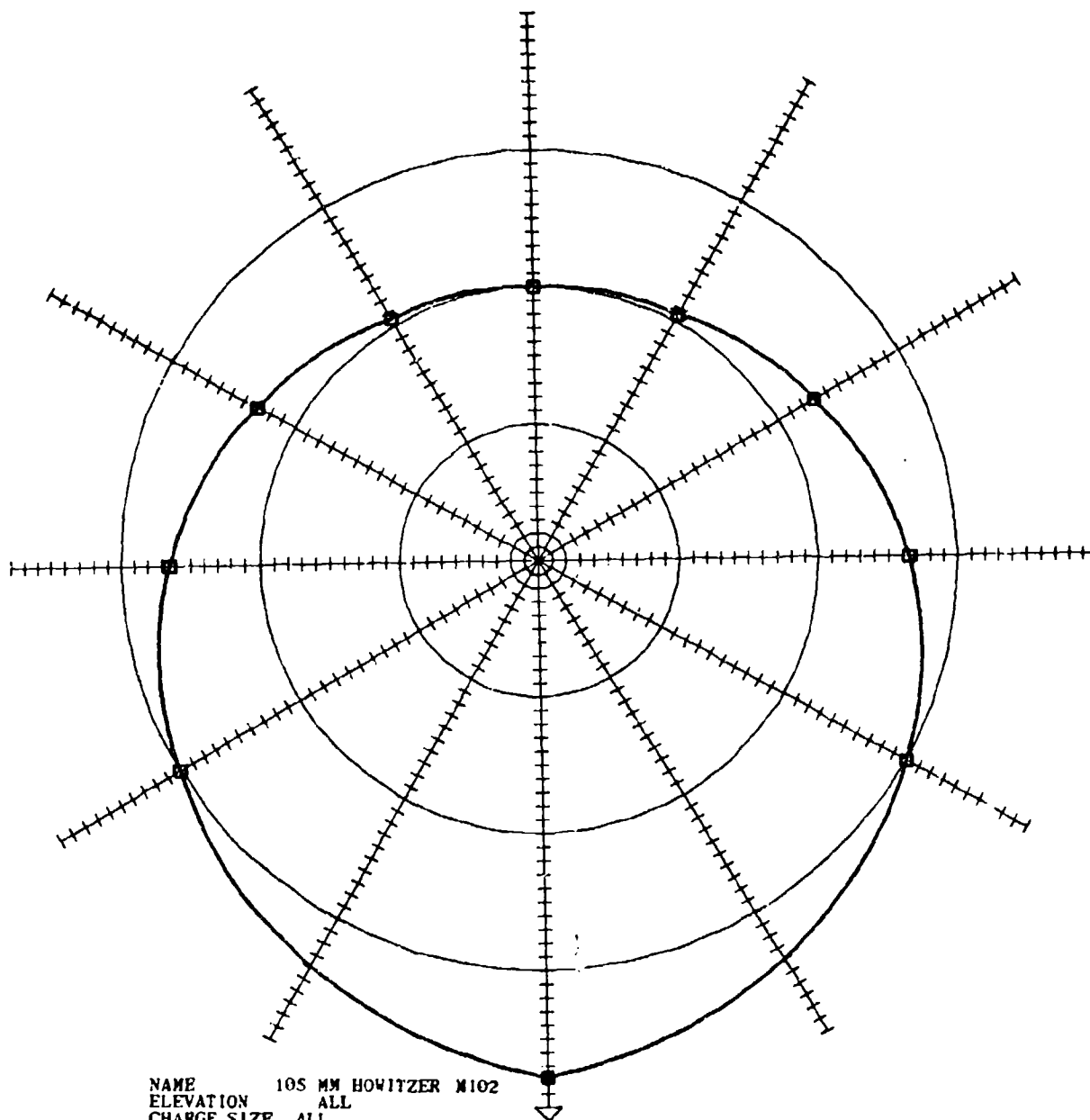


| NAME      | 106 MM RECOILESS RIFLE | M40A1                |
|-----------|------------------------|----------------------|
| ELEVATION | ALL                    |                      |
| CHANNEL   | ENERGY                 | DIFFERENCE FROM REAR |
| 1         | 115.09                 | -4.06                |
| 2         | 118.01                 | -3.41                |
| 3         | 119.17                 | 0.00                 |
| 4         | 117.23                 | -1.93                |
| 5         | 115.44                 | -3.79                |
| 6         | 108.98                 | -4.02                |
| 7         | 111.31                 | -2.40                |
| 8         | 108.75                 | -4.77                |
| 9         | 120.73                 | 2.60                 |
| 10        | 108.51                 | -4.02                |
| 11        | 107.40                 | -4.77                |
| 12        | 109.81                 | -2.40                |
| 13        | 112.44                 | -0.07                |
| 14        | 113.09                 | 0.00                 |
| 15        | 113.09                 | -9.07                |
| 16        | 108.81                 | -4.06                |
|           |                        | ANGLE                |
|           |                        | 0°                   |
|           |                        | 30°                  |
|           |                        | 60°                  |
|           |                        | 90°                  |
|           |                        | 120°                 |
|           |                        | 150°                 |
|           |                        | 180°                 |
|           |                        | 210°                 |
|           |                        | 240°                 |
|           |                        | 270°                 |
|           |                        | 300°                 |
|           |                        | 330°                 |
|           |                        | AVERAGE              |
|           |                        | -1.29                |



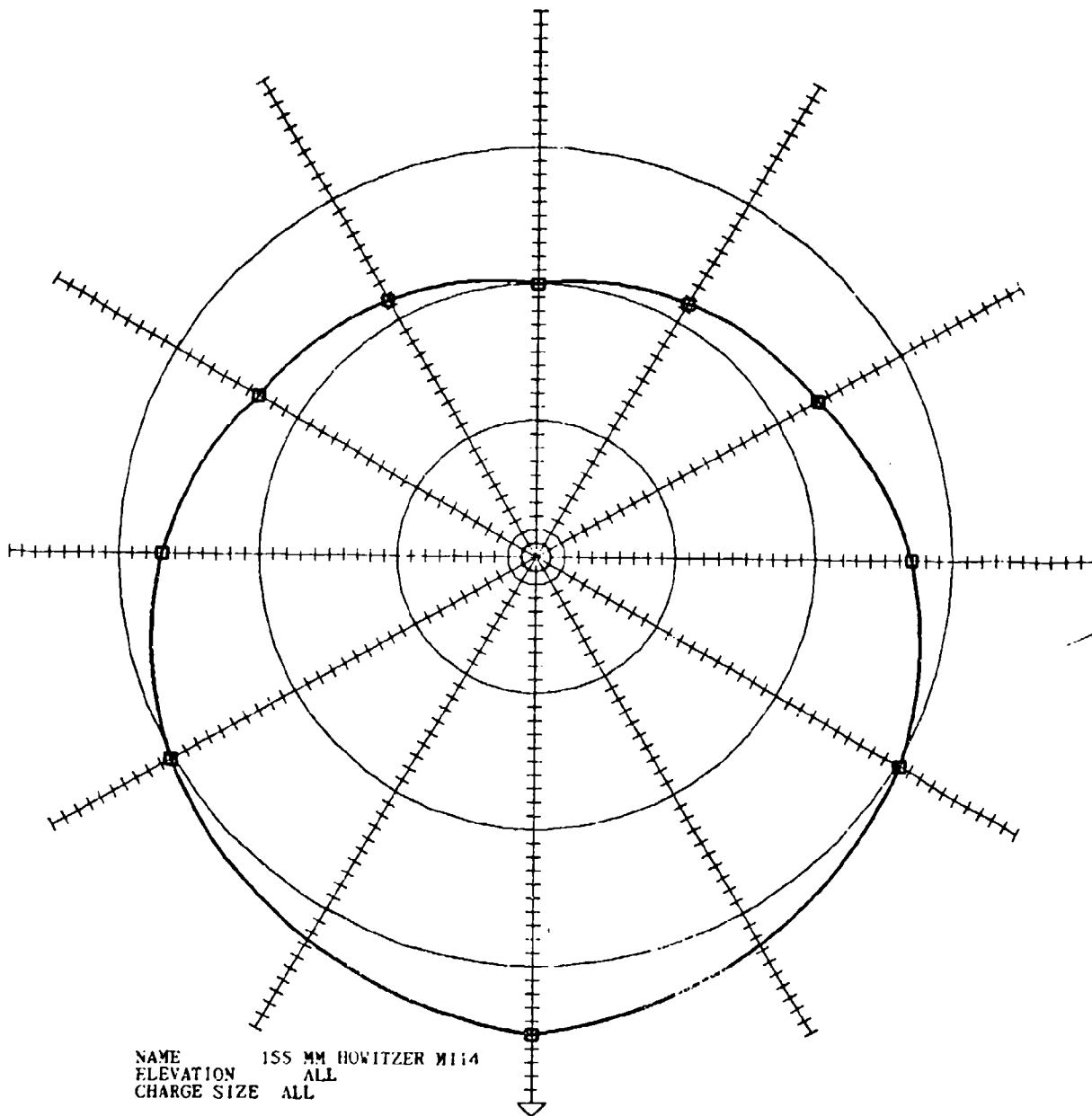
NAME 152 MM SHERIDAN TANK  
ELEVATION ALL  
CHARGE SIZE ALL

| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE | DIFFERENCE<br>FROM REAR |
|---------|--------|-------------------------|-------|-------------------------|
| 1       | 119.19 | 8.43                    | 0°    | 7.56                    |
| 2       | 112.33 | 1.94                    | 30°   | 7.38                    |
| 3       | 110.09 | 0.00                    | 60°   | 7.19                    |
| 4       | 109.99 | 0.13                    | 90°   | 2.73                    |
| 5       | 116.73 | 5.95                    | 120°  | 1.05                    |
| 6       | 111.29 | 7.42                    | 150°  | -0.39                   |
| 7       | 103.73 | 0.19                    | 180°  | 0.00                    |
| 8       | 105.41 | 1.03                    | 210°  | -0.39                   |
| 9       | 117.66 | 7.56                    | 240°  | 1.05                    |
| 10      | 111.01 | 7.59                    | 270°  | 2.73                    |
| 11      | 107.02 | 3.60                    | 300°  | 7.19                    |
| 12      | 105.46 | 1.93                    | 330°  | 7.38                    |
| 13      | 103.83 | 0.38                    |       |                         |
| 14      | 103.62 | 0.00                    |       |                         |
| 15      | 102.34 | -1.16                   |       |                         |
| 16      | 105.57 | 1.87                    |       |                         |
| AVERAGE |        |                         |       | 4.80                    |

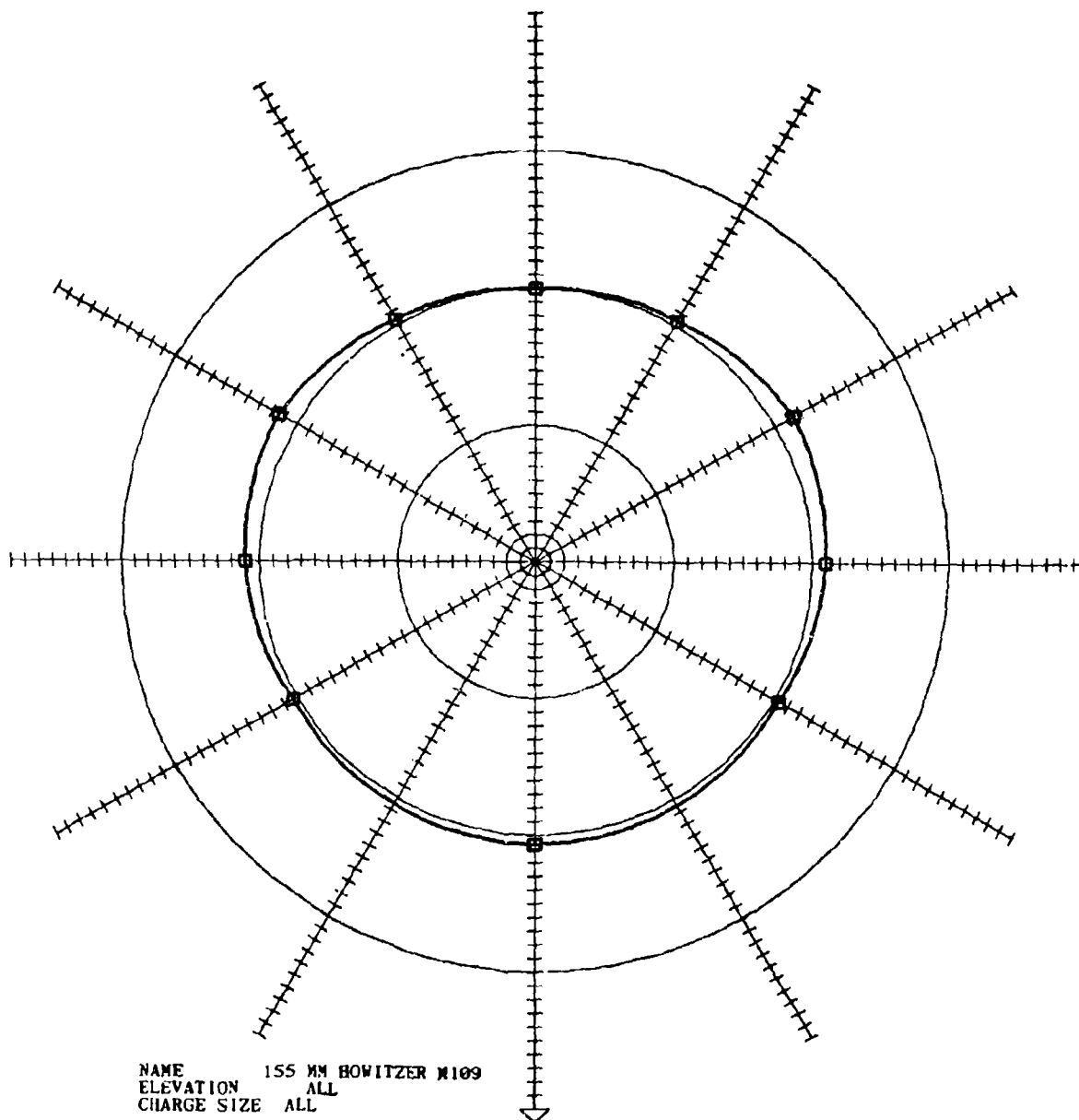


NAME 105 MM HOWITZER M102  
ELEVATION ALL  
CHARGE SIZE ALL

| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE   | DIFFERENCE<br>FROM REAR |
|---------|--------|-------------------------|---------|-------------------------|
| 1       | 101.22 | 10.73                   | 0°      | 17.80                   |
| 2       | 94.75  | 4.31                    | 30°     | 13.91                   |
| 3       | 90.14  | 0.00                    | 60°     | 10.02                   |
| 4       | 92.17  | 1.71                    | 90°     | 6.46                    |
| 5       | 99.24  | 8.84                    | 120°    | 2.97                    |
| 6       | 91.77  | 9.10                    | 150°    | 0.53                    |
| 7       | 84.78  | 1.86                    | 180°    | 0.00                    |
| 8       | 88.65  | 5.45                    | 210°    | 0.53                    |
| 9       | 107.36 | 17.80                   | 240°    | 2.97                    |
| 10      | 94.22  | 11.62                   | 270°    | 6.46                    |
| 11      | 90.68  | 7.72                    | 300°    | 10.02                   |
| 12      | 86.92  | 3.93                    | 330°    | 13.91                   |
| 13      | 84.59  | 1.47                    |         |                         |
| 14      | 82.72  | 0.00                    |         |                         |
| 15      | 82.42  | -0.44                   |         |                         |
| 16      | 88.42  | 5.15                    |         |                         |
|         |        |                         | AVERAGE | 10.84                   |

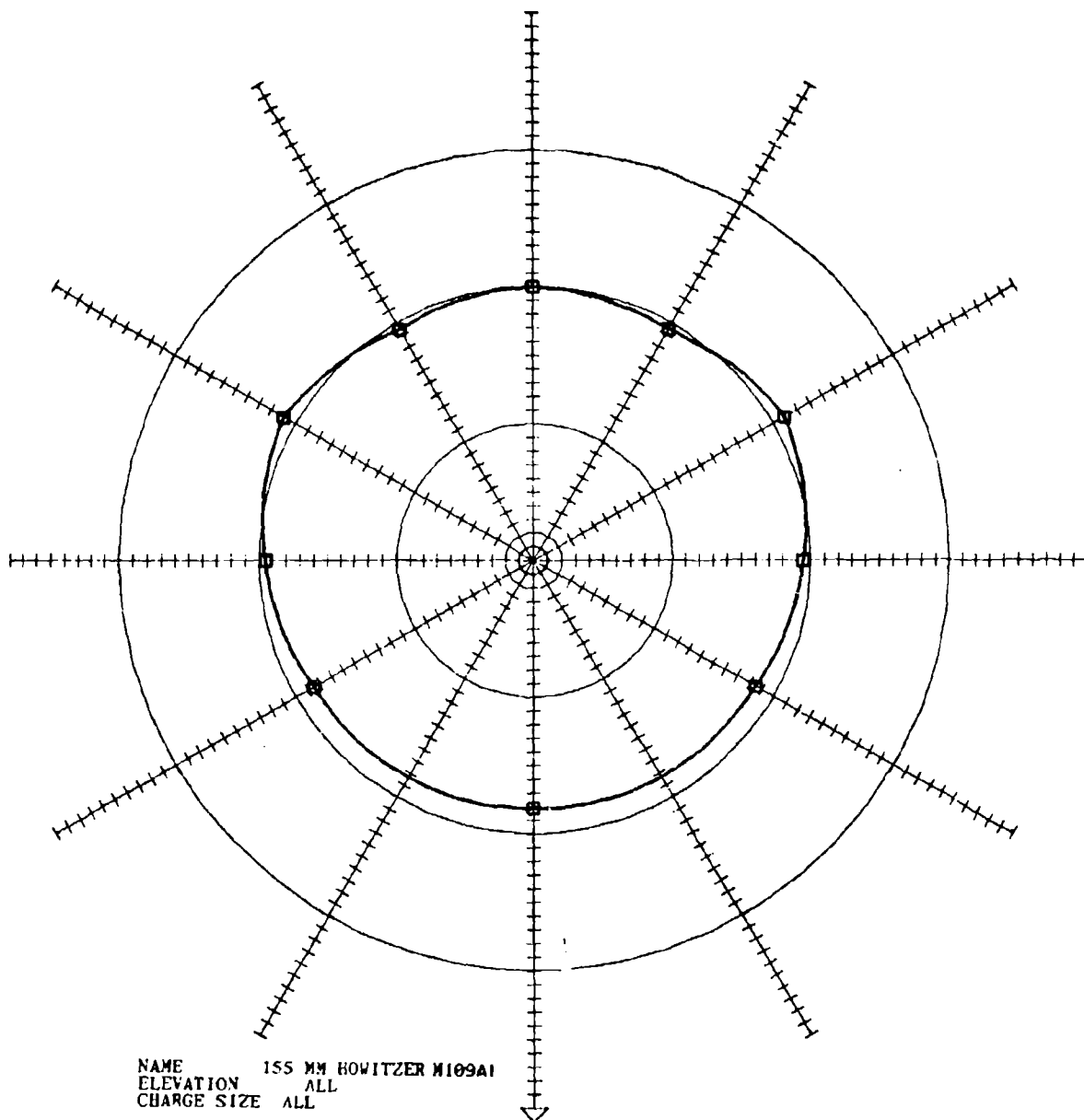


| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE   | DIFFERENCE<br>FROM REAR |
|---------|--------|-------------------------|---------|-------------------------|
| 1       | 112.57 | 9.80                    | 0°      | 14.93                   |
| 2       | 105.84 | 3.41                    | 30°     | 12.55                   |
| 3       | 103.24 | 0.00                    | 60°     | 10.18                   |
| 4       | 105.72 | 2.86                    | 90°     | 6.87                    |
| 5       | 113.15 | 10.71                   | 120°    | 3.20                    |
| 6       | 106.10 | 10.28                   | 150°    | 1.56                    |
| 7       | 99.41  | 3.09                    | 180°    | 0.00                    |
| 8       | 101.99 | 6.24                    | 210°    | 1.56                    |
| 9       | 115.59 | 14.93                   | 240°    | 3.20                    |
| 10      | 106.87 | 9.83                    | 270°    | 6.87                    |
| 11      | 103.64 | 7.42                    | 300°    | 10.18                   |
| 12      | 99.20  | 3.52                    | 330°    | 12.55                   |
| 13      | 97.15  | 1.51                    |         |                         |
| 14      | 97.45  | 0.00                    |         |                         |
| 15      | 97.43  | 1.61                    |         |                         |
| 16      | 102.14 | 6.32                    |         |                         |
|         |        |                         | AVERAGE | 9.45                    |

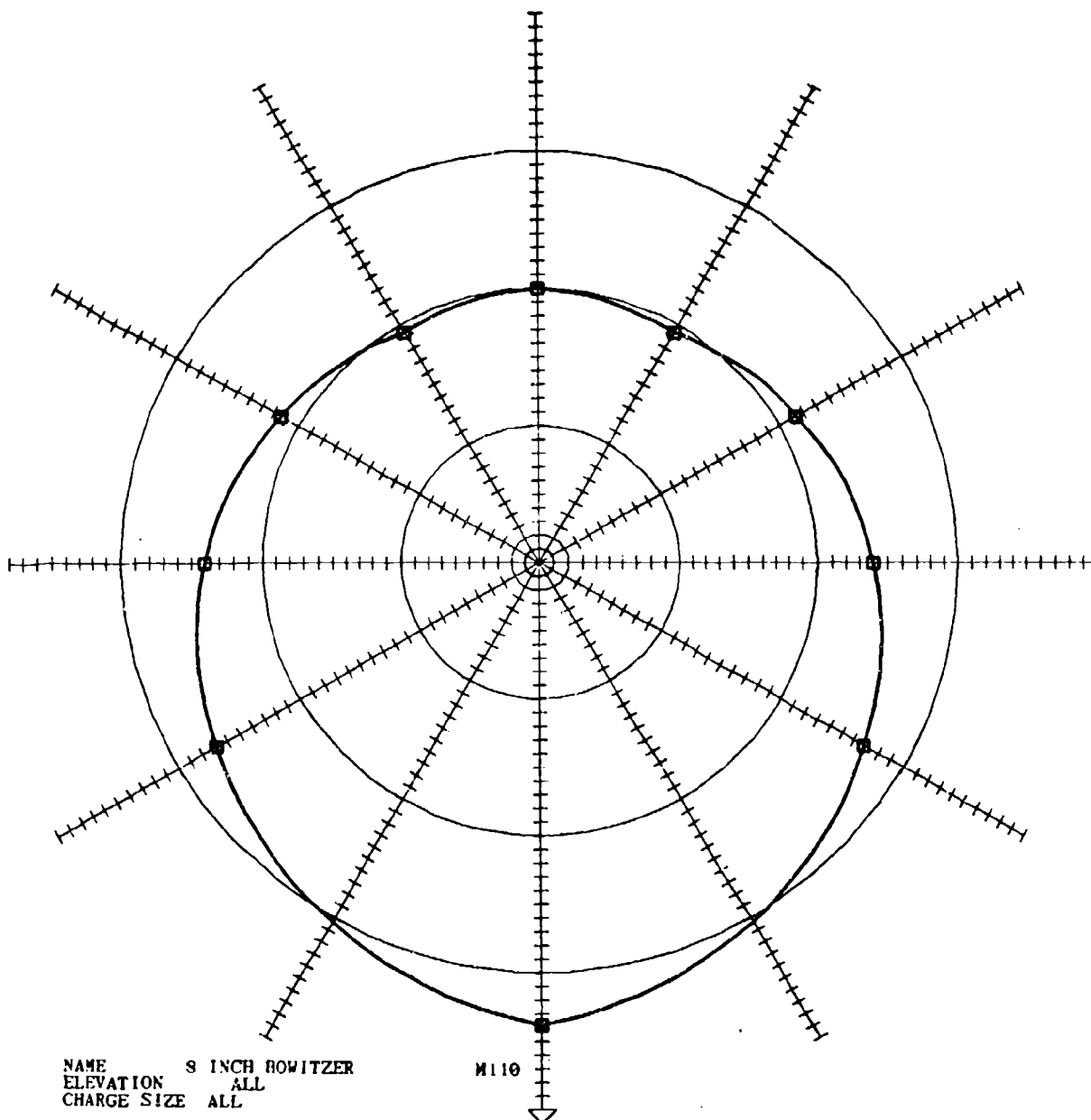


NAME 155 MM HOWITZER M109  
 ELEVATION ALL  
 CHARGE SIZE ALL

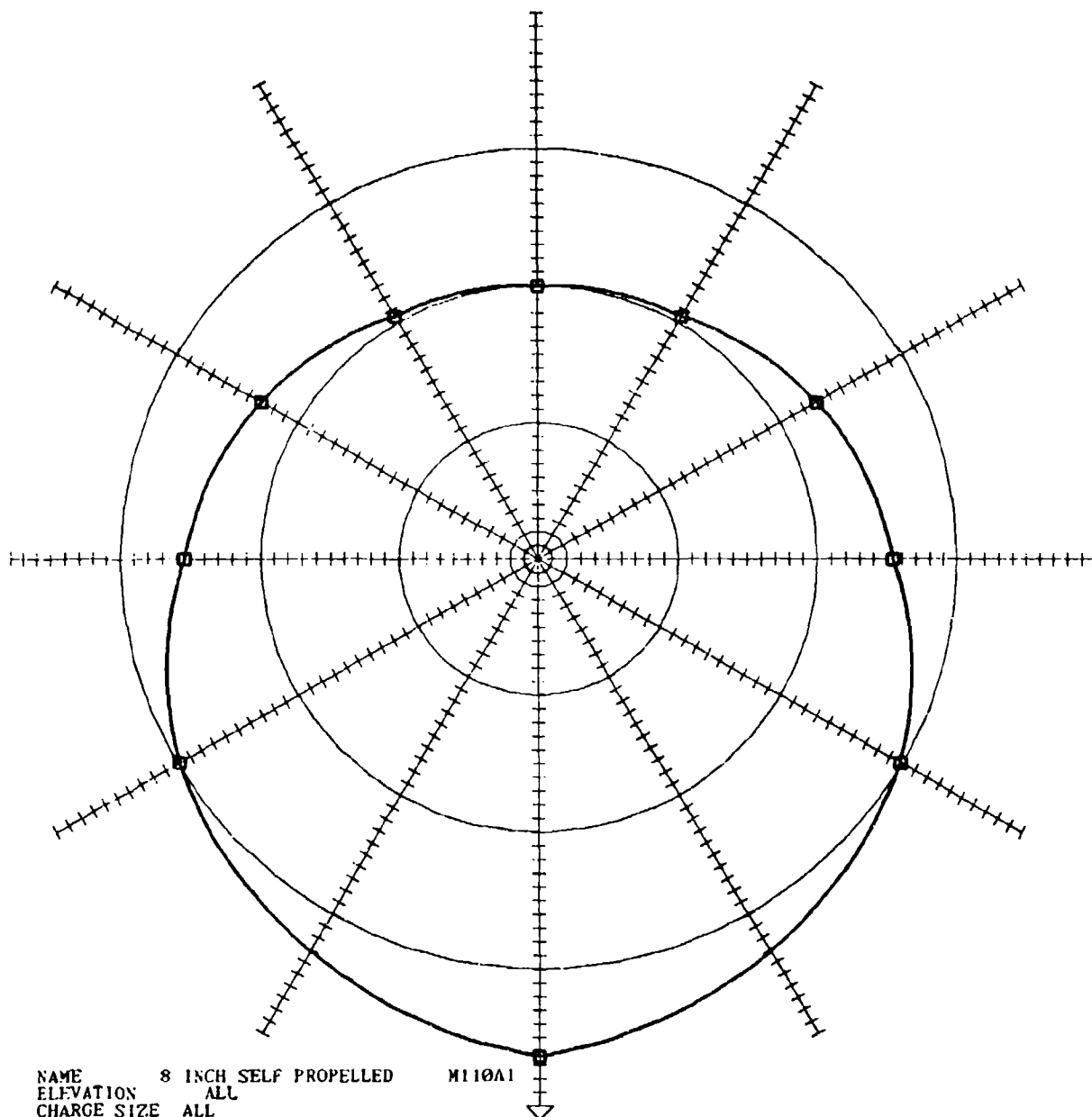
| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE   | DIFFERENCE<br>FROM REAR |
|---------|--------|-------------------------|---------|-------------------------|
| 1       | 112.39 | 1.71                    | 0°      | 0.63                    |
| 2       | 113.37 | 2.50                    | 30°     | 0.46                    |
| 3       | 110.80 | 0.00                    | 60°     | 0.29                    |
| 4       | 111.93 | 0.77                    | 90°     | 1.00                    |
| 5       | 111.16 | 0.05                    | 120°    | 1.45                    |
| 6       | 103.46 | -1.10                   | 150°    | 0.39                    |
| 7       | 104.60 | -0.08                   | 180°    | 0.00                    |
| 8       | 107.69 | 1.00                    | 210°    | 0.39                    |
| 9       | 111.11 | 0.63                    | 240°    | 1.45                    |
| 10      | 104.81 | 0.56                    | 270°    | 1.00                    |
| 11      | 105.98 | 1.74                    | 300°    | 0.29                    |
| 12      | 106.95 | 2.63                    | 330°    | 0.46                    |
| 13      | 105.85 | 1.25                    |         |                         |
| 14      | 104.46 | 0.00                    |         |                         |
| 15      | 103.95 | -0.45                   |         |                         |
| 16      | 105.28 | 0.26                    |         |                         |
|         |        |                         | AVERAGE | 0.67                    |



| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE   | DIFFERENCE<br>FROM REAR |
|---------|--------|-------------------------|---------|-------------------------|
| 1       | 108.66 | -0.42                   | 0°      | -1.88                   |
| 2       | 110.13 | 1.12                    | 30°     | -1.71                   |
| 3       | 109.70 | 0.00                    | 60°     | -1.53                   |
| 4       | 110.73 | 1.02                    | 90°     | -0.49                   |
| 5       | 107.96 | -1.97                   | 120°    | 0.94                    |
| 6       | 101.36 | -2.80                   | 150°    | -0.52                   |
| 7       | 105.42 | 1.08                    | 180°    | 0.00                    |
| 8       | 102.81 | -1.31                   | 210°    | -0.52                   |
| 9       | 100.38 | -1.88                   | 240°    | 0.94                    |
| 10      | 101.81 | -0.73                   | 270°    | -0.49                   |
| 11      | 104.01 | 0.15                    | 300°    | -1.53                   |
| 12      | 103.44 | 0.53                    | 330°    | -1.71                   |
| 13      | 102.80 | -0.29                   |         |                         |
| 14      | 103.33 | 0.00                    |         |                         |
| 15      | 103.57 | -0.77                   |         |                         |
| 16      | 102.83 | -1.14                   |         |                         |
|         |        |                         | AVERAGE | -0.60                   |



| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE   | DIFFERENCE<br>FROM REAR |
|---------|--------|-------------------------|---------|-------------------------|
| 1       | 118.37 | 6.42                    | 0°      | 13.77                   |
| 2       | 114.72 | 1.91                    | 30°     | 10.29                   |
| 3       | 115.08 | 0.00                    | 60°     | 6.82                    |
| 4       | 114.73 | 0.79                    | 90°     | 4.01                    |
| 5       | 119.09 | 6.10                    | 120°    | 1.42                    |
| 6       | 113.15 | 6.58                    | 150°    | -0.64                   |
| 7       | 109.17 | 0.72                    | 180°    | 0.00                    |
| 8       | 110.69 | 3.47                    | 210°    | -0.64                   |
| 9       | 119.55 | 13.77                   | 240°    | 1.42                    |
| 10      | 112.79 | 7.91                    | 270°    | 4.01                    |
| 11      | 109.58 | 4.57                    | 300°    | 6.82                    |
| 12      | 108.67 | 2.08                    | 330°    | 10.29                   |
| 13      | 107.41 | -0.60                   |         |                         |
| 14      | 108.51 | 0.00                    |         |                         |
| 15      | 108.34 | -0.68                   |         |                         |
| 16      | 111.05 | 3.38                    |         |                         |
|         |        |                         | AVERAGE | 7.36                    |



| CHANNEL | ENERGY | DIFFERENCE<br>FROM REAR | ANGLE   | DIFFERENCE<br>FROM REAR |
|---------|--------|-------------------------|---------|-------------------------|
| 1       | 112.21 | 10.65                   | 0°      | 16.33                   |
| 2       | 104.84 | 4.03                    | 30°     | 13.08                   |
| 3       | 100.98 | 0.00                    | 60°     | 9.84                    |
| 4       | 103.39 | 1.89                    | 90°     | 5.41                    |
| 5       | 110.69 | 8.61                    | 120°    | 3.03                    |
| 6       | 102.70 | 8.27                    | 150°    | 0.50                    |
| 7       | 97.73  | 2.37                    | 180°    | 0.00                    |
| 8       | 98.76  | 2.98                    | 210°    | 0.50                    |
| 9       | 116.42 | 16.33                   | 240°    | 3.03                    |
| 10      | 105.55 | 11.46                   | 270°    | 5.41                    |
| 11      | 102.19 | 7.28                    | 300°    | 9.84                    |
| 12      | 97.79  | 3.82                    | 330°    | 13.08                   |
| 13      | 94.74  | 1.17                    |         |                         |
| 14      | 93.88  | 0.00                    |         |                         |
| 15      | 93.67  | -0.48                   |         |                         |
| 16      | 99.49  | 4.28                    |         |                         |
|         |        |                         | AVERAGE | 9.90                    |

APPENDIX E:

WEIGHT EQUIVALENCY TABLES

| <u>Weapon</u>            | <u>Model</u> | <u>Charge<br/>Size &amp;<br/>Type</u> | <u>Weight<br/>(oz)</u> | <u>C-weighted<br/>SEL</u> | <u>F-weighted<br/>SFI</u> |
|--------------------------|--------------|---------------------------------------|------------------------|---------------------------|---------------------------|
| 81-mm mortar             | --           | 4 CZ                                  | 1.56                   | 93.7                      | 95.2                      |
|                          |              | 5 CZ                                  | 1.95                   | 96.2                      | 97.8                      |
|                          |              | 7 CZ                                  | 2.72                   | 99.5                      | 101.2                     |
|                          |              | 8 CZ                                  | 3.10                   | 99.2                      | 100.8                     |
| 4.2-in. mortar           | M30          | 11 CZ                                 | 2.92                   | 94.1                      | 95.9                      |
|                          |              | 20 CZ                                 | 5.30                   | 98.6                      | 100.1                     |
|                          |              | 24 CZ                                 | 6.36                   | 100.2                     | 101.8                     |
|                          |              | 31 CZ                                 | 8.22                   | 102.6                     | 104.2                     |
| 90-mm recoilless rifles  | M67          | NA                                    | 20.0                   | 107.1                     | 109.8                     |
| 106-mm recoilless rifles | M40A1        | NA                                    | 128.0                  | 117.8                     | 121.2                     |
| 152-mm Sheridan tank gun | M551         | NA                                    | 96.0                   | 115.8                     | 120.1                     |
| 105-mm howitzer          | M102         | 3 WB                                  | 12.5                   | 99.2                      | 101.3                     |
|                          |              | 4 WB                                  | 16.3                   | 100.6                     | 103.0                     |
|                          |              | 5 WB                                  | 22.1                   | 102.0                     | 104.2                     |
|                          |              | 6 WB                                  | 30.8                   | 104.8                     | 107.8                     |
| 155-mm howitzer          | M114         | 4 GB                                  | 64.4                   | 109.1                     | 112.7                     |
|                          |              | 5 GB                                  | 87.5                   | 110.8                     | 115.4                     |
|                          |              | 5 WB                                  | 109.7                  | 113.0                     | 117.1                     |
|                          |              | 6 WB                                  | 154.6                  | 114.8                     | 118.6                     |
| 155-mm howitzer          | M109         | 3 GB                                  | 49.4                   | 107.1                     | 109.7                     |
|                          |              | 4 GB                                  | 64.4                   | 109.1                     | 111.8                     |

Key: GB = green bag  
WB = white bag  
CZ = charge zone

| <u>Weapon</u>         | <u>Model</u> | <u>Charge<br/>Size &amp;<br/>Type</u> | <u>Weight<br/>(oz)</u> | <u>C-weighted<br/>SEL</u> | <u>F-weighted<br/>SEL</u> |
|-----------------------|--------------|---------------------------------------|------------------------|---------------------------|---------------------------|
| 8-in. howitzer        | M110         | 5 GB                                  | 87.5                   | 111.8                     | 114.6                     |
|                       |              | 5 WB                                  | 109.7                  | 113.4                     | 116.7                     |
|                       |              | 3 GB                                  | 120.3                  | 111.8                     | 116.0                     |
|                       |              | 5 GB                                  | 210.5                  | 117.8                     | 121.0                     |
| 155-mm howitzer       | M109A1       | 5 WB                                  | 270.9                  | 119.2                     | 127.4                     |
|                       |              | 7 WB                                  | 450.2                  | 118.9                     | 124.0                     |
|                       |              | 3 GB                                  | 49.4                   | 102.7                     | 106.1                     |
|                       |              | 5 GB                                  | 87.5                   | 106.9                     | 109.9                     |
| 8-in. self-propelled  | M110A1       | 5 WB                                  | 109.7                  | 109.7                     | 113.1                     |
|                       |              | 7 WB                                  | 210.4                  | 113.9                     | 117.2                     |
|                       |              | 3 GB                                  | 120.3                  | 110.0                     | 113.0                     |
|                       |              | 5 GB                                  | 210.5                  | 113.9                     | 117.7                     |
| 105-mm tank           | M60          | 5 WB                                  | 270.9                  | 115.7                     | 119.6                     |
|                       |              | NA                                    | 192.0                  | 111.4                     | 114.5                     |
| C-4 plastic explosive | NA           | NA                                    |                        |                           |                           |
|                       |              |                                       | 5.0                    | 107.7                     | 109.5                     |
|                       |              |                                       | 10.0                   | 110.6                     | 112.9                     |
|                       |              |                                       | 20.0                   | 114.6                     | 117.7                     |
|                       |              |                                       | 40.0                   | 118.3                     | 121.5                     |
|                       |              |                                       | 80.0                   | 119.2                     | 124.0                     |
|                       |              |                                       | 160.0                  | 121.3                     | 127.1                     |
|                       |              |                                       | 320.0                  | 125.1                     | 131.2                     |

Key: GB = green bag  
WB = white bag  
CZ = charge zone

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